



مجلة وقاية النبات العربية

مجلة علمية تصدر عن الجمعية العربية لوقاية النبات

Arab Journal of Plant Protection

A scientific Journal Published by the Arab Society for Plant Protection



تونس - ACPP 2022 - Tunisia
PLANT HEALTH
For Secure and Safe Food
الصحة النباتية لغذاء آمن وسليم

**13th Arab Congress
of Plant Protection**
Hammamet - Tunisia
16 - 21 October 2022



Organized by Arab Society for Plant Protection (ASPP)
& Ministry of Agriculture, Water Resources and Fisheries of Tunisia
Represented by National Institute of Agronomic Research of Tunisia (INRAT)



الجمهورية التونسية
وزارة الفلاحة والموارد المائية والصيد البحري

Abstracts Book

Volume 40, Special issue, October 2022

مجلد 40، عدد خاص، تشرين الأول/أكتوبر 2022

*Under the Patronage of his Excellency
the Minister of Agriculture, Water Resources and Fisheries of Tunisia*

Arab Journal of Plant Protection

Volume 40, Special Issue, October 2022



Abstracts Book

13th Arab Congress of Plant Protection

Hammamet, Tunisia

16-21 October 2022

Organized by
Arab Society for Plant Protection (ASPP)
&
Ministry of Agriculture, Water Resources and Fisheries of Tunisia
Represented by
National Institute of Agronomic Research of Tunisia (INRAT)

Edited by
Safaa G. Kumari, Khaled Makkouk, Mejda Daami-Remadi, Asma Najjar,
Hajer Ben Ghanem, Nader Asaad, Mohammad Kassem and Abdul Rahman Moukahel

Editors:

Safaa G. Kumari - *International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beqa's Valley, Lebanon.*

Khaled Makkouk - *Arab Society for Plant Protection, Beirut, Lebanon.*

Mejda Daami-Remadi - *Regional Research Centre on Horticulture and Organic Agriculture (CRRHAB), Chott-Mariem, Tunisia.*

Asma Najar - *National Institute of Agronomic Research of Tunisia (INRAT), Tunis, Tunisia.*

Hajer Ben Ghanem - *National Institute of Agronomic Research of Tunisia (INRAT), Tunis, Tunisia.*

Nader Asaad - *General Commission for Scientific Agricultural Research (GCSAR), Al-Ghab, Hama, Syria.*

Mohammad Kassem - *Department of Plant Protection, Faculty of Agriculture, Aleppo University, Aleppo, Syria*

Abdul Rahman Moukahel - *International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beqa's Valley, Lebanon.*

13th Arab Congress of Plant Protection Committees

Honorary Committee

Dr. Mahmoud Elies Hamza	Minister of Agriculture, Water Resources and Fisheries of Tunisia
Dr. Hichem Ben Salem	DG of the Higher Agricultural Research & Education Institution, Tunisia.
Dr. Mondher Ben Salem	DG of the National Institute of Agricultural Research, Tunisia.
Dr. M. Lahbib Ben Jamâa	DG of the Plant Health and Control of Agricultural Inputs, Tunisia.
Dr. Ibrahim Al-Jboory	President of the Arab Society for Plant Protection, Iraq.
Dr. Bouzid Nasraoui	Vice President of the Arab Society for Plant Protection, Tunisia.

Congress Organizing Committee

Asma Najar (Chairperson)

Mondher Ben Salem	Naima Mahfoudhi	Thouraya Souissi
Mohamed Lahbib Ben Jamâa	Noura Omri	Ahmed Jemmali
Mejda Daami-Remadi	Ikbal Chaieb	Mohamed Ali Ben Abdallah
Hajer Ben Ghanem	Samia Gargouri	Hichem Aounallah
Sonia Bouhachem	Kaouthar Grissa-Lebdi	Riadh Gabsi

Sponsoring Committee

Hichem Aounallah	General Manager, BIOPROTECTION, Tunisia	Coordinator
Asma Najar	National Institute of Agricultural Research, Tunisia	Member
Mondher Ben Salem	DG of National Institute of Agricultural Research, Tunisia	Member
Mokhtar Mechichi	Technical Director of Mabrouka Company, Tunisia	Member
Naima Mahfoudhi	National Institute of Agricultural Research, Tunisia	Member
Hajer Ben Ghanem	National Institute of Agricultural Research, Tunisia	Member

Local logistics Committee

Asma Najar (Coordinator)

Hajer Ben Ghanem	Mourad Ouji	Hafedh Khlif
Naima Mahfoudhi	Zohra Chercheri	Kaouthar Ben Mahmoud
Olfa Bachrouh	Nissaf Mlayeh	Wafa Rouissi
Samia Gargouri	Manal Al Air	Noura Jemaii
Noura Omri	Radhia Amor	Samia Mghandef

Scientific Committee

Mejda Daami-Remadi (Tunisia - Coordinator)

Viral Diseases

Khaled Makkouk - Lebanon
Safaa Kumari - Syria
Imen Hamdi - Tunisia
Elia Choueiri - Lebanon

Asma Najar - Tunisia
Raed Abou Kubaa - Syria
Naima Mahfoudhi- Tunisia
Noureddine Rouag - Algeria

Fungal and Bacterial Diseases

Bouزيد Nasraoui - Tunisia
Mohamed Ali Triki - Tunisia
Mohamed Bechir Allagui - Tunisia
Sihem Ben Maachia - Tunisia
Mejda Daami-Remadi - Tunisia
Emad Al Maarouf - Iraq
Bochra El Bahri - Tunisia
Noura Omri - Tunisia
Hayfa Jabnoun-Khiareddine - Tunisia

Bassam Bayaa - Syria
Samia Gargouri - Tunisia
Abdelhamid Ramdani - Morocco
Naima Boughalleb M'Hamdi - Tunisia
Azza Rhaïem - Tunisia
Wafaa Rouissi - Tunisia
Amira Mougou - Tunisia
Houda Boureghda -Algeria
Zoulikha Krimi - Algeria

Nematodes

Najet Horrigue Raouani - Tunisia
Khalifa H. Dabaj – Libya

Mahfouz M.M. Abd-Elgawad - Egypt

Insects and Integrated Management

Sonia Bouhachem - Tunisia
Ahmad Katbeh - Jordan
Ikbal Chaieb - Tunisia
Mohamed Lahbib Ben Jamâa - Tunisia
Jouda Mediouni - Tunisia
Asma Laarif - Tunisia
Amel Ben Hamouda - Tunisia
Habiba Glida - Tunisia

Abdelsattar Aref Ali - Iraq
Mohamed Braham - Tunisia
Ibtissem Fekih - Tunisia
Olfa Bachrouch - Tunisia
Ahmed Al-Heneidi - Egypt
Sinda Boulehya - Tunisia
Sabrine Attia - Tunisia

Mites

Ibrahim Al-Jboory - Iraq

Habiba Glida - Tunisia

Weed Control

Thouraya Souissi - Tunisia
Mustapha Haidar - Lebanon

Barakat Abu Irmaileh - Jordan
Nedjia Zerman - Algeria

Pesticides

M. El-Said El-Zemaity - Egypt

Hanène Chaabane - Tunisia

Executive Committee of the Arab Society for Plant Protection

Ibrahim Jboory	President	Iraq
Bouزيد Nasraoui	Vice-President	Tunisia
Mustapha Haidar	Secretary-Treasurer	Lebanon
Safaa Kumari	Member & Chairperson of Publications Committee	Syria
Ahmad Katbeh Badr	Member & Chairperson of Honors and Awards Committee	Jordan
Hassan F. Dahi	Member & Chairperson of Membership Committee	Egypt
Houda Boureghda	Member & Chairperson of the Translation Committee	Algeria
Khaled Makkouk	Member & Editor-in-Chief of Arab Journal of Plant Protection	Lebanon
Asma Najar	Member & Chairperson, 13 th ACPP Organizing Committee	Tunisia

Sponsors of the 13th Arab Congress of Plant Protection

Diamond Partner



The Islamic Development Bank is a multilateral development bank, working to improve the lives of those it serves by promoting social and economic development in Member countries and Muslim communities worldwide, delivering impact at scale. ISDB provides the infrastructure to enable people to lead better lives and achieve their full potential. In its missions IDB: (i) believes all people have the right to live in dignity and prosperity, and that nurturing economic growth is the best route out of poverty; (ii) equips people to drive their own economic and social progress at scale, putting the infrastructure in place to enable them to fulfil their potential; (iii) builds collaborative partnerships between communities and nations, across the public and private sectors; (iv) fosters innovative and sustainable solutions to the world's greatest development challenges, as it works towards the UN Sustainable Development Goals.

Gold Partners



**Food and Agriculture
Organization of the
United Nations**

FAO Regional Office for Near East and North Africa plays an active role in promoting "South-South cooperation" across Member Countries and in facilitating dialogue on regional issues and common transboundary challenges. Through a wide range of sectoral expertise, the Regional Office ensures a multi-disciplinary approach to field interventions. Expertise offered ranges from food security to water and natural resources, from crop production and protection to fisheries, forestry, nutrition, food processing and agro-industries.



The International Center for Agricultural Research in the Dry Areas (ICARDA) is an international organization undertaking research-for-development since its establishment in 1975. ICARDA provides innovative, science-based solutions for communities across the non-tropical dry areas. In partnership with research institutions, NGOs, governments, and the private sector, ICARDA's work advances scientific knowledge, shapes practices, and informs policy.



Since 1974, SIPCAM Inagra formulates phytosanitary products, both chemical and biological, as well as biostimulants and special fertilizers for the protection and improvement of the quality of crops. The Tunisian partners: Agriprotec, Atlas Agricole, Promochimie and Société El Khadra, distribute these products with the flag of quality by maintaining commercial relations based on honesty and trust.

Silver Partners



Arab Center for the Studies of Arid Zones and Dry lands (ACSAD) was established in 1968 with the objective of unifying national efforts to develop scientific agricultural research in the arid and semi-arid areas, exchanging information and expertise in order to increase agricultural production.



The overall objective of the Arab Organization for Agricultural Development (AOAD), established in 1970, is to identify and develop linkages between Arab countries, and coordinate all agricultural and agricultural -related activities amongst them.



Russell IPM is a market leader in providing customer focused solutions to the issues facing pest controllers. Russell IPM designs and manufactures pheromone lures and bio pesticides for customers worldwide

 المنظمة الإسلامية للأمن الغذائي Islamic Organization for Food Security l'Organisation Islamique pour la Sécurité Alimentaire	Founded on 2013, IOFS has as strategic mission to ensure sustainable food security in member states of the Organization of Islamic Cooperation (OIC). Among its key objectives, IOFS has: (i) to provide expertise and technical know-how to member states on various aspects of sustainable agriculture, rural development, food security, and biotechnology; (ii) to address problems posed by desertification, deforestation, erosion, and salinity.
Bronze Partners	
	The CGIAR Initiative on Genebanks is a partnership of the Genebanks and Germplasm Health Units (GHUs) under the Genetic Innovation Action Area of the One CGIAR strategy. GHUs enable the production, maintenance, and distribution of healthy germplasm from CGIAR centers as per the international phytosanitary standards to protect agriculture and biodiversity from the risks associated with the entry, establishment, or spread of plant pests. GHUs work in close partnership with NPPOs to help perform their national mandates through awareness raising, capacity development, and partnership arrangements for phytosanitary regulations.
	International Maize and Wheat Improvement Center (CIMMYT) is a non-profit research and training organization. It works with partners, throughout the developing world, to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty.
	UPL is the 5th agrochemical company in the world. After the acquisition of Arysta Life Science, UPL is a global leader in global food systems.
	Syngenta is one of the world's leading agriculture companies, present in more than 100 countries our ambition is to help safely feed the world while taking care of the planet.
	A leader in its sector, BASF has an extensive catalog of fungicides, insecticides, herbicides and seed treatments, which helps farmers to increase crop yields and quality in a sustainable way.
	The National Oil Office was established in 1962. Its activities include the olive sector promotion, buying and exporting olive oil and supplying the country with subsidized vegetable oils.
	The Cereals Office, established in 1962, is mainly responsible for ensuring the role of the public utility in the cereal sector and supplying Tunisia with local and imported cereals. It is also in charge of organizing and adjusting the market, supervising the process of collecting local cereals and creating a national reserve stock.
	Groupeement Interprofessionnel des Fruits (GIFruits) assumes the role of national regulator of fruit markets, ensures the promotion of Tunisian fruits quality and contributes to the marketing and the promotion of their exports.
	Groupeement Obligatoire des Viticultures et Producteurs des Fruits en Tunisie (GOVPF) is a public institution supervised by Ministry of Agriculture, producing certified nursery plants of fruit trees and citrus. It's the only producer of grapevine nursery plant in Tunisia.

	The main specific missions of Interprofessional Group of Vegetables (GIL) are the production of potato seeds, the production of seedlings, conventional and organic seeds of vegetables and the regulation of the market.
	Société Mutuelle Centrale de Semences (COSEM) (1947) is a leader company in the sector of certified cereal seeds in Tunisia. Among its missions the conservation, multiplication and production of seeds of cereal varieties obtained by the National Institute of Agricultural Research of Tunisia (INRAT).
	Centre Technique des Agrumes (CTA) undertakes the development of the citrus sector in Tunisia by adapting the results of scientific research to the conditions of farmers. CTA is also working on diversifying production and developing an IPM method.
	Institut National des Grandes Cultures (INGC) was established in 2009. It mainly works on developing the profitability of major crops in terms of production, quality and suitability of transformation needs.
	Bioprotection is a leading company specializing in the distribution of phytosanitary products and fertilizers. It distributes the products of internationally renowned companies throughout Tunisia. Quality is the main commitment of the company and represents the center of its priorities at all levels: choice of Products, Teams, Service. The reasoned use of phytosanitary products and fertilizers is also at the center of its objectives in order to preserve the environment, wild fauna and flora. The company supports farmers in their use of products in order to promote good agricultural practices.
	RAYEN PHYTAGRI was founded in 2014. The company is specialized in importing and distributing plant protection products. Our mission is to contribute to agricultural development by offering to Tunisian farmer innovative and high-quality products.
	AGROMILLORA MÉDITERRANÉE is the Tunisian subsidiary of AGROMILLORA Group leader in production and marketing of stone fruit rootstock, young trees of stone fruit, grapes vine and olive trees.
	MABROUKA Nursery, created in 1994, specialized in the agricultural field, the production of plants, seeds and fruits. Since 2000, the nursery has the first Tissue Culture Laboratory in Tunisia, which produces rootstock, potato seeds and strawberry plants.
	Atlas Agricole distributes pesticides in the Tunisian market. The company represents Bayer, Corteva as well as other reputed corporations and provides sustainable and innovative solutions.
	HORCHANI DATTES Company is one of the major date growers in Tunisia. The company has been exporting natural and biological dates since 1930, after conditioning and canning them in its modern factories.
	Biosca Tamara is specialized in processing and packaging Tunisian dates. It is certified: IFS& BRC, ISO 9001: 2015, Global Gap, Halal, Kosher, USDA Organic, certificate of conformity CCPB and is exporting to the five continents.

	Official representative of the Brandt and Syngenta brands, the company offers a multitude of fertilizer, herbicide, fungicide, and insecticide products for different crops: cereals, arbo, and market gardening.
	European and Mediterranean Plant Protection Organization (EPPO), the European and Mediterranean Plant Protection Organization, has as objective to protect plants through international cooperation for and with its 52 member countries.
	Bayer is a Life Science company with more than 150-year history and core competencies in the areas of health care and agriculture. With its innovative products, the company is contributing to finding solutions to some of the major challenges of our time. Its device is "Health for all, Hunger for none"
	The Tunisian Grain Company "COTUGRAIN", created more than 30 years ago, is mainly specialized in the marketing and production of seeds.
	NUFARM is a global crop protection company that has been helping growers fight disease, weeds and pests for more than 100 years.
	Since its creation in 1959, the Banque Nationale Agricole (BNA) has not ceased to confirm itself in the financial market, not only as a bank financing agriculture, but also as a universal bank, citizen, modern and closer to Tunisians.
	The STB Bank, which started operating on March 26, 1958, is a pioneer in the development of the country and an example of the modernization of the banking sector. The STB is an essential partner in international relations.
	Sharda Cropchem Limited is engaged in the marketing and distribution of a wide range of formulations and generic active ingredients, It's core strength lies in identifying generic molecules, preparing dossiers, seeking registrations, marketing and distributing formulations or generic active ingredients in fungicide, herbicide and insecticide segments
Exhibitors	
	Agdia EMEA, specialized in the production of kits for plant pathogen detection, virus, bacteria, viroids and fungi. Agdia kits are based on serological and molecular techniques and can be used in the lab or on site.
	Ribosite Biotechnology is a leading Tunisian company in the field of molecular lab reagents industry, intensively committed in Biotech Research & development.
	Agence de Promotion des Investissements Agricoles (APIA) is a non-administrative public establishment, created in 1983, whose main mission is to promote private investment in the fields of agriculture, fishing and associated services.

Arab Journal of Plant Protection

Volume 40, Special Issue, October 2022

Table of Contents

Contents	Abstracts No.	Page No.
Authors Index		E-2
Keynote address	KN1	E-9
Symposia	S1 – S10	E-9
Economic Entomology	EN1 – EN62	E-12
Medical Entomology	ME1 – ME2	E-30
Mites	M1 – M2	E-30
Fungal Diseases	F1 – F66	E-31
Bacterial Diseases	B1 – B17	E-52
Viral Diseases & Phytoplasma	V1 – V41	E-57
Nematodes	N1 – N13	E-72
Weeds	W1 – W4	E-76
Chemical Pesticides	CP1 – CP15	E-77
Plant Extracts	EX1 – EX32	E-81
Integrated Pest Management	IPM1 – IPM6	E-91
Biological Control	BC1 – BC60	E-93
Beneficial Insects	BI1 – BI10	E-112
Climate Change & Plant Protection	CC1 – CC4	E-114
Pest Surveillance	PS1 – PS4	E-116
Soil-borne Pathogens	SB1 – SB5	E-117
Research Coordination	RC1 – RC4	E-119
Food Security & Plant Protection	FS1 – FS3	E-121
Miscellaneous	MI1 – MI10	E-123

Authors Index

Name	Abstract No.	Name	Abstract No.
Abaker, Malik M.A.	EN14	Ahmed, Suad Abdel Gamiel	F36
Abba, Maissa	N3	Mohamed	
Abbas, Ali	F16	Ahmed, Yosra	PS4
Abbas, Enas Fadel	BC17, BC59	Aisanabrah, Hala	B7
Abbas, Ihsan Ali	CP2	Aiter, N.	EX30
Abbas, Khaled	EN22	Ajour, Eyhab	B16
Abbas, Muhammad Taqqi	F37	Akdura, Nevin	V4
Abbassi, F.	V28	Akel, Ensaf Hassan	V6, V32
Abbes, Khaled	CP5, EN12, EN15,	Akhter, Adnan	F37
	EN62	Aknadibossian, Vicken	RC3
Abboud, Rafeek	EN33	Al Dhafer, Hathal M.	B5
Abd Elgawad, Mahfouz M.M.	BC36	Al Ghanoum, Mohamed Izzat	EX12
Abd El-Karim, Hamdi S.	MI6	Al Houssari, Amina	BI9
Abd El-Wahed, Mohamed S.	F38	Al Jabaree, Abdel-Munem	B7
Abd, Sara W.	BC27	Al Jboory, Hala K.J.J.	BC10
Abdalla, Lubna M.	BI10	Al Jiboory, Ibrahim	CP1
Abdallah, Marwa Mohammad	EN39	Al Jouri, Ebraheem	BC41
Abdallah, Nora	BC32, SB3	Al Maghrabi, Sabah Khairu	BC31
Abdallah, Youssef	EN38	Al Mohammed, Kenda Hamade	EX14
Abdallah-Nekache, Nora	F3	Al Omari, Ruba	B7
Abdel Razik, Ahmed Abdel	EN40	Alabdalla, Osama	V10
Moniem		Al-Abdallat, Ayed M.	BC55
Abdelateef, Eltayeb	EN34	Al-Abrass, Nawras	BI4
Abdelaziz, Ouidad	BC3	Alali, Narjes	CP3
Abdelgader, Hayder	CP11, ME2	Alam, Waqar	F24
Abdelhalim, Telal S.	EN34	Alananbeh, Kholoud M.	BC55
Abdelkhalek, Ahmed	V8	Al-Aqili, Naba'a Salman	BC50
Abdellah, Abdel Gader M.	BC12	Al-Assas, Khaled	N12
Abdelly, Chedly	F32	Alazem, Mazen	V17
Abdelmoumen, Taoutaou	F12	Albarni, Nada Mohammad Eid	W3
AbdelRafaa, Omeed A.	N1	Albozidy, Zainib	N9
Abdelrahman, Al-Khair A.	MI8	Aldahoui, Sindab S.J.	BC10
Abd-Elsalam, Kamel A.	MI3	Aldawood, Abdulrahman Saad	EN1
Abdel-Wahed, Mohamed	EN38	Al-Deen, Rudwan Badr	BC37
Abdelzاهر, Hani M. Awad	F57	Al-Ebady, Emad Qasim	EN39
Abderraba, Manef	EX5	Al-Elauimi, Lina	B7
Abdul Rehman, M.	F24	Al-Fahad, Maath Abdul Wahab	V5
Abdul-Azeez, Abdul Al-Kareem	F49	Alfallah, Hassan Al Mahdi	BI2
Abdulhamz., Bushra Hasan	EN17	Al-Gerrawy, Amer J.A.	EN29
Abdulkareem, Tasneem	V10	Alghondi, Moad A.	N9
Abdullah, Samir Khalaf	BC5, BC39	Al-Guboori, Saba Baqer	BC50
Abid, Saadoon Hameed	BC17	Al-Hayale, Esraa Mohamed Ali	EN54
Abo Kaf, Nabil	EN33	Al-Hazmi, Ahmad S.	N1
Abobakr, Yasser	CP12, MI8	Alhussaini, Khaled	BC54
Abou Kubaa, Raied	B8, B13, B15, V29,	Ali, Abeer Hashim Mohamed	EX9
	V32, V37	Ali, Ahlem Bel Hajd	RC4
Abou Tara, Randa	EN28, EN59, B16,	Ali, Asad	BI3
	BC51	Ali, Belgacem	EN56
Abouzkharr, F.A.	EX19	Ali, Dalia	F26, F58
Ab-Talab, Thoria	CP10	Ali, Haneen Abdulhalim	BC28
Abu Obeid, Ibtihal	B7	Ali, Hussain	BI3
Abu-El Samen, Firas	BC55	Ali, Lina	EN41
Abuelnnor, Najat Ali	BI2, EN26	Ali, Mahmoud Faker Mohamed	CP9
Abugnia, Elmunder	B11	Ali, Medhat Wild	V10
Abukashawa, Sumaia M.	BC14	Ali, Rezan	F23
Acheuk, Fatma Ali	EX11, EX29	Ali, Safdar	V2
Adamu, Yunusa Ugys	CP8	Ali, Sara Yousif Elbadawi	EN32
Adimi, Amine	N2	Aljarah, Neran Salem	BC28
Adjlane, Noureddine	BI7	Aljoudi, Maysaa	B16
Adoui, Nabila	MI10	Aljouri, Ebraheem	CP3, EX6
Afghan, Shahid	F25	Al-Juboory, Hurria H.	BC27
Aggoun, Hayet	BC16	Al-Juboory, Ibrahim Jadoaa	EN17
Ahdaya, Saad M.	BI8	Al-Kaeath, Nabeel Abdalla	V39
Ahdouga, Meriem	V37	Alkai, Bassel Fahmi	F41
Ahmad, Mohammad	IPM2	Al-Karablieh, Nehaya	B7, BC55
Ahmad, Salman	B3	Al-Khalaf, Mohammad	V27
Ahmed, Fatma S.	CP13	Al-Khateeb, Nadia	BC9, BC11
Ahmed, Hira Manzoor	V38	Alkowni, Raed	V10
Ahmed, Omya E.	BC12	Allagui, Mohamed Bechir	F52, F53
Ahmed, Qasim	BC7	Allala-Messaoudi, Linda	V21, V24
Ahmed, Raees	BC21	AllAllah, Anwar Jassam	BC17, BC59

Name	Abstract No.	Name	Abstract No.
Alloosh, Maysaa Taofik	F41	Aydi, Neji	FS1
Alloui, Rafika	BC46	Ayed, Fakher	BC25
Alloush, Laïla Abd Alrahim	BC31	Ayed, Sourour	F6
Al-Luhaiby, Aqell A.K.	F40	Azmeh, M. Fawaz	BC26
Al-Maarouf, Emad	F16, F23	Bachrouch, Olfa	EX5
Almasoud, Mustafa	BC54	Badawi, Myriam	EN35
Almasrahi, Ali	F31	Bahlol, Raefat	EN6
Al-Mayahi, Sawsan H.A.	F40	Bakheit, Elharith H.	EN34
Almomany, Ahmad Mohamad	F33	Balady, Zeina Tarek	N12
Al-Mzory, Ali Sami Ali	F56	Baldizzzone, Giorgio	EN11
Al-Nahal, Mohamad Koja	EN28	Balestra, G.M.	B4
Al-Naser, Zakaria	EX8	Barberini, Sara	F62
Alo, Fida	F20	Barech, Ghania	EN8
Alobaidi, Ruaa	BC7	Barhoum, Basima Ahmed	F54, BC31
Alokalah, Bassam	BC37	Barreau, Christian	F1, F3
Alrahban, Bahaa	W3	Basheer, Abdunabi	BC60
Al-Rhayeh, Qusay	V6	Baum, Michael	F20, F61
Al-Riyami, Abdulhamid	BC15	Bayoumi, Alaa E.	CP12, W3
Alsabte, Ahmed	BC7	Belaid, Messaouda	EX11
Al-Sadi, Abdullah	V13	Belaïdi, Hakima	F39
Al-Saleh, Mohammed A.	B5, B17, V1, V22, V23	Belhamra, Mohammed	BC29, CP8
Al-Salti, Mohammed Nayef	BC51	Bellahcene, M.	F42
Al-Salty, Naiif	EN28	Bellahcene, Miloud	F27
Al-Samaan, S.M.	F61	Beltaief, Rihem Adouani	BC18, EN24
Alsamman, Alsamman M.	F20	Ben Abdallah, Dorra	BC24
Al-Sarar, Ali S.	CP12	Ben Abdallah, Hana	EN52
Al-Sawalhah, Imran	BC55	Ben Abdallah, Rania Aydi	BC25, F7, F34
Al-Shahwan, Ibrahim M.	V1, V23	Ben Ali, Amira	V31
Al-Shalchi, Hasanain	CP1	Ben Amar, Fathi	BC56
Al-Sham'aa, Khaled	F20	Ben Amor, Safia	BI1, BI6
Alsouleman, Modar	EN6	Ben Araar, Alaeddine	F55
Al-Subhi, Ali M.	V13	Ben Belgacem, Ali	EX2
Alsuliman, Yasser Mohamed	BC54	Ben Chaaban, Samah	BC35
Al-Taee, Ali Kareem	F9, F48	Ben Cheikh, Nessrine	B10
Al-Taee, Huda Hazim Wafi	F48	Ben Ghanem, Hajer	CC4, V35
Altaf, Adeela	BC21	Ben Halima, Monia Kamel	BC18, BC38, EN24
Al-Taie, Azher Hameed Faraj	BC42	Ben Hmia, Foued	M2
Altamura, G.	B8	Ben Hmida, Foued	EN61, EN62, M2
Al-Yahya, Fahad A.	N1	Ben Jabeur, Maïssa	EX17
Al-Yahyai, Rashid A.	V13	Ben Jamâa, Mohamed Lahbib	BC6, BC47, EN10, EN19, EN21, EX19, EX32, F62, FS1, FS2
Alyousuf, Aqeel	EN9	Ben Jemâa, Jouda Médiouni	EX5
Alzabib, Ali A.	CP12, MI8	Ben Khedher, Saoussen	BC22
Amara, Hadjr	EN8	Ben Mahmoud, Kaouther	BC45, EX28
Amouzoune, Mariam	S3, F66	Ben Nasr, Hmed	EN56
Amer, Mahmoud A.	V1, V22, V23	Ben Romdhane, Mariam	V15
Ami, Sulaiman Naif	N5	Ben Saad, Nihel	M2
Ammar, Nawaim	F7	Ben Salem, Hichem	F10
Ammari, Youssef	EN10	Ben Salem, Ibtissem	RC4
Amrani, A.	EX30	Ben Tassa, Fairouz	EN55
Amri, Ahmed	S3, F20, F66	Ben Yahia, Kaouther	EN10
Anguita-Maeso, Manuel	PS2	Ben Youssef, Noura Omri	BC43, F10
Annabi, Mohamed	F5	Benabdelkader, Messaouda	EN43, EX7
Anthoine, Géraldine	RC1	Benabdelmoumene, Djilali	EX21
Anwar, Waheed	F37	Benaïssa, Kaltoum	EN53
Aouadi, Sameh	BC43	Benarif, K.	F19
Aouini, Mouna	V31	Benazzouz, Kinza	B12
Aqqad, Suad	V10	Benbachir, N.	V28
Arab, Atie	F28, CP3	Bencheikh, Abdelaali	CP15
Arafat, Khaled Hussein	F22	Benchikh, O.	F19
Arias-Giraldo, Luis F.	PS2	Bendif, Hamdi	MI10
Arif, Mokhtar Abdulsattar	EN23	Bendifallah, Leila	BI5, EX26
Aroua, Oumayma	EN42	Benfekhih, Leila Alla	BI6
Arshad, Waqas Raza	F25	Benfradj, Najwa	RC4
Asaad, Nader Y.	V18, CC3	Ben-Hammouda, Moncef	EN25
Ashfaq, Muhammad	V38	Bennour, Chaker	EN56, EX2
Asim, Muhammad	B3	Benouis, Slimane	F39
Askri, Hend	V31	Benourad, Fouzia	EX21
Assaf, Lazgeen Haji	BC5, BC39	Benouzza, S.	F42
Asslan, Louai	BC9, BC11	Benramdane, N.	V28
Assous, Roza Daoudi	N2	Benslimane, Hamida	F17, F18
Attar, Bassem	F20	Benttoui, Nawal	N3
Attawnah, Rasha	V10	Benzebra, A.	V28
Attia, Sabrine	EN45, M2, BC2, BC46	Benzina-Tihar, Farida	B6
Awad, Riham	V10		
Ayad, Jamal	BC55		

Name	Abstract No.
Benzohra, Ibrahim Elkhailil	F39
Bertrand, Mboussi Serge	F59
Besse, Marc	SB4
Bettiche, Farida	CP15
Bianco, Piero Attilio	RC3
Bilal, Nazar A.A.	BC8, BC53
Blümel, Sylvia	RC1
Bnaissa, Keltoum	EX25
Boscia, Donato	B8, B13
Bottalico, Giovanna	V30
Boualem, Malika	EN50, EX21
Bouallala, M'hammed	EX27, W2
Bouamama-Gzara, Badra	EX30, V15
Bouatrous, Asma	F2, F5, F53
Bouazzoum, Noura Mohammed	F51
Bouchareb, Mohamed	EX21
Boudieb, Kaissa	EX23
Boughalleb-M'Hamdi, Naima	RC4
Bouhachem, Sonia Boukhris	B9, EN3
Bouhadida, Mariem	F21, W4
Bouhdida-Mhadhbi, Manel	EN42
Boukhou, Yassine	F4
Boukhris-Bouhachem, Sonia	CP4, V20, V21, V24, V26, V29
Boukteb, Amal	W4
Boulal, Ahmed	EX27, W2
Boulenouar, Noureddine	EX16
Bourahla, Karima	F18
Bouregghda, Houda	BC29, BC32, BC44, BC48, F3, F44, F50, N3, SB3
Bourouba, Leila	BC49
Boushih, Emna	EX5
Bouznad, Zouaoui	B14, BC32, F1, F3, F45, V21, V24, W1
Brahmi, Rabeb	CP5
Burgess, Lester	F2
Bwalya, John	V17
Bystrowski, Cezary	BC6
Camino, Carlos	PS2
Campanale, Antonia	V30
Canto, T.	V41
Cardinali, Alessandra	CP8
Carlson, Bryan	SB1
Carmen, Socaciu	F12
Carretta, Laura	CP8
Caruso, Aureo	EN35
Casati, Paola	RC3
Casse, Nathalie	EN35
Cavaliere, Vincenzo	B15
Cesbron, Sophie	B14
Chaieb, Ikbali	EX24
Chalbi, Arbia	F32
Chaouch, Souad Tahar	BC16
Charles, Essome Sale	F59
Chater, Tayeb	EN61, EN62, M2
Chattha, Muhammad Bilal	F30
Cheffi, Manel	BC56
Chekali, Samira	F2, F6, F52, F53
Chen, Weidong	F21
Chenais, Benoît	EN35
Cherif, Asma	EN30, EN42
Cheriti, Abdelkrim	EX16
Chermiti, Brahim	CP5, EN12, EN15, EN22, EN62
Cherotich, Sheillah	EN20
Chiab, Abdelkarim	EN25
Chiesa, Olga	CP4
Chihat, Saliha	BC44, BC48
Chikh-Khamis, Ziad	EX6
Chiumenti, Michela	V30
Choudhary, Lovneesh	MI9
Choueiri, Elia	B15, EN44, EN47, V11, V12, V32
Choumane, Wafaa	BC26

Name	Abstract No.
Colazza, Stefano	EN23
Constantin, Botez	F12
Cristina, Petrisor	BC33
D'Onghia, Anna Maria	PS1, RC2
Daami-Remadi, Mejda	BC25, F7, F34
Dababat, Abdelfattah Amer	N2, SB5
Dabaj, Kahlifa Hussein	N9, N10, EX22
Dahoua, Moutassem	BC20
Dalal, Mohinder Singh	MI9
Danet, Jean-Luc	V11, V12
Danti, Roberto	F62
Dawoud, Dafalla A.	CP10
Dayab, Khayriyah Misbah	BC30
de Costello, B.	EN26
De Jonghe, Kris	RC1
Debbi, Ali	BC32, F44
Defous, Nacer	EX21
Dehliz, Abderahmene	EX11
Deibeh, Loubna S.	MI5
Dendouga, Wassila	BC29, BC32
Denis, Françoise	EN35
Derbek, Larbi	MI10
Dhahri, Samir	BC6, EN10, EN19
Dhaouadi, Fethia	V16
Dhaouadi, Wissal	BC43
Dibo, Ali	EN6
Djebbi, Salma	B11, BI6, EN31, EN35
Djedouani, Anwaar	F50
Djenaoui, Anfel	V25, V40
Djennaoui, I.	EX30
Djillali, Keltoum	F39
Doriane, Djuissi Tohoto	F59
Doru, Pamfil	F12
Ducos, Christine	F3
Ebrahim, Fawzi	B11
Edward, Martin	EX12
Eissa, Ahmed	EX10
Ekesi, S.	EX3
El Guennouni, Badreddine	FS3
EL Habieb, Rawda Yaagoub	CP2
El Khoury, Yara	V37
El Komy, Mahmoud H.	B5
El Riachy, Milad	EN44
Elair, Manal	V36, V30
Elamin, Elamin M.	IPM3
El-Amin, M.M.A.	BC40
Elazab, Nahla T.	BC23
Elazzabi, Taher Sadegh	MI2
Elbashir, Manal H.	BC14
El-Bouazaoui, Amine	F4
Elfahal, Inshirah A.	ME2
El-Gaali, E.I.	F61
El-Gariani, Najat Khalifa	BC30
El-Hasan, Abbas	BC19
El-Heneidy, Ahmed	BC9, BC11
Elhussein, Salah	ME2
Elkelany, Usama S.	N8
El-Khoury, Yara	B15
El-Komy, Mahmoud H.	BC34, F31
Elliot, Norman	EN9
Elmaghrabi, Adel M.	B11
Elmeradi, Mohamed M.	B11
El-Miziani, Inaam	F4, MI1
El-Morsy, Norhan A.E.	CP6
El-Naas, Mohamed Najeb	EX22
El-Nagdi, Wafaa M.A.	EX13
Elnour, Omer Abdelkader	EN36, IPM3
Elouissi, Mouffok	BC52
El-Rawy, Adel Mohamed	EX1
Elshahawy, Ibrahim E.	F38
El-Shareif, Saleh Abdelhadi	EX22
El-Sharkawy, Hany H. A.	BC23
Elsharkawy, Mohsen Mohamed	BC54
El-Sisi, Yasmen	V11
Emam, Azza	EN38

Name	Abstract No.	Name	Abstract No.
Embaby, El-Sayed M.	F26, F58, F60	Hamwiah, Aladin	F63
Ennouri, Karim	BC56	Hamza, Afaf Rajab	BC1, EN7
Esber, Rehab	EX6	Hamza, Hammadi	EN56, EX2
Essa, Ertyad Y.	V18	Hanafy, A.R.I.	EN27
Ezzine, Olfa	BC6, BC47, EN10, EN19, EN21, EX32, F62	Hanna, Abdalla	EN47
Fahmi, Wael	F16	Hansen, Jeremy	SB1
Fakhfekh, H.	V41	Haouas, Dalila	EN11
Faraj, Hussam	F13	Harbaoui, Kalthoum	F5
Farid, Mezerdi	EX31	Harbi, Ahlem	EN12, EN15, EN22, CP5
Faskha, Shadi Mahmoud	IPM2	Hardy, Ian CW	BC15
Fathallah, Amel	RC4	Harir, Mohamed	M110
Fatima, Saba	F15	Harzallah, Daoud	EX20
Fayod, Dina	EN6	Hasan, Aus A.	M15
Fayyadh, Mohammed A.	F29	Hashim, Ibrahim M.	B110
Ferretti, Luca	RC3	Hassan, Aalaa K.	F40
Fiadh, Abd Hameed	F16	Hassan, Ahmed Elbashir Mohammed	EN36
Fisal, Abeer	F26, F58	Hassan, Feyroz Ramadan	BC5, BC39
Foissac, Xavier	V11, V12	Hassan, Mahmoud	F13
Fortas, Zohra	F27, F42	Hassan, Mohamed B. M.	EX4
Fouad, Eman A.	CP6, CP13	Hassan, Mohammed	F22
Frikha-Gargouri, Olfa	B10, BC24	Hassan, Omar Hussein	F22
Gameel, Salah M.M	EN4	Hassan, Rifaath	F46
Gao, Xuewen	BC34, F31	Hassan, Wazeer A.	F56, V7
Garganese, Francesca	B9	Hatim, Rawad	EN6
Gargouri, Samia	BC45, F2, F5, F6, F21, F52, F53, F55, EX28	Hechaichi, Fatima Zohra	M110
Gasmi, Chedi	F55	Hemissi, Imen	BC45
Gasmi, Wafa Khaled	V20, V26	Hermize, Feryal Bahjat	M1
Gatehouse, Angharad	EX12	Hermosa, Rosa	F44
Ghait, L.	EX30	Hlaiem, Sawssen	BC47, F62
Ghammoudi, Amina A.	N9	Hlaoui, Amen	CP4
Gharbi, Mohamed Saleh	F2, F5, F6	Hodson, Dave	F16
Gharbi, Yaakoub	BC56	Horab, Ahmed	CP12
Ghazal, Ibtissam	BC26	Horrigue-Raouani, Najet	N7
Ghedjmis, Amina	BC29	Houria, Amrane	EX29
Ghelamallah, Amin	EN50	Huggins, David	SB1
Gheorghe, Alin	BC57	Husain, Mureed	EN1
Ghettouche, Afaf	B15	Hussain, Khadim	V1
Giampetruzzi, A.	B8	Ibjijsen, Jamal	F4
Giles, Kris	EN9	Ibrahim, Ghassan	BC9, BC11
Giovani, Baldissera	RC1, RC3	Ibrahim, Mohamed Mahmoud	F35
Glacis, Laurent	V21, V24	Ibrahim, Nesrine	F34
Gnidez, Habiba Glida	EN25	Ibrahim, Yasser E.	B5, B17, BC34, F31
Grissa-Lebdi, Kaouthar	BC2, BC46, EN30, EN42	Ichihashi, Yasunori	W4
Gualano, Stefania	PS1	Imren, Mustafa	SB2
Guarino, Salvatore	EN23	Inam-ul-Haq, M.	BC21
Guesmi-Mzoughi, Ilhem	N7	Ippolito, Antonio	B9, EN3
Guessab, Asmaa	BC52	Iqbal, Zafar	B3
Habak, Hanan	EN6	Iqbal, Muhammad	F30
Haddad, Benalia	V25, V40	Ismail, Imad	V6, V32
Haddadin, Jihad	B7	Istanbuli, Tawffiq	F20, F61, F63
Hadj-Naser, Fathia	N7	Jabnoun-Khiareddine, Hayfa	F7, F34, BC25
Hafeez ul Haq, Muhammad	F37	Jabreer, Abd El Salam	F35
Hafer-Hahmann, Nina	BC2	Jacques, Marie-Agnès	B14
Hafsi, Abir	EN22	Jalal, Haitham Mohie Al-Deen	EN54
Hafsi, Chaouki	EN11	Mohamed	
Hafsi, Mohammed	EX15	Jammezi, Noura	BC43
Haider, Muhammad Saleem	F37	Jaouadi, Imed	RC4
Haj Ali, Mayadah	BC37	Jawalkar, Nilesh Baburao	EX12
Haji, Viyan J.	V7	Jawdha, Yusuf Abou	RC3
Hajo, Mohamad	EN28	Jemai, Noura	BC45, EX28
Hamad, Abd Elmgid Adlan	B1, V19	Jemmali, Ahmed	BC45, EX28, V35
Hamad, Younis K.	F31	Jendoubi, Warda	F21
Hamada, Walid	EX17	Jerbi, Mey	EX24
Hamami, Majdi	EX5	Joly, Laure	CP14
Hamdan, Rehab	V32	Joss, Monika	SB4
Hamdi, Faten	BC24, EX24	Jreijiri, Fouad	V11, V12
Hamdi, Imen	V35	Juan, Cristina	F10
Hamdi, Soumaya Haouel	EX5	Kabli, Nabila	BC4
Hammami, Sonia	BC6	Kaci, Hakima Oulebsir-Mohand	B6
Hammodi, Omar	M15	Kaddoura, Mohammad Jamil	RC3
Hamwiah, A.	F61	Kadri, Zohra	EX16
		Kaidi, Kamel	EX27
		Kallel, Sadreddine	N7

Name	Abstract No.	Name	Abstract No.
Kamran, A.	V22	Loconsole, Giuliana	B13
Kanoo, Hameed Hamoud Ali	V3	Logrieco, Antonio F.	F32
Karahaçane, H. Tahar	N11	Loiseau, Marianne	RC3
Kassem, Amin A. Haj	V18	Lotos, L.	V22
Kassem, Mohammad A.	CC3	Mahdid, Imene	EX30, V25, V40
Kassem, Nabil A.	V7	Mahfoudhi, Naima	EX30, V14, V15, V34, V36, V39
Katbeh, Ahmad	EN13	Mahgoub, Hassan Awad Hassan	EN37
Katis, N.I.	V22, V23	Mahjoubi, Kamal	BC35
Kawas, Hanan	V6	Mahmoud, Dalia Ali	F60
Kehail, Sara A.A.G.	BC12	Mahmoud, Mohamed E.E.	BC14, EN34, EX3
Kehel, Zakaria	S3, F20, F66	Mahmoud, Souad	RC4
Keltoum, Benaissa	EX31	Mahmoudi, Randa	EN51
Kemal, Seid Ahmed	F41	Makhloufi, Souad	F39
Kennan, Hassan O.	IPM3	Makki, M.	V41
Kerali, Ftoun	EN6	Makkouk, Khaled M.	CC1
Kerkoud, Mohamed	B14, V21, V24	Maklad, Mahmoud	EN46
Kerra, Halluma Mohammed	BC1, EN7, EX18	Maknaci, Abdelkader	EX27
Khadraoui, Hadil	EX32	Malik, Tadmur Abdelrazzak	M1
Khafateh, Abdul Rahman	CC2, F43	Manceau, Charles	B14
Khalaf, Mohammed Zaidan	EN17, EN48	Manea, Alaa O.	F29
Khalidi, Mourad	EN8	Mannai, Amal	F10
Khalifa, Hanane	MI10	Mannai, Sabrine	RC4
Khalifa., M.W.	F19	Mannai, Yaussra	EN21
Khamessi, N.	V41	Mansour, Amina	V10
Khammessi, Messaad	F55	Marangi, Carmela	F32
Khan, Ahmad Sattar	F24	Marin, Alexandra M.	BC57
Khan, Muhammad Aslam	V2, V38	Maronsy, Gehan Haji	EN16
Kharouf, Shoula Aboud	F65	Martinez, David	BC18
Kharrat, Mohamed	F21, W4	Marzouki, Rania	EN10
Khatib, Ali El	V32	Masiello, Mario	F32
Khatib, Fateh	N13	Matar, Mohamed	F28
Khelifi, Lakhdar	EX30, V25, V40	Matny, Oadi N	F49
Khemir, Eya	F2, F6, F52, F53	Matrood, Abdulnabi A.	BC40
Khemissi, Asma	V29	Mazahreh, Safa	B7
Khodor, Adil	EX4	Mazzaglia, A.	B4
Khouaja, F.	V41	Mazzoni, Emanuele	CP4
Khriebe, Mohammad Imad	BC26	Mdellel, Lassaad	BC18, EN11, EN24
Kim, Kook-Hyung	V17	Meca, Giuseppe	F32
Klai, Khouloud	EN31, EN35	Megateli, Mohamed	F39
Korayem, A.M.	N6	Mehboob, Saira	F24
Korayem, Ahmed M.	N8	Mehle, Natasa	RC3
Koriem, Ali Mohamed	F47	Mejdoub-Trabelsi, Boutheina	BC22, F7
Kossah, Mohammad	EN41	Mekious, Scherazed	BI6
Krache, Farial	EN50, EX21	Mekki, haniyya	EN8
Krid, Samira	BC56	Mensi, Imene	BC25
Ksouri, Med Fakhri	BC45	Merzoug, A.	EN50
Kthiri, Zaneb	EX17	Messaoud, Chokri	BC47, EX32
Kumar, Lomash	IPM6	Metoui, Nebiha	V16
Kumar, Rohtas	IPM5	Mezghani, Maha	BI1, BI6, EN31, EN35
Kumari, Safaa G.	F4, V18, V19, V33, MI1	Meziane, Malika	V16
Laajimi, Omayma	EN19	Mghandef, Samia	V33
Laala, Samia	B14	Mih, Chewachang Godwill	F59
Laamari, Malik	BC13, BC49, EN51	Minafra, Angelantonio	V30
Laarif, Asma	EX24	Mofleh, Majeda	M15
Lafi, Hamzeh A.	N1	Mogahed, Mohammad Ibrahim	EN2
Lahbib, Nada	B9	Mohamed, E.S.I.	EX3
Lahlouh, Ala	V10	Mohamed, El Tahir I.	EN34
Laidoudi, Nour El-Houda	V25, V40	Mohamed, Majeedha	F46
Lakhdar, Fatima Zohra Moulay	EN55	Mohamed, Moawad M.M.	N6, N8
Lakhdari, Wassima	EX11	Mohamed, Nwara Ali	F35, F51
Lammari, Hamama-Imène	F18	Mohamed, S.A.	EX3
Landa, Blanca B.	PS2	Mohammad, Imad	V10
Laraba, Imane	F3, SB3	Mohammed, Assala Hassan	B1
Lasmer, Hadjer	BC44	Mohammed, Jasim Khalaf	BC17, BC59
Lázaro, Elena	PS3, RC4	Mohammed, Ramadan Y.	F11
Lazreg, Fatiha	BC52	Mokabli, Aissa	N2, N11
Lebdi-Grissa, Kaouthar	EN45	Mokeddem, Aymen	V25
Leblalta, Amina	EX20	Mokrini, Fouad	N2, SB5
Leclercq, Nicolas	BI5	Molan, Younis Y.	BC34
Lehad, A.	EX30	Monte, Enrique	F44
Lehad, Arezki	V15, V25, V40	Montilon, V.	B8
Leslie, Ian	SB1	Morano, Massimo	V30
Leveanu, Ion	BC57	Moretti, Antonio	F32
Limam, Ferid	EX5	Mortada, Christina	V11

Name	Abstract No.	Name	Abstract No.
Mostafa, Fatma A.	EN27	Radwan, Ahmed	EN38
Mouhanna, Ahmad M.	BI4, MI5	Rafai, Mebrouk	W2
Moukahel, Abdul Rahman	V18, V19, MI1	Rahi, Y.J.	B4
Mouna Mhafdh, Mouna	FS1	Rahil, Ashraf A.	MI6
Moussa, Duha	V10	Rahmouni, Ridha	CP5
Moussa, Chaaban	BC35	Ramadan, Nadeem A.	F11
Moussa, Chadha	EX17	Rashad, Younes B.	BC23
Moussa, Zinette	EN44, EN47, B15, BC58	Rashed, Nabaz	F16
Moussi, Abdelhamid	EN49	Rashid, Abeer	F64
Moustafa, Moataz A.M	CP6, CP13	Rasool, Khawaja Ghulam	EN1
Moustafa, Shaima Mohamed Nabil	F57	Ratcliffe, N.	EN26
Mraisha, Faten	EN6	Rawabadeh, Fida'a Ali	IPM1
Muchugi, Alice	EN20	Raza, Ali	F24
Muffti, Shamal Abdullah Al	EN16	Raza, Mohsin	B3
Muhrez, Khayam	F54	Raza, Waqas	B3
Mukhtar, Tariq	V38	Razzaq, Abdul	EN5
Musbah, Mahmoud A.	N10	Regaieg, Hajer	N7
Mustafa, Khitma A.S.	EN34	Reghmit, Abd Ennaceur	B6
Naccache, Chanez	BI1	Rezk, Hussien A.	ME1
Naffaa, Walid	F64	Rhaïem, Azza	MI4
Nagano, Atsushi	W4	Ricardo, Holgado	N11
Nagi, Siham K.	BI10	Rizk, Marguerite A.	MI6
Nahdi, Sabrine	V29	Rocca, Gianni Della	F62
Naher, Falah Hanash	EN17	Rodriguez, Elena	RC1
Najahi, Amal	V14	Rolania, Krishna	EN14, EN60
Najami, Dina	V10	Román-Écija, Miguel	PS2
Najar, Asma	CC4, V16, V31, V33, V35	Roseti, Vincenzo	V30
Najjari, Afef	BI1, EN31	Roshdy, Ola	EN46
Nakkach, Chahnez	EN31	Rouag, N.	F19
Nasir, Shaista	F30	Roxana, Zaharia	BC33
Nassraoui, Romdhane	F55	Rustom, Ghassan	EN59
Navas-Cortés, Juan A.	PS2	Sabbour, Magda Mahmoud Amin	CP7
Naveed, Ghazal	F24	Sabra, Ahmed	V1
Nazari, Kumarse	F16	Sadine, Salah Eddine	EN55
Necaibia, Asma	F45	Saeed, Muhammad	F15
Necira, K.	V41	Sahir-Halouane, Fatma	B6
Neggaz, Rahil	V25, V40	Said, Fazal	BI3
Nehal, Mohmmmed Quja	BC51	Saïda, Mlaouhi	CC4
Nicole, Michel	F27	Saïed, Muna Elhag Suliman	B1
Njuguna, Jane	EN20	Saifi, Hadjer	EN43, EX7,
Norbert, Kuate Tueguem William	F59	Saifi, Rayane	EN43, EX7
Noureddineb, Rouag	BC20	Sakaguchi, Shota	W4
Nourou, Kone Sangou Abdou	F59	Salah, Faiza Elgaili Elhassan	EN32, EX4, EX10
Okasha, Eman	CP3	Salar, Pascal	V11, V12
Olle, Margit	MI7	Saldarelli, S.	B8
Omar, Ayman Faisal	V11	Saleh, Amgad A.	F31, MI8
Omer, Ahmed Adam Eisa	EN32	Salem, Nida	F33
Opit, George	EN9	Salih, Yehay A.	F29
Osama, Laith	F16	SalimAlbireeki, Salama	EX18
Osman, Nour Ahmed	ME2	Sallam, Najeeb Ahmed	F8
Osman, Soad Mohamed	EX1	Salman, Adnan Hafdh	EN17
Othman, Yahya	BC55	Salman, Amal	EN5
Ouaar, Noureddine	F17	Sana, Zouari	EN24
Ouanoughi, Roumaissa	BC29	Santoro, Franco	PS1
Oufroukh, Amar	BC3	Saponari, Maria	B8, B13, V32, V37
Oulebsir-Mohandkaci, Hakima	BC4, EX23	Sarra, Bouheddi	EX29
Palmisano, Francesco	V30	Sarrar, Ali S. Al	MI8
Panini, Michela	CP4	Satia, Laila	EN58
Passera, Alessandro	RC3	Satii, Entisar Ahmed Osman	EN36
Patel, Nagashvar	CP8	Satti, Abdalla Abdelrahim	BC8, BC53, EN37, EN57
Patrice, Ngho Doo Jules	F59	Savino, Vito Nicola	V30
Paulitz, Timothy	SB1	Schenk, Martijn	RC1
Payton, Mark	EN9	Schiffers, Bruno	CP14
Peri, Ezio	EN23	Schlatter, Daniel	SB1
Petrisor, Cristina	BC57	Sekkal, Soumia	EX25
Picciotti, Ugo	B9	Sellami, Farah	N7
Pilania, Sunidhi	EN60	Sellami, Samira	N3
Porcelli, Francesco	B9, CP1, EN3	Selloum, S.	F19
Qane, Khatera	IPM5, IPM6	Selmi, Ilhem	V14, V34
Quaglino, Fabio	RC3	Senoussi, Mohamed Morad	BC3
Quiles, Juan Manuel	F32	Şevik, Murat	V4
		Sghaier, Haitham	BI1, EN31
		Sghaier-Hammami, Besma	F32

Name	Abstract No.
Shah, Sakhawāt	BI3
Shahhzad, Amjad	F24
Shahid, Muhammed	V9
Shahin, Atef A.	F14
Shahwan, I.M.	V22
Shahzad, Tayyab	F15
Sharaf, Mai Omar	BI4
Sharafaddin, Anwar H.	B17, F31
Sharman, Murray	V19
Sherif, Fatma	CP6
Sherlala, Sana Etaieb	BI8
Shiekhmos, Sultan	BC51
Shikh Amin, Khaled	EN41
Shingaly, Shireen Ghaeib Ali	N5
Shirasu, Ken	W4
Shneyder, Yuri	RC3
Siampour, Majid	RC3
Sihama, Ziouche	BC20
Singh, Vikram	MI9
Skhiri, Ikhlas	V36
Slaats, Brigitte	SB4
Smaha, Djamel	N2
Sobh, Hana	RC3
Soudani, Abderrahmane	EN49
Soudani, Nafissa	CP8
Souissi, Amir	F2, F5, F52, F53
Souissi, Rebha	CP4, V20, V26, V29
Soumia, Sekkal	EX31
Spencer-Phillips, P.	EN26
Sriti, Jazia	EX5
Steel, Elspeth	RC1
Steinmöller, Silke	RC1
Stephan, Zuhair	N4
Subhani, Muhammad Nasir	F30
Sultan, Muhammad Tariq	IPM4
Sutantū, Koko Dwi	EN1
Tabban, Fatima Al Zahraa	N13
Tabib, Mariem	N7
Tadesse, W.	F61
Taha, Awad K.	EN34
Taha, Zardasht A.	F9
Tahar-Chaouch, Souad	BC13
Tahat, Monther Mohamad	F33
Talbi, Bader Eddin	V25
Tantawy, Maha A.M.	EN27
Taoutaou, Abdelmoumen	W1
Tarai, Nacer	BC16
Taratufolo, M.C.	B4
Tarchoun, Neji	CP14
Tareq, Ahmed Mohammed	EN17
Tawil, Mohamed	F54
Tawkaz, Sawsan	F61, F63
Tenllado, F.	V41
Tihar-Benzina, Farida	BC4, EX23
Timoumi, Sawssen	BC43
Tirchi, Nadia	N11
Touati-Hattab, Sihem	F1
Toueiti, Awatef Gaies	V26

Name	Abstract No.
Toumi, Khaoula	CP8, CP14
Tounsī, Slim	B10, BC22, BC24
Triki, Mohamed Ali	B10, BC56
Turco, S.	B4
Udupa, Sripada	F4, F20
Umar, M.	V23
Varsani, Arvind	V35
Vatentini, Franco	B14, PS1
Velasco-Amo, María P.	PS2
Venerito, Pasquale	V30
Vereecken, Nicolas J.	BI5
Vicent, Antonio	PS3, RC4
Viorel, Oltenacu	BC33
Vleminckx, Christiane	CP14
Voegelē, Ralf Thomas	BC19
Vorburger, Christoph	BC2
Wafdi, Mohammed	BI7
Wakim, Samer	V12
Wannassi, Takwa	EN12
Widyasari, Kristin	V17
Widyawan, Arya	B5, B17
Yadav, Shweta	IPM6
Yadav, Sova	IPM5, IPM6
Yadav, Surender Singh	EN14, EN60
Yahiaoui, Dorsaf	V16
Yammīne, Wael	V37
Yangui, Islem	BC47, EX19, EX32, F62
Yaseen, Thaer	PS4
Younis, Muddather Salah Aldein	EX10
Younos, Marwa A.	F60
Youssef, Amira	EN44
Youssef, Mahmoud M.A.	N8, EX13
Youssef, Omran	BC19
Youssef, Rawa	EN33
Yuvaa, Bellik	BC20
Zachée, Ambang	F59
Zaharia, Roxana	BC57
Zaidan, Amjad Khalaf	V5
Zaman, Muhammad	V1
Zambare, S.P.	EX12
Zaouadi, Mourad	W2
Zarco-Tejada, Pablo J.	PS2
Zaroug, Mahmoud S.	CP10
Zeity, Mahran	EN18
Zemni, Hassene	V15
Zentane, Eman T.	BI8
Zermane, Nadjia	W1
Zeshan, Muhammad Ahmad	V2
Zewain, Qais K.	B2
Zidi, Marwa	EN35
Zohra, Ouchefoune Fatma	EX29
Zouba, Anis	EN45, EN61, EN62, M2
Zougari, Sahar	EN45, EN61, EN62, M2
Zourari, Sana	BC38

KEYNOTE ADDRESS

KN1

PLANT HEALTH VISION FOR THE 21ST CENTURY: NEW KNOWLEDGE AND APPROACHES. Sophien Kamoun, The Sainsbury Laboratory, Norwich Research Park, Norwich, United Kingdom, Email: Sophien.Kamoun@tsl.ac.uk

Infectious plant diseases cause havoc to world agriculture and threaten to slow efforts to launch a second green revolution to meet the food security needs of a booming world population. Filamentous pathogens, such as the rice blast fungus, wheat stripe and stem rust, the Irish potato famine pathogen, and many others, continue to trigger recurrent epidemics with far reaching consequences. In this talk, I will discuss how it is possible to perform cutting-edge research and significantly advance knowledge on economically important pathosystems, particularly in the post-genomics era. I will focus on the blast fungus *Magnaporthe oryzae*, a devastating cereal killer that infects the crops wheat, barley and rice, which are staple food for a majority of the world population. I will discuss our personal experience with the appearance in Bangladesh of wheat blast and stress the importance of open-science platforms and crowdsourced community responses in tackling emerging plant diseases. Also, together with several collaborators, we gained an unprecedented level of detail of the molecular interactions that define host-pathogen recognitions by solving the crystal structures of effectors of the blast fungus in complex with plant proteins and reconstructing the evolutionary history of these molecular interactions. Our aim is to build on these discoveries to drive both basic and applied plant pathology. We have started to develop a thorough understanding of the biophysical properties of pathogen effector binding to host proteins and their consequences on pathogenesis and immunity. Such knowledge, along with related mechanistic and evolutionary studies will guide the retooling of the plant immune system towards resistance to diseases. Ultimately, we will deliver traits and non-transgenic cultivars for breeding disease resistance in crops.

SYMPOSIA

Symposium I: Plant Health for Food Security and Safety

S1

MYCOTOXINS AS A HIDDEN THREAT FOR FOOD AND FEED SAFETY: RISKS AND CHALLENGES.

Antonio F. Logrieco, Institute of Sciences of Food Production, Research National Council, Via Amendola 122/O, Bari, Italy, Email: antonio.logrieco@ispa.cnr.it

The management of good agricultural practices during pre-harvest is a key issue for minimizing the risk of mycotoxin accumulation in the Mediterranean crops. Such practices can involve crop rotation, tillage, proper fertilization and fungicide or biological control, variety

selection, timely planting and harvests and the control of the insects which often act as vectors of toxigenic fungal spores. On the other hand, the reduction of mycotoxins along the agro-food chain is also highly dependent on correct post-harvest management that must aim firstly at the separation of the infected crop products from the healthy material. Therefore, the use of different tools such as manual sorting or optical sensors is also crucial for reducing the level of mycotoxin contamination of a given crop. Moreover, it is extremely important to prevent post-harvest contamination during the storage by obtaining low temperature and humidity conditions, in order to limit the development of toxigenic fungal genera. An update review will be given on integrated management of pre- and post-harvest practices aiming at minimizing the risk of mycotoxin contamination along the food chain and on main effective solutions developed by EU MycoKey and MycoTwin (<https://www.mycotwin.eu/project>) projects. *This presentation was supported by the EU Project N. 952337*

S2

IMPORTANCE OF PHYTOSANITARY REGULATIONS AND INTERNATIONAL STANDARDS FOR PLANT HEALTH TO ENHANCE FOOD SECURITY. Nico Horn, Director-General European and Mediterranean Plant Protection Organization (EPPO), 21 Boulevard Richard Lenoir, 75011 Paris, France, Email: nico.horn@epppo.int

An important aspect of protecting plant health is to prevent the introduction and avoid the spread of pests. Thereby ensuring that these pests cannot threaten food security. This requires official action by the countries' authorities. This preventive action avoids more effort being needed at farm level to ensure food security. International trade is an important pathway for entry of pests. Regulation provides clarity to exporting and importing countries on the phytosanitary rules that apply to import. Legislation should also provide the legal power to the National Plant Protection Organizations (NPPOs) to take action, e.g. in the case of an interception or an outbreak, and for the right of access for inspections. Qualified inspectors and diagnosticians and adequate inspection and diagnostic facilities are needed. The inspectors and diagnosticians need guidelines and laboratories should have access to diagnostic protocols, for pests that are present and for those not yet present in their country. The IPPC gives guidance in International Standards and implementation material, e.g. on the tasks and functions of an NPPO. EPPO provides Standards for inspection, for identification of pests, and for control of pests. Other important elements for an effective phytosanitary system are surveillance, for early detection of outbreaks and for declaring pest status, horizon scanning and PRA, to focus the work of the NPPO on relevant pests. EPPO gives guidance to NPPOs via its horizon scanning activities, contingency planning exercises and workshops. EPPO also performs PRAs for the EPPO region, usable by countries to justify their measures. With international and regional standards and guidance material provided by the IPPC and EPPO, it is up

to countries to put the required legislation into place and create an adequate structure, to implement the measures needed. Only then can the national system function optimally in an increasingly globalized economy and protect plant health and thereby enhance food security.

S3

CONSERVATION AND USE OF GLOBAL PLANT GENETIC RESOURCES FOR ENHANCING INSECT PESTS AND DISEASE RESISTANCE: MAJOR FOLIAR DISEASES OF BARLEY AS AN EXAMPLE.

Ahmed Amri, Zakaria Kehel, Mariam Amouzoune, Houda Hiddar, Bouchra Belqadi, Rachid Benkirane and Sajid Rehman, International Center for Agricultural Research in the Dry Areas (ICADRA), Rabat, Morocco, Email: A.Amri@cgiar.org

Barley is an important crop worldwide with multiple uses as feed, food and malt and beverages and adapted to most harsh environments. Its production and quality are affected by abiotic stresses and major foliar diseases. Successful breeding for resistance to these diseases will depend on continuous supply of sources of resistance to overcome the changes in virulence of pathogen populations. Genetic resources conserved in genebanks constitute an important reservoir of traits needed by breeders. Due to large sizes of collections, random sampling of core collections were often used to identify sources of resistance. The Focused Identification of Germplasm Strategy (FIGS) is developed and adopted by ICARDA to better target breeders sought traits using the relationship between environmental conditions and the trait. FIGS showed its relevance for many adaptive traits including resistance to major diseases of barley. Reference set derived from the core collection, barley panel constructed by breeders and specific FIGS subsets constructed using filtering and modelling approaches, were screened for resistance to net blotch and spot forms, leaf rust and scald. The results showed that FIGS sub-setting allowed to identify sources of resistance for the three diseases in a reduced number of accessions at both seedling and adult plant stages. GWAS analysis is conducted to assess the differences in markers associated with resistance in different subsets. In addition, the screening of a set of accessions of *Hordeum spontaneum* and of lines derived from crosses with *Hordeum bulbosum* showed the possibility of using barley wild relatives in extending the search for sources of resistance to major diseases.

Symposium II: Advances in Molecular Plant Protection and its Applications in Pest Management

S4

TOMATO PLANTS - *TRICHODERMA-PHYTOPHTHORA NICOTIANAE*, A COMPLEX INTERACTION SYSTEM FOR UNDERSTANDING PLANT DEFENCE MECHANISMS.

Santa Olga Cacciola, Department of Agriculture, Food and Environment (Di3A), University of Catania, 95123 Catania, Italy, Email: sacaccio@unict.it

The early activation of plant-defense-related genes during a three-way plant-antagonist-pathogen interaction in a tomato-*Trichoderma-Phytophthora nicotianae* model

system was studied. The defense mechanisms activated by tomato plants upon the simultaneous colonization of the root systems by *Trichoderma* spp. and *P. nicotianae* were evaluated 72 h post-inoculation by analyzing the transcriptomic profiles of genes involved in the pathways of salicylic acid (i.e., pathogenesis-related proteins—*PR1b1* and *PR-P2*-encoding genes), jasmonic acid (i.e., lipoxygenases enzymes—*TomLoxC*- and *TomLoxA*-encoding genes), and the tomato plant defending protein (i.e., *SlyDF2*-encoding gene). Genetic defense pathways in tomato related to the above pathways in this three-way interaction system are activated from the first stages of the infection process. Moreover, the results support the hypothesis that the ability to elicit a defense response in tomato plants challenged with a root pathogen, such as *P. nicotianae*, is a conserved feature within the same species of *Trichoderma*.

S5

PARASITOID PRE-ADAPTATION IMPROVES BIOLOGICAL CONTROL OF SYMBIONT-PROTECTED APHIDS.

Christoph Vorburger and Silvan Rosbacher, Eawag & ETH Zürich, Überlandstrasse 133, 8600 Dübendorf, Switzerland, Email: christoph.vorburger@eawag.ch

Aphids are commonly infected by the heritable bacterial endosymbiont *Hamiltonella defensa*, which increases aphid resistance to parasitoid wasps. Laboratory cage experiments have shown that the release of parasitoids strongly selects for symbiont-protected aphids, resulting in failed biological control. Other experiments have shown rapid counter-adaptation of parasitoids to the presence of *H. defensa* in their hosts. Taken together, these findings suggest that parasitoid pre-adaptation could be a viable strategy to improve biological control of symbiont-protected aphids. We tested this prediction in laboratory cage populations of black bean aphids (*Aphis fabae*) and their main parasitoid *Lysiphlebus fabarum*. We had parasitoid lines adapted to two different strains of *H. defensa* by experimental evolution, as well as parasitoids evolved on *H. defensa*-free aphids. Their ability to control caged aphid populations comprising 60% unprotected and 40% *H. defensa*-protected aphids, was compared with both *H. defensa* strains present in the populations. Parasitoids that were not adapted to *H. defensa* had virtually no effect on aphid population dynamics compared to parasitoid-free controls, but one of the symbiont-adapted lines and a mixture of both symbiont-adapted lines-controlled aphids successfully, strongly benefitting plant growth. This study thus showed, for the first time, that parasitoid pre-adaptation can improve the control of partly resistant aphid populations harbouring a protective endosymbiont.

S6

INTEGRATED MODERN SYSTEMATICS AND APPLICATIONS FOR MITE BIODIVERSITY CHARACTERISATION.

Marie-Stéphane Tixier, UMR CBGP, Institut Agro Montpellier, INRAE, CIRAD, IRD, University of Montpellier, Montpellier, France, Email: marie-stephane.tixier@supagro.fr

Systematics is the Science that secures biodiversity knowledge for functional applications in agriculture, health and environment, with key issues for biological control and biodiversity management under global changes. Systematics aims to identify and position organisms in the tree of life, considering evolutionary aspects. Systematics has a long history meaning that classification and identification are permanent matters. However, sometimes this history is complex, organisms are not well named, their classification is not consensual as authors have different opinions, especially for mites because of their very small size and associated difficulties to observe morphological characters and to assess evolutionary meaning (i.e. convergences, intra or interspecific variations). To cope with both correct identification and classification, integrated systematics combining the use of different characters (morphological/molecular characters, biogeography/distribution, biological features) and associated analyses has been developed. Focusing on plant protection applications, we will present first how methods evolved to access more numerous and diverse characters for answering questions on synonymies, phylogeny, life traits and community ecology for pest control issues. Second, we will present examples where taxonomy was applied to classical, augmentative and conservative biological control, for determining predator/prey interaction in a climate change context and to develop agroecological management in increasing functional diversity in crops. We will also focus on collaborative taxonomy, through advances in social networks, easier distant collaboration and associated tools for the development of databases and their use in mite systematics and ecology. Finally, we will question the future of Acari systematics considering education of students, systematics attractiveness, international collaborations and perennial positions in our institutions.

Symposium III: Research and Innovation for Sustainable Crop Protection

S7

THE CHALLENGES OF AUTOMATIC COUNTING AND IDENTIFICATION OF INSECT THREATS USING SMART TECHNOLOGY. James R Bell, Rothamsted Research, Harpenden AL5 2JQ, United Kingdom, Email: james.bell@rothamsted.ac.uk

In this presentation image processing and how the science has progressed will be discussed. Deep learning has promoted the use of smart camera traps and phone apps, but they are not without issue. I will show the limits of these algorithms to detect insects, using aphids as an example. I will focus my talk on detecting insects in flight. The technical challenges of accurately identifying aphids and other small insect pests to species level using mVLR and opto-acoustic methods will be discussed. Aphids migrate at altitude and also just above crop height, producing a wingbeat signal that is an order of magnitude weaker than mosquitoes, making this group hard to detect. Given that there are thousands of aphid species, the challenges for automatic detection seem fraught with difficulty. I will show how rigorous data processing coupled with biological

knowledge can progress this activity. I will finish with a decision support slide from <https://insectsurvey.com>

S8

HOW TO COPE WITH RESISTANCE TO INSECTICIDES TO IMPROVE PEST MANAGEMENT. Emanuele Mazzoni, Department of Sustainable Crop Production, Faculty of Agriculture, Food and Environmental Sciences – Università Cattolica del SacroCuore – Piacenza, Italy, Email: emanuele.mazzoni@unicatt.it

Insecticides since their introduction have played and still have a strategic role in sustainable production of food, animal feed and also for protection against disease vectors. But due to their intrinsic characteristics, they act as a strong driving and selecting force against insect pest populations, above all when crop protection is not approached with an integrated view and insecticides are considered the only possible tool. Of course, misuses has created significant concern about their side-effects like environment pollution, food safety and biodiversity reduction. One more negative effect of insect control only relying on insecticide application, is the selection of individuals able to survive to the insecticide toxic effects. Even if insecticide resistance is sometime a neglected issue, at least by the public, it is not of secondary impact and importance. Insecticide resistance is a serious threat for pest management and the knowledge of involved mechanisms as well as an understanding of insecticide mode of actions is a necessary pre-requisite to develop sustainable and efficacious integrated pest management strategies to delay insecticide resistance onset and to maintain crop production level and quality. Nowadays we know that many pests have evolved resistant populations due to different mechanisms: from mutations in the insecticide target site to the presence of several enzyme families (e.g. esterases, mixed function oxidases, glutathione S-transferases) involved in insecticide detoxification, sequestration and excretion. Such mechanisms can have different relative importance within the various taxonomic groups and this must be considered to improve integrated pest management strategies.

Symposium IV: Application of Behavioral Control Tools as a Safe and Effective Alternative in Pest Management

S9

ROLE OF PHEROMONE APPLICATIONS IN SUSTAINABLE CROP PROTECTION. Shaker Al-Zaidi, Russell IPM, United Kingdom. Email: shakir@russellipm.com

Pheromones and other semiochemicals are playing an increasing role in providing targeted and sustainable crop protection strategies. This is becoming more and more important at a time where blanket spray of pesticides is impacting severely on pollinators, natural enemies, and other non-target insects. Management strategies based on mating disruption, till recent years, were exclusive to high value crops due to its high production cost. However, recent advances in biotechnology, made it more possible to make the active material at fraction of the previous cost. This in turn made it possible to attempt to manage serious pests

impacting food commodities at a price affordable to farmers in Asia, Africa and Latin America leading to major reduction in insecticide input in the production of maize and rice. Attract and kill proved to be a cost-effective tool in the management of fruit fly. Further successes have been achieved through deploying attractants and repellents within the framework of a strategy called “push and pull” against many pests such as whiteflies, thrips and blueberry midge to name few. More interestingly, all the approaches above showed more robust performance when the strategy was combined with soil treatment with entomopathogenic fungi such as *Metarhizium anisopliae*.

S10

MANIPULATION OF PLANT PESTS HOST-FINDING AND ACCEPTANCE BEHAVIOR: PRACTICAL APPLICATIONS IN IPM. Baldwyn Torto, International Centre of Insect Physiology and Ecology (icipe), Behavioural and Chemical Ecology Unit, P.O. Box 30772-00100, Nairobi, Kenya, Email: btorto@icipe.org

The agricultural sector is important for many African economies. It offers a reliable source of employment and income to small and medium-scale farmers who cultivate a wide range of crops. Despite its socio-economic significance, crop production in Africa is constrained by numerous biotic and abiotic factors. Of the biotic factors, pests and diseases are of paramount importance, causing yield losses of 40-100% depending upon the crop. The problem has been exacerbated in recent years with the introduction of invasive pests, which have established in certain regions of the continent because of the conducive bioclimatic conditions. Farmers coping strategies to reduce crop losses, including crop rotation, application of plant products and synthetic pesticides, to name a few, have been implemented with varying degrees of success, leading to over-reliance on synthetic pesticides. The over-reliance on pesticides has led to the evolution of pesticide-resistant pests. Given the importance of the agricultural sector on the continent, researchers are encouraging farmers to embrace IPM strategies to control pests and to increase crop productivity. Innovative solutions, such as exploiting and integrating behaviour-modifying (semiochemical) based tools to disrupt the weak links in the life cycles of pests could prove effective in pest control. This presentation outlines recent research conducted at the International Centre of Insect Physiology and Ecology (icipe), Nairobi, Kenya on the chemical ecology of key above- and below-ground insect pests in Africa leading to the identification of behaviour modifying chemicals that can be used in IPM strategies.

ECONOMIC ENTOMOLOGY

EN1

DETECTION AND CONTROL OF RED PALM WEEVIL UNDER FIELD CONDITIONS. Abdulrahman Saad Aldawood, Khawaja Ghulam Rasool, Koko Dwi Sutantu and Mureed Husain, Plant Protection Department, Economic Entomology Research Unit, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia, Email: aldawood@ksu.edu.sa

Date palm, *Phoenix dactylifera* L. is the most important fruit crop in the Middle East and known to be seriously damaged by red palm weevil, *Rhynchophorus ferrugineus* Oliv. In the present study an integrated pest management (IPM) program was investigated against this deadly pest under field conditions. The program was launched at different date palm orchards at Huraymila Governorate, Riyadh, Saudi Arabia. The infested date palm trees were detected using acoustic device, Treevibe (Insectronic), Greece. Components of the IPM program included chemical insecticides, aluminum phosphide (fumigation), emamectin benzoate (Treecare) (trunk injection), fipronil (sprayed); and some biological control agents such as entomopathogenic fungi, *Beauveria bassiana* (BbSA-1), *Metarhizium anisopliae* (MaSA-1), and entomopathogenic nematode, *Steinernema carpocapsae* (Koppert), as compared to control (water). All treatments were delivered into date palm trunk through injection. Efficacies of the treatments were recorded by monitoring the activities of RPW inside date palm trunk before and after treatments application using Treevibe acoustic device. Agricultural practices were recorded in all different farms to measure their effects on infestation rate. In some farms the most correlated practices that had effects on infestation rate were practiced in some farms for comparison. Results of the study were quite promising and will be presented.

EN2

LABORATORY EVALUATION OF SOME PETROLEUM OILS AND INORGANIC SALTS SINGLE AND COMBINED WITH INSECTICIDES FOR CONTROL OF THE RED PALM WEEVIL, *RHYNCHOPHORUS FERRUGINEUS* (OLIVIER). Mohammad Ibrahim Mogahed, Pests and Plant Protection Department, National Research Center, 33 EL Behouth St. Dokki, Giza, P.O. 12622, Egypt, Email: mogahedprof@hotmail.com

Experiments were conducted under Laboratory conditions to investigate the effectiveness of petroleum oil, inorganic salts and chemical pesticides (Cydial L) against 4th larval instar of red palm weevil *Rhynchophorus ferrugineus* (RPW) which was exposed to obligatory feeding on apple fruits treated with different concentrations of the tested compounds alone and as mixture. General average of mortality was 69.6% and 55.2%, with use of Cydial L and used car oil, respectively, whereas inorganic salts caused mortality of 13.6%. Data obtained revealed that injection of the mixture of the three tested substances (inorganic salts, used car oil and Cydial L at concentrations 5 and 7.5% caused 80 and 88% mortality, whereas 10% concentration caused RPW larval mortality of around 100%, 72 hours after treatment, followed by the mixture of used car oil with Cydial L, then the mixture of inorganic salts with used car oil, as compared with the control composed of larvae fed on apple fruits injected with distilled water. The results also showed that the individual use of the tested compounds such as Cydial L (pesticide) was the most effective, followed by used car oil and then inorganic salts against RPW larvae. Statistical analysis of the results showed that there was a significant difference between individual treatments, between the results of inorganic salts and those collected

from the treatment with used car oil, as well as between the treatment of inorganic salts and chemical pesticides ($F=4.28$, $LSD=12.65$). There was no significant difference at 5% between treatment with the mixtures of the three tested compounds. The results indicated that the mortality rate of red palm weevil larvae increased as the concentration of the tested materials increased. It was concluded from the data obtained that the concentration of 10% of the mixture of the three tested materials was the most effective against the red palm weevil larvae, in addition to the low cost and environmental protection from chemical pollutants, and reduction of health hazards to humans.

EN3

RED PALM WEEVIL INVASION MODELLING AND CONTROL OPTIONS. Sonia Boukhris Bouhachem¹, Antonio Ippolito² and Francesco Porcelli². (1) Laboratory of Plant Protection, National Institute of Agronomic Research of Tunisia (INRAT), 2049 Ariana, Carthage University, Tunisia; (2) DiSSPA-University of Bari Aldo Moro, Via Amendola 165/a, 70126 Bari, Italy, Email: francesco.porcelli.phd@gmail.com

The *Rhynchophorus ferrugineus* Olivier 1790 (RPW) remains an invasive species despite the abundant studies and control efforts. Today the weevil menaces the Caribbeans and the Neotropics with their Oil Palm production. Here we consider pest bionomics and the guild of its symbionts to discuss available control approaches in different countries and host plants. Morphological features such as paragenital pouches with their nematode and bacteria inhabitants, the phoretic mites, the grubs plasmophagy and the associated yeast create a protective infestation site. The modelling suggests disturbing relevant tracts of pest autecology and synecology in adequate time and mode, thus unpairing the pest fitness and mitigating the damages consequent to infestation. The SAPW *Rhynchophorus palmarum* Linnaeus, 1758, and the Agave Weevil *Scyphophorus acupunctatus* Gyllenhaal, 1838 well mirror RPW on different host plants helping to better understand the plant-to-pest interaction and the inflicted damage in the palearctic and neotropic realms.

EN4

DATE PALM FARMERS MISTAKES THAT HINDER THE CONTROL OF THE RED PALM WEEVIL, RHYNCHOPHORUS FERRUGINEUS (OLIVIER). Salah M.M. Gameel, Plant Protection Research Institute, Agricultural Research Center, Egypt, Email: Salah_gameel@yahoo.com

This intensive field study was conducted in the two largest Oases which cultivated economic date palm in the New Valley Governorate, Egypt to monitor the mistakes made by the farmers, which delay control measures and contribute to increase in the infestation with red palm weevil. One of the factors which delay detection and application of control measures is the fact that many farmers do not envisage the pest danger and do not know the infestation symptoms and the different pest stages, and mainly depend on the Directorate of Agriculture in all procedures related to the control. During horticultural practices many mistakes are often made by farmers which increase infestation levels such

as: 1) protection spraying is not carried out after pruning and offshoot removal, in addition to transfer of offshoots and date palm leaves from infested farms to healthy areas; 2) leaving the infested date palm waste that contains pest stages on the edges of the walkways and internal roads, which makes it a source of renewed infestation; 3) there is no interest in examining and pruning date palm males and palms originated from seeds (uneconomical); 4) periodic examination to identify the infestation of the red palm weevil is not carried out once a month; 5) lack of interest in controlling mice and rats; 6) many farmers believe that external spraying of pesticides or dusting with agricultural sulfur and burning infested palms eliminates the red palm weevil; 7). Treatment with a high concentration of pesticides leads to date palm death, 8) wrong injection of the date palm heart (Jumara) could kill the tree. After raising farmers' awareness and correcting those mistakes, the red palm weevil infestation decreased to 48.27% after the first year of training.

EN5

MONITORING OF THE ANNUAL PRESENCE OF THE PEACH FRUIT FLY BACTEROCERA ZONATA (SOUNDERS) COMPARED TO THE MEDITERRANEAN FRUIT FLY CERATITIS CAPITATA WIEDEMANN USING ATTRACTING PHEROMONE TRAPS IN MIXED ORCHARDS IN BAGHDAD GOVERNORATE. Abdul Razzaq and Amal Salman, Ministry of Agriculture, Agricultural of Extension and Training Office, Abu Ghraib, Bagdad, Iraq, Email: amal2004s2000@yahoo.com

This study was carried out to monitor annual presence of the peach fruit fly *Bacterocera zonata* compared to the Mediterranean fruit fly *Ceratitis capitata* in mixed orchards (deciduous and citrus) from 22/9/2016 to 28/12/2017 in three mixed orchards with an area of 25 dunums in the Baghdad governorate, Sadr Canal area. The results showed a decrease in the incidence of the Mediterranean fruit fly. The number of *Ceratitis capitata* insects caught in attraction pheromone traps of delta type was very weak compared to the number of peach fruit fly trapped, despite the availability of their host plants, as insect's numbers peaked on deciduous plants in the second week of June with a total of 1081 insects/trap/week when the maximum temperature was 42°C, the lowest was 30°C and the relative humidity was 19%. Whereas, in citrus populations, the insects peaked in the fourth week of December, with a total of 58 insects/trap/week when the maximum temperature was 17°C, minimum 11°C, and relative humidity 52%. The peach fruit fly was present throughout the study period in the orchards despite fluctuation in their numbers when the host was not available, but they did not disappear. The insect numbers peaked at the beginning of the third week of July with a total of 6160 insects/trap/week when maximum temperature was 46°C and the minimum was 33°C and the relative humidity was 13%. Whereas the insect peaked on its citrus hosts in the first week of November with a total of 4449 insects/trap/week when the maximum temperature was 17°C and the minimum was 11°C, and relative humidity was 52%, and it was more harmful to citrus fruits than the Mediterranean fruit fly

despite being together. The integrated management program for both insects will be discussed.

EN6

STUDY OF THE BEHAVIOR OF CODLING MOTH ON DIFFERENT APPLE VARIETIES IN LATTAKIA GOVERNORATE, SYRIA. Faten Mraisha¹, Ali Dibo², Hanan Habak¹, Modar Alsouleman¹, Raefat Bahlol¹, Dina Fayod¹, Ftoun Kerali¹ and Rawad Hatim¹. (1) Agriculture Scientific Research Center, Latakia, Syria, Email: mraishafaten@gmail.com; (2) Hama University, Faculty of Agriculture, Alsalmia, Syria.

This study was carried out at the Kassab Research Station of the Scientific Research Center in Latakia, Syria for three years from 2017 to 2019 to study the behavior of the codling moth *Cydia pomonella* on different apple varieties with the use of pheromone traps. Fruit samples were also observed, and infestation rate was calculated. The results showed a clear variation in infestation rate with codling moth and ranged from 10% in Ain al-Dulbah site to 26% in Al Sakhra village, and it was 20% for golden variety during September 2017 and increased to 52% during the 2018 season, whereas it ranged between 12% and 23% on the varieties introduced during the 2017 season and reached 60% in 2018 and 42% during the 2019 season. Adults started to appear in early May and continued until October. With two flight peaks recorded, they coincided with the beginning of June and September.

EN7

SURVEY OF *LICHTENSIA VIBURNION* ON OLIVE TREES IN SABRATA, LIBYA. Afaf Rajab Hamza¹ and Halluma Mohammed Kerra². (1) Ministry of Agriculture and Livestock, Tripoli, Libya, Email: afafhamzahamza@gmail.com; (2) Plant Protection Department Faculty of Agriculture, University of Tripoli, Libya.

A study was conducted to survey the distribution of olive scale insect (*Lichtensia viburni*) (Hemiptera: Coccidae) on olive trees at Sabrata west of Tripoli province. The study covered the following 13 regions: Al-Alalga, Abu-Jdua, Nahda, OM-Elhaloof, Aggar, Tillil, Al-wadi, Dahman, BIR-Elkarma, Khatatba, Gerwed, Kharasan, and Al-Gabbar. The results obtained showed that the insect *L. viburni* was found in all regions surveyed, but the infestation rate range was 3.3-24.7% in farms frequently irrigated, and 0.00-12% in dry land farming systems. The higher infestation rate was found at Om-Elhaloof (24.7%), 20.9% at Al-alalga, and the least infestation rate was detected on trees at Gabbar and Al-wadi, 3.3 and 0.7%, respectively. Table olive cultivars (Taliani, and Ocolana) were more susceptible to insect infestation compared to other olive cultivars, whereas oil cultivar Safagsi was more sensitive than Nab-Elgamal cultivar.

EN8

IMPORTANCE OF MYRMECO FAUNA ASSOCIATED WITH A POMEGRANATE AGROECOSYSTEM IN THE HODNA BASIN. Ghaniyya Mekki, Hadjr Amara, Ghania Barech and Mourad Khaldi, Department of Agronomic Sciences, Faculty of

Sciences, University Mohamed Boudiaf of M'sila 28000, Algeria, Email: ghaniyya.mekki@univ-msila.dz

This work was carried out in the region of Ouled Slema (M'sila) belonging to a semi-arid bioclimatic zone in Algeria. The study was carried out during two seasons (winter and spring of 2017). It aimed to contribute to the understanding of diversity of arthropods associated with a pomegranate orchard, with a focus on the bio-indicator role of ants in this agro-ecosystem. The survey of arthropod species was made by using different methods of sampling (barber pots, soil washing, hand capture). Results obtained revealed the presence of 101 species of Arthropods. The Insects were the most represented with a dominance of members of the order Hymenoptera, with high abundance of members of the family Formicidae, especially in the spring. Ants played a crucial ecological role in pomegranates by contributing to the biological control of larvae and nymphs of pests such as *Ceratitis capitata*.

EN9

SEQUENTIAL SAMPLING PLANS FOR APHIDS ON WINTER CANOLA. Aqeel Alyousuf¹, Kris Giles², Norman Elliott³, George Opit² and Mark Payton². (1) University of Basra, Basra, Iraq, Email: aqeel.alyousuf@okstate.edu; (2) Oklahoma State University, Oklahoma, USA; (3) USDA- ARS, Oklahoma, USA.

The results of spatial distribution pattern analyses indicated that turnip aphids, green peach aphids and combined aphids on both sub-plant and whole canola plant units were highly aggregated in canola fields. Enumerative sequential and Iwao's sequential classification sampling plans, were constructed for action thresholds of 25, 50, and 100 aphids per sub-plant unit. Relative to pest management decision making and based on sequential sampling plans for aphid populations based on Iwao's methodology would be useful near economic thresholds.

EN10

BIOMETRIC AND CHEMICAL EVALUATION OF CORK OAK ACORNS (*QUERCUS SUBER*) IN NORTHWESTERN TUNISIA. Olfa Ezzine¹, Kaouther Ben Yahia¹, Samir Dhahri¹, Rania Marzouki^{1,2}, Youssef Ammari¹, Mohamed Lahbib Ben Jamaa¹. (1) National Research Institute of Rural Engineering, Water and Forests, 2080 Ariana, Tunisia; Email: olfa.ezzine@gmail.com; (2) High Institute of Biotechnology of Beja, Tunisia.

Cork oak acorns play an important role in the natural regeneration of cork oak which depends mainly on the abundance of the acorn. The objective of this study was to evaluate the phytosanitary status of cork oak acorns in three forests located in northwestern Tunisia. Acorn samples were collected from soil surface, sorted in healthy and attacked acorns and then measured their width, length and diameter. The attacked acorns were classified according to number of holes per acorn. The percentage of infested and un-infested acorns differed between forests. Infestation varied between 8 and 28%. The biometric study of acorns showed that those attacked by insects had reduced length and weight as compared to healthy ones. Two types of insects which attack acorns were identified: *Cydia* sp. (Lepidoptera) and *Curculio* sp. (Coleoptera). Larvae of these two species

attacked the nut. A single acorn can be attacked by a single species or both species at the same time. Within the same acorn, we can observe between 1 and 3 exit holes of *Curculio* sp. located in the middle, and between 1 and 2 exit holes of *Cydia* sp. located at the bottom. The biochemical study (protein determination) of healthy and attacked acorns showed that the difference in protein content of the kernel is significant between the two types of acorns. It seems that the attack of the insects has an effect on the nut and not on the pericarp or the whole acorn. The highest amount of protein was recorded in Ain Draham Forest. It seems that this forest offers good quality acorn. Whereas, Bellif forest offers a lower acorn quality, but they are more robust to insect attacks since the difference between healthy and attacked acorns in protein content was not significant. It can be concluded that the attack of acorns by insects was not considerable. Nevertheless, annual monitoring is essential for the preservation of Tunisian forests.

EN11 MORPHOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF *COLEOPHORA PERPLEXELLA* TOLL (1960) ON CEREAL CROPS.

Dalila Haouas¹, Lassaad Mdellel¹, Chaouki Hafsi² and Giorgio Baldizzone³. (1) Laboratory of Support for the Sustainability of Agricultural Production Systems in the North West Region, Ecole Supérieure d'Agriculture du Kef, University of Jendouba, Tunisia; Email: dalila_haouas@yahoo.fr; (2) Regional Commissariat for Agricultural Development of Kef, Tunisia; (3) Scuola di Biodiversità di Villa Paolina, Asti, Italy.

During agricultural seasons 2015-2016, a varying degree of vegetation cover loss was detected in barley and oat plots at Kef region, Tunisia. A laboratory study of samples taken from these crops showed that damage was caused by lepidopteran larvae. Due to the extent of damage caused by this pest, morphological and biological traits (life cycle, host plants and geographical distribution) were studied. Morphological study of the adult indicated that it belongs to Lepidoptera order, Microlepidoptera suborder, Coleophoridae family, *Coleophora* genus and *Perplexella* species. Biological characteristics study showed the presence of five larval instars and a pupa inside an insect made case. Larvae fed on leaves, causing tunnels and the adults appeared in March. Concerning geographical distribution, results showed more abundance of pest larvae in the northern and different eastern Kef sites (Eddir, Oued El Ain, Oued Malegue, SidiHaraghi) compared to southern sites (Tejrouine, Dahmanie, Ksour). The pest was observed on oat, barley, wheat and triticale host plants with high damage to oat.

EN12
DYNAMIC POPULATIONS OF THE APRICOT SEED
WASP *EURYTOMA SAMSONOWI* AND CONTROL
STRATEGY. Takwa Wannassi, Khaled Abbes, Ahlem Harbi and Brahim Chermiti, University of Sousse, High Agronomic Institute of Chott-Mariem, Department of Biological Sciences and Plant Protection, Sousse, Tunisia, Email: takwa.wannassi@issacm.u-sousse.tn

Eurytoma samsonowi (Hymenoptera: Eurytomidae) is an emerging pest species was recorded in 2015 in the oasis of Gafsa, south-west of Tunisia. It is considered as a serious pest of apricot seeds causing significant fruit losses. Field trials were carried out between 2017 and 2019 aimed to determine the population dynamics and a control strategy. Results on its biology showed that the wasp is a univoltine species completes one generation per year. Females oviposit their eggs in March-April in the nucellar tissue of the developing apricot seed. After that, the hatched larvae feed on the seed causing massive fruit fall and then it enters in diapause by end of June-beginning of July. The larva pupates mostly in January and the wasps emerge by the end of February until end of March. The efficiency of four insecticides, which are Deltacal 25 EC (Deltamethrin, 25 g/l), Cypercal 250 EC (Cypermethrin, 250 g/l), Bombard 100 EC (Alphamethrin, 100 g/l) and Synara 25WG (Thiamethoxam, 25%) were assessed under field conditions. Treatment of early ripe cultivar Bakour with Synara and Bombard, respectively, showed 20 % and 40% yield loss rates (LR) compared to 58% for the control. Treatment of mid ripe cultivar Amor Leuch revealed 24% LR for Synara, 50% for Bombard compared with 80% for the control. In case of the late maturing cultivar Bayoudhi, the LR was estimated to be 26% for both insecticides, with 80% for the control. Looking into the treatments with Cypercal and Deltacal compared to the control which were performed on early maturing cultivar Bedri, the LR was 48, 30 and 67%, respectively. Independent of cultivar and with one application treatment, Synara was very efficient against the apricot wasp as systemic insecticide which reduced infestation by 80%, and the other tested contact insecticide Bombard, Cypercal and Deltacal were efficient in reducing infestation. In conclusion, these insecticides are recommended to significantly reduce fruits infestation.

EN13
THE PRIMARY CAUSES FOR THE DEATH OF
SOME PINE TREES IN JORDANIAN FORESTS.
Ahmad Katbeh, Department of Plant Protection, Faculty of Agriculture, The University of Jordan, Amman, 11942, Jordan, Email: Ahmadk@ju.edu.jo

The number of dead pine trees was observed increasing during the last few years in several forests in the north of Jordan, including Nuwairan, Wasfi Al-Tal, Dibein and Al-Rumman forests. Through field visits to these sites, different infestation levels were detected according to the location, which was higher in areas facing sunlight more than others. The trees most susceptible to infestation were those facing drought, with broken branches, or those adjacent to previously infested trees. Examination of dead trees in all sites showed that all of them were infested with bark beetles. Samples of infested branches and bark were taken at various heights from dead trees after cutting with an automatic saw. Adult beetles and patterns of tunnels engraved on wood or bark were examined at the Insect Museum at the University of Jordan. Four species of bark beetles of the Scolytinae of the Curculionidae family of the order Coleoptera were identified: *Pityogenes calcaratus*, *Orthotomicus erosus*, *Hylastes linearis* and *Crypturgus mediterraneus*. There is still a need to know the prevailing bark beetle species in the

rest of the Kingdom's forests and to determine the infestation rate in order to design an appropriate control program. Preserving the environment and using safer control methods such as pheromones and repellants should be considered. Symptoms of infestation, global geographical distribution, and available data on the biology and ecology of these species will be presented.

EN14

FIRST REPORT ON DIVERSITY OF WHITE GRUB SPECIES (SCARABAEIDAE: COLEOPTERA) FAUNA FROM HARYANA, INDIA. Malik M.A. Abaker^{1,2}, Krishna Rolania¹ and S.S. Yadav¹. (1) Department of Entomology, CCS Haryana Agricultural University, Hisar, India, Email: malick.termit@yahoo.com; (2) Plant Protection Directorate, Gezira, Sudan

The present work provides information on diversity of white grub species from the different climatic zones (Arid, Semi-arid and Dry-arid) of Haryana state, India. The survey was conducted in the monsoon season of 2019-2020 using light traps and the coleopteran adults were collected through hand picking. Collected adults (234 samples) were scientifically preserved before sending for identification to Rajasthan Agricultural Research Institute, Jaipur (Rajasthan, India). A total of 18 species were found during the study period under 13 genera distributed in five subfamilies. Most of these species were newly reported in Haryana while expected species *Holotrichia consanguinea* was recorded with very low abundance. The most dominant species, *Phyllognathus dionysius* was observed up to 36.3% followed by *Anomall dimidiata* and *Chiloba acuta* (10.7%), *Onthophagus gazella* (6.8%), *Onitis philemon* (5.1%) and *Barhmina flavoserica* (4.7%). The lowest abundance (0.9%) was observed in species *H. consanguinea*, *A. ruficapilla* and *H. serrata* followed by *Catharsius sagax* and *A. dorsalis* (0.43%). Diversity index of subfamily Dynastinae recorded highest abundance of 39.7%, whereas the subfamilies Rutelinae, Scarabaeinae, Cetoniinae and Melanthinae were recorded with abundance of 15.4, 15.4, 14.5 and 12.8%, respectively. However, high Shannon Biodiversity Index was noticed ($H = 2.173$) for the members of Scarabaeidae family from Haryana.

EN15

ASSESSMENT OF THE BIOTIC POTENTIAL OF THE MEDITERRANEAN FRUIT FLY *CERATITIS CAPITATA* ON SELECTED CULTIVATED SOLANACEAE. Ahlem Harbi, Khaled Abbes and Brahim Chermiti, High Agronomic Institute of Chott-Mariem, Chott-Mariem, Sousse, Tunisia, Email: harbi.ahlem@hotmail.fr

Fruit flies of the family Tephritidae are among the most important pests of fruit and vegetable crops in the world. This is particularly the case in Tunisia where *Ceratitis capitata* (Diptera: Tephritidae) is a hindrance to the development of fruit crops. In this work, we tested the demographic parameters of *C. capitata* on Solanaceae species either on intact fruits or on their juices. *C. capitata* was able to develop and survive on all Solanaceae species tested except green pepper. The highest survival rate was recorded on tomato with around 80%. The highest pupal

weights in both intact fruits and their juices were 12.12×10^{-3} and 5×10^{-3} g, respectively. Regarding the larval development time, the longest time was observed on eggplant fruits (14 days) followed by tomato (11 days) while on pepper and red pepper, it was 9 days. The hierarchy observed in the larval performance of each fruit species could be explained in part by the biochemical composition of the host fruit.

EN16

BIOLOGICAL STUDY ON CUCURBIT FLY *DACUS CILIATUS* (LOEW) AND THE EVALUATION OF SOME INSECTICIDES FOR ITS CONTROL IN KURDISTAN REGION-IRAQ. Gehan Haji Maronsy¹ and Shamal Abdullah Al-Muffti². (1) Department of Plant Protection, Collage of Agricultural, University of Duhok, Iraqi Kurdistan, Iraq, Email: gehan.younis@uod.ac; (2) Department of Biology, College of Science, University of Duhok, Iraqi Kurdistan, Iraq.

Survey for fruit fly on different host plants was carried out at many villages in the provinces of Duhok, Erbil and Sulaimaniyah in Kurdistan region, Iraq, during the period from mid-September until first December 2017 and from mid-May until end of September, 2018. Results obtained indicated the presence of the Ethiopian fruit fly *Dacus ciliatus* (Loew) which belong to the family Tephritidae, order Diptera. This pest was found infesting most vegetables including cucurbitaceae and some of fruit trees such as fig. Investigation of some biological aspects showed that the mean egg incubation period was 6.7 ± 0.404 days, and the egg hatching rate was 75%. The duration of 1st, 2nd and 3rd instars period were 2.45 ± 0.114 , 3.35 ± 0.109 and 4.5 ± 0.114 days, respectively. The mature larvae entered the pre-pupa stage during two days. The average pupal stage lasted 7.85 ± 0.220 days. The pre-oviposition period was 6-10 days with an average of 7.7 ± 0.538 days. The oviposition period was 18-23 days with an average of 20.1 ± 0.604 days, and the post-oviposition period was 43-52 days with an average of 47.1 ± 0.835 days. Eggs were usually deposited in masses of 28-113 eggs per mass. The number of the total eggs laid by a single female was 389 eggs with a mean of 51.4 eggs per day. The effectiveness of some insecticides was also evaluated under laboratory conditions. The results showed that the insecticide Vantex had the lowest toxicity on cucurbit fly adults. Whereas, the highest toxicity was reported for the insecticide Matador. The LC_{50} values of Bullmac, Vantex and Matador insecticides on adults were 36 ppm, 3.6 ppm and 1 ppm, respectively.

EN17

SOME INVASIVE PESTS OF THE IRAQI AGROECOSYSTEM. Mohammed Zaidan Khalaf¹, Ahmed Mohammed Tareq², Ibrahim Jadooa Al-Juboory³, Falah Hanash Naher⁴, Adnan Hafdh Salman⁴ and Bushra Hasan Abdulhamz⁴. (1) Integrated Pest Control Research Center, Directorate of Agricultural Research, Ministry of Science & Technology, Baghdad, Iraq, Email: mkhalaf34@yahoo.co.uk; (2) Medical Technical Institute/Mansour, Middle Technical University, Baghdad, Republic of Iraq; (3) Arab Society for Plant Protection, Amman, Jordan; (4) Integrated Pest Control Research

Center, Directorate of Agricultural Research, Ministry of Science & Technology, Baghdad, Iraq.

The presence of some invasive pests was registered in Iraqi agroecosystem during the past few years. These pests included: two subspecies of palm borers belonging to the Genus *Oryctes*, Arabian Rhinoceros Beetle, *Oryctes agamemnon arabicus* Fairmaire and root borer *Oryctes agamemnon matthiessini* Reitter during 2013 and caused huge damage in palm trees. Mexican black Scale, *Saissetia miranda* (Cockerell & Parrott) in 2017 caused damage in Fig trees. Vine mealybug, *Planococcus ficus* (Signorato) during 2018 caused an economic damage on fig trees. Banded conical snail (Linnaeus) during 2019 caused an important damage in wheat, yield contamination and infect animals (Young ruminants) causing lung inflammation (Pneumonia). Parasitism with entomopathogenic nematodes *Rhabditis blumi* and *Metarhabditis adenobia* were recorded on palm borers. In addition, parasites belonging to the families Encyrtidae and Cecidomyidae were recorded on *S. miranda* and *P. ficus*. These results will help the future studies concerning the invasive pests of the Iraqi agroecosystem and the design of appropriate integrated pest management programs.

EN18

TWO NEW RECORDS OF JUMPING PLANT LICE (HEMIPTERA: TRIOZIDAE) FROM SYRIA. Mahran Zeity, Latakia Center for Scientific Agricultural Research, General Commission for Scientific Agricultural Research, Damascus, Syria, Email: mzma2009@gmail.com

Two species of jumping plant lice of the family Triozidae (Hemiptera, Psylloidea) were collected during the regular survey of plant health in the governorate of Latakia, Syria. The collected species were identified as fig leaf-rolling psyllid (FLRP) *Trioza brevigenae* Mathur and *Phylloplecta trisignata* (L w) on the *Ficus microcarpa* and *Rubus* sp., respectively. Both species are not yet reported from Syria. Fig leaf-rolling psyllid is not well reported and studied globally due to the similarity of its symptoms with other insects such as thrips and mealybugs associated with the same leaves of some trees. Occurrence of these species is restricted to only three countries, India, United States and Cyprus. Based on images and unpublished data, these species may inhabit *Ficus microcarpa* in many Arabian and European countries that share the Mediterranean basin. On the other hand, *Rubus* psyllid has been reported from several countries around the world, including some neighboring countries such as Lebanon and Turkey.

EN19

LIFE CYCLE STUDY OF CASAMA INNOTATA ON ACACIA HORRIDA IN SOUTHERN TUNISIA. Omayma Laajimi^{1,2}, Olfa Ezzine¹, Samir Dhahri¹ and Mohamed Lahbib Ben Jam  a¹. (1) University of Carthage, National Institute for Research in Rural Engineering Water and Forest (INRGREF), 2080 Ariana, Tunisia, Email: omaymalaajimi@gmail.com; (2) University of Tunis El Manar, Faculty of Science of Tunis, Tunisia.

In December 2009, a defoliation of *Acacia horrida* trees caused by mature larvae of *Casama innotata* (Lepidoptera: Erebid  e) was observed in Jebel Broumet in

southern Tunisia. This work aimed to investigate the biology of this pest for the first time in Tunisia. Larvae of *C. innotata* were collected from the field during spring 2019 and maintained in the laboratory until adult emergence and reproduction. Neonate larvae were reared on *A. horrida* leaves and were used for the morphometrical study and for determining the number of instars and the duration of each stage until pupation and adult emergence. Pupal stage duration and sex ratio were determined. Results obtained showed that female fecundity was 189 eggs/female. Hatches that fed on optimal diets went through 5 stages. The duration of the larval development is about 30.166  0.70 days (min=23, max=41). The duration of each instar larva ranged from 5 to 8 days, with first instar larvae spending the longest time to molt to the second instar. Body length measurements were 3.8 mm for the first instar and went up to 19.5 mm for the fifth instar. Duration of pupal stage was about 11.53  0.33 days (min=7, max=15). The duration of life cycle from larva to adult lasted 40 days and the sex ratio was 0.73. It can be concluded that foliage quality and temperature fluctuations can have major effects on the pests' life cycle. Further tests should be conducted to determine larval feeding preferences.

EN20

INSECTS ASSOCIATED WITH MARULA (SCLEROCARYA BIRREA A. RICH) IN KENYA: IMPLICATIONS ON INDIGENOUS TREE SPECIES DOMESTICATION. Sheillah Cherotich¹, Alice Muchugi¹ and Jane Njuguna². (1) Genetic Resource Unit, World Agroforestry Centre, Nairobi, Kenya, Email: Cherotich.sheillah@yahoo.com; (2) Department of Plant Pathology, Kenya Forestry Research Institute, Nairobi, Kenya.

Marula (*Sclerocarya birrea* A. Rich; family Anacardiaceae) is widely grown species in drylands of Kenya and provide key nutrients and enhance diversification in agroforestry systems. A study was conducted to identify insects associated with *S. birrea* in Eastern Kenya and its implications on domestication. One hundred *S. birrea* trees were randomly selected in Kitui and Makueni County. Bait traps were erected on branches of selected trees to capture visiting insects. Pan traps and sweep nets were used to capture flying insects on sites. Mature and immature fruits were randomly selected and cut. Data obtained was analyzed using GenStat version 21 and descriptive charts used to inform the difference in insects' interaction with *S. birrea*. Beneficial insects identified included *Musca* spp., *Eumenes* spp., *Pentala* spp. and members of Apidae, Braconidae, Peridae, Libellulidae and Vespidae. Defoliation was higher in Makueni county associated with Lepidoptera attack (54%). Scale insects (Hemiptera) were major pests of the fruit in Kitui, occurred at 48.1% causing rotting and premature abortion of fruits. Coleoptera members occurred at 4% in Kitui. Cerambycidae and Curculionidae larvae were found in 30% of probed mature fruits in Kitui and Makueni. Among the probed seeds, 11.7% had empty endosperms implying poor pollination levels. This study gives an insight on *S. birrea*-insect interaction as key potential factor for successful tree species domestication.

EN21

LARVAL COMPETITION ON *QUERCUS AFARES* IN THE NATURAL RESERVE OF AIN ZANA IN NORTHWESTERN TUNISIA. Yaussra Mannai, Olfa Ezzine and Mohamed Lahbib Ben Jemâa, University of Carthage, National Research Institute of Rural engineering, Water and Forests (INRGREF) BP10, Avenue Hédi Karray, 2080 Ariana, Tunisia, Email: yaussra.mannai@yahoo.fr

Ain Zana, is a natural reserve, situated at 900m altitude with an area of 47 ha in northwestern Tunisia. Vegetation is characterized by the presence of the endemic and the hybrid species *afares* oak (*Quercus afares*), a small relict population growing together with *Q. suber* and *Q. canariensis*. In 2009, a significant defoliation caused by larvae of Lepidoptera mainly *Operophtera brumata* (Lep, Geometridae) was observed. In this work we aimed to study the competition between this pest and other Lepidoptera species. Investigations were carried out in Ain Zana, every week, from mid-March to late April from 2009 until 2013. Two branches from 10 mature *afares* oak trees were monitored, one low-level branch and one from crown height level were cut and bagged. In the laboratory, branches were sorted to count larval density and to calculate diversity index. A total of 1130 individuals of 20 species belonging to 6 families were recorded. The most diverse family was the Noctuidae (40% of collected larvae) and the most abundant family was the Geometridae (75% of collected larvae). In all study years, *O. brumata* was the most abundant species, with 69% of collected larvae. To the contrary, *Colotois* sp. was the less abundant (0.35%). Shannon index was low and varied between 0.99 and 3. These values indicated that the Lepidopterous fauna on *afares* oak is poorly diversified. Whereas species distribution appears to be balanced and varied between 0.33 and 0.8. The monitoring of Lepidoptera species in Tunisian oak forests seems to be very important since it gives information about pest outbreaks and help to better manage these ecosystems.

EN22

THE BLACK FIG FLY *SILBA ADIPATA* AS AN EMERGING PEST IN TUNISIA: PRELIMINARY DATA ON GEOGRAPHIC DISTRIBUTION, BIOECOLOGY AND DAMAGE. Khaled Abbas, Ahlem Harbi, Abir Hafsi and Brahim Chermiti, High Agronomic Institute of Chott-Mariem, P.O. Box 47-4042, Chott-Mariem, Sousse, Tunisia, Email: abbes.kaled@live.fr

Frugivorous fruit flies are considered among the most damaging pests of cultivated fruit crops. The most studied ones are those of the Tephritidae family such as the Mediterranean fruit fly (Medfly) *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). The black fig fly (BFF) *Silba adipata* McAlpine (1956) (Diptera: Lonchaeidae) is a frugivorous monophagous fly species originating from the Mediterranean basin and the Middle East region. Not much data is available in the literature regarding its bio-ecology, symptoms, distribution and damage. In 2015, severe fruit losses caused by this pest were reported in numerous fig producing areas in Tunisia. In this study we report for the first time this pest in Tunisia. Furthermore, laboratory and field observations performed in the main Tunisian fig production areas allowed to address the geographic

distribution of this pest, its status in Tunisia and symptoms caused by it. BFF was found widely distributed in Tunisia, as it was detected in all 12 fig producing areas. Moreover, in the period between 2016 and 2018, field monitoring of the infestation rate on different fig cultivars grown in the three main production areas in Tunisia (Djebba-Thibar, Chott-Mariem and Medenine), which allowed to assess the damage it caused. It was found that high losses on figs and caprifigs occurred depending on the year, the region and the cultivar. Maximum infestation rate of caprifigs was observed on cultivar Weldani in the region of Medenine in 2016 (81.25 %), whereas the highest infestation rate of figs was observed on cultivars Wahchi Thibar (88.17%), Thguegli Thibar (73.68%), Bouhouli Thibar (67.27%), Sawoudi (61.64 %), Thguegli Djebba (60 %) and Bouhouli Djebba (50.60 %). Consequently, the BFF should be considered as an emerging economic pest of caprifigs and figs in Tunisia. Possible control methods are explored and will be discussed.

EN23

A NOVEL DITERPENE HYDROCARBON IDENTIFIED FROM BRASSICA SPP. SEEDLINGS, IS MEDIATING HOST LOCATION PROCESS OF THE HERBIVOROUS STINK BUG *BAGRADA HILARIS*. Mokhtar Abdulsattar Arif^{1,2}, Salvatore Guarino³, Ezio Peri² and Stefano Colazza². (1) Ministry of Agriculture, Directorate of Plant Protection, Baghdad, Iraq, Email: mokhtar.arif@unipa.it; (2) Dipartimento di Scienze Agrarie, Alimentari e Forestali, Università degli Studi di Palermo, Viale delle Scienze Ed. 5, 90128 Palermo, Italy; (3) Istituto di Bioscienze e Biorisorse (IBBR), Consiglio Nazionale delle Ricerche (CNR), Corso Calatafimi 414, 90129 Palermo, Italy.

Bagrada hilaris Burmeister is a stink bug native to Asia and Africa and invasive in the United States, Mexico, South America and Italy. This pest determines damage to various vegetable crops in the genus *Brassica*, with seedlings being particularly susceptible to *B. hilaris* attacks. In Italy, this pest is confined to Pantelleria island where it feeds on caper (*Capparis spinosa* L.). In this study, the role of volatile organic compounds (VOCs) emitted by seedlings of three *Brassica* species on host preference of *B. hilaris* was evaluated. The main objective of this study was to identify the chemicals cues involved in the host plant location processes through laboratory and field studies. Behavioral bioassays carried out in dual choice arena and olfactometer, indicated that adult *B. hilaris* preferred *B. oleracea* and *B. napus* over *B. carinata*. A field trap bioassay, done in an infested caper field and using living *B. oleracea* seedlings as lure, indicated that the seedlings can attract a consistent number of individuals in traps compared with the control. *Brassica oleracea* seedlings volatiles were collected and bioassayed toward *B. hilaris* individuals using electroantennographic techniques and behavioral observation. The crude extracts of the VOCs from *B. oleracea* seedlings and liquid chromatography non-polar fraction attracted *B. hilaris* individuals, whereas there were no responses to the more polar fractions. Chemical analysis using GC-MS, indicated that the main constituent of the non-polar fraction is a diterpene hydrocarbon of novel structure, with trace amounts of several other diterpene hydrocarbons.

This compound occurred in VOCs from both of the preferred host plants *B. oleracea* and *B. napus*, but not in VOCs of *B. carinata*. The structure of this compound, named brassicadiene, was characterized. This compound isolated and bioassayed in olfactometer elicited attraction response versus *B. hiliaris*, suggesting that it is involved in identifying host plant location.

EN24

INVASIVES PESTS OR NEW SPECIES ON ORNAMENTAL PLANT AND THEIR RISK. Monia Kamel Ben Halima¹, Rihem Adouani Beltaief¹, Zouari Sana¹ and Lassaad Mdellel². (1) Higher Agronomic Institute of Chott Mariem (ISA CM), University of Sousse, Tunisia, Email: kamonia_tn@yahoo.fr; (2) Higher School of Agriculture (ESAK), University of Jendouba, Kef, Tunisia.

During the 2007–2020 period, a survey was conducted to identify pests or invasive species on ornamental plants and their distribution in different areas of Tunisia. Seven mealybug species (Hemiptera, Pseudococcidae) belonging to five genera were identified: *Maconellicoccus hirsutus* Green, *Phenacoccus peruvianus* Granara de Willink, *Phenacoccus madeirensis* Green, *Planococcus vovae* Nasonov, *Planococcus citri* Risso, *Ferrisia virgata* Cockerell, *Pseudococcus longispinus* and *Targioni-Tozzetti*. These mealybugs were found on twelve ornamental plants belonging to nine families. All species were recorded during the dry season except *P. citri* was the single specie recorded during the wet season. Moreover, three aphid species were detected for the first time in different areas and host plants. *Eulachnus tuberculos temmatus* (Lachninae: Eulachnini) was collected on Aleppo pine *Pinus halepensis*. *Siphonotrophia cupressi* (Hemiptera: Aphididae) on Cypress *Cupressus sempervirens*. *Greenidea ficicola* was encountered in *Ficus* species such *Ficus nitida*. The new pest *Corythauma ayyari* (Hemiptera: Tingidae) was found on *Jasminum grandiflorum* (Spanish jasmine), *Jasminum sambac* (Arabian jasmine) and *Agonosceca succincta* Heeger (Hemiptera, Aphalaridae), and on *Ruta Chalepensis* plant. In addition, this study showed the presence of *Greenidea ficicola* on figs and *P. peruvianus* on pepper and tomato plants.

EN25

POPULATION DYNAMIC OF WHITE GRUBS IN TUNISIA BASED ON CULTURE ROTATION. Habiba Glida Gnidez¹, Abdelkarim Chiab² and Moncef Ben-Hammouda². (1) Laboratory of Entomology, Higher School of Agriculture of El-Kef, El-Kef, Tunisia, Email: hablida@yahoo.fr; (2) Laboratory of Cereal Production Physiology, Higher school of Agriculture of El-Kef, Tunisia.

In northern Tunisia, white grubs (Coleoptera, Scarabaeoidea: Melolonthidae) are pests of field crops, particularly cereals. The dynamics of their populations was studied according to crop rotation by measuring the rate of infestation. Soil sampling over three growing seasons in Tinja/Bizerte region (Northern Tunisia), revealed the presence of two species, *Pseudoapterogyna euphytus euphytus* (Buquet, 1840) and *Pseudoapterogyna tynetis* (Baraud, 1972) belonging to the Rhizotrogini tribe. This study also showed that the fields were heavily infested. The

damage varied with time during the same year and from one year to another. The highest density of 70 larvae/m² was recorded in 2017. Results also showed that several crops have been damaged by white grubs: cereals (wheat, barley and oak), legumes (fenugreek), sulla and rapeseed. Larval densities differed between crops and crop rotation did not affect their populations because of the polyphagy of larvae.

EN26

ANALYSIS OF THE VOLATILE COMPOUNDS OF CONFUSED FLOUR BEETLE *TRIBOLIUM CONFUSUM* DU VAL IN WHEAT FLOUR. Najat Abuelnnor¹, N. Ratcliffe², B. de Costello² and P. Spencer-Phillips³. (1) Plant Protection Department, Faculty of Agriculture, University of Tripoli, Tripoli, Libya, Email: najat.abuelnnor@gmail.com; (2) Centre for Research in Analytical, Material and Sensor Sciences, University of the West of England, Bristol, UK; (3) Centre for Research in Plant Science, University of the West of England, Bristol, UK.

Solid-phase micro-extraction (SPME) fibres and automated thermal desorption (ATD) tubes were used with gas chromatography-mass spectrometry (GC-MS) to investigate volatile secretions from the headspace gas of adults and larvae of confused flour beetle *Tribolium confusum* du Val. A number of VOCs were specifically linked with adults of confused flour beetle *T. confusum*. These compounds were 2-methyl-p-benzoquinone and 2-ethyl-p-benzoquinone and 1-pentadecene. However, this study found that benzoquinones were not present in the headspace volatiles of the larvae of confused flour beetle, whereas, 1-pentadecene was detected in adults and larvae of this beetle.

EN27

COMBINED EFFECT OF PLANTING SPACES, NPK FERTILIZER AND HUMIC ACID ON THE INFESTATION RATES OF INSECT PESTS AND RUST DISEASE ON COMMON BEAN PLANTS. Fatma A. Mostafa¹, Maha, A.M. Tantawy² and A.R.I. Hanafy². (1) Plant Pathology Research Institute, Egypt, Email: fatmamostafa27@yahoo.com; (2) Plant Protection Research institute, Egypt.

Three planting spaces (7, 10 and 13 cm) between common bean seeds (polista) and different rates of NPK fertilizer and Humic acid (Humic+25% NPK, Humic+50% NPK, Humic+75% NPK, 100% NPK and Humic 100%) were evaluated during two successive seasons (2018 and 2019) at Suze Governorate to determine their combined effect on the rust *Uromyces appendiculatus* disease severity, population density of some insect pests, mainly aphids (*Aphis gossypii*, *Myzus persicae* and *Aphis craccivora*), whitefly (*Bemisia tabaci*) and jassids (*Empasca lybica*) on common bean plants, *Phaseolus vulgaris* cv. polista and to assess pod yield. The severity of rust disease infection and infestation with studied insects were affected significantly by planting space, as common bean plants cultivated at the closest planting space (7 cm) harbored significantly higher numbers of all the four pests and produced the highest weight of common bean pods in the two seasons. NPK fertilizer and Humic acid had a significant effect on the rust disease

infection and on the tested insect pests. The lowest infestation rate of the studied insect pests and rust disease infection were obtained from the common bean plants treated with Humic acid+50% NPK. Common bean plants which received Humic acid+75% NPK produced the significantly highest weight of pod in the two studied seasons. The infection rate with rust disease and infestation with the three studied insects were affected significantly by planting space and fertilizer levels. Common bean plants planted at the widest space (13 cm) and received Humic acid only exhibited the lowest infestation. Infection rate for all studied pests in the two seasons. Common bean plants planted at the narrowest space (7 cm) and treated with Humic acid+75% NPK showed the highest pod yield, for the two seasons. On the contrary, the lowest pods yield was obtained from common bean plants cultivated in widest spaces (13cm) and did not receive Humic acid and NPK fertilizer.

EN28

BIOLOGICAL AND ENVIRONMENTAL STUDY OF MAIZE STEM INSECTS IN SYRIA. Randa Abou Tara¹, Mohamad Kojia Al-Nahal², Naiif Al-Salty² and Mohamad Hajo³. (1) Faculty of Sciences, University of Damascus, Damascus, Syria, Email: randaaboutara@hotmail.com; (2) Faculty of Agriculture, University of Aleppo, Aleppo, Syria; (3) The General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria.

The field study was carried out by Al-Hasakah Research Station, the Agricultural Scientific Research Authority (GCSAR) during the years 2010 and 2011 using the randomized complete block design and the dry planting method (Afira). Sorghum seeds were planted on three main dates: the first on May 1st, And the second on June 1st, and the third on July 1st for both years of study (2010-2011). The flying activity of *Sesamia cretica* (Lederer) butterflies began in the first and third weeks of April with an average of 0.33 and 1 moth/trap, forming the first generation. This generation took between 6 and 8 weeks with an average of 2.41 and 2.16 moths/trap/week, with five generations/year for the two years of the study 2010-2011. These generations overlapped, and the fourth generation was the most prevalent and therefore the most harmful and the last generation was the longest. The flying activity of *Sesamia nonagrioides* (Lefebvre) butterflies in the Mediterranean started in the second and third week of April with an average of 0.33 moth/trap, forming the first generation. This generation lasted 5 and 7 weeks and averaged 1.57 and 1.8 moths/trap/week. It had six overlapping generations for the years 2010-2011, respectively, and the third generation was the most harmful. The flying activity of the European corn stalk butter *Ostrinia nubilalis* (Hübner) butterflies began in the third week of April with an average of 0.33 moth/trap in the first generation. This generation took 4 and 4 weeks with an average of 2.25 and 0.915 moth/trap/week and achieved three and four generations for the years 2010 and 2011, respectively.

EN29

ECOLOGICAL LIFE TABLES OF TOMATO BORER *TUTA ABSOLUTA* (MEYRICK) ON TOMATO IN GREENHOUSES. Amer J.A. Al-Gerrawy, Faculty of

Agriculture, Wasit University, Iraq, Email: aabbod@uowasit.edu.iq

The tomato borer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is considered as a devastating pest of tomato crop in both fields and greenhouses, infesting all parts of the plant except roots during all growth stages causing qualitative and quantitative losses in yield. The results of life tables construction showed that the egg stage was more critical for death factors during the period from 3rd March to 14th April with death rate of 45.46%, whereas the predation was responsible for 34.87%, in spite of many death factors which affects insect population density. The trend index (Ti) was increased to 1.85. Results also showed that the larval stage was more critical (41.09%) in another generation which was during 14th May to 6th June and predation was the most influencing factor which caused death of 32.13%. The trend index (Ti) decreased compared with previous generation to 1.07 and that refers to increase in death factors such as parasitism and predation.

EN30

***TUTA ABSOLUTA*: IS IT STILL AN INVASIVE PEST OF TOMATO CULTIVATIONS IN TUNISIA?** Asma Cherif and Kaouthar Grissa-Lebdi, Laboratory of Entomology-Acarology, Department of Plant Protection and Post-Harvest Diseases, National Agronomic Institute of Tunisia, 43 Avenue Charles Nicolle, Cité Mahrajène 1082 Tunis, Tunisia, Email: assoumacharif1986@gmail.com

Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) was classified as among the most serious pest of tomato crops in Tunisia. Since its first detection in 2008 and until now, various studies were conducted in order to better understand and manage this pest. In fact, *T. absoluta* has shown a high genetic conformity and a high ability to develop under different levels of temperature and relative humidity. Moreover, this pest had the potential to achieve up to 4 to 5 annual flight peaks and 3 to 4 generations of eggs and larvae under greenhouse and field conditions. To manage this pest, appropriate control programs were carried out. In this context, the combined use of mass trapping and insecticides produced an encouraging result, given that problems of resistance to insecticides was absent. Furthermore, rate of twenty *Trichogramma cocoeciae* (Marchal) (Hymenoptera: Trichogrammatidae) per tomato plants tested in protected and open filed crops proved to be as effective in reducing the pest population. In conclusion, 10 years after its first detection, *T. absoluta* was well known and managed in Tunisia. However, further studies are still needed in order to avoid any future problems of resistance to insecticides, which is the case in many countries.

EN31

A GENERAL LOOK ON DESCRIPTIVE DATA OF BACTERIAL COMMUNITIES ASSOCIATED WITH GUTS OF TOMATO FRUIT BORER, *TUTA ABSOLUTA* (MEYRICK) AND *HELICOVERPA ARMIGERA* (HÜBNER). Afef Najjari¹, Salma Djebbi², Chahnez Nakkach², Khouloud Klai², Haitham Sghaier³ and Maha Mezghani¹. (1) Laboratory of Microorganism and Active Biomolecules (LR03ES03), Faculty of Sciences of Tunis, University of Tunis El Manar, Tunisia, Email:

afef.najjari@fst.utm.tn; (2) Laboratory of Biochemistry and Biotechnology (LR01ES05), Faculty of Sciences of Tunis, University of Tunis El Manar, Tunisia; (3) Laboratory "Energy and Matter for Development of Nuclear Sciences" (LR16CNSTN02), National Center for Nuclear Sciences and Technology (CNSTN) and University of Manouba, ISBST, BVBGR-LR11ES31, Biotechpole Sidi Thabet, Ariana, 2020, Tunisia.

Tomato is the main horticultural crop in Tunisia. It is the second most important commodity produced in terms of quantity and contributes strongly to Tunisia's sustained economic growth. However, this crop is subjected to many constraints, including the permanent threat of pests. In Tunisia, the tomato moth *Helicoverpa armigera* (Lepidoptera : Noctuidae) and the South American leafminer, *Tuta absoluta* (Lepidoptera : Gelechiidae) are among the main pests of tomato crops. Larval stages of both pests cause direct feeding damage and reductions to both yield and fruit quality. Unfortunately, chemical insecticides have been the main control tool used against these Lepidoptera pests, but decrease in efficacy has been attributed to the development of insecticide resistance. Recent studies have indicated potential links between insect gut microbiota and insecticide resistance. However, the bacterial communities of *H. armigera* and *T. absoluta* remain poorly characterized. In this study, we analyzed the composition and diversity of gut bacteria of these two tomato pests using Illumina Next-Generation Sequencing of 16S ribosomal RNA amplicons. Results showed the prevalence of proteobacteria phylum in *H. armigera* and *T. absoluta* with a relative abundance of 96.31% and 94.3%, respectively. In addition, some pathogenic group, including *Serratia* and *Enterobacter*, were only observed in *H. armigera*. These results provided the first comprehensive description of the gut microbial community of *H. armigera* and *T. absoluta* to understand better the link between insect gut microbiota and insecticide resistance.

EN32

SUSCEPTIBILITY OF SOME TOMATO GENOTYPES TO TOMATO FRUIT BORER (*TUTA ABSOLUTA*) AND POTATO TUBER MOTH (*PHTHORIMAEA OPERCULELLA*). Sara Yousif Elbadawi Ali¹, Ahmed Adam Eisa Omer² and Faiza Elgaili Elhassan Salah². (1) Agricultural Research Corporation (ARC), Wad Medani, Sudan, Email: saraelbdawi@gmail.com; (2) Department of Crop Protection, Faculty of Agricultural Science, University of Gezira, Wad Medani, Sudan.

The tomato fruit borer, *Tuta absoluta* (Merick), and the potato tuber moth (*Phthorimaea operculella* Zeller), are among the most serious pests affecting tomato crops. This study aims to assess the susceptibility of some tomato cultivars to these pests. It was conducted to evaluate the performance of seven tomato genotypes (Salama 1, Gs12, Pimp 2012, Cherry big size, Castle rock, LR279 and LR277) compared with a local check (Allah Kareem). Field experiments were carried out at the University of Gezira Farm, Sudan, during the winter seasons of 2013-2014 and 2014-2015. The experiments were arranged in a randomized complete block design (RCBD), with three replicates. Three

parameters (number of active mines, infested fruits (%), and yield kg/fed) were used as indicators for the susceptibility and tolerance or resistance of the tomato genotypes. There was no significant difference between the mean infestation of *T. absoluta*. Castle rock and Gs12 showed lowest infestation, whereas Allah Kareem showed lowest infestation during the second season. For *Phthorimaea operculella* significant differences were obtained on tomato genotypes, and cv. Salama1 showed the lowest infestation. Fruit infestation showed significant differences for *Tuta absoluta* and *Phthorimaea operculella*; with lowest infestation observed on cv. Cherry big size. However, cv. Allah Kareem produced lowest infestation during the second season. Yields were significantly different ($P \leq 0.05$) between tomato genotypes, with cv. Cherry big size gave the highest yield. The cvs. Cherry big size and Gs12 were likely to be tolerant or resistant to the infestation with leaf miners and thus could be considered as promising tomato genotypes and be recommend for large scale cultivation to verify their resistance under different environmental conditions.

EN33

THE EFFECT OF CONSTANT TEMPERATURES ON *TUTA ABSOLUTA* ADULTS DEVELOPMENT, LONGEVITY AND FECUNDITY DURING PARTHENOGENESIS REPRODUCTION. Nabil Abo Kaf¹, Rafeek Abboud² and Rawa Youssef^{1,2}. (1) Department of Plant Protection, Faculty of Agriculture, Tishreen University, Syria, Email: nabil.abokaf@tishreen.edu.sy; (2) Agricultural Scientific Research Center in Lattakia, Syria.

Tuta absoluta (Lepidoptera: Gelechiidae) is a widespread pest that infects crops of the Solanaceae family, but its main host is tomato *Lycopersicon esculentum* (Miller). This study was conducted at the Agricultural Scientific Research Center in Lattakia, Syria in 2019 to determine the periods of different stages, the life span of adults, fecundity, and egg laying for the tomato leaf miner at constant temperatures (10, 20 and 30°C), relative humidity (60-65%) and photoperiod (8:16) (D: L), to assess the effect of constant temperatures on the phenomenon of asexual reproduction (Parthenogenesis) because of its importance in developing control strategies for this dangerous pest, especially techniques based on the use of pheromones and male sterilization. The leaf miner completed its development under all studied constant temperatures. The results obtained showed that the periods of different stages was shortened with temperature increase, and the periods of egg incubation, larvae and pupae was shorter at 30°C and reached 3.95, 11.9 and 4.95 days, respectively. That is, the development time from egg to adult was the shortest (20.8 days) at 30°C and reached 34.84 days at 20°C and was longest at 10°C and reached 125 days. longest longevity of females was 50-53 days at 20°C, and the highest fecundity was 12.98 at 20°C and the lowest was 2.19 at 30°C, whereas the females did not lay unfertilized eggs at 10°C. The female preoviposition period (APOP) ranged between 2.75 days at 20°C and 4.31 days at 30°C, and the total preoviposition period (TPOP) ranged from 36.86 days at 20°C to 42.21 days at 30°C.

EN34

RESISTANCE OF SOME SUDANESE TOMATO ACCESSIONS TO TOMATO FRUIT BORER (*TUTA ABSOLUTA*). Elharith H. Bakheit¹, Awad K. Taha², Mohammed E.E. Mahmoud¹, Telal S. Abdelhalim¹, Khitma A.S. Mustafa¹, El Tahir I. Mohamed¹ and Eltayeb Abdelateef³. (1) Agricultural Research Corporation, Wad Medani, Sudan, Email: nazeerazo@yahoo.com; (2) College of Agricultural Studies, Sudan University of Science and Technology, Shambat, Sudan; (3) Biotechnology and Genetic Engineering Corporation, National Center for Research, Sudan.

A field experiment was conducted for three consecutive seasons at Kassala and Gash Research Station farm, Sudan to evaluate the resistance of 12 Sudanese tomato accessions to tomato fruit borer *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) compared to 4 hybrids widely cultivated in Sudan. A randomized complete block design, with three replications, was used to evaluate cultural practices of the Sudan's Agricultural Research Corporation. The resistance parameters evaluated were: number of active mines, infested plants/plot, infestation rate of fruits (%), days to 50% flowering, fruit diameters (FD), total soluble solids (TSS), density of trichomes/cm² (DT), chemical constituents and yield (ton/ha). The results revealed high significant differences between accessions and hybrids ($p < 0.001$) in infested plants/plot, mean number of active mines/plant, infestation rate of fruits/plot, TSS, fruit diameter (cm) and yield of tomato (ton/ha) for the three seasons as well as the interaction between seasons and accessions and hybrids. High significant difference was revealed between accessions and hybrids on the DT and content of Lycopene, Tannin, Carotene and Ascorbic acid. Accessions HSD11429, HSD6071 and HSD14358 showed the least infestation rate of leaves/plot, least number of active mines/plant and least infestation rate of fruits/plot. The same accessions had highest TSS, yield and TD on leaves. Accessions, HSD14358 showed highest content of Tannin followed by HSD11429 and HSD6069. Lycopene content was found high in HSD4420, HSD4419 and HSD6639, whereas HSD6069, HSD4420 and HSD6639 had the highest Carotene content. On other hand, the content of ascorbic acid was found highest in HSD4419, HSD10689 and HSD10665. TSS and DT had negative correlation with leaves infestation rate/plot and number of mines/plant. Results obtained showed that accessions; HSD6071, HSD11429 and HSD14358 resistant to infestation with *T. absoluta* and produced high yield of tomato. Due to their hairiness and inclusion of high number of trichomes, high TSS and Tannin content, the three elite accessions of tomato in this study can be introduced as source of resistance to *T. absoluta*.

EN35

INSERTION OF MARINER TRANSPOSONS INTO RESISTANCE GENE OF THE COTTON BOLLWORM *HELICOVERPA ARMIGERA* GENOME. Khoulood Klai^{1,2}, Marwa Zidi^{1,2}, Salma Djebbi¹, Benoît Chenais², Aurore Caruso², Myriam Badawi², Françoise Denis², Nathalie Casse² and Maha Mezghani¹. (1) Laboratory of Biochemistry and Biotechnology, Faculty of Sciences of Tunis, University of Tunis El Manar, Tunisia, Email:

khoulood.klai@fst.utm.tn; (2) Laboratoire Mer, Molecules, Santé, Faculty of sciences and technique, Le Mans University, France.

Transposable elements are mobile genetic elements that can change its position within a genome. Several studies have shown that transposable elements can create genetic changes leading to resistance in pest populations. Studies on *Helicoverpa zea* have shown that transposable elements are inserted into or near the P450 detoxification genes. The cotton bollworm, *Helicoverpa armigera* (Lepidoptera: Noctuidae) is a polyphagous pest that feeds on important crops worldwide. This insect has developed resistance against many insecticides. In the current study, we investigated the insertion of *Mariner like element*, a class II transposons, into or near the glutathione-S-transferase (GST) genes identified previously in *H. armigera*. For this, we annotated *Mariner Like elements* from *H. armigera* genome through bioinformatics tools. Then, we scanned the contigs containing the genes of GST by performing a blast of *Mariner* transposons annotated against these contigs. An insertion of a *Mariner* transposon was retrieved in a GST gene. Further analysis of other resistance genes and transposable elements insertions will be more helpful to get a better understanding of mobile DNA dynamics in *H. armigera* genome.

EN36

EFFECTS OF DIFFERENT SOWING DATE AND SPACING ON INSECT PESTS INFESTATION ON COTTON IN GEZIRA, SUDAN. Entisar Ahmed Osman Sattii¹, Ahmed Elbashir Mohammed Hassan² and Omer Abdelkader Elnour¹. (1) Agriculture Research Corporation, Integrated Agricultural Pests Management Research Centre, Entomology Research Program, Wad Madani, Sudan, Email: nasraarc@gmail.com; (2) Department of Crop Protection, Faculty of Agriculture Science, University of Gezira, Sudan.

In the Sudan, Gezira Scheme, the cotton, *Gossypium barbadense* was grown under irrigation without insecticidal use of more than thirty years (1911-1945). That may be due to the traditional growing of cotton, in the same area under rainfed before the establishment of Gezira Scheme. Starting with the 1945/46 season until now, more than 300 insecticides and insecticide mixtures were recommended. The yield average was less than 7.0 kantar/feddani for upland cotton. Cotton is one of the most important crops produced in Sudan. A field experiment was conducted during the 2016/2017 season at the Experimental Farm of the Faculty of Agricultural Sciences, University of Gezira, Sudan. The objective of this study was to evaluate the effects of different sowing dates (early in 20/6/ 2016 and late sowing in 20/7/2016) and spacing (15 cm and 50 cm) between the plant holes on the cotton cultivar Hamied on the insect pest complex and on some species of natural enemies and quality of cotton, without insecticide application. Data of the impact of these insect pests was followed by a regular weekly survey. The results showed that the infestation of the sucking insects whitefly, *Bemisia tabaci*, Jassid, *Empoasca lybica* started in July and increased in numbers to reach the peak in August and October, respectively. The narrow spacing harbored high numbers of whitefly, and the infestation with mealybug reached its peak in September.

The meteorological data revealed that high rainfall affected cotton mealybug negatively. The cotton cultivar hosted high population of natural enemies during September and October. The highest mean lent cotton yield was recorded for the early sowing date.

EN37

SEASONAL OCCURRENCE OF *CALIOTHRIPS SUDANENSIS* ON SOME CROPS AT SHENDI AREA, RIVER-NILE STATE, SUDAN. Hassan Awad Hassan Mahgoub¹ and Abdalla Abdelrahim Satti². (1) Faculty of Science, University of Shendi, Shendi, River-Nile State, Sudan, Email: apbc.92@gmail.com; (2) Environment, Natural Resources and Desertification Research Institute, National Centre for Research, Khartoum, Sudan.

Shendi is a promising agricultural area (latitude 17°N; longitude 23°E) in the River-Nile State, Sudan. However, many economic pests, including thrips, negatively affect production. Among prevailing thrips species, the grey cotton leaf thrips *Caliothrips sudanensis* is a common pest of legume crops. The current work aimed to study the seasonal occurrence of the grey cotton leaf thrips (*C. sudanensis*) on some crops based on field surveys (November 2011 to February 2013) and a field experiment (October to December 2013) conducted at Shendi area. The surveyed crops included lablab bean, alfalfa and common bean, whereas the experiment was carried out on common bean. The results showed that common bean and lablab bean sustained significantly higher infestation levels of this pest during the first four months (September– December) than alfalfa, whereas the latter crop attracted significantly higher infestation levels at the end of season (January - February), when the other two crops reached senescent stage. However, the overall seasonal means showed significantly highest infestation level ($55.56 \pm 2.75\%$) by the common bean, and the lowest by alfalfa. Accordingly, the peak reproduction of *C. sudanensis* occurred between November and December, as this period witnessed significantly higher nymphal populations than adults, which coincided with a decrease in temperature and an increase in relative humidity. The study recommends more research on cultural practices to escape peak infestation levels by this pest.

EN38

USING MORPHOLOGICAL CHARACTERISTICS TO DISTINGUISH BETWEEN MALE AND FEMALE PUPAE OF THE PINK BOLLWORM, *PECTINOPHORA GOSSYPIELLA* (SAUNDERS). Ahmed Radwan, Mohamed Abdel-Wahed, Azza Emam and Youssef Abdallah, Plant Protection Department, Faculty of Agriculture, Ain Shams University, Hadayek Shubra, Cairo, Egypt, Email: Ahmed_Adel_Aly@agr.asu.edu.eg.

The pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is the most serious pest of cotton crop as larvae attack the cotton plants and they are active after hatching causing serious boll damage. Researchers distinguish between males and females in the larval stage as the male larva has pink gonads that are visible through the dorsal integument of the fifth abdominal segment, whereas they are absent in the female larva. The aim of this study was to identify the distinguishing

morphological characteristics in male and female pupae which make it possible to distinguish between male and female pupae. The presence of a terminal triangular appendage, which is relatively long at the end of the female abdomen and very similar to the ovipositor in the adult female, while it is short and hook-like in the male pupae, and it is similar to the aedeagus in adult male and is rarely absent.

EN39

EFFECT OF LOW LETHAL DOSE OF MICROWAVE RADIATION AND HOST TYPE ON SOME BIOLOGICAL FACTORS OF COWPEA WEEVIL *CALLOSBRUCHUS MACULATES*. Emad Qasim Al-Ebady and Marwa Mohammad Abdallah, Plant Protection Department, College of Agriculture and Forestry, Mosul University, Iraq, Email: semadd82@yahoo.com

This study revealed the effect of lethal dose on the general mean of eggs number/10 females of *Callosobruchus maculatus* which was affected by the legume host and was around 97, 123.94 and 117.78 eggs/10 females for cowpea, chickpea and pea, respectively. The mean eggs number decreased significantly by increasing the energy and the exposure time of the lethal low dose. It reached 93.59 and 92.85 eggs/10 females for energy level of 100 and 250 watt and 83.50 and 78.22 eggs/10 females for exposure time of 15 and 25 sec., respectively, compared with control females which laid 117.78 eggs/10 females. The mean adult's emergence of *C. maculatus* from chickpea was around 76.86%, and was higher than that in cowpea and pea which reached 63.89 and 67.70%, respectively. Results obtained showed that the increase of lethal low dose caused a decrease in adult's emergence rate that reached 73.04 and 65.93% at energy levels of 100 and 250 watt, respectively, and 65.97 and 61.33% for exposure time of 15 and 25 sec., respectively, compared to 81.16 % for the control. Furthermore, this study revealed no significant effect of lethal low dose on the male:female sex ratio of *C. maculatus* reared on three host grain legumes.

EN40

SOME ASPECTS ON THE BIOLOGY OF THE GROUNDNUT BORER *CARYEDON SERRATUS* OLIVIER. Ahmed Abdel Moniem Abdel Razik, Agricultural Research Corporation (ARC), Integrated Agricultural Pests Management Research Centre, Gezira Research Station, Sudan, Email: aabdelmoniem66@gmail.com

Groundnut borer, *Caryedon serratus* Olivier (Coleoptera: Bruchidae) is the only insect species known to infest kernels and intact pods of groundnut, thus it potentially becomes the most important major store pest of groundnut. The literature on the biology of *C. serratus* is scanty and is only available for the other bruchid, *Callosobruchus maculatus* (F) and related species, *C. chinensis* (L). For this reason, this work aimed at studying the biology of this species. The studies included mating process and frequency, developmental period of the eggs, larvae, pupae and adults of both sexes and preference of the females to oviposit on shelled and unshelled groundnut and the sex ratio of the progeny. Results revealed that mating occurred soon after adult emergence, and took around 16-18 minutes. Both

females and males mated once during their lifespan. The mean incubation period of the eggs was 6.28 and 5.33 days, larval development was completed in 16.71 and 15 days, pupal stage lasts for about 13 and 13.3 days, the mean adult longevity was 13.42 and 12 days and the total life cycle was completed in 50 and 45 days for females and males, respectively. The larvae undergo three moults and the mean larval instars duration were 3, 3.7, 3.8 and 4 days for the first, second, third and fourth instars, respectively, whereas the pre-pupal period took 2 days. Females deposited significantly more eggs on unshelled than on shelled groundnuts (38 and 28/female). The pre-oviposition period was one day, oviposition period ranged 2-4 days and the post-oviposition period ranged 3-5 days. The oviposition started on the second day and reached the peak on the third day. The eggs hatched and the sex ratio (males:females) was 1.17:1.

EN41

FIRST REPORT OF *CERCOPIS* SSP IN CEREAL FIELDS IN SYRIA. Lina Ali, Khaled Shikh Amin and Mohammad Kossah, Department of Plant Protection, Faculty of Agriculture, Aleppo University, Aleppo, Syria, Email: lina.7755@gmail.com

The recent climatic changes in the world have caused a significant change in the distribution and density of insects, and the emergence of new insect pests. In the past few years, it has been observed that an insect of the spittle bug family known as *Cercopis* spp. (Hemiptera: Cercopidae) emerged in the cereal fields in Syria. It is not known whether or not they cause damage to cereals, but their presence in abundance in the fields caused a general concern among farmers. The aim of this research was to investigate whether or not this insect can cause damage to cereals and other plants and quantify the damage, if any. Several cereal varieties and other plant species were planted under laboratory conditions (Sham 1, Sham 4, Furat 1, Chickpea, Flax, Syrian thistle, Milk thistle and Alfalfa) in plastic pots with 3 replications and following a complete randomized block design. After germination and growth, infestation with insects was implemented at a rate of 10 insects/pot, in addition to a control without infestation. Symptoms due to insect infestation appeared on cereal leaves in the form small white spots which turned to pale yellow and spread on the leaf blade. These spots often combined and break the leaves. A damage 1-5 scale was developed based on the percentage of infested tillers, where 1 = no damage, 5 = more than 50% of the tillers were infested. Barley had the highest infestation score of 4.1 among the other plant species tested.

EN42

MONITORING OF FOUR NOCTUIDAE SPECIES IN TUNISIAN ARTICHOKE CROPS. Asma Cherif¹, Oumayma Aroua¹, Manel Bouhda-Mhadhbi² and Kaouthar Grissa-Lebdi¹. (1) Laboratory of Entomology-Acarology, Department of Plant Protection and Post-Harvest Diseases, National Agronomic Institute of Tunisia, 43 Avenue Charles Nicolle, Cité Mahrajène 1082 Tunis, Tunisia, Email: assoumacharif1986@gmail.com; (2) Potato and Artichoke Technical Center, Road Jedaida-Essaida, 2031 Manouba, Tunisia.

Artichoke (*Cynara scolymus* L.) is classified as an important crop in Tunisia. However, it may be threatened by a large number of pests including lepidopteran, coleopteran and hemipteran species. A field survey was carried out from 20 February to 15 May 2018 in two Tunisian regions (Essaida (Governorate of Manouba) and Sid-Thabet (Governorate of Ariana) to monitor four Noctuidae species (*Helicoverpa armigera* (Hübner), *Spodoptera littoralis* (Boisduval), *S. exigua* (Hübner) and *Agrotis segetum* (Denis & Schifferrmüller). One sex pheromone trap/ha for each species was used and checked each week. Survey results obtained indicated that these species had one to two generations during the study period and no significant difference was found between the two study regions ($P>0.05$). Moreover, a significant correlation was noted between the male flight activity and the study region. This work may help Tunisian farmers to develop effective and appropriate management program to reduce possible damages caused by these pests.

EN43

QUALITATIVE AND QUANTITATIVE INVENTORY SURVEY OF FABA BEAN APHIDS IN THE ARID REGION OF ALGERIA (CASE OF BISKRA ZONE). Rayane Saifi¹, Hadjer Saifi² and Messaouda Benabdelkader³. (1) Laboratory of Dedspaza, BP 145 RP, Biskra Mohamed Khider University, University Center of Tamanrasset, Tamanrasset, Algeria, Email: rayanesaifi2015@gmail.com; (2) Nuclear Biotechnology and Technology Laboratory in National Center for Nuclear Science and Technology, Sidi Thabet Technopole, 2020, Dept of Biological Sciences, University of Tunis El Manar, Tunisia; (3) Department of Environment and Agronomy, Jijel University, Laboratory of Applied Microbiology, Setif, Algeria.

In arid regions of Algeria, especially in Biskra region, the faba bean comes first in the production of pulses. This bean crop is exposed to attacks of more than 70 insect species that together cause damage to all stages in the plant's development. Among these insects, aphid species were the most abundant pests, which are considered as the most harmful crop pest in the world. The objective of this study was to characterize the diversity and abundance of aphid species of bean culture in the arid region of Biskra, using yellow traps and direct observations by means of the magnifying glass in faba bean (*Vicia faba*) fields. Eight species of winged aphids were encountered on this crop. The populations of *Aphis fabae*, *Aphis pisum*, *Aphis craccivora* and *Myzus persicae* are respectively the most invading to faba bean. In terms of prospects, it would be interesting to continue this study on population dynamics, not only of aphids but also of other pests and their natural enemies in this crop. Our results showed that *A. fabae* is a harmful pest for beans, and for this reason it is necessary to implement more studies concerning its bioecology, its impact on the yield as well as finding methods of biological control as an alternative to chemical control against this aphid and other pests on the crop.

EN44

A NEW REPORT OF OLIVE TREES INFESTATION WITH THE OLIVE PYRALID MOTH, *EUZOPHERA PINGUIS* (HAWORTH, 1811) IN LEBANON. Zinette Moussa¹, Elia Choueiri², Amira Youssef³ and Milad El Riachy⁴. (1) Laboratory of Entomology, Lebanese Agricultural Research Institute, Fanar, Lebanon, Email: zmoussa@lari.gov.lb; (2) Department of Plant Protection, Lebanese Agricultural Research Institute, Tal Amara, Lebanon; (3) Hasbaya Station, Lebanese Agricultural Research Institute, Hasbaya, Lebanon; (4) Department of Olive and Olive Oil, Lebanese Agricultural Research Institute, Tal Amara, Lebanon.

The cultivation of olive trees, *Olea europaea* L., is considered one of the oldest and the most important crops in Lebanon. Its cultivated area is estimated around 58,800 hectares mostly rainfed. Seventy percent of the production is destined for olive oil, and thirty percent for table olives. The economic olive pests and diseases that threaten the olive groves in Lebanon are: the olive fruit fly *Bactrocera oleae* (Gmelin) (Diptera, Tephritidae); the olive moth *Prays oleae* (Bernard) (Lepidoptera, Yponomeutidae); the peacock eye disease induced by ascomycetous fungus *Spilocaea oleagina* (Castagne) S. Hughes (Pleosporales, Venturiaceae) and verticillium wilt caused by *Verticillium dahliae* Kleb. (Hypocreales, Incertae sedis). A larva of *Euzophera pinguis* (Haworth) (Lepidoptera, Pyralidae) known as olive pyralid moth, was spotted for the first time in the country in September 2015 in the region of Hasbaya at Hasbaya District. Galls, swelling and cracking symptoms with extensive internal necrosis were observed on barks, branches and twigs. Later, same symptoms were reported in two olive groves in the village of Kherbet Kanafar in West Bekaa District situated at 30 km away from the first source of infestation. A survey conducted in these two regions in October of the same year indicated that this new invasive pest is well established in Hasbaya, whereas no other infestation was reported in West Bekaa. However, another survey done in May 2017 indicated a new attack in Kefraya region, West Bekaa situated at 2-3 km away from the second source of infestation. This study showed that *E. pinguis* is a new invasive pest on olive trees in Lebanon and the potential risk of its spread to other areas of olive production is very high.

EN45

EFFECT OF TEMPERATURE ON SOME BIOLOGICAL PARAMETERS OF THE POMEGRANATE BUTTERFLY *DEUDORIX LIVIA* (KLUG, 1834) UNDER LABORATORY CONDITIONS. Sahar Zougari^{1,2,3}, Sabrine Attia², Anis Zouba³ and Kaouthar Lebdi-Grissa². (1) Department of Biological Sciences, Faculty of Science of Tunis. University of Tunis El Manar, Tunisia, Email: sahar.zougari@gmail.com; (2) Department of Plant health and Environment, LR14AGR02 of Bioaggressors and Integrated Pest Management in Agriculture, National Agronomic Institute of Tunisia, University of Carthage, Tunisia; (3) Technical Centre of Dates, Tunisia.

Pomegranate butterfly *Deudorix livia* (Klug, 1834) (Lepidoptera: Lycaenidae) is known as one of the major

insect pests that cause damage on pomegranate fruits. It was observed in Tunisian pomegranate orchards since 2006. This work aimed to determine the effect of two temperatures (30 and 35°C) on some biological parameters of this insect reared in the laboratory under controlled conditions (HR = 70 ± 10%; light period 16L: 8D). Results obtained showed that insects accomplished their total developmental cycle in 43.2±2.13 and 40.8±1.35 days at 30 and 35°C, respectively.

EN46

EXPLORATORY STUDIES ON EFFECTIVENESS OF SOME INSECTS AND FUNGI THAT ATTACK MALE BUNCHES OF SAGAI DATE PALM CULTIVAR IN EGYPT. Mahmoud Maklad¹ and Ola Roshdy². (1) Faculty of Agriculture, Ain Shams University, Egypt, Email: Mahmoud_Maklad@agr.asu.edu.eg; (2) Plant Protection Research Institute in Mansoura at Agriculture Research Center, Egypt.

Date palm (*Phoenix dactylifera* L.) is considered one of the oldest cultivated plants in the world. In Egypt, it is one of the most important fruit crops that widely distributed in different districts and it was observed to be severely affected by many insects and diseases. This study was conducted on date palm trees cultivated in sandy soil during the 2016 and 2017 seasons to compare and identify the most important symptoms of insects and fungal diseases of male flower inflorescences of Sagai cultivar and examine the manifestations of the infection and determine the percentage and amount of damage resulting from the infection, and the amount and viability of pollen grains. In addition, this study aimed to control insects that attack the bunches, and isolate and diagnose *Fusarium* spp. associated with these insect pests. *Fusarium oxysporum* and *Fusarium solani* were isolated from infected parts and identified following standard methods. Three bunches from each male palm tree were collected, especially those showing signs of infection and deformities, as molds appeared on the lower part of the flower inflorescences and the flowers turned brown, with high moisture content in some of the flowers of the upper part of the male inflorescences, and some flowers did not open. It was also clear from the study that insects and pathogenic fungi on the male flowers quality and ability to pollinate.

EN47

INSECTS ASSOCIATED WITH OAK TREES IN LEBANON. Zinette Moussa¹, Elia Choueiri² and Abdalla Hanna³. (1) Laboratory of Entomology, Plant Protection Department, Lebanese Agricultural Research Institute, Fanar, Lebanon; (2) Plant Protection Department, Lebanese Agricultural Research Institute, Tal Amara, Lebanon, Email: echoueiri@lari.gov.lb; (3) Skaff Estate Ammiq, Bekaa, Lebanon.

Forests in Lebanon cover about 137K ha. Broadleaved forests constitute 57% of the total forest cover followed by coniferous forests (32%) and mixed forests (11%). Oak forests (Fagaceae) are native in the country and occupy the largest areas of approximately 40K ha. The most common species are the kermes oak, *Quercus calliprinos*, the gall oak *Q. infectoria*, the Turkey oak *Q. cerris* var. *pseudocerris* and the Brant's oak *Q. brantii*. While the minor

species are: *Q. libani*, *Q. cedrorum*, *Q. ithaburensis ungeri*, *Q. microphylla* and *Q. pinnatifida*. However Human activities in addition to climate change have obviously negative impact on oak trees which become more vulnerable to pests and diseases. A total of 20 insect species associated with oak trees were recently identified in Lebanon. The most dangerous one is the gypsy Moth *Lymantria dispar* (Lepidoptera: Erebiidae), with outbreak in 2019 causing a complete defoliation to *Q. calliprinos* and *Q. cerris*. The oak Leafminer *Phyllonorycter libanotica* (Lepidoptera: Gracillariidae) and the giant mealybug *Ceroputo pilosellae* (Hemiptera: Coccidea) are the most species recorded on *Q. infectoria* and *Q. calliprinos* during the last 3 years sharing the same geographic area. They are followed by the oak Processionary *Thaumetopoea processionea* (Lepidoptera: Thaumetopoeidae) on *Q. calliprinos* and *Q. cerris*. Three species from five of Cynipidae (Hymenoptera) were recorded as new to Lebanon: *Andricus caputmedusae*, *Plagiotrochus quercusilicis* and *Neuroterus quercusbaccarum* in addition to *Cynips quercus* and *Andricus coriarius*. Other minor pests reported are: *Zeuzera pyrina* (Lepidoptera: Cossidae); *Melolontha melolontha* (Coleoptera: Scarabaeidae); *Myzocallis* sp. (Hemiptera: Aphididae); two wood borers (Coleoptera: Buprestidae) *Agilus chrysoderes* and *Coraebus florentinus*; four armored scales *Chionaspis lepineyi*, *Aspidiotus nerii*, *Diaspidiotus viticola* and *Aonidiella aurantii* (Hemiptera: Diaspididae). Two species *Xylosandrus compactus* (Coleoptera: Scolytidae) and *Kermes echinatus* (Hemiptera: Kermesidae) were identified for the first time in Lebanon on *Q. calliprinos* and *Q. ilex* respectively.

EN48

ECOLOGICAL SOUND CONTROL STRATEGIES FOR POPULATION SUPPRESSION OF DATE PALM BORERS. Mohammed Zaidan Khalaf, Integrated Pest Control Research Center, Directorate of Agricultural Research, Ministry of Science & Technology, Baghdad, Iraq, Email: mkhalaf34@yahoo.co.uk

Cultural practices, hand collection of larvae, light traps, entomopathogenic nematodes and fungi were investigated to manage of palm borers *Oryctes* spp. in date palm orchards during the years 2013-2018. Cultural practices, such as sanitation and pruning frond bases, hand collection of larvae during regular annual service work and light traps with solar energy were practiced annually in one orchard for five years. In the second orchard, cultural practices were applied for two years, light trap for one year only, and no hand collection of larvae was done during the period. The third orchard was use as a control treatment. Results showed reduction in population density of larvae and adult of *Oryctes* spp. of 91.6%, 53.0% and 76.1%, 41.1% in the 1st and 2nd orchard, respectively. The results also demonstrated the impact of moon light phases on the number of *Oryctes* spp. adults caught by light trap and the existence of an inverse relation between moon light and flight activity of adults. Biological experiments also revealed that entomopathogenic nematode, *Rhabdits blumi* can cause high mortality rate reaching 71.67% and 15% mortality in the larvae and adults of Arabian Rhinoceros Beetle, *Oryctes agamemnon arabicus*, respectively, under laboratory

conditions. Using concentration 1×10^9 conidia/ml of the entomopathogenic fungus *Beauveria bassiana* as direct spray on the ARB larvae, led to 66.7% mortality when used at the concentration of 1×10^9 conidia/ml. However, when used at the concentration 1×10^{11} conidia/ml a higher mortality rate in a shorter period of time was observed with $LT_{50} = 12.75$ and $LT_{90} = 20$; whereas *Metarhizium anisopliae* caused a rate of malformed adults. The results depicted the effectiveness of some integrated ecological sound control methods for monitoring and population suppression of *Oryctes* spp. in date palm orchards.

EN49

OBSERVATIONS ON THE PHENOLOGY OF LOCUSTS IN THE GREAT ALGERIAN SAHARA (ORTHOPTERA: ACRIDIDAE). Abderrahmane Soudani^{1,2} and Abdelhamid Moussi¹. (1) Laboratory of Genetic, Biotechnology and Valorization of Bio-resources, University of Biskra, Algeria, Email: abderrahmane.soudani@univ-biskra.dz; (2) National Institute of Plants Protection of Algeria.

The presence and abundance of locusts in 6 anthropogenic oasis habitats of the Greater Algerian Sahara (Adrar district) were studied for two successive years to determine the phenology of adult and nymphal stages. Eleven species were sufficiently abundant to evaluate at least some elements of their phenology. The period of maximum abundance of adults and nymphs varied from species to species, particularly in the spring, summer and autumn. Three groups of species were discovered: the first is a non-seasonal group for hygrophilic species that reproduce strongly during the summer in irrigated habitats. Two seasonal groups, one of xerophilic species appearing only in the spring-autumn in the non-irrigated habitat and the other of the mesophilic species, which are permanent and remain almost all the year, while moving between the two types of habitat. The data collection method used in this study was insufficient to determine definitively the number of generations.

EN50

HEMIPTERA AN REDOUBTABLE PEST OF CROPS. Malika Boualem, Farial Krache, A. Merzoug and Amin Ghelamallah, Plant protection laboratory, Faculty of Natural and Life Sciences, Agronomy Department, Abdelhamid Ibn Badis University of Mostaganem, Algeria, Email: malika.boualem@univ-mosta.dz

The management of phytosanitary problems including crop pests requires adequate and effective control strategies for better yield. Indeed, the damage caused by crop pests influences the economic profitability of agricultural production systems. Hemiptera insects constitute as a significant cause of this drop in yield. This is a group of extremely common insects in the world and has evolved alongside flowering plants (angiosperms) which almost all species act as hosts of aphids, whiteflies, scale insects etc. These insects had piercing-sucking mouthparts, and they are considered as extremely harmful causing considerable crop damage, either directly by feeding on the plants or indirectly by transmitting harmful disease agents such as Citrus tristeza virus. Honeydew excreted by these pests promotes the

attraction of the Mediterranean fruit fly, wasps, ants, and also promotes the growth of certain fungal diseases. The complexity of this group of pests requires the development and implementation of an integrated pest management strategy that meets the social and economic and social needs of the country.

EN51

THRIPS SPECIES ASSOCIATED WITH OLIVE TREES IN ALGERIA. Randa Mahmoudi and Malik Laamari, Institute of Veterinary and Agricultural Sciences, University of Batna 1, P.O. Box 05000, Batna, Algeria, Email: randa.mahmoudi@univ-batna.dz

The olive cultivation occupies an important place in the economy of the Mediterranean countries, especially in North Africa. In Algeria, the area cultivated with this crop reached 389,000 hectares during the 2010/2011 season, and production reached 5.2 million quintals of olives and 67,000 tons of olive oil, which made it ranked eighth globally. The cultivation of olives in this country is prone to several pests, as it negatively affects the returns in terms of quantity and quality. The annual losses caused by pests are estimated at more than 15%. Among these pests, thrips occupy an important place, as it feeds on soft parts and cause deformation of leaves and fruits and their early fall. Despite its importance, particularly in the Mediterranean basin, thrips were not the subject of adequate studies. In Algeria, thrips are not fully known, and its economic impact has not been evaluated yet. This study aimed mainly to highlight the biodiversity of thrip insects associated with olive trees in Algeria. Field survey, by taking samples twice monthly, confirmed the presence of 10 thrips species, the most important were: *Franklinella occidentalis*, *Thrips tabaci*, *Thrips angusticeps* and *Haplothrips aculeatus*.

EN52

INVENTORY OF ASSOCIATED PHYTOPARASITES IN THE OASES OF NEFZAOUA (KEBILI GOVERNORATE), TUNISIA. Hana Ben Abdallah, Arid Land and Oases Cropping Laboratory, Institute of Arid Land, Route Eljorf, Medenine, Tunisia, Email: hana_benabdallah74@yahoo.fr

The study of the biodiversity of oases agrosystems was carried out through a survey of 53 oases in the Nefzaoua region, Tunisia. The inventory of the phyto-sanitary problems of the oases crops showed that the main observed parasites were *Apate monachus*, *Ectomeylois ceratoniae* and *Parlatoria blanchardi*. Results showed that 45.73% of the oases are affected by phyto-parasites. *Apate monachus* fabricius is one of the pests that contributes to the fragility of the phoenicultural sector and generally attacks the leaves of the middle crown. In our study, it was estimated that 17.48% of palm trees were affected by attacks of *Apate monachus* in the oases surveyed in Nefzaoua. *Ectomeylois ceratoniae* zeller was the most feared insect that has plagued decades of oases in southern Tunisia, specifically attacking date palm and pomegranate. The fruits of date palms and pomegranates are the most threatened and the most attacked by the date worm. The date infestation rate was 23.76%. In Tunisia, the date worm is in first place on the pest severity scale. The date

palm white scale *Parlatoria blanchardi* Targ is associated with most of the date plantations, especially the young ones, and in case of severe attacks, it can stop the growth completely. It is most frequently encountered on young palms or poorly maintained palms. The date palm white scale colonizes all the aerial parts of the date palm (palms, pinnae and sometimes even bunches and fruits). It is considered one of the main pests because it ranks second on the gravity scale after *Ectomeylois*. Treatments with phyto-sanitary products constitute a technique, which is not frequently practiced in the oasis agrosystems. In addition, the presence of various varieties sensitive to chemical treatments and the adoption of traditional know-how based on biological control has therefore limited their use. In this case, phyto-sanitary treatments have shown that 3.58% of farmers use phyto-sanitary products for the protection of their crops.

EN53

INVENTORY OF INSECTS, WEEDS AND DISEASES IN THE HENNA CROP IN BISKRA'S OASIS (ALGERIA). Kaltoum Benaissa, Department of Agricultural Sciences, University of Mohamed Kheder, Biskra, Algeria, Email: kaltoum.benaissa@univ-biskra.dz

The henna crop is one of the crops known at Zayban region, the oases of Biskra (southeast Algeria), because of its resistance to dry and desert climate and it is considered a source of income for the residents of this region. A preliminary study was carried out in the field with henna farmers to identify weeds that compete with the main crop, as well as insects and diseases that cause damage to this crop. For that reason, a questionnaire for farmers was prepared and information on different aspects of the crop was collected during the year 2015. The questionnaire covered 30 producers of henna in the villages of eastern Zeban. The answers allowed the collection of the main biotic factors that affect the yield of henna. The results obtained showed that for weeds, the Quackgrass (*Cynodon dactylon* L) was the main competitive weed in addition to seven other plant species. Furthermore, six insect species were listed as harmful to the crop. All farmers claimed that henna is considered to be resistant to fungal and bacterial diseases.

EN54

EFFECT OF HOST PLANT ON SENSITIVITY OF TOBACCO LEAF WORM *SPODOPTERA LITURA* (FAB.) TO SOME INSECTICIDES. Haitham Mohie Al-Deen Mohamed Jalal and Esraa Mohamed Ali Al-Hayale, College of Agriculture and Forestry, University of Mosul, Iraq, Email: dr.haithamjalal@gmail.com

A laboratory experiment was conducted to determine the sensitivity of the third larval instar of tobacco leafworm *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) to pesticides (Emamectin benzoate, Spinosad and Match) which fed on chard, corn and cabbage. Results showed that the general effect of pesticides reached its highest when the larvae fed on corn leaves. Mortality rate reached 64.23% 24 hours after treatment, whereas the general effect of pesticides was minimal when the larvae fed on chard leaves, with a mortality rate of 48.35% 24 hours after treatment. Emamectin benzoate was more effective than other

pesticides on larvae that were fed on three host plants, and mortality reached 73.03% after 24 hours after treatment, whereas Match was the weakest pesticide on larvae with mortality rate of 37.6%. The general mortality rate 24 hours after treatment was 53.7%, whereas mortality rate 48 hours after treatment was 27.11%. The relative efficacy of pesticides was 74.93, 53.6 and 21.28% for Emamectin Benzoate, Spinosad and Match, respectively.

EN55

VARIETAL PREFERENDUM OF DATE PALM SCALE INSECT *PARLATORIA BLANCHARDI* TARG IN PALM GROVES OF CENTRAL ALGERIA. Salah Eddine Sadine^{1,2}, Fairouz Ben Tassa¹ and Fatima Zohra Moulay Lakhdar¹. (1) Faculté des Sciences de la Nature et de la Vie et Sciences de la terre, Université de Ghardaïa, Algérie, Email: sadine@univ-ghardaia.dz; (2) Laboratoire de Recherche sur la Phœniciculture, Faculté des Sciences de la Nature et de la Vie. Université KASDI Merbah-Ouargla, Algérie.

The date palm scale insect *Parlatoria blanchardi* Targ. (Homoptera: Diaspididae) is one of the most important insect pests of date palm in Algeria. This work presents a contribution to study this pest in Ghardaia palm groves (Central Algeria). The infestation rate on four dates' varieties: Azerza, Deglet Nour, Ghars and Timjjouhert was monitored. Results showed that the variety Ghars was the most infested with a 62.52 individual/cm², followed by Azerza. The other varieties were infested at low rates. In conclusion, in the palm groves of Ghardaia (Central Algeria), the date palm scale has preference to infect the Ghars variety. Some other varieties such as Azerza and Deglet Nour can also be preferred. These results were also found in other regions in Algerian Sahara, but the variety of Deglet Nour came in second position.

EN56

INTERACTION BETWEEN *BEMISIA TABACI* AND *TUTA ABSOLUTA* ON HOSTS OF THE SOLANACEAE MEMBERS. Chaker Bennour, Belgacem Ali, Hammadi Hamza and Hmed Ben Nasr, Arid Area Institute Kebili, Tunisia. Email: chakerbennour2011@gmail.com

The silver leaf whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera, Aleyrodidae) and the South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera, Gelechiidae) are serious pests of greenhouse crops. These two insects parasitize several host plants, in particular species of *Solanaceae* family. The two insects might compete for nutritional resource and space for reproduction on the host plant. As a direct consequence of such competition the populations' dynamic of both insects will deeply vary when they simultaneously occur. This study aimed to evaluate the interactive ecological relationship between the populations of the two insects. Enumeration of individuals of each species at different lifecycle stages on the leaves of fruiting eggplant *Solanum melongena* and tomato *Solanum lycopersicum* plants showed that *Bemisia tabaci* prefers to parasitize eggplant whereas the preferred host plant for *Tuta absoluta* was tomato. At the egg stage, the two

insects can live together on the same host. However, the presence of *Tuta absoluta* larvae on plant leaves lead to a significant drop in the density of *Bemisia tabaci* population. This fact was observed in particular on tomato. These findings suggest that pests' management might be directed against *T. absoluta* larvae when they co-exist with *B. tabaci*. Such approach might improve costs of the two pests' control and eventually decrease the undesirable side effects of the applied chemicals.

EN57

INSECT VECTORS OF PLANT PATHOGENS THAT THREATEN AGRICULTURAL PRODUCTION IN SUDAN. Abdalla A. Satti, Environment, Natural Resources and Desertification Research Institute, National Centre for Research, P.O. Box 6096, Khartoum, Sudan; Email: satisattisat@yahoo.com

Several biotic and abiotic factors that contribute to plant diseases spread among different host plants are well documented. However, insects are important biotic agents causing widespread distributions and outbreaks of many diseases in the field. Severe outbreaks of leaf curl viral disease in cotton and tomato crops are primarily correlated with high population density and activity of *Bemisia tabaci*. Accordingly, this paper sheds light on the important insect species involved in transmitting deleterious plant pathogens of economic significance in Sudan. The paper listed 15 insect species (pests and non-pests) reported as vectors of more than 25 plant pathogens, mostly viruses. Some insect pests, such as *B. tabaci*, *Aphis craccivora* and *Aphis gossypii*, transmit a complex of over 7 destructive plant viruses, including mainly that cause leaf curl, mosaic, dwarf, stunting, yellowing, wilting, mottling, rosette and vein thickening symptoms. The magnitudes of damage inflicted by such diseases on some major host plants will be presented. A package of cultural control measures that proved to be successful against certain vectors in the country will be suggested for further testing as a component of integrated disease management.

EN58

EFFECT OF CHEMICAL APPLICATION COMBINED WITH VARIETAL PRECOCITY TO CONTROL BRUCHIDS *BRUCHUS LENTIS* IN LENTIL. Laila Satia, Entomology and Integrated Pest Management Laboratory, Plant Protection Research Department, National Institute of Agricultural Research (INRA), Avenue Ennasr, Rabat, Morocco, Email: Laila.satia@inra.ma

Pulses are attacked by a wide range of insect pests, which limit their potential yield and quality. The lentil bruchid *Bruchus lentis* Frölich, 1767 (Coleoptera: Chrysomelidae) causes serious storage problems. In Morocco, damage can reach 53% eight months after storage by affecting seed yield, germination rate, commercial value, and nutritional quality. Control of this weevil relies mainly on seed fumigation (especially Aluminium phosphide AIP) which presents significant risks. Therefore, sustainable and ecological management is required to control this hazardous pest. The efficacy of insecticide treatment combined with

varietal precocity to control *B. lentis*, was assessed in the field. The chemical application and the varietal precocity had a significant effect (at $P < 0.05$) on infestation rate, grain yield, and 1000 seed weight. This treatment applied at early pod formation stage significantly reduced the infestation by weevils in the field and storage by 60%, with an average yield increase of 42% and 34% for the late and early varieties, respectively. The late variety presented a significantly higher infestation rate than the early variety. The rational chemical control reduces attack by 60%, while early winter varieties allow lentil plants to escape from high population density. Combining these methods with other environmentally friendly and sustainable storage methods will preserve lentil grain quality and limit yield losses.

EN59

INSECT FAUNA OF THE DAMASCENE ROSE *ROSA* × *DAMASCINA* IN SYRIA. Randa Abou Tara¹ and Ghassan Rustom². (1) Faculty of Science, Damascus University, Syria, Email: randaaboutara@hotmail.com; (2) Arab International University (AIU), Syria.

The Damascene rose in Syria is exposed to many insect pests that affect it and cause serious economic damage, some of which threaten its cultivation. The site of the cultivation of the Damascene rose was visited, specifically the village of Al-Marah, which is famous for the cultivation of the rose and the manufacture of its products. After several visits over two growing seasons (2020/2021 and 2021/2022), the following insect pests were identified: *Agrilus cuprescens* Ménétries 1832; *Capnodis tenebricosa* Olivier 1790; *Capnodis carbonaria* Klug 1829; *Cerambyx dux* Faldermann 1837; *Macrosiphum rosae* Linnaeus 1758; *Chalcophorella stigmatica* Schoenherr 1817; *Otiorhynchus* sp. Germar 1822 and *Perotischloranus* Laporte & Gory 1836.

EN60

ASSESSMENT OF POPULATION DYNAMICS OF CUCUMBER MOTH, *DIAPHANIA INDICA* IN BITTER GOURD. Sunidhi Pilonia¹, Surender Singh Yadav² and Krishna Rolania¹. (1) Department of Entomology, CCS Haryana Agricultural University, Hisar, India, Email: sunidhi037@gmail.com; (2) Plant Protection Department, Directorate of Research, CCS Haryana Agricultural University, Hisar, India.

Cucumber moth, *Diaphania indica* infestation is becoming one of the most significant obstacles in cost-effective cucurbit production. Given the increasing demand for qualitative and quantitative yield improvements, it is necessary to investigate the population fluctuation of the *D. indica*, and its interaction with various weather parameters. Therefore, the experiment was laid out in 26 plots of size 3x3 m in size with a space of 150x45 cm between plots using the variety 'Pusa Do Mausami' of bitter gourd during fall of 2019 at Entomological Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India. Simple random sampling was used to collect weekly data on the larval population of *D. indica* on bitter gourd, whereas different abiotic parameters were obtained from the meteorological observatory of the institute. The analysis indicated that the *D. indica* population commenced from 33rd

SMW. The highest population (5.4 larvae per plant) was reported during the 37th SMW i.e. in the month of September. Maximum and mean temperature, pan evaporation rate, and bright daylight hours all exhibited significant positive correlations with this pest, while relative humidity and rainfall indicated a negative correlation. It can be concluded that the information obtained from this study could be useful in predicting the population of *D. indica* and at any given time, and it can be effective in initiating the appropriate control measures to avoid high yield loss.

EN61

PHYSICAL CONTROL AGAINST *ORYCTES AGAMEMNON ARABICUS FAIRMAIRE* (1896) USING LIGHT TRAPS. Tayeb Chater, Anis Zouba, Sahar Zougari and Foued Ben Hmida, Technical Centre of Dates, Tunisia, Email: chatertayeb2017@gmail.com

Oryctes agamemnon (Coleoptera: Scarabaeidae) is one of the most important pests that affect date palms in Tunisian oases, where the larvae feed on the trunk and roots, weakening the date palm, which becomes subject to falling due to strong winds. This work aimed to develop a light trap model to use for the control of this insect in the oases. Experimental farms were selected in the oases of Dhafiriya, Chabat, Marah Lahawar and the Rjim Maatoug, and selection of orchards was based on the importance of infestation by this Coleoptera insect. Various models of light traps (model 2012, model 2013 and 2014 model) were placed in the experimental orchards (one trap in each orchard), and they were connected to an electrical source. This study indicated that the light trap model 2014 was the most effective in capturing adults of *O. agamemnon*, and collected numbers by this trap was higher than the numbers of adults trapped by the models 2012 and 2013 by 3 and 5 times, respectively.

EN62

DEVELOPMENT OF A HOMEMADE MOSQUITO NET MODEL TO CONTROL DATE WORM OF PALM TREES IN TUNISIAN OASES. Sahar Zougari¹, Anis Zouba¹, Tayeb Chater¹, Khaled Abbes², Brahim Chermiti² and Foued Ben Hmida¹. (1) Technical Centre of Dates, Tunisia, Email: sahar.zougari@gmail.com; (2) Department of Biological Sciences and Plant Protection, University of Sousse ISA-CM, Tunisia.

Ectomyelois ceratoniae is an economic pest in Tunisia. It causes important production losses that can reach 80% for pomegranates and 20% for dates. Physical control using mosquito nets is considered the most effective for protecting date fruits. The aim of this study was to evaluate the effectiveness of two models of mosquito nets (imported model and made in Tunisia model). According to the results obtained, there was no significant difference between the two models in protecting date fruits. In fact, the infestation rate of dates protected by the two models of mosquito nets was very similar. The Tunisian model seemed to be efficient to protect dates from infestations caused by carob moth and maintain high date fruits quality.

MEDICAL ENTOMOLOGY

ME1

EVALUATION OF SOME ENVIRONMENTAL FACTORS AFFECTING THE POPULATION DENSITY OF HOUSE DUST MITES IN ASTHMATIC PATIENT'S HOMES IN ALEXANDRIA, EGYPT.

Hussien A. Rezk, Applied Entomology and Zoology Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt, Email: hussien.rezk@alexu.edu.eg; hussienrezk@yahoo.com

House dust mites are the most common cause of allergy in human dwellings and among asthmatics. This work had determined the population density of house dust mites in asthmatic patient's homes and the effect of some environmental factors on their population. Samples were collected from asthmatic patient homes in different localities throughout summer months between May to September. A total of 9711 house dust mites were found in 10 gram of 138 dust samples with an average of 70.4 mites/sample. Thirteen mite species belonging to seven families were identified. The most common species belonged to the family Pyroglyphidae with 82% of the total followed by those belonging to Acaridae (8.2%), Glycyphagidae (6.2%) and Cheyletidae (3.2%). The least common were Ascidae (0.2%) Tarsonemidae (0.1%) and Macrocheledae (0.1%). Among the collected samples, the *D. pteronyssinus* counted for 7055 cases, i.e. 72.7% of the total, with an average of 51.1 mites/10 g dust. The American house dust mite, *D. farinae*, existed in only 9%, followed by *T. putrescentiae* (7.2%), *B. freemani* (5.1%) and *C. malaccensis* (3.0%). Other mite species were found in only few numbers. *Euroglyphus maynei*, which has been firstly recorded in Alexandria as a dust mite, represented 0.31% of the total mites collected. It existed in the dust of mattresses and carpets mainly in some old houses. In addition, the results indicated a great variability of mite numbers in different rooms in the same home. The bedroom had the greatest numbers of pyroglyphid mites. Mattresses dust and carpet floors harbored significantly more mites than wood floors. Concerning the age of homes, the data clearly indicated that no significant difference was found between the amounts of mites in old compared with new homes.

ME2

LARVICIDAL PREPARATIONS FROM ARGEMONE MEXICANA SEED OIL DILUTED WITH OTHER FIXED OIL. Inshirah A. Elfahal¹, Salah Elhussein², Nour Ahmed Osman² and Hayder Abdelgadir¹. (1) Agricultural Research Corporation, Wad Medani, Sudan, Email: inshirahelfahal@gmail.com; (2) University of Gezira, Wad Medani, Sudan.

Mosquitoes are important vector of malaria diseases. Larvicidal oils, were used extensively to kill air breathing larvae by toxicity or suffocation. *Argemone mexicana* seeds produced stable oil that contains toxic alkaloids with larvicidal activity when used as EC formulation. In this study argemone seed oil mixed with other stable oil as a larvicidal preparation are described. The stable oils used for dilution were extracted from groundnut,

sunflower, sesame and maize. Argemone oil was diluted with other oils (25, 75 and 100%) and bioassayed against mosquito larvae. Pure argemone seed oil showed increased larvicidal activity which was affected with incubation time and reached 100%. Compared with other oils, groundnut oil seemed to have an antagonistic activity to Argemone oil. Sesame seed oil alone had very little larvicidal activity. However, when used as a diluent, it markedly augmented the action of diluted argemone oil, more than what was observed for sunflower oil. The larvicidal activity of Argemone seed oil did not decrease with the dilutions made using maize oil. Pure maize grain oil exhibited a larvicidal activity comparable to that of argemone oil.

MITES

M1

EFFECT OF THREE CAPSICUM ANNUUM L. CULTIVARS ON THE LIFE OF BROAD MITES POLYPHAGOTARSONEMUS LATUS. Feryal Bahjat Hermize and Tadmur Abdelrazzak Malik, Department of Plant protection, College of Agriculture Engineering Sciences, University of Baghdad, Baghdad, Iraq, Email: feryalbahjat@yahoo.com

A laboratory study was conducted to determine the effect of three cultivars of pepper Carisma, Sierra nevada and Barbarian on some life aspects of broad mite *Polyphagotarsonemus latus*. The results showed that the shortest incubation period for eggs was 2.23 days, larval stage 2.23 days, nymph stage 3.43 days, and for larval development and total nymph 5.67 days. The highest survival rate for broad mite stages was observed for sweet pepper variety Carisma with 74.13%, followed by Sierra Nevada and Barbarian was the least. Results showed that the broad mite adults life aspects varied when grown on different pepper varieties. The Carisma cultivar recorded the longest adult life (female and male) which reached 7.37 days for adult females and 5.07 days for adult males. The shortest period before laying eggs was 1.27 days, and the period after laying eggs reached 4.03 days. The average total number of eggs laid was 19.03 eggs/female/day, and egg hatching rate was 80.20%. The sex ratio (female: male) on the variety Carisma was 1:3.

M2

MONITORING AND FOLLOW-UP OF THE DATE SPIDER MITE "BOUFARWA" INFESTATION DURING THE HIBERNATION PERIOD. Nihel Ben Saad^{1,2}, Anis Zouba², Sabrine Attia¹, Sahar Zougari², Tayeb Chater² and Foued Ben Hmia². (1) Department of Plant health and Environment, LR14AGR02 of Bioaggressors and Integrated Pest Management in Agriculture, National Agronomic Institute of Tunisia, University of Carthage, Email: nihelbensaad@gmail.com; (2) Technical Centre of Dates, Tunisia.

The date palm mite *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) is considered as one of the main pests of date palm in Tunisia. When present, it can cause severe damage to date palm fruits and make them unfit for human consumption. The aim of this study is to identify the hibernation sites of *O. afrasiaticus*. Studies were carried

out in four regions in the Tozeur Governorate (Hezwa, Nafta, Tozeur and Hamma). The results revealed that *O. afrasiaticus* was not found on ripe fruit and spends the winter hibernation period on different parts of the palm at different rates.

FUNGAL DISEASES

F1

A MOLECULAR BASED STRATEGY FOR CHEMOTYPING *FUSARIUM* ISOLATES AND PHENOTYPING RESISTANCE OF WHEAT CULTIVARS TO *FUSARIUM CULMORUM*. Sihem Touati-Hattab¹, Christian Barreau² and Zouaoui Bouznad³. (1) Amar Telidji University, Laghouat, Algeria, Email: Touatisihem03@yahoo.fr; (2) National Institute of Agronomic Research, INRA, MycSA, Bordeaux, France; (3) National Higher School of Agronomy, ENSA, Algiers, Algeria.

Fusarium head blight caused by *Fusarium* spp. leading to reduced yields and kernels contamination by mycotoxins is a serious disease in Algeria similar to other many wheat growing areas of the world. In this study, *Fusarium culmorum* seemed to be the major pathogen associated with this disease in Algeria. The type of mycotoxins produced by four *F. culmorum* isolates and their capacity to confer the disease on spikes and accumulate type B trichothecenes in the grain was evaluated. PCR assays with the primers Tox5 developed for the gene *Tri 5* were used to confirm the potential ability of the isolates to produce trichothecenes. 17 specific primers for the gene *Tri12* of each chemotype were used to characterize NIV and DON producing chemotypes. The four strains were used for artificial spray inoculations on wheat spikes to determine their potential in generating FHB symptoms and accumulating mycotoxins in local field conditions. A panel constituted of four durum wheat and four soft wheat varieties generally cultivated in Algeria and of two newly bred durum wheat lines were evaluated. Specific real-time PCR assays aimed to quantify the DNA of *F. culmorum* in 104 samples of grains obtained from ears of varieties inoculated in field. The results showed a correlation between the level of invasion of the grain and the quantity of accumulated toxin. These values are consistent with a promising use of the real-time PCR as an accurate tool for phenotyping resistance of wheat cultivars to *Fusarium*.

F2

SPATIAL DISTRIBUTION OF ROOT AND STEM DISEASES OF CEREALS IN RELATION TO CLIMATIC ZONES IN TUNISIA. Samia Gargouri¹, Eya Khemir^{1,2}, Asma Bouatrous^{1,2}, Emir Souissi^{1,2}, Samira Chekali³, Mohamed Saleh Gharbi¹ and Lester Burgess⁴. (1) Institut National de la Recherche Agronomique de Tunisie, Tunisia, Email: samia.gargouri@iresa.agrinet.tn; (2) Institut National Agronomique de Tunisie, Tunisia; (3) Pôle Régional de Recherche Développement Agricoles du Nord-Ouest semi-aride, Kef, Tunisia; (4) Institute of Agriculture, Faculty of Science, University of Sydney, Australia.

Diseases caused by soil-borne and residue-borne fungal pathogens, namely *Fusarium* foot and root rot (FFRR)

incited by *Fusarium* spp., eyespot caused by *Oculimacula* spp. and take-all (*Gaeumannomyces* spp.) are major constraints to cereal production in Tunisia. Surveys were conducted over four years period (2010-2014) to assess the incidence and distribution of these diseases in 300 cereal crop areas across different climatic zones in Tunisia. Disease incidence was assessed for FFRR by isolation from a random sample of 50 plants whereas, for take-all and eye-spot, it was based on visual assessment of the symptoms on roots and stems. More than 90% of the crops sampled were affected by at least one disease, and more than 50% were affected by multiple diseases. *Fusarium* foot and root rot was widely distributed, being detected in 90% of the crops. In contrast, eye spot and take-all were more restricted to wetter zones and were detected in 64% and 23% of the crops, respectively. Take-all was not observed in the arid zones. Incidence of the three diseases significantly varied between climatic zones and years. The highest in-crop incidence of all three diseases was observed in the wetter areas. Incidence of take-all was significantly higher in 2013 which was characterized by a dry autumn, whereas, the incidence of FFRR and eyespot increased significantly across cropping seasons. Overall, durum wheat was most affected by the three diseases. Barley was the least affected by eyespot and none of the oat crops showed symptoms of take-all. This survey highlighted the effectiveness of break crops in reducing the incidence of FFRR. However, such an effect was not observed in take-all and eyespot. The molecular identification of the pathogen species revealed the dominance of *F. culmorum*, *O. yalundae* and *G. tritici* for FFRR, eyespot and take-all, respectively. Results obtained provide a valuable basis for framing guidelines for the management of root and stem rot diseases in different climatic zones across the cereal growing areas of Tunisia.

F3

THE PATHOGENICITY OF THE MAIN SPECIES CAUSING CROWN ROT AND HEAD BLIGHT OF WHEAT IN ALGERIA. Nora Abdallah-Nekache¹, Imane Laraba¹, Christine Ducos², Christian Barreau², Zouaoui Bouznad¹ and Houda Bouregghda¹. (1) Laboratoire de Phytopathologie et de Biologie Moléculaire, Département de botanique, Ecole Nationale Supérieure Agronomique, Algiers, Algeria, Email: abdallah.nora87@gmail.com; (2) Institut National de la Recherche Agronomique, Bordeaux, France.

Head blight and crown rot diseases are the most important worldwide fungal diseases of wheat. Our recent study revealed that the main species causing crown rot disease of wheat in Algeria were *F. culmorum*, *F. pseudograminearum*, *Microdochium majus* and *M. nivale*. Whereas *Fusarium* head blight is mainly caused by *F. culmorum*. This study aimed to evaluate the pathogenicity of these species. Three different pathogenicity tests were conducted *in vivo* by soil and head inoculation and *in vitro* by seed inoculation. Fourty fungal isolates were used, ten isolates belong to *F. culmorum* isolated from symptomatic crowns, ten isolates belongs to the same fungi isolated from blighted heads, ten isolates belong to *F. pseudograminearum* and ten belong to *Microdochium* spp. Results showed that *F. culmorum* isolates were the most pathogenic on wheat

seedlings and heads *in vitro*. However, *F. pseudograminearum* isolates were the most pathogenic on the crown, whereas the isolates of *Microdochium* spp. were the least pathogenic in the three tests. The results obtained showed that there was no effect of the origin of the fungal isolates, whether taken from crown or head on their pathogenicity toward seedlings, crowns or heads. It was also found that the isolates obtained from crowns were also pathogenic on heads and those obtained from heads were pathogenic on crowns. High correlations were found between *Fusarium* isolates pathogenicity on the wheat seedlings *in vitro* and on the head for the two *F. culmorum* groups (crown origin: $r=0.89$ and head origin: $r=0.85$). These results provided a simple *in vitro* test to predict pathogenicity of *F. culmorum* isolates for head blight disease and then economize time by choosing the isolates in laboratory before field or greenhouse inoculation of wheat heads.

F4

MORPHOLOGICAL CHARACTERIZATION AND PATHOGENICITY OF NINE *FUSARIUM* SPP. ISOLATES COLLECTED FROM BARLEY SEEDS (*HORDEUM VULGARE* L.) IN MOROCCO. Inaam El-Miziani¹, Yassine Boukhou², Sripada Udupa¹, Jamal Ibijbijen², Amine El Bouazaoui³ and Safaa G. Kumari⁴. (1) International Center for Agricultural Research in the Dry Areas (ICARDA), Rabat, Morocco, Email: i.el-miziani@cgiar.org; (2) Moulay Ismail University, Faculty of Science, Meknes, Morocco; (3) Ibn Toufail University, Faculty of Science, Kenitra, Morocco; (4) ICARDA, Terbol Station, Beqa'a Valley, Zahle, Lebanon.

Barley (*Hordeum vulgare* L.) is the most produced and consumed grain in the world, and is an important source of food, forage and livestock feed in many developing countries including Morocco. *Fusarium* head blight (FHB) is one of the main fungal diseases of grain crops such as wheat, barley and maize caused by different species of the genus *Fusarium*. The FHB species complex produces mycotoxins that affect livestock feed, the baking, milling quality of wheat, the malting and brewing qualities of malt barley. Nine isolates of *Fusarium* spp. causing necrosis with typical FHB symptoms were isolated from infected barley genotypes planted at ICARDA's Merchouch station, Rabat, Morocco. After seeds harvesting, all nine FHB isolates were purified and morphologically identified by characterizing their culture appearance (colony color, texture, form, and margin), shape and size of the macroconidia, and presence or absence of microconidia. Pathogenicity of these isolates was studied under controlled conditions using two inoculation methods (soil inoculation and hydroponic culture) on 12 barley varieties (Flinders, Litmus, Oxford, Commander, Latrobe, Vlaming, Fleet, Granger, Rosalind, Buloke, Keel and Campus). Morphological characterization using the Leslie and Summerell key, implied 5 different macroscopic and microscopic morphologies very similar to: *Fusarium acuminatum* (two isolates), *F. crookwellense* (two isolates), *F. avenaceum* (two isolates), *F. sambucinum* (one isolate) and *Fusarium culmorum* (two isolates). All 9 isolates caused FHB symptoms on all 12 barley varieties tested in both inoculation methods and the number of infected spikelets was assessed. Four barley varieties (Keel, Buloke, Latrobe

and Commander) showed a heavy fungal infection (infected spikelet over 65%) and were considered susceptible to infection with the disease. Whereas, four barley varieties (Campus, Oxford, Vlaming and Granger) were resistant to the nine isolates compared to the other barley varieties (infected spikelet less than 35%). In addition, a significant difference ($P < 0.05$) was observed between *Fusarium* species.

F5

INCIDENCE OF FOOT ROT DISEASE IN COMMERCIAL DURUM WHEAT GENOTYPES UNDER CONTINUOUS WHEAT CROPPING IN NORTHWEST TUNISIA. Asma Bouatrous^{1,2,3}, Kalthoum Harbaoui⁴, Samia Gargouri⁵, Amir Souissi^{1,2}, Mohamed Salah gharbi⁶ and Mohamed Annabi¹. (1) Laboratoire Sciences et Techniques Agronomiques, Institut National de la Recherche Agronomique de Tunisie, Tunisia, Email: bouatrouasma@yahoo.fr; (2) Institut National Agronomique de Tunisie, Tunisia; (3) Centre Régional de Recherche en Grandes Cultures de Béja, Tunisia; (4) Ecole Supérieure d'Agriculture de Mateur, Tunisia; (5) Laboratoire de protection des végétaux, Institut national de la recherche agronomique de Tunisie, Rue Hédi Karray, Tunisia; (6) Laboratoire des Grandes Cultures, Institut National de la Recherche Agronomique de Tunisie, Université de Carthage, Rue Hédi Karray, Araina, Tunisia

Durum wheat is the main cereal crop in Tunisia. The increasing need for this food commodity leads to shorter rotation with frequent continuous wheat cropping. This would lead to increased incidence of soil-borne pathogens including *Fusarium* species responsible of foot and root rot. This study was designed to explore the incidence of foot rot caused by *Fusarium* species on five commercial durum wheat varieties (Karim, Nasr, Maali, Oum Rabiaa and Khiar) grown under one or two years of successive wheat cropping. The trial was conducted during three cropping seasons (2016-2019) at the Agricultural Experimental Station of the Regional Crop Research Center in Beja northwest Tunisia. The study results showed that the previous crop significantly ($p<0.001$) affected *F. culmorum* incidence. However, there was no significant differences between the cultivars. Average disease incidence reached 7.16% after one year of wheat cropping and to 20.01% after two years of continuous durum wheat cropping. Furthermore, significant interaction between the cultivars and the number of years of continuous wheat cultivation for the incidence of *F. culmorum*, Khiar and Maali varieties showed the lowest incidence with 10% and 15%, respectively, under two years of successive wheat cropping. In contrast, Karim and Nasr varieties showed the highest incidence (30% and 26%, respectively). The study results also showed that there was no significant differences in the measured yield parameters after one and two years of wheat cropping. The high significant differences ($P<0.001$) in grain yield means in the three cropping seasons indicates a potent effect of climate conditions on this parameter. The cultivars Khiar and Maali seemed to be the best choice for a continuous durum cropping. It would be useful to test this hypothesis under high foot and root rot pressure.

F6

REACTION OF DURUM AND BREAD WHEAT VARIETIES AND ADVANCED LINES TOWARD FUSARIUM FOOT AND ROOT ROT IN THE TUNISIAN SEMI-ARID REGION. Samira Chekali¹, Samia Gargouri², Eya Khemir^{2,3}, Sourour Ayed² and Mohamed Saleh Gharbi². (1) Pôle Régional de Recherche Développement Agricoles du Nord-Ouest semi-aride, Kef, Tunisie, Email: samirachekali@yahoo.fr; (2) Institut National de la Recherche Agronomique de Tunisie, (3) Institut National Agronomique de Tunisie.

Reaction of Tunisian durum and bread wheat genotypes to foot and root rot caused by *Fusarium culmorum* was evaluated in an inoculated and non-inoculated experimental field trials conducted at Kef Experimental Station (North Ouest Tunisia) during the 2016/2017 and 2017/2018 growing seasons. Thirty-three wheat genotypes including 6 new and 6 old varieties and 16 advanced lines of durum wheat, and 5 bread wheat varieties were used in this study. Disease severity was estimated at the mature stage by the extent of stem browning, on a 0-5 scale and the percentage of premature whiteheads. In addition, impact of inoculation with *F. culmorum* on grain yield, thousand kernel weight (TKW) and heading date were also evaluated. Results showed that bread wheat genotypes were less susceptible than durum wheat with significant lower disease severity and percentage of white heads. Inoculated plots showed significant lower grain yield and TKW losses in bread wheat (32 and 9%) compared to durum wheat (54 and 11%). A delay for four days in heading date was recorded for inoculated durum wheat which makes it more susceptible to drought conditions. There was no significant difference among durum wheat genotypes for all evaluated parameters under inoculated and non-inoculated conditions in both years. Whereas, INRAT 100 developed the least percentage of white heads (41% in 2016/2017 and 61% in 2017/2018). The new variety Salim showed the highest disease severity (3.75 in 2016/2017 and 2.5 in 2017/2018). In addition, durum genotype 9 expressed the lowest grain yield and TKW losses which averaged 25 and 5%, respectively. Furthermore, all measured parameters were significantly higher in the dry (2016-2017) season for both inoculated and non-inoculated plots compared to the 2017/2018 season. This work confirmed the higher susceptibility of durum wheat to *F. culmorum* compared to bread wheat and highlighted the impact of climatic conditions on disease severity and potential yield loss in the farming system of north-west Tunisia.

F7

POTATO FUSARIUM DISEASES: INTERACTIONS BETWEEN FOUR FUSARIUM SPECIES ON POTATO PLANTS AND TUBERS AND THEIR INFLUENCE ON DISEASE SEVERITY. Boutheina Mejdoub-Trabelsi¹, Hayfa Jabnoun-Khiareddine², Rania Aydi Ben Abdallah², Nawaim Ammar² and Mejda Daami-Remadi². (1) Higher School of Agriculture of Kef, University of Jendouba, Tunisia, Email: boutheinam2002@yahoo.fr; (2) Integrated Horticultural Production in the Tunisian Centre-East, Regional Research Centre on Horticulture and Organic Agriculture, University of Sousse, Chott-Mariem, Tunisia.

Potato Fusarium diseases occur worldwide and are responsible for considerable plant and yield losses. Fusarium dry rot during storage and Fusarium wilt of plants are both caused by a complex of *Fusarium* species of variable aggressiveness (*F. sambucinum*, *F. oxysporum*, *F. solani* and *F. graminearum*). The aim of this study was to elucidate the interactions occurring between the different *Fusarium* species associated with potato (plants and tubers) and their influence on disease severity. Interactions between these *Fusarium* spp. was evaluated using single and mixed infections (15 *Fusarium* inocula) on a local potato cultivar (Spunta). Data based on dry rot severity, indicated that the mixed infection based on *F. sambucinum* and *F. solani* (C2-1) was found to be the most aggressive inoculation treatment on tubers. This treatment was followed by the mixed inoculum of *F. sambucinum* with *F. oxysporum* (C2-4) and the mixed inoculum of *F. sambucinum* with *F. solani* and *F. graminearum* (C3-4). Based on Fusarium wilt and vascular browning severity and subsequently their effect on potato growth and production parameters, results showed that the wilt severity, induced by C2-1 (*F. sambucinum* + *F. solani*), C2-2 (*F. solani* + *F. oxysporum*) and C3-3 (*F. sambucinum* + *F. oxysporum* + *F. graminearum*) were found to be the most severe. This study clearly indicated that disease development including severity of Fusarium wilt and Fusarium dry rot are expected to be more augmented when more than one *Fusarium* species were present. The relative predominance of *F. sambucinum* may reflect its competitive potential in mixture and its relative involvement in potato Fusarium severity. Overall, these results indicated that mixed infections by *Fusarium* spp. result in synergistic interactions in potato and can increase Fusarium wilt and dry rot severity.

F8

FUNGI ASSOCIATED WITH WHEAT, BARLEY AND SORGHUM IN MUKIRAS REGION, YEMEN. Najeeb Ahmed Sallam, Plant Protection, Nasser's Faculty of Agriculture, Sciences University of Aden, Yemen, Email: Najeebcurd2007@yahoo.com

This study was conducted in the Plant Protection Laboratory of Nasser College of Agricultural Sciences, University of Aden during 2019-2020 to detect fungi associated with grains of wheat and barley local varieties, and sorghum grains from five regions in the Mukiras region, Republic of Yemen. The most frequently isolated fungi from wheat were *Aspergillus niger* (32%), *Helmenthosporium sativum* (15%) and the least frequently isolated fungi were *Penicillium* sp. (9%) and *Chaetomium globosum* (7%). The most frequently isolated fungi from barley were *Aspergillus niger* (29%), *Alternaria alternata* (15%), and the least frequently isolated fungi were *Cladosporium* sp. (5.5%) and *Macrophomina phasiolina* (4%). The most frequently isolated fungi from sorghum were *Aspergillus niger* (28%), and the low frequently isolated fungi were *Penicillium* sp. and *Fusarium moniliforme* (7%). Seedling symptoms test results showed that average germination rate of mukaras wheat variety seeds was 89.6% among which 23.2% were infected by seed borne mycoflora. The isolated fungi were *Alternaria alternata*, *Fusarium moniliforme*, *Drechslera australiensis* and *Aspergillus* spp. Barely seeds germinated at an average rate of 80.6% among which 22.4% were infected by seed

borne mycoflora. The isolated fungi were *A. flavus*, *A. alternata*, *Cladosporium* sp., *A. niger*, *F. moniliforme*, *Curvularia lunata* and *Chaetomium globosum*. Al dorabaida sorghum variety seeds germinated at an average rate of 88.2% among which 18.8% were infected by seed borne mycoflora. The isolated fungi were *C. lunata*, *F. oxysporum*, *Drechslera sorghicola*, *A. alternata*, *Cladosporium* sp. and *Polymyxa graminis*. *P. graminis* belonging to *Plasmodiophorales* is known to be a virus transmitting fungus to barley and wheat and this is its first report in Yemen.

F9

DISTRIBUTION OF WHEAT ROOT ROT DISEASE IN NINEVAH AND ERBIL GOVERNORATES, IRAQ.

Ali Kareem Al-Ta'ae and Zardasht A. Taha, Plant Protection Department., College of Agriculture and Forestry, University of Mosul, Iraq, Email: aaltaae@yahoo.co.uk

The Results of field survey conducted in Ninevah and Erbil governorates to assess the distribution of root rot disease in wheat have shown variability in infection levels. In Ninevah, the highest infection rate of 27.5% was reported in Bashika, and the lowest of 16.9% in Hamdaniyeh, whereas in Erbil the highest infection rate of 25.8% was reported in Grdy Mawan and the lowest of 21.5% in Khalwan. Isolation result from infected wheat roots showed the presence of *Bipolaris sorokiniana* (Sacc.) Shomaker, *Fusarium graminearum* (Schwabe), *F. culmorum* (Wm. G. Smith) Sacc and *F. poae* (Schwabe) on wheat in Iraq. *B. sorokiniana* had the highest isolation rate of 54.1% in Tallafar and the lowest rate of 37.1% in Qapakian, followed by *F. culmorum* with isolation rate ranged between 22.1 to 25.4%. Confirmation of the identification of the isolated fungi were conducted by the use of polymerase chain reaction (PCR) using 2 specific primers FP82F and FP82R. The expected PCR product (220 bp) obtained from a specific molecular marker (FP82), confirmed that they belong to *F. Poae*. However, this is the first molecular study that clearly indicated the presence of *F. Poae* on wheat in Iraq.

F10

TOXIGENIC FUNGI AND MYCOTOXINS IN OAT SILAGE BEFORE AND AFTER FERMENTATION.

Amal Mannai¹, Noura Omri Ben Youssef², Cristina. Juan³ and Hichem Ben Salem¹. (1) Laboratory of Animal and Forage Productions, National Institute of Agronomic Research of Tunisia (INRAT), University of Carthage, Street Hédi Karray, 1001 El Menzah 1, Tunisia, Email: mannaamal1991@gmail.com; (2) Laboratory of Field Crops, National Institute of Agronomic Research of Tunisia (INRAT), University of Carthage, Street HédiKarray, 1001 El Menzah 1, Tunisia; (3) Laboratory of Food Chemistry and Toxicology, Faculty of Pharmacy, University of Valencia, Spain.

Forage silage is commonly used for dairy cattle feeding in many countries. In Tunisia, oat is the most used forage species for silage production. Inappropriate ensiling process and silo opening management would lead to silo colonization by fungi, to mycotoxin production and subsequently to the deterioration of silage quality. The aim of the study was to identify and quantify the mycoflora

composition and mycotoxins from 15 oat silage silos. Each silo was sampled before compaction (P1: pre-fermentation), and 40 days after silo opening (P2: 100 days of fermentation). Total fungal counts of samples were performed on potato dextrose agar (PDA) medium. Mycotoxins were extracted using the QuEChER method and analyzed by LC-MS/MS and GC-MS/MS for the determination of 23 mycotoxins simultaneously. At P1, the main fungi isolated were *Penicillium* sp. (71%), *Fusarium* sp. (38%) and *Aspergillus* sp. (18%), with *Penicillium chrysogenum*, *Fusarium graminearum* and *Aspergillus fumigatus* being the most prevalent species. After 100 days of fermentation, the trend has changed since *Penicillium* sp. and *Aspergillus* sp. were frequently isolated (49 and 47% of contaminated silos, respectively). However, *Fusarium* sp. was only isolated in 9% of the silos. Average total fungal counts (CFU g⁻¹) differed ($P < 0.05$) from 5.26×10^3 to 1.14×10^4 CFU/g of dry matter in pre and post-fermentation samples, respectively. Moreover, the results showed the presence of *Fusarium* mycotoxins, deoxynivalenol (DON), HT-2 toxin and enniatins (ENB, ENB1) At P1 and P2 stages. The highest values detected were for DON in the two stages. DON maximum values were 3337 and 211 µg/kg dry matter for P1 and P2, respectively. Our findings suggest that the pre-harvest phase of the ensiling process is most likely the main source of fungi and mycotoxins in oat silage.

F11

MONITORING OF POWDERY MILDEWS DISEASE ON DIFFERENT HOST PLANTS IN CERTAIN LOCATIONS OF IRAQ.

Nadeem A. Ramadan¹ and Ramadan Y. Mohammed². (1) Biology Department, /College of Science, Mosul University, Iraq, Email: nadeem.ramadan53@yahoo.com; (2) Plant Protection Department, College of Agriculture, Salahaldeen University, Iraq.

A field survey was conducted to investigate the spread of powdery mildew disease on different host plants located in certain areas of the governorates of Nineveh, Erbil and Dohuk. The study included 103 plant species (34 species of wild plants, 32 species of trees & shrubs, 23 species of vegetables, 9 species of field crops and 5 species of ornamentals). Powdery mildew disease was observed on 46 species: 16 species belong to the family Asteraceae (Compositae), 5 species belong to the Ammiaceae (Umbelliferae), 4 species belong to the family Poaceae (Gramineae) and 3 species of each Brassicaceae (Cruciferae) and Cucurbitaceae, two species of each Polygonaceae, Malvaceae and Rosaceae, and one species for each of the Fagaceae, Dipsacaceae, Convolvulaceae, Vitaceae, Verbinaceae, Rubiaceae and Moraceae. Disease severity in the infected plants ranged between severe infection (17 plants), to medium infection (26 plants) and light infection (3 plants). Conidia was found on one or both surfaces of the leaves and on the stems, buds, flowers and fruits of the infected plants. The disease was recorded for the first time in Iraq on 21 plants as new hosts for powdery mildew; 12 plants of which belong to the family Asteraceae, 3 plants belong to the Ammiaceae and other plants were distributed among other families. *Sphaerotheca cephalarii* was recorded on the

Cephalaria syriaca and *Phyllactinia* sp. on the *Althaea rosea* for the first time in Iraq.

F12

THE ROLE OF THE RACE OF *PHYTOPHTHORA INFESTANS* ON THE RESPONSE OF POTATO TO INFECTION. Taoutaou Abdelmoumen¹, Socaciu Carmen², Pamfil Doru² and Botez Constantin². (1) Department of Botany, Ecole Nationale Supérieure Agronomique, Algiers, Algeria, Email: Abdelmoumen.taoutaou@edu.ensa.dz; (2) Life Sciences Institute, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania.

Potato (*Solanum tuberosum*) is one of the major crops worldwide. It is threatened by the oomycete *Phytophthora infestans*. This pathogen was the responsible agent for the Irish famine in the 1840s. In this research we studied the effect of *P. infestans* race on the response of potato to inoculation. Two potato genotypes each carrying one of the resistance gene R2 and R5 were inoculated with several *P. infestans* races. However, both potato genotypes were sensitive to infection by the pathogen, but they reacted differently. Fourier transformed infrared spectroscopy (FTIR) was used to analyze the responses of potato plants. The spectra obtained showed that there were suppressed peaks and/or induced peaks depending on the race used in the inoculation.

F13

THE STRATEGY OF THE ARAB CENTER FOR THE STUDIES OF ARID ZONES AND DRY LANDS (ACSAD) TO REDUCE BREAD WHEAT INFECTION WITH RUST DISEASES. Mahmoud Hassan and Hussam Faraj, Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria, Email: shmahasyr@gmail.com

This research was carried out at the research stations of the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD). It was found that early sowing of wheat reduced rust infections and high plant density increased infection severity. The best way to control rust diseases is selecting resistant genotypes, which is the main goal of ACSAD. A total of 62 varieties and promising lines of durum and bread wheat improved by ACSAD were evaluated under artificial infection to test their sensitivity to the Ug99 strain of stem rust, and under natural infection to yellow rust disease. Twenty-four bread wheat genotypes showed medium sensitivity (MS) in the range MS20-MS1. The two cultivars ACSAD 1123 and ACSAD 1149, recently selected, were moderately resistant (MR), while 23 genotypes of durum wheat were resistant (R). For the strain Ug99 of stem rust, 7 genotypes were moderately resistant (MR) whereas the cultivars ACSAD 1245 and ACSAD 1315 were moderately sensitive. For yellow rust infection severity, our results showed that 9 bread wheat genotypes were highly susceptible (90S to 10S) namely ACSAD 59, ACSAD 67, ACSAD 883, ACSAD 885, ACSAD 1063, ACSAD 1123, ACSAD 1131, ACSAD 1147, ACSAD 1157. Reaction of the promising line ACSAD 1103 was MS while ACSAD 1071 and ACSAD 1115 were moderately resistant (MR). Reaction of the remaining 18 genotypes was resistant (R). For durum wheat, 26 genotypes were resistant (R), 3 were moderately

resistant (MR20 - MR5), and 3 (ACSAD 65, ACSAD 357, ACSAD 1103) were MS. ACSAD distributes the promising resistant genotypes to the Arab countries in order to verify their performance under local climatic conditions. The best performing lines could be used at large scale to improve wheat yields.

F14

MONITORING DIVERSITY OF WHEAT STRIPE AND STEM RUST PATHOGENS BY INTERNATIONAL TRAP NURSERIES AND RACE ANALYSIS. Atef A. Shahin, Department of Wheat Diseases Research, Institute of Plant Pathology (PPRI), Sakha Agricultural Research Station, Kafrelsheikh, 33717, Agriculture Research Center (ARC), Egypt, Email: a.a.shahin@hotmail.com

Wheat stripe and stem rust pathogens populations can be highly diverse for virulence phenotypes, exemplified by the emergence of the *Puccinia graminis* f. sp. *tritici* (Pgt) Ug99 (Race TTKSK) and the “Warrior” race of wheat stripe rust *Puccinia striiformis* f. sp. *tritici* (Pst). Race analysis was conducted under greenhouse conditions based on a virulence/virulence pattern to differential host genotypes carrying stripe and stem rust resistance genes (Yr and Sr genes). New Pst and Pgt races were detected in Egypt that were virulent to the widely deployed stripe and stem rust resistance genes; *Sr24*, *Sr25*, *Sr31*, *Sr38* and *Yr1*, *Yr17*, *Yr27*, *YrSp*, respectively. In addition, international trap nurseries widely used in the world for monitoring and detection of variability in wheat rusts were used. The resistance to wheat stem and yellow rust of wheat cultivars and advanced breeding genotypes in the international yellow rust trap nursery and international stem rust trap nursery, from ICARDA and CIMMYT, were studied under natural infection in 2017/18 and 2018/19 growing seasons under field conditions. Early monitoring of rust diseases helps in avoiding wheat rust epidemics caused by *Puccinia* spp. with significant effect on wheat production worldwide, including Egypt.

F15

VIRULENCE CHARACTERIZATION OF LEAF RUST ISOLATES FROM 2017-18 WHEAT CROP IN SINDH, PAKISTAN. Muhammad Saeed¹, Saba Fatima² and Tayyab Shahzad². (1) Wheat Research Sub-Station Murree, Pakistan, Email: saeedkalvi114@gmail.com; (2) PMAS-Arid Agriculture University Rawalpindi, Pakistan.

Wheat leaf rust disease, caused by *Puccinia triticina* poses serious threat to 80% of the wheat cultivated across Pakistan. One hundred and twenty-nine leaf rust samples collected from Sindh during 2017-18 wheat cropping season were processed and eleven single uredinial isolates were revived and analyzed using north American set of differentials. Six virulent profiles were found amongst these isolates. LKTSS was most common, found in four isolates; LKFJS was identified in two isolates. MKPSS, LKFKS, PKKSS and LKHSS were identified in single isolate only. Virulence was absent for *Lr2a*, *Lr9*, *Lr19*, *Lr27+31* and *Lr28*. Whereas, only a single isolate PKKSS was virulent to *Lr2c* and isolate LKFKS to *Lr18*. Virulence for the leaf rust genes *Lr1*, *Lr16*, *Lr24*, *Lr28*, *Lr17*, *Lr30*,

Lr10, *Lr14a*, *Lr3bg*, *Lr14b*, *Lr20*, *Lr13*, *Lr23*, *Lr22b* were found along with cv. Morocco under controlled conditions. Overall high frequency of leaf rust phenotypes were identified in limited number of samples. The avirulence/virulence information of *Lr* genes should be utilized in gene deployment and breeding programs, particularly for Sindh province.

F16

MONITORING STEM RUST INFECTION IN VARIOUS WHEAT PRODUCTION AREAS ACROSS IRAQ FROM 2016-2020. Emad Al-Maarouf¹, Kumarse Nazari², Dave Hodson³, Abd Hameed Fiadh⁴, Nabaz Rashed⁵, Laith Osama⁴, Ali Abbas¹ and Wael Fahmi⁴. (1) University of Sulaimani, Sulaimani, Iraq, Email: emad.ghalib@univsul.edu.iq; (2) ICARDA Regional Cereal Rust Research Center (RCRRC), Izmir, Türkiye; (3) International Maize and Wheat Improvement Center (CIMMYT), Mexico City, Mexico; (4) Ministry of Agriculture, Baghdad, Iraq; (5) Ministry of Agriculture and Water resources, Erbil, Iraq.

Black stem rust disease incited by *Puccinia graminis* f. sp. *tritici* (*Pgt*), is currently a major source of concern to wheat producers due to the emergence of the new race Ug99 and its group members in the Middle East. Using standard surveillance protocol and GPS, disease surveys were conducted in the main wheat production areas across Iraq during the period 2016-2020. Response of the commercial bread and durum wheat cultivars were evaluated against stem rust disease at adult plant stage. Distribution map of stem rust was developed using GPS and disease severity and incidence. Stem rust samples collected from commercial wheat fields, biological wheat trap nurseries and yield trial plots were sent to advance rust labs for race analysis. Medium to high stem rust infection were detected in 44.9% of the fields (40 Fields) in central and north-east Iraq in 2016, low to medium infection in 45% of the fields in 2018, low to high stem rust infection in 60.5% of the fields (75 Fields) in 2019, and low to medium infection in 16.6% of the fields in 2020. The highest disease severity and infection was 100S, and the majority of bread wheat cultivars showed susceptible reaction to stem rust disease. Baraka, Al-Rasheed, Sham 6, Adana 99, Rezgari, Acsad 65, SaberBeg, Hawler 2 and Ciyhan99, Cimmito, Rabia and Intisar showed high susceptible reaction to stem rust disease in most farmer fields, whereas, Charmo, Azmar 2, Sarah and Alwand were resistant. Five *Pgt* races TKTTC, TKTRC, RKJTF, PRJSC and KRKSC were identified in 2016, Digalu races TKTTF, TKKTF and TTTTF were predominant in 2017 and 2018. Out of seven recovered isolates in 2019, four were classified as TKKTF, two as race TKTTF and one as race TTKTT.

F17

MORPHOLOGICAL VARIATION AND VIRULENCE GENE CHARACTERIZATION OF PYRENOPHORA TRITICI-REPENTIS POPULATION. Nouredine Ouair and Hamida Benslimane, Ecole Nationale Supérieure d'Agronomie, Département de Botanique 1, Avenue Pasteur, Hassan Badi, Alger, Algérie, Email: n.ouair@edu.ensa.dz

Tan spot of wheat caused by *Pyrenophora tritici-repentis* (Died.) Drechs. is an important economical disease

worldwide. It has been reported to occur in Algerian growing wheat areas for a long period of time. This region has a special interest because it is close to the wheat origin center, which makes it a potential area for high pathogen diversity. A morphological characterization has been conducted on a population of 85 isolates collected from several Algerian growing wheat areas. This included colonies characters (mycelia type, mycelia and pigment colors), mycelia growth at optimal temperature of 25°C, and *in-vitro* sporulation. DNA isolates have been extracted using a modified phenol/chloroform method, through which phenol has been substituted by proteinase K, and a grinded glass added to improve grinding mycelia, then ToxA virulence gene was looked for, in all isolates using PCR. Results showed a large variation among isolates related to all parameters evaluated. The modified DNA extraction method allowed successful DNA extraction with reasonable quality, and ToxA gene was amplified in 78% of the isolates.

F18

FIRST REPORT OF PYRENOPHORA TERES, THE CAUSAL AGENT OF BARLEY NET BLOTCH IN ALGERIAN WHEAT FIELDS. Hamida Benslimane¹, Karima Bourahla² and Hamama-Imène Lammari¹. (1) Ecole Nationale Supérieure Agronomique. Avenue Pasteur, Hassan Badi, Algiers, Algeria, Email: h.benslimane@ensa.dz; (2) M'hamed Bougara University (UMBB), Faculty of Sciences, Department of Biology, Algeria.

Pyrenophora teres is the causal agent of net blotch, one of the most important diseases affecting barley crops in Algeria. This pathogen has been isolated for the first time in Algeria from infected wheat leaves, during routine survey. Leaves showing necrotic lesions were brought to the laboratory for analysis. Pathogen identification was carried out, through Koch postulates, as well as using cultural and morphological features, and then confirmed using molecular methods. After single spore isolation, conidia size and the numbers of cells per spore were evaluated for 50 single-spore isolates, followed by macroscopic examination of the colonies. Pathogenicity tests were conducted through isolates inoculation of durum wheat, bread wheat, and barley. PCR amplification using three different specific primer pairs were carried out; the first pair amplified a specific sequence of *P. teres*, whereas the two other pairs were used in a multiplex PCR to identify either of the two forms: *P. teres* f. *teres* or *P. teres* f. *maculata*. All isolates showed straight cylindrical conidia, rounded at both ends and having several transverse pseudo-septa. They germinate from any cell, measured 60.6-147.7 µm in length, and 15.2-22.7 µm in width, with 3 to 6 cells per conidium. These observations are in agreement with those reported by references that described the species *P. teres*. Isolates showed homogeneous colonies appearance, with greenish-white fluffy cotton mycelia. The cultures were marked by the obvious presence of coremia, which is characteristic to *P. teres*. Inoculation induced small dark brown lesions in both durum and bread wheat; symptoms evolved to an oval necrotic spot, which coalesce in large necrotic lesions. The pathogen was re-isolated from infected tissues. Molecular identification highlighted the suspected DNA bands and

confirmed that the isolated pathogen was in fact *P. teres* f. *teres*.

F19

VARIETAL BEHAVIOR OF SOME CHICKPEA GENOTYPES TO WILT DISEASE INDUCED BY *FUSARIUM OXYSPORUM* F. SP. *CICERIS*. N. Rouag¹, M.W. Khalifa², O. Benchikh³, S. Selloum¹ and K. Benarif¹. (1) Department of Agronomy, Faculty of Nature and Life Sciences, University of Ferhat Abbas Sétif-1, Algeria, Email: n.rouag@univ-setif.dz; (2) Laboratory of Characterization and Natural Resources Valorization, Faculty SNV-TU, University Bordj Bou Arreridj, Algeria; (3) Department of Microbiology, Faculty of Nature and Life Sciences, University of Ferhat Abbas Sétif-1, Algeria.

The reaction of forty-two varieties and genotypes of chickpeas regarding root wilt disease induced by *Fusarium oxysporum* was investigated under the natural conditions of infection and conducted at the ITGC experimental station in Sétif, Algeria. The infected plants of the different chickpea genotypes have shown multiple symptoms in the field caused by the local strain of *Fusarium oxysporum* f. sp. *ciceris* belonging to race II of the pathogen. These symptoms ranged from lateral or partial wilting with some ramifications to total desiccation of the plant, sometimes combined with very slow growth of symptomatic plants. Based on infection rate, the 42 tested genotypes were placed in 7 groups, with no genotype showed absolute resistance. In terms of disease severity, results obtained revealed the presence of three homogeneous groups. The first group formed by the most resistant genotypes in this case Flip10-368C; Flip11-77C; Flip11-186C; Flip11-124C; Flip11-142C, Flip11-152C; Flip11-69C; Ghab 05; Flip11-159C; Flip11-90C; Flip10-357C and Flip11-37C while the second group included FLIP genotype 10-382C which was found to be the most sensitive to natural infection. Thus, the genotypes of *Cicer arietinum* L. which have shown significant levels of resistance to *Fusarium* wilt can be integrated into breeding programs for disease resistance.

F20

GENOTYPING BY SEQUENCING IDENTIFIED QTLs FOR ASCOCHYTA BLIGHT RESISTANCE IN CHICKPEA. Fida Alo¹, Michael Baum¹, Zakaria Kehel¹, Udupa, Sripada¹, Khaled Al-Sham'aa¹, Alsamman M Alsamman², Tawffiq Istanbuli¹, Bassem Attar^{1,3} and Ahmed Amri¹. (1) International Center for Agricultural Research in the Dry Areas (ICARDA), Beirut, Lebanon, Email: f.alo@cgiar.org; (2) African Genome Center, Mohammed VI Polytechnic University, Ben Guerir, Morocco; Agriculture Genetic Engineering, Research Institute, Giza, Egypt; (3) The Scottish Association for Marine Science, Scottish Marine Institute, Oban, Argyll, Scotland PA37 1QA, UK.

Ascochyta blight (AB) caused by the fungal pathogen *Ascochyta rabiei* is a devastating foliar disease of chickpea (*Cicer arietinum* L.). The genotyping-by-sequencing (GBS)-based approach was deployed for mapping QTLs associated with AB resistance in chickpea in a recombinant inbred lines population (AB482) derived from a crosses ILC 1929 X ILC482, tested under six different

environments. In total, five clusters and four hotspots were detected on CalG04 pertaining to AB resistance in the populations AB482, contain nine QTLs. This is the first time 'ILC482' genotype was used as a donor for resistance to AB. Gene ontology (GO) assigned these QTLs to 120 genes, many of which were associated with stress and disease resistance, with most important genes belonging to resistance gene families including Leucine-Rich Repeat (LRR) and transcription factors families. Our results may refer to the flowering-associated gene GIGANTEA as a possible key factor in AB resistance in chickpea.

F21

***FUSARIUM* SPECIES ASSOCIATED WITH CHICKPEA WILT.** Mariam Bouhadida¹, Warda Jendoubi¹, Samia Gargouri², Weidong Chen³ and Mohamed Kharat¹. (1) Field Crops Laboratory, University of Carthage, National Institute of Agricultural Research of Tunisia, Rue Hedi Karray, El Menzah, Tunisia, Email: mariembouhadida76@gmail.com; (2) Plant Protection Laboratory, University of Carthage, National Institute of Agricultural Research of Tunisia, Rue Hedi Karray, 1004 El Menzah Tunis, Tunisia; (3) USDA-ARS, Washington State University, Pullman, WA 99164, USA.

In Tunisia, wilting symptoms on chickpea characterized by browning and necrosis of subcortical and xylem tissues of the crown and the main root have been attributed solely to race 0 of *Fusarium oxysporum* f. sp. *ciceris* (FOC0). Recently, chickpea cultivars known to be resistant to FOC0 showed similar symptoms. To identify the causal agent, symptomatic chickpea plants were collected during 2013-2016 from several chickpea growing areas. A total of 388 isolates with specific morphological characters of the genus *Fusarium* were isolated from the root and stem tissues of collected plants. PCR using specific primers were conducted to identify the isolates up to the species level. Among the 388 isolates, 85 were identified as *F. redolens*, and 174 as *F. oxysporum*. Further molecular analysis on *F. oxysporum* using specific primers of the Pisatin Demethylase gene of *F. oxysporum* f. sp. *pisi* (*FOP*) showed the expected amplicon for 60 isolates. These results were further confirmed by DNA sequencing of the translation elongation factor 1 α gene (*TEF* 1- α) and blasting sequences against the *Fusarium* multilocus sequence typing (MLST) database and the *Fusarium*-ID database. Pathogenicity assays using isolates of *F. redolens* and *FOP* from different geographic origins on three chickpea genotypes (ILC482, JG62 and cv. Beja 1) indicated that *F. redolens* and *FOP* were highly virulent on chickpea, inducing disease symptoms similar to those caused by the yellowing pathotype of FOC.

F22

PREDICTION OF ALFALFA ROOT ROT DISEASE SEVERITY UNDER SALINITY CONDITIONS. Khaled Hussein Arafat¹, Mohammed Hassan² and Omar Hussein Hassan¹. (1) Plant Pathology Department, Faculty of Agriculture, New Valley University, Egypt, Email: omahassan@agr.nvu.edu.eg; (2) Plant Pathology Department, Faculty of Agriculture, Assuit University, Egypt.

Alfalfa roots are infected with several fungal pathogens under saline conditions. The effect of two salts of NaCl and CaCO₃, at three concentrations for each on mycelia growth *in vitro* and disease severity (DS%) under greenhouse conditions were studied to determine the relation between disease severity (DS%) and water salinity. *In vitro*, the highest effect on mycelial growth was detected at electrical conductivity (EC_w value) of 18.75 ds/m² and reached 8.80 and 9.44% with NaCl and CaCO₃, respectively. Furthermore, the fungal pathogen *Exserohilum* sp. was the most affected by water salinity and reached 7.38%. Disease severity of alfalfa root rot increased gradually with the increase of water salinity level. Disease severity at the highest level of water salinity with NaCl and CaCO₃ EC_w value of 18.75 ds/m² ranged between 42.76 and 43.53% for NaCl and 44.04-44.42% for CaCO₃. Moreover, with respect to *Fusarium* sp., the highest disease severity with NaCl ranged between 49.17 and 50.73%. Whereas with CaCO₃, disease severity ranged between 50.00 and 50.52%. It was found that the relation between disease severity and fungi, salt type, salt concentration, root and shoot length followed a multiple regression model ($r^2=88.83\%$).

F23

GENETIC DIVERSITY, MATING TYPES, AND POPULATION STRUCTURE OF *ASCOCHYTA RABIEI* IN IKR, IRAQ. Rezan Ali and Emad Al-Maaroof, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaimania, Iraq, Email: rezan.salih@univsul.edu.iq

A study was carried out to determine the incidence of Aschochyta blight disease in various chickpea production areas across IKR, Iraq, as well as to estimate the genetic diversity and relationship among the DNA of *Ascochyta rabiei* isolates using 24 primers (RAPD, ISSR, SSR and ERIC) and to determine their mating types using multiplex MAT-specific PCR with the SP21, Tail5 and Com1 primers. The genomic DNA of the isolates was extracted from 50 mg of lyophilized ground mycelium using an Addbio DNA extraction kit with purity range of 1.5-1.8 and then electrophoresis on an agarose gel. The disease was found in 59% of the fields and 51 *A. rabiei* isolates were isolated from 141 infected fields across 29 districts in four provinces. The 24 primers produced a total of 299 bands. 212 bands were 70.9% polymorphic, whereas 87 bands were shared by all tested isolates. OPD-18, ArA06T and BA8 showed the most polymorphism and produced the most polymorphic bands (13 bands), whereas BA5 produced the fewest single bands (2). PIC values ranged from 0.16 (BA5) to 0.96 (BA11), with a moderate mean value of 0.74 indicating an increase in ability discrimination when using these primers. Genetic diversity ranged from 0.16 to 0.96, with a mean of 0.76, and the genetic distance between 34 *A. rabiei* isolates ranged from 0.14 to 0.55. According to the dendrogram, isolates 33 and 34 had the lowest dissimilarity (0.14), whereas isolates 2 and 32 had the highest dissimilarity (0.55). UPGMA analysis classified the selected isolates into six major clusters (C1 to C6) and genetic STRUCTURE analysis classified all the genotypes into two groups. Both mating types existed in the pathogen population. MAT 1-2 isolates were more common (54.3%) than MAT1-1 isolates (45.7%). Both

mating types were present in equal proportion in Sulaimani and Garmian, whearse, mating type 1-2 isolates were 75% and 57% more prevalent in Halabja and Erbil, respectively.

F24

HISTOPATHOLOGICAL CHANGES IN MANGO *MANGIFERA INDICA* SEEDLINGS INOCULATED WITH *CERATOCYSTIS MANGINECANS*, THE CAUSAL AGENT OF MANGO SUDDEN DECLINE. Abdul Rehman¹, M. Waqar Alam², Saira Mehboob³, Ghazal Naveed¹, Amjad Shahhzad⁴, Ali Raza⁵ and Ahmad Sattar Khan⁶. (1) Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan, Email: rehman.abdul@uaf.edu.pk; (2) Institute of Agricultural Sciences, University of Punjab, Lahore, Pakistan; (3) Institute of Plant Protection, Plant Pathology Section, AARI, Faisalabad- Pakistan; (4) Pir Mehar Ali Shah Arid Agriculture University, Rawalpind, Pakistan; (5) Sub-campus Burewala, University of Agriculture Faisalabad, Pakistan; (6) Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan.

Mango production is hindered by the attack of number of diseases such as malformation, anthracnose, leaf spots and die back. But the recently appeared mango sudden decline caused by *Ceratocystis manginecans* which was associated with gum exudation, white and black streaks in vascular bundles under the bark, and ultimately sudden death within few weeks is considered as the most serious threat to mango industry of Pakistan. Present studies were designed to find some resistance sources. To achieve this, inoculation was done with *C. manginecans* on 50 one year old mango seedlings having good morphological characters collected from district Khanewal, Punjab province. Data was recorded 10, 25, 40 and 55 days after inoculation. Lesion length of each 50 mango seedlings with three replications was measured in both upward and downward direction in centimeters. Movement of *C. manginecans* in the vascular tissues by fungal mycelium was examined in the cross sections of artificially inoculated seedlings. Movement of the fungus was higher in upward direction as compared to downward direction. Maximum lesion length in both upward and downward directions was found in seedlings KHW-515 followed by KHW-506 and KHW-490, whereas least lesion length was recorded in seedlings KHW-48. Re-isolation from artificially inoculated seedlings confirm that *C. manginecans* was responsible for wilting and death of infected mango seedlings. Histopathological studies indicated that the fungus colonization and tylosis formation led to the blockage of vascular system and tissue discolorations, which is the mechanism responsible for wilt and death of infected mango seedlings.

F25

RELATIONSHIP OF *COLLETOTRICHUM* SPECIES IN CAUSING SUGARCANE RED ROT IN PAKISTAN. Waqas Raza Arshad and Shahid Afghan, Sugarcane Research and Development Board Punjab, Pakistan, Email: waqasr.arshad@gmail.com

Sugarcane is a high value cash crop in Pakistan and is of great significance for sugar related industries, second largest agro-industry sector after textile. However, the red rot

disease of sugarcane causes huge losses due to the reduction of sucrose and deterioration of the juice. The aim of this study was to identify *Colletotrichum* species in 3 sugarcane varieties associated with the red rot through polyphasic approaches, which included phylogenetic, morpho-cultural analyzes and pathogenicity tests. Four isolates from the state of Punjab and two from Sindh, Pakistan, were preliminary analyzed with the glyceraldehyde-3 phosphate dehydrogenase gene (GAPDH), as an initial measure for species diversity. Later on, the representative isolates of each species were sequenced with the β -tubulin (TUB2) gene, calmodulin (CAL), DNA lyase (APN2/MAT IGS) and the ITS-rDNA region. Morphocultural characterization was performed by evaluating the mycelial growth rate (MGR), colony appearance and the shape and size of 25 conidia and appressoria. For the pathogenicity test asymptomatic leaves and stalks of sugarcane were tested with and without injuries. Phylogenetic analysis associated with morphocultural characteristics and the pathogenicity test of the six isolates revealed three *Colletotrichum* species: *Colletotrichum falcatum* (5 isolates) and *Colletotrichum plurivorum* (1 isolate) causing the red rot disease in sugar cane. All species were pathogenic in wounded leaves and stalks, with *C. falcatum* being the one causing the largest lesions (1.05 cm) in leaves and *C. plurivorum* in stalks (0.64 cm). Therefore, this study confirms the results of a similar study undertaken in Brazil regarding association of *C. falcatum* and *C. plurivorum* as a sugarcane pathogen.

F26

PATHOLOGICAL AND PHYSIOLOGICAL STUDIES ON *FUSICLADIUM OLEAGINEUM* (= *SPILOCAEA OLEAGINA*) THE CAUSAL AGENT OF OLIVE LEAF SPOT DISEASE AND OLIVE DEFOLIATION. El-Sayed M. Embaby¹, AbeerFisal² and Dalia Ali³. (1) Plant Pathology Department, National Research Centre (NRC), Cairo, Egypt, Email: embaby.elsayed@yahoo.com; (2) Higher Institute for Agriculture Co-operation, Egypt; (3) Botany and Microbiology Department, Faculty of Sciences, Ain Shams University, Egypt.

Olive leaf spot (OLS) or peacock spot, is caused by the fungus, *Fusicladium oleagineum* (= *Spilocaea oleagina*, Castagne (Hughes) = *Cycloconium oleagina*). OLS is the most important leaf disease of olive in many olive-growing regions worldwide with yield losses of up to 20% in some cases. Diseased samples were collected from two different Governorates in Egypt. Results obtained from pathological studies indicated that isolation from diseased olive leaves collected from Ismailia and Behira regions, Egypt identified three fungal species: *Alternaria alternata*, *S. oleagina* and *Stemphylium botryosum*. *F. oleagineum* was the most frequently compared fungus. Pathogenicity test of *F. oleagineum* was confirmed on olive leaves according to Koch's postulates. *F. oleagineum* was found to reduce NPK contents in leaves of all infected olive cultivars. Physiological studies showed that olive leaf extract medium gave the best linear growth of *F. oleagineum* compared with others. Whereas PDA medium gave the best sporulation. The best linear growth and sporulation of *F. oleagineum* was found at pH 5.5. Dark:light cycle enhanced the linear growth and sporulation of *S. oleagina* as compared to continuous

dark or light conditions. *In vitro F. oleagineum* was able to produce both cellulase and pectinase enzymes 7 and 14 days after inoculation.

F27

VERTICILLIUM WILT OF THE OLIVE TREE IN ALGERIA: BETTER UNDERSTANDING OF THE DISEASE LEADS TO BETTER CONTROL. Miloud Bellahcene¹, Zohra Fortas² and Michel Nicole³. (1) Department of Natural and Life Sciences, Institute of Sciences, Belhadj Bouchaïb University Center, Ain Témouchent, Algeria, Email: belahcene_miloud@yahoo.fr; (2) Department of Biotechnology, Faculty of Natural and Life Sciences, University of Oran1, Ahmed Ben Bella, Algeria; (3) Plant Resistance UMR, Research Center, Montpellier, France.

The olive tree (*Olea europea* L.) attracted more interest in recent years not only in the Mediterranean, the main olive-growing region in the world, but also in other continents, notably America. This increase in interest, in addition to the socio-economic and environmental impact of this species, is due to the particular health and nutritional benefits of olive oil. In Algeria, the spread of this crop is limited by several pests and microorganisms, which often have a significant impact on yield. The soil fungus, *Verticillium dahlia* Kleb, the causal agent of *Verticillium* disease, has become a lethal factor for the olive tree. Because of the difficulty in identifying this disease visually in the orchard, as olive *Verticillium* wilt is a vascular disease, it spread in recent years to many olive groves in Algeria. Infected olives are characterized by slow decline and apoplexy. Surveys conducted in the main olive-growing regions of Algeria made it possible to locate the foci of disease infection, and estimate the infestation rate and collect a large number of fungal strains. This population of causative agent was then characterized by different molecular techniques such as PCR, RAPD and RFLP. Result obtained showed that the pathogen population appears to be genetically similar and has similar genetic characteristics. The molecular approach also placed the collection of *V. dahlia* in the non-defoliant pathotype group (ND), which seems least aggressive compared with the defoliant pathotype (D). Sequencing data showed a strong homology (99%) with isolates of *Verticillium dahliae*. These results confirm that all of the isolates collected were in fact *V. dahliae*.

F28

ASSESSMENT OF OLIVE FRUIT DISEASES SPREAD IN LATTAKIA GOVERNORATE, SYRIA. Mohamed Matar¹ and Atie Arab². (1) Department of Plant Protection, Faculty of Agriculture, Tishreen University, Syria, Email: dr.mmatar@hotmail.com; (2) Scientific Agricultural Research Center, Lattakia, Syria.

A field survey was carried out in the olive groves in Lattakia Governorate in Syria during October 2017 and 2018 in order to investigate the distribution of olive fruit diseases, isolate and identify causal pathogens and study their pathogenicity. The survey included 128 orchards planted with the Dermlaly and Khidery varieties in 16 locations, which belong to four regions (Al-Markaz, Jableh, Al-Hafah

and Qirdaha). Prevalence and incidence of fruit diseases were estimated and the correlation rate between the incidence of olive fruit fly *Bactrocera oleae* Geml. and the diseases incidence was evaluated. The causal pathogens were isolated from infected drupes and their pathogenicity was confirmed in the laboratory. The results showed a spread of olive drupe rot disease (*Camarosporium dalmaticum* (Thüm.) Zachos) and olive fruit fly on both varieties in all locations. Whereas, olive Anthracnose (*Colletotrichum* sp.) was spread on mature olives in some of the surveyed locations. Findings also revealed that there was a significant positive correlation between the olive fruit fly infestation and the incidence of both diseases. The highest infestation rate with olive fruit fly was 59.88% and the highest incidence of olive fruit rot disease and olive anthracnose disease on the Dermlaly variety were 19.13% and 9.25%, respectively, in Al-Haffa region in 2018 season. The infestation rate with olive fruit fly, olive fruit rot and olive anthracnose varied according to olive varieties and environmental conditions (humidity and altitude). The Dermlaly variety was more susceptible to both diseases.

F29

MOLECULAR IDENTIFICATION OF *FUSARIUM* SPECIES ASSOCIATED WITH THE PHENOMENON OF WILT OF TISSUE CULTURE DATE PALM OFFSHOOTS AND EVALUATION OF SILVER NANOPARTICLES AND *TRICHODERMA LONGIBRACHITUM* IN THEIR GROWTH. Mohammed A. Fayyadh, Alaa O. Manea and Yehay A. Salih, Plant Protection Department, College of Agriculture, University of Basrah, Iraq, Email: muamer2010@yahoo.com

The aim of this study, which was conducted during the period 2019-2021, was to isolate and identify the fungi associated with the wilt phenomenon in date palm offshoots produced by tissue culture and planted in permanent orchards. Molecular identification of *Fusarium* isolates based on amplification of the ITS1-ITS4 gene region and nucleotide sequencing showed that isolate F1 and F7 were identical to *F. proliferatum* isolate with a percentage of similarity reached 100 and 98%, respectively, and F3 and F4 isolates were identical to *F. fujikuroi* isolate with a percentage of similarity 99.8 and 100%, respectively. As for the F6 isolate, it was identical with *F. solani* isolate, with a similarity of 94.8%. The sequences of isolates were deposited in the US National Center for Biotechnology Information (NCBI) under the codes OM535259, OM535261, OM535264, OM535265 and OM535266, respectively. The results also showed that silver nanoparticles inhibited the growth of all tested fungi, and the rate of inhibition ranged between 50-70%. On the other hand, the biological fungus *T. longibrachiatum* caused inhibition in the growth of all tested fungi with an inhibition rate of more than 80%.

F30

BIODIVERSITY OF *PENICILLIUM* ISOLATES IN PAKISTAN. Muhammad Nasir Subhani¹, Muhammad Iqar¹, Shaista Nasir² and Muhammad Bilal Chattha³. (1) Department of Plant Pathology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan, 54590,

Email: nasirsubhani.iags@pu.edu.pk; (2) Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan 38400; (3) Department of Agronomy, Faculty of Agricultural Sciences University of the Punjab, Lahore, Pakistan, 54590.

Penicillium a well-known fungus found ubiquitous in nature having above 350 known species. Members of *Penicillium* are generally known as soil inhibiting fungi, mainly having a decomposition function. With their diverseness in environment, *Penicillium* species have great significance in biomes, gardening and agro-based industry. Twenty *Penicillium* species were acquired from the Fungal Culture Bank of Pakistan (FCBP). These species were characterized microscopically, macroscopically and molecularly. The fungal species were grouped according to their resemblance with each other on the basis of their phylogenetic characters into subgenera. In this study the phylogenetic analysis was done by isolating fungal DNA and the segregation between the fungal species was done on the basis of ITS base sequences and the phylogenetic tree was constructed based on the difference among the species. Phylogenetic analysis showed that within the subgenus there was a little difference among all species, but when the phylogeny between the species of different subgenera was compared, the resemblance decreased within the species. The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite. The phylogenetic tree showed that the evolution started in these 20 species form *Penicillium minioluteum* which mutated to *P. duclauxii*. These species gave rise to *P. oxalicum* and *P. simplicissimum* which latter mutated to *P. herquei*. *P. herquei* mutated and two species formed *P. citrinum*. Three species originated form *P. atrovirens*, *P. canescens* and *P. janczewskii*. *P. fellutanum* gave rise to *P. madriti* which mutated to *P. vulpinum* and this species changed to *P. crustosum* and this mutated and gave rise to species *P. verrucosum*, and community of these were mutated and changed to *P. italicum* and *P. expansum*. In turn, these mutated to two other species of *Penicillium* and formed *P. cyclopium* and *P. virridicatum*. Identification of *Penicillium* species is generally a difficult task not only for Pakistani taxonomist but also for other taxonomists who did not try to identify species or lower taxa. Our conclusion to highlight assembling the sequences order from outsized set of species was compulsory that we gave emphasis to only one gene. ITS1 and ITS2 regions are found conserved in all fungal species, so these regions can be used for the identification as well as for the characterization and for taxonomic classification. The degree of variability in ITS region remains very low. This region facilitates to separate the closely related taxa. The additional information provided by sequencing was sufficient to establish phylogenetic relationship between *Penicillium* species.

F31

MOLECULAR CHARACTERIZATION AND PATHOGENIC VARIATION OF *FUSARIUM* SPECIES ASSOCIATED WITH ONION IN SAUDI

ARABIA. Mahmoud H. El-Komy^{1,2}, Xuewen Gao³, Anwar H. Sharafaddin¹, Amgad A Saleh¹, Yasser E. Ibrahim¹, Ali Almasrahi¹, and Younis K. Hamad⁴. (1) Department of Plant Protection, College of Food and Agricultural Sciences, King Saud University, Kingdom of Saudi Arabia, Email: malkomy@ksu.edu.sa; (2) Mycology and Plant Diseases Survey Department, Plant Pathology Institute, Agriculture Research Center, Giza, Egypt; (3) Key Laboratory of Integrated Management of Crop Diseases and Pests, Department of Plant Pathology, College of Plant Protection, Nanjing Agricultural University, Nanjing, China; (4) Plant Pathology Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

Fusarium basal rot (FBR) has become a major disease causing considerable economic losses to onion growers worldwide. In this study, a total of 87 isolates of *Fusarium* spp. were recovered from onion plants showing symptoms of FBR in five regions in Saudi Arabia. These fusaria isolates were identified to the species level by sequencing three different fungal nuclear regions of internal transcribed spacer, elongation factor 1- α , and the second largest subunit of DNA-directed RNA polymerase-II. Morphological and phylogenetic analyses showed that there were six main *Fusarium* species recovered from onion tissues. However, *F. oxysporum* species complex (FOSC) and *F. solani* species complex (FSSC) were found to be the dominant species associated with onion fields in all locations. Pathogenicity tests on onion seedlings and bulbs, showed that onion can be infected by all these species, but variations in aggressiveness and virulence were observed among the isolates. Furthermore, isolates that were pathogenic on bulbs were sometimes not pathogenic on seedlings and vice versa, suggesting occurrence of tissue specialization by these pathogens. The phylogenetic analysis grouped onion isolates in five well-supported clades that corresponded to species classification, with a bootstrap value of 86 or 100%. No clade was related to its geographic onion production regions or pathogenicity. However, high sequence variation within FOSC, and FSSC isolates, suggesting that these *Fusarium* species have the potential to become a major production constraint for onion growers, and explain their presence in onion regions with markedly different climate. This work is the first confirmed report of the direct and primary cause of FBR in in Saudi Arabia. Knowing the diversity of the fusaria species present in onion growing area is a key component of preventing dramatic losses in production. Furthermore, the potential toxin risks of these toxigenic *Fusarium* isolates should be evaluated.

F32

IDENTIFICATION OF DIFFERENT *ALTERNARIA* SPECIES ISOLATED FROM THE HALOPHYTE *CAKILE MARITIMA* BELONGING TO DIFFERENT TUNISIAN BIOCLIMATIC REGIONS. Besma Sghaier-Hammami^{1,2}, Arbia Chalbi², Giuseppe Meca³, Juan Manuel Quiles³, Chedly Abdelly², Carmela Marangi⁴, Antonio F. Logrieco⁵, Mario Masiello⁵ and Antonio Moretti⁵. (1) Institut National Agronomique de Tunisie, Université de Carthage, Tunis, Tunisia, Email: sghaierhammamibesma@gmail.com; (2) Laboratoire des Plantes Extrêmophile, Centre de Biotechnologie de Borj-Cédria, Hammam- Lif, Tunisie; (3)

Laboratory of Food Toxicology, Department of Preventive Medicine, Nutrition and Food Science Area, Faculty of Pharmacy, University of Valencia Avenida Vicent Andres Estelles s/n, 46100 Burjassot, Valencia, Spain; (4) Institute for Applied Mathematics “M. Picone”, Via G. Amendola 122/D, Bari, Italy; (5) Institute of Sciences of Food Production, Research National Council (ISPA-CNR), Via G. Amendola 122/O, Bari, Italy

Cakile maritima, (sea rocket) is an extremophile C3 halophyte (Brassicaceae) which is widely distributed on sandy coasts. In addition to its role in ecosystem coastal preservation, this halophyte is also considered an edible plant, used traditionally as a green vegetable for human and animal consumption. Unfortunately, *C. maritima* is attacked by different fungal species, mainly belonging to *Alternaria* genus. This fungus affects several crops in the field and can cause harvest and postharvest decay of plant products. The main objective of the present work was to isolate and identify fungal strains from different parts (stems, leaves and seeds) of the plant growing in different bioclimatic Tunisian areas (arid, semi-arid, semi-humid and humid). The analysis of the combined gene sequences showed that no difference existed between the fungal species, which are all clustered in the *Alternaria* cluster. Forty-seven strains had high homology with *A. alternata* reference strain, 13 grouped with *A. arborescens* reference strain, 12 grouped with *A. mali* reference strain, and 7 strains were not well defined, with *A. mali* as their closest species. In vitro production of tenuazonic acid (TA), alternariol (AOH), alternariolmonomethyl ether (AME), and altenuene (ALT) was evaluated. Approximately, 68% of strains simultaneously produced AOH, AME and TA. Only two *A. alternata* and one *A. mali* strains were ALT producing. Pathogenicity tests on leaves of *C. maritima* were carried out with 41 representative strains. *Alternaria arborescens* showed the highest pathogenicity compared to *A. alternata* and *A. mali*, but no statistically significant differences in pathogenicity were observed. This is the first study on Tunisian populations of *Alternaria* species isolated from the extremophile *C. maritima*.

F33

FIRST RECORD OF DIFFERENT FUSARIUM SPECIES ASSOCIATED WITH BANANA PANAMA DISEASE IN THE JORDAN VALLEY. Ahmad Mohamad Almomany, Nida Salem and Monther Mohamad Tahat, Department of Plant Protection, School of Agriculture, The University of Jordan, Amman, Jordan, E-mail: momanyah@ju.edu.jo

Fusarium wilt of banana caused a great loss in world production, and Jordan started suffering from this disease since 2008. Field observations and sample collections were conducted from 2015 to 2018 in the whole Jordan Valley to evaluate the incidence and severity as well as the distribution of Panama disease. Ten to eleven banana orchards were visited in south and north Jordan Valley, and thirty-two orchards in Middle Jordan Valley. Five hundred and sixty soil, irrigation water samples in addition to vascular strand samples were collected from all visited fields. Data showed that the average disease incidence in the whole Jordan Valley was 68.2% and disease severity 2.79. In south

Jordan Valley the disease incidence varied from 0 to 100% and disease severity from 0 to 3.7 with an average of 66.1 % for disease incidence and 2.37 for disease severity, with three different fusarium species identified. In north Jordan Valley, disease incidence varied from 0 to 100% and disease severity from 0 to 3.8 with an average of 57.7% and 2.46 for disease incidence and disease severity, respectively, and five *Fusarium* spp. were molecularly identified as *Fusarium brachygibbosum*, *Fusarium proliferatum*, *Fusarium andiyazi*, *Fusarium equiseti* and *Fusarium oxysporum* f. sp. *cubense*. In middle Jordan Valley, the average disease incidence was 80.8% and 3.55 for disease severity and 54 % of the isolates were *Fusarium oxysporum* f. sp. *cubense*, whereas 22% of the isolates was *Fusarium verticillioides*. This is the first report of *Fusarium musae* and *Fusarium equiseti* on banana in Jordan. In addition to *Fusarium oxysporum* f. sp. *cubense*, six *Fusarium* species were also reported to be dominant in all banana production areas in Jordan.

F34

CONIELLA GRANATI (SACCARDO) CAUSING TWIG DIEBACK AND FRUIT ROT ON POMEGRANATE (*PUNICA GRANATUM* L.) IN TUNISIA: CULTIVAR RESPONSE AND PLANT HOSTS. Hayfa Jabnoun-Khiareddine¹, Rania Aydi Ben Abdallah¹, Nesrine Ibrahim² and Mejda Daami-Remadi¹. (1) Integrated Horticultural Production in the Tunisian Centre-East, Regional Research Centre on Horticulture and Organic Agriculture, University of Sousse, Chott-Mariem, Tunisia, Email: jkhayfa@yahoo.fr; (2) Higher Agronomic Institute of Chott-Mariem, University of Sousse, 4042, Chott-Mariem, Tunisia.

Pomegranate (*Punica granatum* L.) twig dieback and fruit rot disease incited by *Coniella granati* (Saccardo) has been recently reported in Tunisia causing branch dieback, shoot blight and fruit rot. The present study was undertaken in order to characterize *C. granati*, to evaluate the response of nine known pomegranate cultivars toward this newly emerging pathogen, to study its host range and to identify its extracellular cell wall degrading enzymes. Collected *C. granati* isolates were shown able to grow between 10°C and 30°C with an optimal mycelial growth at 20-25°C. The fungus was able to grow in a pH range of with an optimum growth at pH 4-5 for Cg1 and Cg2 isolates. Plant response was determined based on fruit lesion diameter and length of external, internal and pycnidia-bearing lesions observed on wounded and detached branches. All cultivars tested were susceptible to *C. granati* fruit rot where the least lesion diameter of 87-88 mm, 9 days post-inoculation (DPI), was observed on Gabssi and Zaghouani cultivars. At 30 DPI, detached branches were found to be moderately susceptible to *C. granati* infection with only cv. Chetwi being moderately tolerant. *C. granati* isolates tested were able to cause dry rot on nine out of ten different fruits, with apple, tomato and fakous (*Cucurbita melo* var. *flexuosus*) fruits being the most susceptible. On detached branches, *C. granati* was weakly pathogenic on orange and pear compared to apple and loquat and was nonpathogenic on olive, fig, peach, prune, and apricot branches. Using specific media, *C. granati* isolates produced laccase, protease, pectinase, pectate transeliminase, and cellulase, but no amylolytic and lipolytic

activities were detected. Thus, as *C. granati* represents a threat to all Tunisian pomegranate cultivars as well as for other tree fruit species, the search for effective management methods towards this disease should continue.

F35

USING SOIL SOLARIZATION FOR THE CONTROL OF SOIL BORNE PLANT PATHOGENS IN NORTH-EASTERN LIBYA. Nwara Ali Mohamed¹, Mohamed Mahmoud Ibrahim² and Abd El Salam Jabreer¹. (1) Plant protection Faculty of Agriculture, Omar El Mukhtar, Libya, Email: nwboshakoa@gmail.com; (2) Agricultural Engineering Faculty of Agriculture, Cairo University, Egypt.

The tests were carried out during 2013 and 2014 summers in two different geographical and climatic locations in Libya. The first one was the area of El-Beida characterized by a mountainous landscape and the second one was the area of Benghazi characterized by flat costal landscape with relatively high levels of temperature and humidity. Irrigated and non-irrigated soils were prepared in these locations using plastic cover of various thickness and color (transparent, black, yellow). Monitoring soil temperature showed that it reached its maximum at 16:00 hr when temperature reached 42°C in the soil top layer and efficiency of solarization decreased with the soil depth. The temperature at 10cm depth reached 41.7 and 42.9°C, respectively for El-Beida and Benghazi and was high compared to non-solarized soils (28.1 and 29.3, respectively for El-Beida and Benghazi). Results showed also that the effect of treatments increased as the moisture level of the soil increased. Results of isolation of El-Beida soils before treatment with solarization resulted in the following fungi: *F. solani*, *F. oxysporum*, *F. roseum*, *Pythium* spp. and *Sclerotinia* spp. For Benghazi soils the most important fungi that were isolated were *F. solani*, *F. oxysporum*, *F. roseum*, *F. tricinum*, *Fusarium* spp. *Pythium* spp. and *Mucor* spp. There was a decrease in the number of fungi detected after solarization especially in the irrigated treatment. Transparent plastic increased soil temperatures and gave a higher effect on fungi at both studied sites during the summer months. The results indicated that the fungi were totally eliminated, and the rate of sun sterilization was 100% after re-sterilization in the second year. *F. solani* was the most affected by solarization, whereas *F. oxysporum* could only be removed after two consecutive years of soil solarization.

F36

EVALUATION OF SODIUM BICARBONATE SALT FOR THE CONTROL OF POWDERY MILDEW (*LEVILLULA TAURICA*) AND EARLY BLIGHT (*ALTERNARIA ALTRNATA*) DISEASES IN TOMATO. Suad Abdel Gamiel Mohamed Ahmed, Agricultural Research Corporation, Wad Medani, Sudan, Email: suadgamiel5@gmail.com

Vegatable production is gaining an increasing importance in the Sudan. Tomato is one of the important vegetables which is cultivated all over the country, wherever irrigation water is available to sustain its production. Pests and diseases are the major constrains for the production of tomato in Sudan. The most important of which is powdery mildew disease caused by the fungus *Levillula taurica* and

early blight disease caused by the fungus *Alternaria alternata*. The effect of Sodium Bicarbonate salt was evaluated to control powdery mildew and early blight diseases in tomato. Field experiments were carried out at Gezira Research Station for two seasons, 2016/ 2017 and 2017/2018. The salt was sprayed twice at the rates of 150, 190 and 220 g/100 L of water to run-off immediately after disease appearance and compared to the conventional fungicide Aleenazole 25% EC at the rate of 30ml/100 L water and to the untreated control. The salt reduced powdery mildew disease incidence by 41-53% and 50-67% in 2016/2017 and 2017/2018 seasons, respectively. Disease severity was satisfactorily reduced by 52-55% and 31-67% compared to the untreated control in the first and second seasons, respectively. In addition, using the salt reduced early blight disease incidence and severity. However, the salt was equally effective as the synthetic fungicide Aleenazole. Among the rates tested, Sodium bicarbonate salt at the rate of 190 g/100 L was more effective in reducing disease severity and incidence. A significant increase in yield was obtained in all salt dosage rates of 150, 190 and 220g/100 L of water compared to the synthetic fungicide and the untreated control. The mean % increase in crop yield achieved by the use of the three salt concentrations and the standard Aleenazole 25% EC was 145.4%, 169.4%, 164.2% and 138.6%, respectively.

F37

EVALUATION OF THE EFFECT OF BIOCHAR AND COMPOST AS SOIL ORGANIC AMENDMENT AGAINST EARLY BLIGHT (*ALTERNARIA SOLANI*) IN TOMATO. Muhammad Taqqi Abbas, Muhammad Hafeez ul Haq, Muhammad Saleem Haider, Waheed Anwar and Adnan Akhter, Institute of Agricultural Sciences University of the Punjab, Lahore Quaid-i-Azam Campus, Lahore, Punjab 54590, Pakistan, Email: muhammadtaqqi52@gmail.com

Sustainable agriculture deals with the efficient use of resources for the benefit of mankind and its environment. Use of heavy doses of chemicals like fertilizers or pesticides is not suitable for sustainable agriculture. Biochar usage is an alternative method to control diseases and enhance plant growths. This study evaluated the effective use of different concentrations of biochars and composts to promote plant growth and nutrients availability, such as N, P and K in the presence and absence of *Alternaria solani*. Two types of biochar, wood biochar and Green waste biochar at 3% and 6% concentrations and compost were used as a soil amendment. All the different concentrations were effective on disease reduction and enhancement of plant biomass. Wood biochar at 6 % concentration had better effect than other treatments. It also enhanced stem and root growth. Biochar also reduced the disease incidence and severity in plants. Under stress conditions, nitrogen and phosphorus contents were increased in tomato. It was observed that nitrogen content was increased by 12.44% and phosphorus content by 55.17%. Disease incidence was 90% in tomato plants grown in soil and it was reduced to 40% and disease severity by 47% when grown in 6% wood biochar. In conclusion, biochar had positive impact in reducing early blight infection in tomato by reducing incidence and disease

severity and enhance plant growth. Biochars can play an important role in sustainable agriculture.

F38

EFFICACY OF PLANT RESISTANCE ELICITOR SALICYLIC ACID AGAINST *CEPHALOSPORIUM MAYDIS* AND ITS EXOGENOUS APPLICATION FOR CONTROLLING LATE WILT DISEASE OF MAIZE.

Ibrahim E. Elshahawy¹ and Mohamed S. Abd El-Wahed². (1) Plant Pathology Department, National Research Centre, Cairo, Egypt, Email: ibrahim_nrc@yahoo.com; (2) Department of Botany, National Research Centre, Cairo, Egypt.

Late wilt, a disease that severely affects maize fields across Egypt, is caused by the fungus *Cephalosporium maydis* and is characterized by relatively rapid wilting of maize plants prior to tasseling and until shortly before maturity. Resistant maize cultivars are currently controlling the pathogen, but the disease is constantly spreading to new areas. The disease appears at a late phenological stage of the plant, implying that plant hormones are involved in pathogenesis. The purpose of this study was to look into the efficacy of the plant resistance elicitor salicylic acid (SA) against *C. maydis* *in vitro*, as well as its role in reducing the incidence of late wilt disease in greenhouse and field settings. SA significantly reduced the colony diameter and spore germination of *C. maydis* in *in vitro* trials conducted on PDYA and/or PDYB amended with the desired concentrations of 50, 100, 150, 200, and 250 ppm. The efficiency increased with increasing salicylic acid concentration, and 250 ppm was the most effective, reducing colony diameter by 100% and spore germination by 90%. Three SA (at 250 ppm) application methods, grain soaking GS, foliage spraying FS either individually or in combination GS+FS, and two maize cultivars, landraces and fine seed 1005, were used to control late wilt disease in pots and field plot experiments. SA treatments significantly reduced disease incidence and increased plant growth in the pots of the two maize cultivars, with a high efficacy for GS+FS in comparison to the positive control. Despite minor differences, GS and FS treatments provided adequate protection against late wilt. SA treatments reduced disease incidence in pots not only by directly inhibiting pathogens, but also by inducing resistance mechanisms in maize plants. The indirect effects of SA against the pathogen were attributed to the induction of antioxidant enzymes (including peroxidase and polyphenoloxidase), chitinase, chlorophyll contents, total phenols, and flavonoids. When compared to the untreated control, SA treatments not only reduced late wilt symptoms but also increased ear yield on both maize cultivars under field conditions.

F39

BAYOUD DATE PALM EPIDEMIOLOGY IN ALGERIA: SPREAD FACTORS AND PROTECTION MEASURES NEEDED IN CONTAMINATED OASES AND MEANS OF PREVENTING SPREAD TO UNCONTAMINATED GROVES. Ibrahim Elkhali

Benzohra¹, Mohamed Megateli¹, Hakima Belaidi², Keltoum Djillali¹, Slimane Benouis¹ and Souad Makhloufi¹. (1) Experimental Station for Biophysical Environment, Naama,

Centre for Scientific and Technical Research on Arid Regions (CRSTRA), Biskra, Algeria, Email: ibrahimelkhalil@live.fr; (2) Laboratoire Ecodéveloppement des Espaces, Department of Environmental Sciences, Djilali Liabes University of Sidi Bel Abbès, Sidi Bel Abbès, Algeria.

The aim of this study was to present the epidemiological data on Bayoud's disease on date palm (*Phoenix dactylifera* L.), in Algeria. This stress is caused by the telluric fungus *Fusarium oxysporum* f. sp. *albedinis* (Killian & Maire, 1930), (Foa), which is the most destructive and threatening disease in North Africa. It is widespread especially in Morocco, North of Mauritania and in large part of the Algerian palms groves. The spread of this disease have been monitored based on surveys and field trips as well as the sampling and isolation of Foa strains. According to the data obtained, the disease affected the majority of old palm groves which are on the edge of oueds and valleys, especially the regions of Saoura, Gouarrara and Touat provinces in the southwest of Algeria, and also in the central region of Tidikelt. The Mozab region is contaminated mainly in the west, south and center, whereas the east such as Guerrara and Zelfana are disease-free areas. The risk and the disease spread direction are always to the east, which make the risk of the arrival of this constraint in Ziban, Souf and Oued Righ provinces is high. Because of these findings, effective prophylactic and curative measures must be imposed and applied to limit the spread of Bayoud towards the oases of south-eastern Algeria.

F40

CONTROL OF CUCUMBER FUSARIUM ROOT ROT DISEASE CAUSED BY *FUSARIUM SOLANI* BY USING SOME ENVIRONMENT FRIENDLY MATERIALS. Aalaa K. Hassan¹, Sawsan H.A. Al-Mayahi² and Aqell A.K. Al-Luhaiby². (1) Department of Plant Protection, College of Agricultural Engineering Sciences, University of Baghdad, Iraq, Email: aalaammh@gmail.com; (2) The Directorate of Agriculture, Baghdad, Ministry of Agriculture, Iraqi.

This study was conducted to evaluate the efficacy of some chemical and biological materials, *solo* or in combination, in reducing cucumber *Fusarium* root rot disease caused by *Fusarium solani*. The results of laboratory evaluation of the efficacy of ascorbic acid, coumaric acid and potassium phosphate in inhibiting the radial growth of the pathogen, showed that the chemical inducer K₂HPO₄ achieved 100% inhibition at concentrations of 600, 800 and 1000 mg/L, and coumaric acid completely inhibited the *Fusarium solani* at 800 and 1000 mg/L, whereas ascorbic acid gave similar effect (100% inhibition) at the concentration of 1000 mg/L. The fungicide beltanol achieved complete growth inhibition of the pathogenic fungus when used at the concentration of 2000 mg/L. Under greenhouse conditions, the treatment of mixing potassium phosphate and coumaric acid and ascorbic acid with the pathogenic fungus was the best treatment and reduced incidence and severity of infection with *F. solani* to 3.33, 1.33, 3.33 and 1.33%, respectively, compared to the control with values of 83.33 and 81.33%, respectively. In addition, this treatment caused an increase in the fresh and dry weight of the plant compared

to the other treatments. The treatment induced systemic resistance by increasing the total phenol content 15 days after adding the pathogen, compared to the control (without pathogenic fungi). The mixed treatment of ascorbic + K₂HPO₄ + Coumaric + *F. solani* achieved the highest phenol content after 15 days and reached 1.367 mg/g, compared to the control treatment (pathogenic only) of 1.200 mg/g, followed by the other treatments. High protein content was also associated with the mixed treatment and reached 22.33% compared to the control (15.00%).

F41

EFFECT OF SOWING DATE AND GENOTYPE ON FUSARIUM WILT EPIDEMIC OF CHICKPEA UNDER FIELD CONDITIONS IN NORTHERN SYRIA. Maysaa Taofik Alloosh¹, Seid Ahmed Kemal² and Bassel Fahmi Alkai¹. (1) Department of Plant Protection, Faculty of Agriculture, Al Baath University, P.O. Box 77, Homs, Syria, Email: Mysaa2006@hotmail.com; (2) Biodiversity and Crop Improvement Program, International Center for Agricultural Research in the Dry Areas (ICARDA), Rabat Institutes, P.O. Box 6299, Rabat, Morocco.

Field experiments were conducted at ICARDA chickpea wilt sick plot in Tel Hadya, Aleppo, Syria during the spring seasons of 2011 (20 genotypes) and 2012 (21 genotypes) and planted in two dates (February and Late March) in split plot design (planting date as main plot and genotypes as sub-plots), in two replicates. Fusarium wilt incidence was recorded at 7-10 days intervals in both seasons and three disease parameters (final disease score, AUDPC and rate of disease development) were calculated to measure the effects of sowing date and resistance of chickpea genotypes to the disease. The mortality rate of the susceptible check cv. Ghab-1 was over 90% in both seasons. In both seasons, highly significant ($P \leq 0.001$) sowing date by genotype interactions were observed for the three disease parameters measured. The correlation of the three disease parameters were high and significant, with some genotypes showed increase in wilt susceptibility when planted in March as compared to February. The two seasons' evaluations suggested that four genotypes (FLIP01-33, FLIP02-40, FLIP01-2, and FLIP03-26) were highly resistant to wilt/root rot, and final wilt disease score can be used to evaluate breeding lines. The four resistant genotypes identified can be used as sources of resistance in the chickpea breeding program.

F42

BIOCONTROL EFFICIENCY OF *TRICHODERMA HARZIANUM* AGAINST OLIVE *VERTICILLIUM* WILT. S. Benouzza¹, M. Bellahcene² and Z. Fortas¹. (1) Laboratory of Biology of Microorganisms and Biotechnology, Department of Biotechnology, Faculty of Sciences, University of Oran, 1 Ahmed Ben Bella, Algeria, Email: salehatecbio@hotmail.fr; (2) University of Ain Temouchent, Algeria.

Olive (*Olea europaea* L.) is one of the most important tree crop species in Algeria, cultivated both for oil and canned fruits. One of the major constraints for olive cultivation is Verticillium wilt, a vascular disease caused by

the soil borne fungus *Verticillium dahliae*. It is a widespread disease in olive growing regions in many parts of the world. Because of the persistence of *Verticillium* microsclerotia in the soil, control strategies that do not rely on complete soil sterilization often fail to completely suppress the disease. Fungicides are frequently recommended for plant disease management but may negatively impact the environment and non-target organisms. One of the strategies used to control pathogens is myco-parasitism whereby a species or strain of fungus directly attacks and feeds on other fungi. *Trichoderma* sp. are active mycoparasites against a range of economically important aerial and soil-borne pathogens, and is successfully used as a biocide in greenhouse and field applications. The aim of this study was to isolate *Trichoderma* species from the olive rhizosphere in the Algerian northwest showing antagonistic properties against an isolate of *V. dahliae* obtained from olive Nesmot region (Mascara, Algeria). A total of 26 rhizospheric isolates were collected and identified. *In Vitro* tests showed that five isolates belonging to *Trichoderma harzianum* and *T. atroviride* were able to significantly reduce pathogen mycelial growth. Based on this *in vitro* screening, a single isolate of *T. harzianum* (TM15) was selected for *in vivo* trial, because of its strong ability to inhibit pathogen mycelial growth. *Trichoderma harzianum* has significantly reduced the severity of *Verticillium* wilt on eggplant. This research may help to highlight the role of *T. harzianum* in the biological control of *V. dahliae*.

F43

SURVEY AND DISTRIBUTION OF PHYTOPHTHORA SPECIES, THAT THREATEN PLANTS AND TREES IN SYRIA. Abdul Rahman Khafateh, Faculty of Agriculture, Tishreen University, Lattakia, Syria, Email: Dr.Khafateh54@yahoo.com

Plant diseases caused by Phytophthora species will remain an ever threatening to agriculture and natural ecosystems. Severe pressure from pathogens due to favourable climatic conditions, can represent threats to nursery production of plants and trees. In Syria, Phytophthora species that can attack different plants and trees has been isolated and defined on corn meal agar medium (CMA), and the development and severity of the diseases have been monitored since 1986 until to date. Eleven species have been isolated and defined on vegetables, plants, trees and nurseries after studying their morphological and physiological stages and biometric measurements and testing their pathogenicity. The following species were identified: *P. citrophthora*, isolated from the lower part of citrus trees stem with gummosis symptoms as well as from fruits; *P. cactorum* isolated from strawberry plants carrying symptoms of crown rots and on apple; *P. infestans*, isolated from potato and tomato plants with typical symptoms of late blight; *P. capsici* isolated from roots and fruits of peper and squash; *P. fragariae* isolated from raddish roots of strawberry; *P. cryptogea* isolated from roots of carthmus; *P. cinnamomi* isolated from stems of declining eucalyptus, pine and jugland trees; *P. nicotiana* isolated from potato, tobacco, tomato and egg plants; *P. pistaciae* isolated from *Pistacia vera*; *P. citricola* and *P. cactorum* isolated from almond. The development and severity of the above-mentioned diseases

and their frequency have been studied, which confirms the need for an integrated management of these diseases.

F44

GENETIC DIVERSITY OF FUSARIUM OXYSPORUM ASSOCIATED WITH TOMATO DISEASES IN ALGERIA. Ali Debbi^{1,2,3}, Rosa Hermosa³, Enrique Monte³ and Houda Boureghda¹. (1) Laboratory of Phytopathology and Molecular Biology, Department of Botany, National Superior School of Agronomy, Algiers, Algeria, Email: ali2b78@gmail.com; (2) Laboratory of Mycology, Center of Biotechnology Research, Constantine, Algeria; (3) Laboratory of phytopathology and biocontrol, Department of Microbiology and Genetics, Spanish-Portuguese Institute for Agricultural Research (CIALE), University of Salamanca, Salamanca, Spain.

Surveys in various production areas of tomato crop in Algeria were conducted from 2012 to 2015. A total of 50 isolates of tomato *Fusarium* wilt were obtained from diseased tomato plants. A molecular characterization study was performed using specific primer PF02-03 led to identified 29 isolates as *Fusarium oxysporum*. Additionally, PCR amplification with specific primers P12-F2B/P12-R1, SIX3-F1/SIX3-R2, SIX4-F1/SIX4-R1 and SIX3-G137C-F1/SIX3-R2 discriminated between *Fol* races, and *Forl* forma species, allowing the identification of 19 out of the 29 isolates as *Fusarium oxysporum* f. sp. *lycopersici* (*Fol*); 17 isolates as race 2 (dominant race), 2 isolates as race 3 and none of the isolates were identified as race 1. Furthermore, the *in vivo* pathogenicity test showed a large diversity in term of disease index ranged from 1.2 to 3.7 recorded by F9 (*Forl*) and F30 (*Fol*) isolates, respectively. This characterization was completed by a study of isolates diversity by the ISSR markers, showing a high genetic diversity detected within the same race as well as between isolates belonging to different races. The results showed that only 10 isolates tended to cluster by pair of isolates with similarity index more than 0.55 and the rest of isolates showed similarity index less than 0.5. However, a correlation might be noted between virulence and molecular discrimination assay using specific primers.

F45

ANALYSIS OF THE PATHOGENIC MYCOFLORA OF BARLEY SEEDS: OCCURRENCE OF TWO NEW SPECIES, CURVULARIA SPICIFERA AND CURVULARIA LUNATA IN ALGERIA. Asma Necaibia and Zouaoui Bouznad, Laboratory of Phytopathology and Molecular Biology, Department of Botany, ENSA, El Harrach, Algiers, Algeria, Email: asmass316@gmail.com

Cereal crops occupy a strategic place both in the world and in Algeria; they are the main food and feed source. As many other crops, they are attacked by diseases which affect yield directly and are responsible for seed spoilage. The aim of this work was to improve our knowledge on the pathogenic mycoflora transmitted by barley seeds. Fungal cultures isolated from seeds using "Agar Test" method were microscopically identified. Some fungal species obtained are commonly observed on seeds such as *Drechslerateres* (Sacc.) Shoemaker and *Fusarium* spp., others were rarely reported (*Bipolarissorokiniana* (Sacc.) Shoemaker) or

detected for the first time in Algeria such as *Curvularia spicifera* (Bainier) Boedijn and *Curvularia lunata* (Wakker) Boedijn. Assays of *in vivo* inoculations of *C. spicifera* and *B. sorokiniana* were conducted on barley plants, and only the pathogenicity of *B. sorokiniana* was confirmed.

F46

THE IMPACT OF TARO LEAF BLIGHT CAUSED BY *PHYTOPHTHORA COLOCASIAE* IN THE MALDIVES. Rifaath Hassan¹ and Majeedha Mohamed². (1) The Research Centre, The Maldives National University, Maldives, Email: rifaath.hassan@mnu.edu.mv; (2) Faculty of Engineering Science and Technology, The Maldives National University, Maldives.

Taro (*Colocasia esculenta*) had been selected and vegetatively propagated as a staple food in many parts of the world including the Maldives. In Maldives, taro had been used as a staple food, even though the taro production has comparatively slowed down since the early 2000's. Taro remains an underutilized crop in Maldives due to the little attention paid to it and due to scarcity of land available for production. In addition, the susceptibility to many diseases including Taro Leaf Blight caused by the fungus *Phytophthora colocasiae* poses a potential serious threat on food security in many taro growing regions. Taro leaf blight was first officially documented around 2017 and the disease rapidly spread throughout the southernmost parts of the island. The fast spread was enhanced by planting susceptible varieties, movement of infected planting materials from one island to another and due to favorable weather conditions. This study provides an overview of taro leaf blight disease in the Maldives, its origin, distribution, biology, management and its impact on the community. It will also focus on the management practices of the taro farmers, such as chemical and cultural measures and to see whether the good management strategies that has been used over the years can somehow tackle this disease. In this presentation will also discuss future plans on how to mitigate and better manage this disease to produce a higher sustainable yield.

F47

ISOLATION AND CULTIVATION OF THE FUNGUS AND THE ALGA OF THE LICHEN *XANTHORIA PARIETINA* INFECTING CITRUS TREES IN EGYPT.

Ali Mohamed Koriem, Faculty of Technology and Development, Zagazig University, Egypt, Email: Ali.koriem@yahoo.com

Studying lichens did not attract enough attention from plant pathologists to study their eventual role as plant pathogens. During the recent years, and after many histopathological and physiological studies, the harmful effect of epiphytic lichens on higher plants, especially trees, has been investigated. Isolation, cultivation and identification of the fungus and alga are the first step in this direction. It was noticed that many citrus orchards in Egypt, especially the neglected ones, were heavily infected with lichens. The more abundant lichen species was *Xanthoria parietina*. Different methods for isolating the fungus and the alga were used. The best method for isolating the fungus was by means of the discharged spores from ascocarp on the

surface of plain agar, whereas the micropipette technique was the best method for isolating the alga. To cultivate the isolated fungus and alga, different media were used. Soil-extract proposed by Lilly and Barnett was the best media for the fungus growth. The maximum growth of the alga was observed in liquid Bold's basal mineral medium + citrus tree branches followed by bold's basal medium + protease peptone. Different factors affecting spore germination and growth rate of both fungus and alga, including temperature, pH and light intensity, were also studied.

F48

THE FIRST REPORT OF *PESTALOTIA RHODODENDRI* CAUSING CROWN ROT DISEASE OF STRAWBERRY IN IRAQ. Huda Hazim Wafi Al-Taae and Ali Kareem Al-Taae, Plant Protection Department, College of Agriculture and Forestry, University of Mosul, Iraq, Email: htaae@yahoo.com

Strawberry (*Fragaria ananassa* Duch.) is one of the most important berryfruit crops for local consumption in Iraq. Infected plants were collected from a strawberry farm in Ninevah province (North Iraq) during the spring 2018. The fungus was isolated from diseased tissues and initially identified based on its morphological characteristics using conidial and hyphal structures. After incubation, numerous acervuli were especially produced in chlorotic leaves of strawberry plants. On PDA, aerial mycelium was white, more branched and golden brown and colonies reached 70 mm in diameter 7 days after incubation in the dark at 24°C. Acervuli were produced in old culture. Conidia were fusiform, five celled, straight or slightly curved. The darker median cells were three celled with a thick wall. Normally, the upper two cells were brown with a darker band at the septa between them, whereas the lowest cell was lighter in color. The apical and basal cells were conical in shape, thin walled and colorless. Appendages appeared at the apex and base. There were two to four appendages, mostly three. Based on morphological and cultural characteristics, the *Pestalotia* sp. was identified as the causal agent. Pathogenicity of the fungus was confirmed by Koch's postulates. molecular identification of the fungal pathogen was done by amplifying the internal transcribed spacer (ITS) region of the conserved ribosomal DNA. All these ITS sequences showed 100% similarity with those of *Pestalotia rhododendri* isolates in the GenBank database. The Iraqi isolate is now preserved in the GenBank and assigned the accession No. MN128595.1 To the best of our knowledge, this is the first molecular record of *P. rhododendri* on strawberry in Iraq.

F49

USE OF CALCIUM CARBIDE IN REDUCTION OF AFLATOXIN B1 IN MAIZE GRAIN. Oadi N. Matny and Abdul Al-Kareem Abdul-Azeez, Department of Plant Protection, College of Agriculture, University of Baghdad, Iraq, Email: Oadi77@yahoo.com

This study was conducted during 2015/2016 to test the efficacy of calcium carbide on *Aspergillus flavus* growth and production of AFB1 in laboratory and storage conditions. The results obtained showed that 0.1 and 0.125

g/l of calcium carbide decreased significantly the biomass of fungus mycelia in the liquid medium YSE (1.83 and 1.42 g, respectively) compared with control treatment (4.32 g). The results of laboratory experiment showed reduction of spore number in calcium carbide treatment (0.1, 0.125 and 1.5 g/l) in YSE medium. All treatments reduced the average number of spores which was 50.62×10^6 , 41.25×10^6 , and 2.16×10^6 spore/ml, respectively for the three concentrations compared with the control treatment (56.25×10^7 spore/ml). Laboratory results showed a significant reduction of the AFB1 production compared with the control treatment (fungal only) in the liquid medium YSE. The concentration of AFB1 (0.075, 0.1 and 1.25 g/l) was 0.3 for the 1st concentration and was non-detectable for the 2nd and 3rd concentrations, compared with the control (5.7 µg/kg). Calcium carbide used at different weights reduced the AFB1 in maize contaminated with 1×10^4 *A. flavus* spore suspension under storage experiment. No AFB1 was detected in all treatment treated with calcium carbide. The treatment with 0.15 and 0.175 g/l calcium carbide reduced production of AFB1 and no toxin was detected 60 days after treatment, compared with the control treatment (fungal only), which produced 4.4 µm/kg. No significant effect of calcium carbide in degrading the AFB1 in stored maize grain contaminated artificially with the toxin during 6 weeks of storage under laboratory conditions.

F50 IDENTIFICATION AND STUDY OF PATHOGENICITY OF FUNGAL SPECIES ASSOCIATED WITH WHEAT SEEDLING BLIGHT IN SOUTHERN ALGERIA. Anwaar Djedouani and Houda Bouregghda, Laboratory of Phytopathology and Molecular Biology, Department of Botany, The National Higher School of Agronomy, El Harrach, Algiers, Algeria, Email: anwaardjed13@gmail.com

Seedlings blight caused by seed-borne and/or soil-borne fungi can affect different crops, especially when climatic conditions are conducive to infection. Wheat seedlings showing symptoms of post-emergence damping-off have been collected in southern Algeria in the regions of El Ménéa, Ghardaïa, Amenas and Ourgla. The morphological identification of the fungal isolates obtained from these seedlings resulted in the identification of 8 species, five isolated from the collar *Neocosmospora solani* (syn. *F. solani*), *F. sporotrichioides*, *F. verticillioides*, (*F. pseudograminearum* / *F. graminearum*), *Microdochium* spp. and three isolated from the leaves, *F. acuminatum*; *F. chlamydosporum* and *F. semitectum* (Syn: *F. incarnatum*). The study of the temperature effect on *Fusarium* spp. and *Microdochium* spp. growth showed that the growth interval ranged between 10 and 35°C, and that the optimum growth for the eight species was obtained between 20 and 30°C. Pathogenicity tests of the isolated species were carried out on the collar of the wheat (cv. Vitron) known for its susceptibility to the pathogen. The inoculation was conducted by adding the inoculum at the time of sowing with an inoculum previously cultured on a wheat-based substrate. The assessment of aggressiveness was done according to a 0-3 disease scale 40 days after sowing. The results obtained

showed that all the isolates obtained (isolated from the crown and leaves) induced typical symptoms of crown rot with a disease index varied from 0.66 to 1.54. It should be noted that *F. semitectum* (syn: *F. incarnatum*) is reported for the first time on wheat in Algeria.

F51 BIOCHEMICAL CHANGES IN THE LEAVES OF FABIA BEAN (*VICIA FABA*) CULTIVARS INFECTED WITH THE FUNGAL PATHOGEN BOTRYTIS FABAE. Noura Mohammed Bouazzoum and Nwara Ali Mohamed, Plant Protection Department, Faculty of Agriculture, Omar El Mukhtar, Al-Beida, P.O. Box 919, Libya, Email: nwbooshakoa@gmail.com

The study was carried out to evaluate the effect of *Botrytis fabae* that caused faba bean chocolate spot on some biochemical changes in two cultivars Benghazi (Resistant) and Egyptian (susceptible). The results showed that reducing sugars content was significantly increased in the tested cultivars, Benghazi and Egyptian. The total of non-reducing sugars content were significantly lower in infected leaves of both cultivars than in the control. The crude protein (soluble protein) content was decreased in infected leaves of both tested cultivars compared with those of healthy controls. Total phenol and oxidative enzymes were significantly higher in infected leaves of Benghazi cultivar than that of the Egyptian cultivar. In addition, the accumulation of peroxidase enzyme was higher than catalase enzyme in the leaves of both cultivars.

F52 CROP SEQUENCES AS A TOOL FOR MANAGING SOIL POPULATIONS OF *FUSARIUM CULMORUM* AND WHEAT FOOT AND ROOT ROT IN TUNISIA. Eya Khemir^{1,2}, Amir Souissi^{1,2}, Samira Chekali³, Mohamed Bechir Allagui¹ and Samia Gargouri¹. (1) National Agronomic Institute of Research of Tunisia, University of Carthage, Tunisia, Email: eyakhemir@hotmail.fr; (2) University of Carthage, Tunis, Tunisia; (3) Regional Pole of Agricultural Research and Development of North-West, Kef, Tunisia.

Fusarium foot and root rot (FFRR) of cereals, caused by *Fusarium culmorum*, is one of the most important soil- and residue-borne diseases in Tunisia. Control of the disease relies primarily on cultural practices such as crop rotation. The objective of the present study was to investigate the effect of three previous crops (wheat, faba bean and fenugreek) on the inoculum level of *F. culmorum* in the soil and on the incidence of the fungus in wheat roots and stems. The study was carried out in two climatic areas in Tunisia, located in the sub-humid and semi-arid regions. This study used quantitative real-time polymerase chain reaction and soil dilution technique to measure the DNA and CFU of *F. culmorum*, respectively, in the soil during summer of 2013. Incidence of *F. culmorum* was evaluated in spring 2014 and 2015 in roots and stem bases of wheat cultivated after the three treatments in the two sites. Results showed that break crops of faba bean and fenugreek reduced significantly ($P=0.004$) the amount of *F. culmorum* DNA in soil, by 58% (faba bean) and 65% (fenugreek), and decreased

significantly ($P=0.002$) numbers of *F. culmorum* propagules per g of soil by 83% (faba bean) and 85% (fenugreek). Pearson's correlation test showed that *F. culmorum* DNA concentration (pg DNA/g soil) was correlated ($r = 0.92$; $P < 0.001$) with CFU of this fungus (CFU/g soil). The non-cereal crops (faba bean and fenugreek) also reduced the incidence of *F. culmorum* present in durum wheat roots and stem bases in the two areas during the 2013/14 and 2014/15 cropping seasons. This study demonstrated for the first time in Tunisia that break crops are effective in reducing *F. culmorum* inoculum in the soil and decrease infection in wheat roots and stems. These results are useful for developing and implementing guidelines for the management of FFR of durum wheat and confirmed reliability of using qPCR as a tool to quantify Fusarium in the soil

F53

SPATIAL DISTRIBUTION OF FUSARIUM FOOT AND ROOT ROT OF CEREALS ACCORDING TO CLIMATIC REGIONS IN TUNISIA. Eya Khemir¹, Asma Bouatrous¹, Amir Souissi¹, Samira Chekali², Mohamed Bechir Allagui¹ and Samia Gargouri¹. (1) National Agronomic Institute of Research of Tunisia, University of Carthage, Tunis, Tunisia, Email: eya-khemir@hotmail.fr; (2) Regional Pole of the Developmental Agricultural Research in the Semi-Arid North-West, Kef, Tunisia.

The aim of this study was to estimate the incidence of Fusarium foot and root rot of cereals in 266 fields located in different climatic regions during 2012/13, 2013/14 and 2014/15 cropping seasons. Isolation was made from roots and crowns of 50 plants randomly collected. In addition, 28 soil samples were analyzed by qPCR for *F. culmorum* and *F. pseudograminearum*. Morphological identification of 5877 isolates of *Fusarium* from the plant samples revealed the dominance of *F. culmorum*. Other minor species (less than 30%) isolated included *F. avenaceum*, *F. compactum*, *F. equiseti*, *F. oxysporum* and *Microdochium nivale*. However, only *F. culmorum* DNA was detected from the soil and DNA amounts were classified as leading low and medium risk of subsequent crop damage according to the SARDI risk assessment protocol ('Predicta® B' Soil Testing Service). Overall, the frequency of recovery of *F. culmorum* was higher in crowns (22%) than in roots (10%). This result gave insight on the infection process of this species. The 3 years survey revealed the wide distribution of *F. culmorum* across the different climatic zones being recovered from more than 85% of the sampled crops. However, the crop incidence was significantly higher in the humid zone (32%) compared to the sub-humid (17%) and semi-arid (15%) zones. In addition, incidence in the fields varied significantly between years and was the highest in 2013 (26%) and the lowest in 2015 (16%). This study also revealed that the durum wheat showed significantly higher frequency of infection (23%) than bread wheat (15%), oat (11%) and barley (10%). This survey could highlight the effect of previous crops on the disease incidence. Thus, the frequency of isolation of *F. culmorum* from cereals was significantly higher after a cereal crop than a break crop. These results are in agreement with soil analysis where there was a correlation between the amount of DNA of *F. culmorum* and the incidence of *F. culmorum* in the subsequent crop.

F54

EFFICACY OF OLIVE MILL WASTEWATER (OMWW) IN CONTROLLING VERTICILLIUM DAHLIAE KLEB. THE CAUSAL AGENT OF OLIVE WILT DISEASE IN VITRO. Khayam Muhrez¹, Mohamed Tawil² and Basima Barhoum¹. (1) General Commission for Scientific Agricultural Research, Latakia, Syria, Email: khayam.m@tishreen.edu.sy; (2) Faculty of Agriculture, Tishreen University, Latakia, Syria.

This study aimed to evaluate the efficacy of olive mill wastewater (OMWW) (five different concentrations) against *Verticillium dahliae* the causal agent of olive wilt. Colony growth rate during 25 days and inhibition rate were investigated. Results showed that all tested OMWW concentrations had an inhibitory effect on the mycelial growth of *V. dahliae*, and the two OMWW concentrations 100 and 150 ml/l caused 99 % inhibition, whereas OMWW at 75 ml/l inhibited the pathogen growth by 21.29%, whereas OMWW at 50 and 25 ml/l caused the lowest inhibition rate of 8.88 and 4.95%, respectively. These data indicated that OMWW has good potential in controlling olive wilt by inhibiting the mycelial growth of *V. dahliae* and that needs further confirmation to control the disease in the field.

F55

FUSARIUM FOOT AND ROOT ROT OF WHEAT: EFFECT OF SEED TREATMENTS ON DISEASE DEVELOPMENT AND AGRONOMIC CHARACTERS IN RELATION TO INFECTION LEVEL. Chedi Gasmi¹, Alaeddine Ben Araar¹, Messaad Khammichi¹, Romdhane Nassraoui¹ and Samia Gargouri². (1) Institut National des Grandes Cultures, Postal Box N°120, 8170, Boussalem, Jendouba, Tunisia, Email: gasmichedi@hotmail.fr; (2) Institut National de la Recherche Agronomique de Tunisie, Tunisie.

The effect of seed treatments on the agronomic characters and incidence of Fusarium foot and root of wheat was evaluated in four experiments. The first trial was set up in northwest Tunisia during the cropping seasons 2016-2017 and 2017-2018. Seeds of durum wheat were inoculated with a spore suspension of *F. culmorum* at the rate of 10^6 spores/ml and then treated with Fludioxonil + Difenoconazole + Thiametoxam (F+D+Th); Prochloraz + Triticonazole (P+T) and Difenoconazole (D). The results from this trial indicated a significant increase of emergence and grain yield (GY) in treated plots compared to the untreated plots for both years. The F+D+Th and P+T treatments were the most effective and increased the emergence and GY by an average of 59.63% and 56.96%, respectively. Both fungicides also decreased (not significantly) the incidence and severity of *F. culmorum* at seedling stage. The second trial was set up after a legume crop under natural field conditions in two locations during 2015-2016. Overall, foot and root rot were significantly lower compared to the first trial. None of the treatments was efficient in increasing the agronomic parameters or decreasing the disease incidence and severity. The last trial was a demonstration trial conducted under natural infection in two plots grown after durum wheat and legume in 2019-2020. In sub-plots grown after durum wheat, (P+T) was

significantly efficient in reducing incidence of the disease as well as in increasing the seedling emergence whereas in sub-plots grown after legume, the different treatments did not affect the incidence of the disease. To conclude, Fungicide seed treatments mainly increased plant emergence and yield and decreased disease incidence and severity in wheat plots with high infection levels but had little or no effect when wheat was under low disease pressure. F+D+Th and P+T were the most efficient treatments to improve agronomic characters and to decrease foot and root rot.

F56

EFFECT OF UREA SPRAYS ON DEFOLIATION AND DECOMPOSITION OF HEALTHY AND SCABBED APPLE LEAVES. Wazeer A. Hassan and Ali Sami Ali Al-Mzory, Plant Protection Department, College of Agricultural Engineering Sciences, University of Duhok, Kurdistan Region, Iraq, Email: ali.sami@uod.ac

Urea at 5 and 10% were sprayed on scabbed apple trees caused by *Venturia inaequalis* before defoliation at post-harvest in mid-October, 2015, and showed considerable effect which instigated early fall of both scabbed and healthy leaves one week after treatment. Practically, immersed leaves in urea rapidly decomposed i.e. turn brown with distinctive leathery texture when dried. Urea efficiency was apparent in decomposing 14 and 20.8% of apple leaves with both concentrations, respectively, with loss in dry weight of 13.9 and 17%, respectively. Autumn application of urea at 10 and 20% produced the least amount of discharged ascospores of 7 and 5.3×10^4 ascospores/ml, respectively, compared to 27.5×10^4 in the control. Thus, both treatments suppressed amount of primary inoculum by 74.8 and 80.7 %.

F57

PREVALENCE OF *PYTHIUM APHANIDERMATUM* IN IRRIGATION WATER OF SOME FARMS IN DAWMAT AL-JANDAL, AL-JOUF, SAUDI ARABIA, AND THE POSSIBILITY OF CONTROLLING DAMPING-OFF DISEASE OF CUCUMBER USING *PYTHIUM OLIGANDRUM* ISOLATED FROM THE SAME REGION. Shaima Mohamed Nabil Moustafa^{1,2} and Hani Mohamed Awad Abdelzahr^{1,2}. (1) Biology Department, College of Science, Jof University, Sakaka, Saudi Arabia, Email: moustafa.shaima@yahoo.com; (2) Department of Botany and Microbiology, Faculty of Science, Minia University, Minia City, Egypt.

Dawmat Al-Jandal is a green oasis adjacent to Nefoud desert in the northern region of Saudi Arabia. This oasis is characterized by the abundance of its underground water and its various agricultural fields since ancient times. Although the irrigation system in the desert areas is by means of spraying or dripping, in Dawmat Al-Jandal region, this system is permanent through many branching irrigations channels. Damping-off diseases have been observed in some cultivated crops in several farms in the area. Many isolates of *Pythium aphanidermatum* have been isolated from the roots and stem basal parts of diseased plants. To confirm Koch's postulate, the susceptibility of cucumber plants to *P. aphanidermatum* infection and the damping-off disease incidence on germinating seeds and seedlings were tested. Results showed the high virulence of *P. aphanidermatum*

towards cucumber germinating seeds and caused a 100% infection rate. Fortunately, *Pythium oligandrum* has been isolated from one of the fields in the same region, which is known to be a potential antagonist used for the biological control of *P. aphanidermatum* diseases. Results showed that by adding a mixture of hyphae and asexual and sexual spores of *P. oligandrum* to cucumber seeds exposed to *P. aphanidermatum*, the disease was controlled fully (100%), which is an indication *P. oligandrum* can be used to control cucumber damping-off caused by *P. aphanidermatum*, with high efficiency.

F58

EVALUATION OF AMISTAR® (AZOXYSTROBIN A) AGAINST *FUSICLADIUM OLEAGINEUM* (= *SPILOCAEA OLEAGINA*) FUNGUS THE CAUSAL AGENT OF OLIVE LEAF SPOT OR PEACOCK EYE SPOT DISEASE. Dalia Ali¹, El-Sayed M. Embaby² and Abeer Faisal³. (1) Department of Microbiology, Faculty of Sciences, Ain Shams University, Egypt; (2) Plant Pathology Department, National Research Centre (NRC), Cairo, Egypt, Email: embaby.elsayed@yahoo.com; (3) Higher Institute for Agriculture Co-Operation, Egypt.

Bird's eye spot or peacock eye spot also known as olive leaf spot (OLS) disease, caused by *Fusicladium oleagineum* (Syn=*Spilocaea oleagina*) fungus is one of the important foliar diseases affecting olive trees (*Olea europaea* L.) in Egypt and worldwide. To confirm the early infection by this disease, the latent infection is detected using the leaves soaked into 5% sodium hydroxide solution and incubated at 50°C for 3-5 minutes. The fungi *F. oleagineum* were isolated and identified from the abnormal diseased olive leaves collected from orchards located in Ismailia and Behira Governorates. The *F. oleagineum* was the most frequently detected compared with other fungi. Pathogenicity test was confirmed. The fungus was re-isolated from artificially inoculated leaves, thus the Kock's postulates were completed. *In vitro* Azoxystrobin A extract (Amistar compound) was found to decrease the linear growth and sporulation of *F. oleagineum*. Increasing Amistar concentration decreased both linear growth and sporulation of *F. oleagineum*. *In vivo* Azoxystrobin A extract (Amistar compound) used was found to reduce the infection rate of olive leaf spot (OLS) disease with all olive tested cultivars compared with un-treated control. Under field conditions, enhanced chlorophyll a & b, carotenoid, soluble sugar, polysaccharide and total carbohydrate contents (as mg/g fresh weight) was observed after spraying with Azoxystrobin A extract (Amistar) compound to control olive leaf spot (OLS) disease in all olive tested cultivars compared with untreated control.

F59

CONTROL OF HELMINTHOSPORIOSIS IN *ORYZA SATIVA* VARIETIES BY TREATMENT WITH 24-EPIBRASSINOLIDE. Kuete Tueguem William Norbert¹, Ngoh Dooh Jules Patrice², Kone Sangou Abdou Nourou³, Mboussi Serge Bertrand⁴, Chewachang Godwill Mih¹, Essome Sale Charles¹, Djuissi Tohoto Doriane¹ and Ambang Zachée¹. (1) Laboratory of Biotechnologies, Phytopathology and Microbiology Unit, University of Yaounde I., PO Box,

812, Cameroon, Email: wilbert2@ymail.com; (2) Department of Biological Sciences, Faculty of Science, University of Maroua, PO Box 814 Maroua, Cameroon; (3) University of Dschang, Department of Plant Biology, Applied Botanic Research Unit, PO Box 67 Dschang, Cameroon; (4) University of Douala, Laboratory of Plant Biology, Cameroon.

The foliar application of 24-epibrassinolid (EBR) is evaluated for its potential negative effects on the development of *Bipolaris oryzae* and its influence on the synthesis of defense substances in the leaves of rice plants. In the field, a multifactorial split-plot experimental design was followed which included two rice varieties (NERICA 3 and local variety KAMKOU) and five treatments (T0: control, T1: EBR, T2: Banko plus, T3: NPK fertilizer, T4: mixture: NPK + Banko plus + EBR) with three replications. Agro-morphological, epidemiological parameters, and the production of defense substances were evaluated. Results obtained showed significant effect of EBR on plant growth, yield, synthesis of secondary metabolites and defense proteins and disease resistance. The EBR significantly reduced rice grain losses by favoring an average yield of about 1.55 tones/ha over the control and 1.00 tones/ha over NPK for both varieties studied. The EBR had no effect on the disease incidence, however, disease severity was greatly reduced with 46.2% efficiency for the variety NERICA 3 and 45.3% for the variety KAMKOU. The determination of the total protein and phenolic compounds after the application of the hormone showed protein accumulation in the leaves of the respective varieties NERICA 3 and KAMKOU treated with the EBR (117.89±1.92 and 148.53±0.44 eqBSA/mg/WFM) in contrast to untreated plants (104.97±5.88 and 128.18±7.38 eqBSA/mg/WFM). The EBR also induced an increase in total phenols in plant leaves compared to control plants with respective values of 13.73 and 5.37 eqAG/mg/WFM. The enzymatic activities of PPOs, POXs and PR2s were higher in leaves from EBR-treated plants. These results suggested that 24-epibrassinolide can be used for the control of helminthosporiosis in cultivated plants.

F60

DETECTION OF FUNGI AND THEIR TOXINS AFFECTING FIG FRUIT QUALITY. Dalia Ali Mahmoud¹, E.M. Embaby² and Marwa A. Younos³. (1) Department of Microbiology, Faculty of Science, Ain Shams University, Egypt, Email: marwayounos@yahoo.com; (2) Plant Pathology Department, National Research Centre, Cairo, Egypt; (3) Food Toxicology and Contaminants Department, National Research Centre (NRC), Cairo, Egypt.

Over 25 to 30 percent loss of fruits are caused by fungal diseases. Several fungi invade and damage fig fruits and changes all the biochemical contents affecting quality. This study aimed to survey mycoflora and mycotoxins affecting fig fruit quality. Five orchards were selected, and 480 fungal isolates were isolated and identified. The fungal isolates studied were found to belong seven fungal genera: *Alternaria alternata*, *Aspergillus niger*, *Aspergillus parasiticus*, *Aspergillus flavus*, *Aspergillus terreus*, *Botrydiploia theobromae*, *Cladosporium* sp., *Penicillium* sp., *Rhizopus stolonifer* and *Fusarium* sp. Isolates which

belong to *Alternaria alternata*, *Aspergillus flavus* and *A. parasiticus* were found to decrease fruit quality by reducing fruit weight (g), size (cm³), length (cm) and diameter (cm³), total soluble solids (TSS%), and increased moisture content. Only six isolates of *A. parasiticus* gave positive reaction which produced one or more aflatoxins. All tested pesticides alternatives *i. e.* ascorbic acid, benzoic acid and citric acid (all of them organic acids) had antifungal effects and were able to reduce disease incidence of fig fruits caused by *A. parasiticus* compared with untreated control.

F61

EVALUATION OF DOUBLE HAPLOID LINES OF COMMON WHEAT FOR YELLOW AND STEM RUST RESISTANCE AND IDENTIFICATION OF CLOSELY LINKED MARKERS AND GENES ASSOCIATED WITH YELLOW AND STEM RUST RESISTANCE THROUGH LINKAGE MAPPING AND QTL ANALYSIS. S.A. Tawkaz¹, T.M. Istanbuli¹, W. Tadesse¹, A. Hamwieh¹, E.I. El- Gaali², S.M. Al-Samaan³ and M. Baum¹. (1) International Centre for Agricultural Research in the Dry Areas (ICARDA), Beirut, Lebanon, Email: s.tawkaz@cgiar.org; (2) Department of Oil Crops, Agriculture Research Centre (ARC), Wad Madani, Sudan; (3) Agricultural Genetic Engineering Research Institute (AGERI), Agricultural Research Centre, Cairo, Egypt.

Wheat (*Triticum aestivum* L.) is one of the most important food crops in the world, and it is cultivated on a total area of 220 million hectares with current average annual production of about 750 million ton. Global wheat production increases by 1% while the demand for wheat increases by 1.7%. Wheat production is affected by abiotic (e.g. heat, drought) and biotic (e.g. yellow rust, stem rust, Septoria, fusarium, insects) stresses. Combating these challenges and fulfilling the wheat demand needs the application and utilization of rapid and efficient breeding techniques and tools such as doubled haploids (DH) and marker assisted selection. This study aimed to evaluate 144 DH common wheat lines derived from a cross between Hamam-4 (yellow and stem rust susceptible variety) and Gladius (yellow and stem rust resistance variety) to identify closely linked markers and genes associated with yellow and stem rust resistance. The evaluation has been conducted at Kulumsa, Ethiopia during 2014 and 2015 growing seasons for stem and yellow rust diseases under natural infection. The results indicated significant differences among the genotypes for both diseases during both seasons. Yellow rust infection was heavy in 2014 season, while stem rust infection was severe in the 2015 season. The severity of yellow and stem rust at Kulumsa in 2014 compared to 2015 season indicated the effect of seasonal variation in disease development and pressure. A total of 65 and 117 lines in 2014, and 100 and 16 lines in 2015 were identified to be resistant to yellow and stem rust, respectively. Biparental QTL mapping was carried out using DArT molecular marker. Markers wPt-4628, wPt-1548, wPt-2607, wPt-7101 and wPt-9724 were significantly associated with yellow rust resistance, while markers wPt-665375, wPt-2859, wPt-226, wPt-2600 and wPt-8105 were linked to stem rust resistance. These markers should be validated using another elite set of spring bread wheat

genotypes to be used for marker-assisted selection in the wheat breeding program.

F62

ARAR (*TETRACLINIS ARTICULATA*) DIEBACK IN TUNISIA: THE CAUSAL AGENT AND BIOCONTROL. Sawssen Hlaiem^{1,2}, Islem Yangui^{1,3}, Olfa Ezzine¹, Gianni Della Rocca⁴, Sara Barberini⁴, Roberto Danti⁴ and Mohamed Lahbib Ben Jamâa¹. (1) University of Carthage, National Institute for Research in Rural Engineering Water and Forest (INRGREF), Ariana, Tunisia, Email: sawssenhlaiem@gmail.com; (2) University of Carthage, National Agronomic Institute of Tunisia (INAT), Tunis, Tunisia; (3) University of Carthage, National Institute of Applied Science and Technology (INSAT), Tunis, Tunisia; (4) National Research Council, Institute for Sustainable Plant Protection of Italy (IPSP-CNR), Firenze (Florence), Italy.

The fungi appear to be the most common pathogens causing plant diseases and severe damage. The most widely distributed, with a large host range and economic impact are the ascomycetes groups belonging to the *Botryosphaeriaceae* family. Infected plants showed a progressive dieback of shoots, branches, twig blight symptoms and trunk canker. In Tunisia, this phenomenon was observed on maquis since 2012. In this study, a survey was conducted in 2017, in northeastern Tunisia. Symptoms of wilting, necrosis and branch cankers were observed on *Tetraclinis articulata* (local name Arar). Numerous pycnidia were detected on the surface of infected branches. The aim of this work was to identify the causal agent of *T. articulata* dieback, confirm its virulence and propose an alternative strategy of biocontrol with *Trichoderma harzianum*. Morphological features and phylogenetic analysis of the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA identified the pathogen as *Diplodia seriata*. The evaluation of the pathogenicity was carried out on asymptomatic excised branches of *T. articulata*. The Koch's postulates were met. This finding is the first record of *D. seriata* as fungal pathogen associated with branch canker of *T. articulata* in Tunisia. The antagonistic potential of *T. harzianum* was assessed *in vitro*. *D. seriata* and *T. harzianum* were thus directly confronted on PDA medium during 6 days. The results obtained were encouraging and revealed that this antagonist inhibited (64%) mycelial growth of the pathogen compared to the untreated control.

F63

IDENTIFICATION OF NEW CHICKPEA GENOTYPES RESISTANT TO FUSARIUM WILT (*FUSARIUM OXYSPORUM* F. SP. *CICERIS*). Tawffiq Istanbuli, SawsanTawkaz and Aladin Hamwieh, The International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Zahle Bekaa Valley, Lebanon, Email: t.istanbuli@cgiar.org

Fusarium wilt (*Fusarium oxysporum* f. sp. *ciceris*) of chickpea is the major limiting factor to chickpea production worldwide. Host plant resistance is the major component in the management of fungal diseases in chickpea (*Cicer arietinum* L.). This study was conducted with an aim to identify new sources of resistance against fusarium wilt.

The experiment was conducted in 2017-2018 in a sick plot at ICARDA, Terbol station, Bekaa valley, Lebanon. The experiment was laid out in an augmented block design (ABD), and the susceptible check (highly susceptible line) ILC482 was repeated after each tenth rows. The total number of the genotypes used in this study was 974, they included 34 accessions from the genebank, and 940 breeding lines from the chickpea breeding program of ICARDA. The first round of evaluation identified seven-hundred and thirteen lines (73%) as resistant with wilt incidence <10% infection rate. The second round of evaluation (2020/2021) confirmed the resistance of 129 genotypes with wilt incidence <10% infection rate, and only 45 genotypes without any symptoms. These genotypes were selected to distribute them through the chickpea fusarium wilt Nursery (CFWN) in 2021 for further testing in different locations. This is an important material in chickpea to enhance fusarium wilt chickpea resistance in the future.

F64

FUNGAL PATHOGENS ASSOCIATED WITH CROWN AND COLLAR ROT OF APPLE TREES IN SOUTHERN SYRIA. Abeer Rashid and Walid Naffaa, Damascus University, Faculty of Agriculture, Department of Plant Protection, Damascus, Syria, Email: walid1851966@yahoo.com

Crown and collar rot of apple trees is a destructive and widespread disease in most areas of the world. Surveys were conducted to describe disease symptoms, estimate disease incidence, and identify pathogens associated with this disease in southern Syria. Disease incidence observed was 0.08–10% in most studied sites, only in Alroom location it was 17.8%, with average of 11.8%. Symptoms included small pale green leaves, sparse foliage, and a reddish-brown discoloration of inner bark of the infected area at the base of infected tree. The isolated fungi belonged to the genera *Phytophthora*, *Rosellinia*, *Rhizoctonia*, *Phialophora*, *Acremonium*, *Pestalotiopsis*, *Cylindrocarpon* and *Verticillium*. *Phytophthora* was isolated from all infected trees, and was the most frequent pathogen (53.7% of total isolates). *Phytophthora* isolates recovered from crown cankers of apple were identified as *P. cactorum* (91.5 %) and *P. cambivora* (8.5%). The results of this study are the first report of crown and collar root rot of apple in Syria.

F65

STUDYING THE RESISTANCE AND REACTION TYPE FOR NUMBER OF FABA BEAN GENOTYPES AGAINST *UROMYCES VICIAE*-FABAE AND IDENTIFICATION VIRULANT SYRIAN ISOLATES. Shoula Aboud Kharouf, College of Agriculture, Al-Furat University, Deir Ezzor, Syria, National Commission for Biotechnology (NCBT), Damascus, Syria, Email: Shoula_kharouf@yahoo.com

The aim of this study was to identify the resistance level in some faba bean genotypes and cultivars against *Uromyces viciae-fabae* (Pers) Schroet to investigate the existence of different physiological races in Syria during the 2018-2019 season. Eighteen genotypes and cultivars of faba bean (*Vicia faba* L.) were selected from the breeding materials of General Commission for Scientific Agricultural

Research (GCSAR) and some agricultural companies that distribute seeds of cultivars resistant to bean rust disease. Field, laboratory and the green house tests were carried out at the National Commission for Biotechnology (NCBT) during the 2018-2019 season. When more than 50% of faba bean plants were in the flowering stage, they were artificially inoculated with suspension of uredospores collected from several fields of early matured plants. The inoculation was carried out in excess moisture under polyethylene cover for 48 hours. The disease symptoms appeared 11-12 days after inoculation. The disease severity and infection type were estimated by a scale ranging from 0=immune to 9=highly susceptible, based on the density and size of pustules on leaves and other parts of the plant. The results showed that temperature 25°C was optimal for rust uredospores formation and showed that five of the tested genotypes, Hama2, faba bean municipality (princess), faba bean ghouta Al sham and H 04/56 were highly resistant or resistant, whereas the other nine genotypes and cultivars Faba bean dafadei broad, HBP/SOE/ 2008, Faba bean Syrian Cyprian, H 04/ 57, HBP/SOD/2007, REBAE 40, H 04/ 52, Hama 3 and HBP/SOD/2008 were moderately resistant. Two genotypes S.81077 and Alaassi Spanish were susceptible, and two genotypes were highly susceptible, ILB 1814 and faba bean Syrian enhancer. Differential reactions of faba bean genotypes inoculated with four different isolates, illustrated that genetic variability existed among *Uromyces viciae-fabae* (Pers) Schroet in the region. This data indicated the presence of several physiological races in Syria, but further studies are needed to determine their identity.

F66 (Please see Page E-127)

BACTERIAL DISEASES

B1

REACTION OF SOME COTTON GENOTYPES TO BACTERIAL BLIGHT DISEASE AND ASSESSMENT OF MOLECULAR DIVERSITY OF THE CAUSAL AGENT IN THE SUDAN. Muna Elhag Suliman Saied¹, Assala Hassan Mohammed² and Abd Elmgid Adlan Hamad². (1) University of Gezira, Faculty of Agricultural Sciences, P.O. Box 20, Wad Medani, Sudan, Email: saiemuna@gmail.com; (2) Agricultural Research Corporation, Integrated Agricultural Pests Management Research Center, P.O. Box 126, Wad Medani, Sudan.

Cotton (*Gossypium hirsutum*) is considered as an important cashy crop in many countries of the world. Sudan after introducing the Bt cotton, increased the area cultivated with this crop. The bacterial blight caused by *Xanthomonas axonopodis* pv. *malvacearum* is one of most destructive diseases of cotton throughout the world. Objectives of this study were to survey this disease and to determine differences between varieties that were collected from different locations. Two surveys were undertaken in Rahad agricultural Scheme during 2015/16 and 2016/17 seasons to investigate the occurrence, incidence and severity of cotton bacterial blight (CBB). Results obtained revealed that during 2015/16, disease incidence range was 72-100% with severity of 1.6-2.5 according to a 0-5 scale, whereas in the 2016/17 season, disease incidence levels ranged between 81- 100 %

and with disease severity of 1-2.5. Surveys results showed that CBB was high on Bt cotton (seeni1 variety), the dominant variety grown in Sudan. In the field experiment conducted at El-Rahad scheme, all 27 genotypes were infected with bacterial blight. The variety Barazil-1 was the most resistant with 16.8% disease incidence and 0.6 disease severity, whereas the variety Wager was the most susceptible to CBB with 85% disease incidence. Morphological characteristics and biochemical tests showed that the bacterium was negative to gram stain, citrate, H₂S and KIA tests and positive to KOH, catalase and oxidase tests. Results obtained revealed that the bacteria cannot survive for three seasons on trash leaves. Repetitive-PCR genomic fingerprinting using ERIC primers readily detected four distinct groups with some variation within subgroups. The latter were identified and separated into four main genotypes and that there are four subspecies within the tested isolates.

B2

FIELD AND LABORATORY PRELIMINARY STUDIES ON WATERMELON NECROSIS DISORDER OF MELON CROP IN IRAQ. Qais K Zewain, Al-Hadba College, University Mosul, Iraq, Email: qkzewain@hcu.edu.iq

This study was carried out because of a severe outbreak of unknown disorder which caused heavy economic losses to watermelon farmers over many Iraqi provinces which cultivate this crop. A field survey was conducted over 49.5 hectares of melon fields during the spring season in four Iraqi provinces; Anbar, Kirkuk, Erbil, and Penguin/Sulaymaniyah. The survey results showed that disease incidence range was 0-80% in Anbar, Kirkuk, and Erbil, whereas it ranged around 5-20% in the Penguin and Kalar districts/Sulaymaniyah provinces. It was also noted that plants grown under the shade of summer fruit trees or intercropped with summer crops like sunflower, escaped from this disease. No resistant or tolerant varieties were observed among many melon varieties cultivated in surveyed areas, except the local variety that was able to escape infection. Minor differences in the varieties susceptibility to the disease were noticed. No difference was found between well and bad practiced plants in its susceptibility to this disease. The disease was named as watermelon rind necrosis (WRN) on the basis of visible symptoms on internal rind, flesh appearance and taste of melon fruit. In addition to some laboratory tests conducted for the purpose. A positive correlation was found between disease incidence and the difference between night and day temperatures during the period before fruit ripening.

B3

PREVALENCE OF HUANGLONGBING ASSOCIATED WITH DIAPHORINA CITRI IN DIFFERENT CITRUS GROWING AREAS OF PUNJAB IN PAKISTAN. Salman Ahmad, Zafar Iqbal, Muhammad Asim, Mohsin Raza and Waqas Raza, Department of Plant Pathology, College of Agriculture, University of Sargodha Punjab, Pakistan, 40100, Email: salman.ahmad@uos.edu.pk

Citrus greening (CG) or huanglongbing (HLB) is an important citrus disease caused by motile bacteria,

Candidatus liberibacter spp. and significantly affects the yield. Currently, citrus greening is prevalent in all citrus growing areas of Punjab, Pakistan and is a potential threat to citrus production. Therefore, efficient control requires a detailed knowledge of its spread and population dynamics of its insect vector. The current research was designed with the following objectives in mind: 1) to study the population dynamics of Asian citrus psyllid *Diaphorina citri*, the vector of citrus greening 2) to record the incidence of citrus greening in different growing areas of Punjab and estimate yield losses caused by this disease. Surveys were conducted to assess disease incidence and yield losses. Whereas, correlation and regression analysis were used to determine the relationships between citrus psyllid and citrus greening on one hand and between the environmental factors and citrus greening on another hand. The results revealed highest disease incidence in Faisalabad (45%), and lowest (21.67%) in Multan. Similarly, yield losses due to citrus greening were found maximum (33.5%) in Faisalabad and lowest (15.5%) in Multan. There was significant and positive correlation between citrus psyllid population and citrus greening on Hinnow, Musambi and Feutrell's early cultivars. In contrast with the effect of relative humidity, maximum and minimum temperatures and rainfall showed significant correlation with citrus greening incidence.

B4

A MODIFIED MLVA APPROACH LED TO NEW FINDING IN CLUSTERING THE *PSEUDOMONAS SYRINGAE* PV. *ACTINIDIAE*. A. Mazzaglia, S. Turco, M.C. Taratufolo, Y.J. Rahi and G.M. Balestra, Università degli Studi della Toscana, Department of Agricultural and Forest Sciences (DAFNE), via San Camillo de Lellis snc, 01100 Viterbo, Italy, Email: angmazza@unitus.it

Pseudomonas syringae pv. *actinidiae* (Psa) is a Gram-negative bacterium responsible for the outbreak of kiwi canker of cultivated kiwifruits worldwide. It was first isolated, identified and described in Japan in 1984. Later, the pathogen was reported in China, Korea, New Zealand, South America and in the European Continent. Five different biovars have been described based on the phenotypic and genomic analysis, of which biovar 3 is the one responsible for the pandemic since 2008. In order to investigate the pathogen population structure, epidemiology and infection pathways, a modified molecular approach multi locus VNTR analysis (MLVA) was set up and 19 loci were applied to a comprehensive dataset of 152 individuals. Based on hierarchical clustering, discriminant analysis of principal components (DAPC) and structure analysis, results showed an unpredicted high number of Psa clusters, representing 14 different populations. Some groups matched to the five biovars currently accepted, others seem to be quite related to them, and another group emerged as completely independent. All but one of the fourteen identified populations are scattered throughout south-eastern Asia; only representatives of the population corresponding to the biovar Psa3 are retrievable anywhere else in the world. How this assay is useful to thoroughly depict genetic variants of the pathogen will be discussed.

B5

DETECTION OF 'CANDIDATUS LIBERIBACTER ASIATICUS' THE CAUSAL AGENT OF CITRUS GREENING IN CITRUS NURSERIES IN SAUDI ARABIA. Yasser E. Ibrahim, Arya Widyawan, Mahmoud H. El Komy, Hatha M. Al Dhafer and Mohammed A. Al-Saleh, Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia, Email: yasereid@ksu.edu.sa

Citrus greening, also known as huanglongbing (HLB), is a destructive citrus disease worldwide including in Saudi Arabia and is caused by closely related species of systemic fastidious *Candidatus* bacteria. The Asian citrus psyllid (ACP), *Diaphorina citri*, is the vector of the *Candidatus* *Liberibacter asiaticus* (CLAs). Besides their transmission through the ACP, the propagation of infected plant materials is responsible for expanding the geographical distribution of HLB. To minimize the possibility of nurseries being effective as CLAs sources, a survey of citrus nurseries in all of Saudi Arabia's citrus-producing areas was conducted. Quantitative and conventional PCR assays were used to examine leaf tissue samples from 352 trees, which represented 5% of the total number of potted trees at the nurseries. Only 14.6 % were positive for CLAs in both tests. Our findings corroborate the importance of citrus nurseries in the spread of CLAs in Saudi Arabia, and they emphasize the necessity for quarantine and certification programs for nurserymen to produce pathogen-free budwood, which could help to reduce unauthorized budwood introductions.

B6

MOLECULAR AND FUNCTIONAL DIVERSITY OF PGPR FLUORESCENT *PSEUDOMONAS* ISOLATED FROM RHIZOSPHERE OF OLIVE (*OLEA EUROPEA* CV. *EUROPEA*). Farida Benzina-Tihar, Hakima Oulebsir-Mohand Kaci, Abd Ennaceur Reghmit and Fatma Sahir-Halouane, Laboratory of Valorization and Conservation of Natural Resources, Department of Biology University of Mhamed Bougara, Boumerdes, Algeria, Email: f.benzina@univ-boumerdes.dz

Genetic diversity of plant growth-promoting rhizobacteria (PGPR) fluorescent pseudomonads associated with olive (*Olea europaea* cv *europaea*) rhizosphere was analyzed. Bacteria were collected from major olive growing regions of Northern Algeria. The isolates were identified based on physiological and biochemical characters. A total of 60 isolates were divided to two groups, fluorescent Pseudomonads (78%) and non-fluorescent Pseudomonads (22%). Selected fluorescent isolates were screened for plant growth promoting properties including production of indole acetic acid, phosphate solubilization, denitrification ability and production of antifungal metabolites. Furthermore, 16S rDNA sequence analysis was performed to identify and differentiate between these isolates. Based on 16S rDNA sequence similarity the isolates were designated as *Pseudomonas plecoglossicida*, *P. putida*, *P. monteilii*, *P. libaniensis*, *P. azotoformans* and *P. fluorescens*. Differentiation of isolates belonging to the same group was achieved through genomic DNA fingerprinting techniques, including repetitive extragenic palindromic (REP) and

enterobacterial repetitive intergenic consensus (ERIC) analyses. The genetic diversity observed among the isolates and rep-PCR-generated fingerprinting patterns revealed that PGPR fluorescent pseudomonads are associated with olive rhizosphere and that *P. fluorescens* is a dominant species. The knowledge obtained herein regarding the genetic and functional diversity of fluorescent pseudomonads associated with olive rhizosphere is useful for understanding their ecological role and potential utilization in sustainable agriculture.

B7

XYLELLA FASTIDIOSA IS NOT DETECTED YET IN JORDAN: RECENT SURVEY RESULTS. Nehaya Al-Karablieh^{1,2}, Ibtihal Abu Obeid³, Jihad Haddadin³, Ruba Al Omari³, Abdel-Munem Al-Jabaree³, Lina Al-Elaumi², Safa Mazahreh³ and Hala Aisanabrah¹. (1) Department of Plant Protection, School of Agriculture, The University of Jordan, 11942 Amman, Jordan, Email: n.alkarablieh@ju.edu.jo; (2) Hamdi Mango Research Center for Scientific Research, The University of Jordan, 11942 Amman, Jordan; (3) National Agricultural Research Center, 19381 Baqa, Jordan.

The bacterium *Xylella fastidiosa* is a destructive pathogen which attacks a wide range of hosts of more than 350 plant species, causing various diseases. Recent outbreak of *X. fastidiosa* on olives and other major crops in many countries in the European Union and other countries in the Mediterranean region is considered a serious threat to the Jordanian agricultural sector. Therefore, a survey was conducted during the years 2016-2020 on the presence of this bacterium in Jordan on different hosts including olives (975 samples), grapevine (200), stone fruits (475), pome fruits (15), citrus fruits (250) oleander (40), rosemary (40) ornamental plants (40) grown all over Jordan. Samples were taken from plants showing suspected symptoms and from asymptomatic plants, and potential Hemiptera insect vector samples were also collected. All plant samples were tested for the presence of *X. fastidiosa* using commercial Elisa kits, followed by molecular confirmation by conventional PCR using 3 set of primers. Insect samples were tested using commercial kit of real time LAMP method. All tested samples did not show any positive results in comparison to the positive control used. These results suggest demonstrate that *X. fastidiosa* does not occur yet in Jordan. However, extensive monitoring program and checking the borders is needed to prevent the entrance of this serious pest into the country.

B8

XYLELLA FASTIDIOSA RESISTANCE IN OLIVE AND OTHER CROPS. P. Saldarelli¹, A. Giampetruzzi², R. Abou Kubaa¹, G. Altamura¹, V. Montilon¹, D. Boscia¹ and M. Saponari¹. (1) CNR, Istituto per la Protezione Sostenibile delle Piante, Bari, Italy, Email: pasquale.saldarelli@ipsp.cnr.it; (2) Dipartimento di Scienze del Suolo della Pianta e degli Alimenti, Università degli Studi di Bari Aldo Moro, Bari, Italy.

Olive quick decline syndrome (OQDS), a severe disease affecting susceptible olive cultivars in southern Italy has been associated with infection with *Xylella fastidiosa* (*Xf*) subsp. *pauca*, genotype ST53. Due to the lack of

effective therapy to cure infected plants, search for genetic resistant traits in susceptible hosts is actively pursued. In citrus or in grape, the presence of resistance mechanisms has been described, paving the way to new sustainable and long-term control strategies for *Xylella*-induced diseases. Following the OQDS epidemic, resistant phenotypes were observed in olive cultivars which led to investigate the corresponding mechanism. Studies consistently showed that lower populations of the bacterium occur in resistant olive trees of the cultivars Leccino and FS17, and transcriptome profiling indicated the involvement of specific cell wall surface receptors belonging to the leucine rich receptor-like kinases. Similar genes were found overexpressed in resistant mandarin and are present in the Pierce disease's resistance locus 1 in grapevine. Interestingly, Leccino resistance is also efficient against other bacterial strains, i.e. belonging to subsp. *fastidiosa* and *pauca*. Moreover, studies of the xylem anatomy showed that a lower percentage of occlusions and smaller diameter vessels occurred in resistant olive cultivars, which likely contribute to restrict the bacterial movement.

B9

DESCRIPTION OF IMMATURE INSTARS OF THE POTENTIAL VECTORS PHILAENUS SPUMARIUS AND NEOPHILAENUS CAMPESTRIS OF XYLELLA FASTIDIOSA IN TUNISIA. Nada Lahbib^{1,2,3}, Sonia Boukhris Bouhachem¹, Ugo Picciotti³, Francesca Garganese³, Antonio Ippolito³ and Francesco Porcelli³. (1) Plant Protection Laboratory of National Institute of Agricultural Research of Tunisia, Tunisia, Email: nadalahbib48@gmail.com; (2) University of Tunis El Manar, Faculty of Sciences of Tunis, Tunisia; (3) Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Bari, Italy.

Philaenus spumarius (Linnaeus, 1758) and *Neophilaenus campestris* (Fallén, 1805) (Hemiptera, Aphrophoridae) are main vectors of the fastidious bacteria *Xylella fastidiosa* subsp. *pauca* ST53, infecting mainly olives in Apulia, Italy. Both species are present in Tunisia, and are candidate vectors. In this study we differentiated the nymphal stages of both species by morphological characteristics. The immatures were collected from the end of February to May 2018-2020. The nymphs were gathered from their host plant to be stored in labelled tubes and preserved by 75% EtOH. For each instar, 10 specimens of each instar were measured based on head capsule width (distance between eyes), number of compound eyes elements, antennae, labium, tibia and total body length. The five instars were illustrated using stereoscopic and compound light microscope by thick-slide mounting in the same EtOH, plus scanning electronmicroscopy. Results showed that it was possible to discriminate each instar and the species in EtOH-stored collections.

B10

STUDY OF THE IN VITRO INTERACTION BETWEEN THE BIOCONTROL 32A STRAIN OF BACILLUS VELEZENSIS AND THE PHYTOPATHOGENIC STRAINS OF AGROBACTERIUM TUMEFACIENS AND ERWINIA AMYLOVORA. Nessrine Ben Cheikh, Slim Tounsi,

Mohamed Ali Triki and Olfa Frikha-Gargouri, Laboratory of biopesticides, Centre of Biotechnology of Sfax, Tunisia, Email: olfafrikhagargouri@gmail.com

The study of the interaction occurring between the beneficial and the pathogenic microbes is interesting for the development of effective biopesticides for the management of plant diseases. However, very little is still known about the influence of these complex interactions on the biocontrol determinants of beneficial bacteria, especially *Bacillus velezensis* strains. This study aimed to evaluate the effect of the interaction of *B. velezensis* 32a strain with the phytopathogenic strains C58 and B6 of *Agrobacterium tumefaciens* and *Erwinia amylovora*. For this purpose, the effect of the *in vitro* co-culture of the biocontrol and the phytopathogenic strains on bacterial growth, the production of antibacterial compounds and the expression of their biosynthesis genes was investigated. Results obtained suggested the modulation of antibacterial compounds production according to the interacting phytopathogenic bacteria.

B11

SURVEY FOR THE BACTERIUM *XYLELLA FASTIDIOSA* IN OLIVE TREES AT THE AL-KHUMS REGION, WESTERN LIBYA. Adel M. Elmaghrabi¹, Mohamed M. Elmeradi², Fawzi Ebrahim¹ and Elmunder Abugnia¹. (1) Biotechnology Research Center, P.O. Box 30313, Tripoli, Libya, Email: maghrabiam@hotmail.com; (2) Almrigh University, Faculty of Sciences, Al-Kums, Libya.

The aim of this survey was to investigate the occurrence of the bacterium *Xylella fastidiosa* in olive trees at Al-Khums region, which is environmentally suitable for olive trees culture, as this tree is considered one of the important food sources in Libya. The disease caused by this bacterium is one of the most destructive to olive and other trees, and is spreading quickly in a number of countries in the Mediterranean basin. A total of 200 samples of different olive trees were selected randomly. Samples were collected from four geographical regions (Souk Al-Khamis, Al-Zawad, Al-Jahawat and Celine) with 50 samples from each region. The GPS device was used to locate each tree. Samples were collected from the four sides of the tree and at the middle and top heights of the tree, with 10-12 mature leaves collected from different branches of the tree. Each collected sample was placed in a plastic bag marked with appropriate information. Four hard pieces from leaf petioles + leaf blades/sample were homogenized, and the extract was tested by ELISA at the Biotechnology Laboratory in Tripoli. Although, the initial symptoms from some target trees showed typical symptoms of the disease, test results showed that none of the tested olive trees were positive for *X. fastidiosa*.

B12

EFFECT OF CITRUS STUBBORN DISEASE (*SPIROPLASMA CITRI*) ON THE CHEMICAL COMPOSITION OF ORANGE (*CITRUS SINENSIS* L. OSBECK) FRUIT ESSENTIAL OILS. Kinza Benazzouz, Faculty of Biological and Agricultural Sciences, Mouloud

Mammeri University of Tizi-Ouzou, Tizi-Ouzou, Algeria, Email: kkesbia@yahoo.fr

The present study investigated the effect of stubborn disease (*Spiroplasma citri*) on the chemical composition of fruit essential oils of sweet orange (*Citrus sinensis*). Results showed that the essential oils extracted from both healthy and infected fruits did not have the same physicochemical characteristics but have the main oil components e.g with octanal, β -phellandrene, d-limonene, 1r- α pinene, and d-limonene as major compounds. However, the infection led to the synthesis of toxic substances like (2-cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-cis, decanal trans-p-mentha-2, 8-dienol, 2cyclohexen-1-ol and 1-methyl-4-[1-methyl-4-(1-methylethyl)]-cis, at low concentration (<1%). It was also demonstrated that essential oils affected negatively the proliferation of bacteria such as *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923 and *Pseudomonas aeruginosa* ATCC 27853. The minimum inhibitory concentration (MIC) for the bacterial strains was 4 μ L/L from infected and 32 μ L/L from healthy fruits.

B13

MEMBRANE CAPTURE TECHNIQUE (MCT), A USER-FRIENDLY ASSAY FOR *XYLELLA FASTIDIOSA* DIAGNOSIS. Raied Abou Kubaa, Giuliana Loconsole, Donato Boscia and Maria Saponari, CNR, Institute for Sustainable Plant Protection, via Amendola 122/D, 70126 Bari, Italy, Email: raied.aboukubaa@ipsp.cnr.it

The bacterium *Xylella fastidiosa* can attack a wide range of host plant species causing serious diseases in agricultural crops such as Pierce's disease of grapevine, phony peach disease, plum leaf scald, citrus variegated chlorosis disease, olive quick decline as well as leaf scorch of almond. The recent establishment of *Xylella fastidiosa* (*Xf*) in the EU territory and the wide range of EU host plants increased the need to update continuously the current diagnostic protocols available for *Xf* detection with rapid tools suitable for processing large number of samples directly in the field without moving the infected material to *Xf*-free-areas. In the present work, a membrane capture technique (MCT) was developed to assess infections of *Xf* in different host species. Twigs-prints or spots of plant sap preparations recovered from infected and *Xf*-free plants were directly immobilized on Whatman 3 paper. Infected plants of olive, oleander, polygala and almond, were sampled in orchards located in the Apulian contaminated area (Southern Italy). Experiments were carried out in three replicates and prints/spots were tested immediately, after 40 days and 1 year by Realtime Lamp-PCR. The efficiency and reliability of MCT was validated in comparison with Realtime PCR assays on DNA extracts recovered from the same plant material used for MCT. The overall results showed the ability of Whatman membrane to retain the bacterium in prints or sap spots stored at room temperature even for one year without any change in reaction efficiency. Therefore, the use of MCT directly in the field can prevent the spread of *Xf* by plant material from infected to *Xf*-free areas. Moreover, the membranes prepared directly in field and stored at room temperature can safely keep the target up to one year until it can be processed by reference laboratories for *Xf* diagnosis.

B14**CHARACTERIZATION OF THE FIRST ISOLATES OF *XANTHOMONAS CAMPESTRIS* PV. *CAMPESTRIS* IN ALGERIA.**

Samia Laala¹, Sophie Cesbron², Mohamed Kerkoud³, Franco Valentini⁴, Zouaoui Bouznad¹, Marie-Agnès Jacques² and Charles Manceau⁵. (1) ENSA, Ecole Nationale Supérieure d'Agronomie, 1Avenue Pasteur, Hassan Badi - 16000 El Harrach - Alger, Algeria, Email: s.laala@ensa.dz; (2) INRA, UMR1345 Institut de Recherche en Horticulture et Semences, Beaucozéz, France; (3) Diag-Gene, 8 rue Lenôtre, 49066, Angers, France; (4) CIHEAM, IAMB - Mediterranean Agronomic Institute of Bari Via Ceglie, 9, 70010 Valenzano BA, Italy; (5) Anses, Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail, Laboratoire de la santé des végétaux, 7 rue Dirméras, 49044 Angers, France.

Xanthomonas campestris pv. *campestris* (Xcc) causes black rot of cruciferous plants. Xcc is a seed-borne bacterium and is considered as the most destructive disease to cruciferous, worldwide. Although the sources of contamination are various, the seed remains the main source of transmission. Typical symptoms of black rot were first observed in 2011 on cabbage and cauliflower fields in the main production areas in Algeria. Leaf samples displaying typical symptoms were collected during the 2011-2014 period. A total of 170 strains were isolated from 45 farmer's fields. Xcc isolates were very homogeneous in morphological, physiological and biochemical characteristics similar to the reference strains and reacted positively to the pathogenicity and molecular tests when analyzed by multiplex PCR using specific primers. This is the first report of isolating Xcc in Algeria. The genetic diversity within Algerian isolates was assessed in comparison with strains isolated worldwide. A multilocus sequence analysis based on two housekeeping genes (*gyrB* and *rpoD*) was carried out on 77 strains representatives of Algerians isolates. The strains isolated in Algeria grouped into 20 haplotypes defined with 68 polymorphic sites. The phylogenetic tree obtained showed that Xcc splits in two groups and all Algerian strains clustered in group 1 and splitted into three subgroups. No relation was observed between haplotypes and the origin of the seed lots, the variety of cabbage, the year of isolation and the agro climatic regions.

B15**ASSESSMENTS ON THE PRESENCE OF *XYLELLA FASTIDIOSA* POTENTIAL VECTORS IN LEBANON.**

Yara El Khoury¹, Raied Abou Kubaa², Vincenzo Cavalieri², Zinette Moussa³ and Elia Choueiri⁴. (1) CNRS-L, National Council for Scientific Research in Lebanon, National Center of Marine Sciences, Jounieh-Lebanon, Email: khouryaragro@gmail.com; (2) CNR, Italian National Research Council, Institute for Sustainable Plant Protection, Bari-Italy; (3) Lebanese Agriculture Research Institute, Laboratory of Entomology (LARI), Fanar-Lebanon; (4) Lebanese Agriculture Research Institute, Department of Plant Protection (LARI), Tal Amara, Lebanon.

The understanding of the epidemiology of vector-transmitted plant diseases such as *Xylella fastidiosa*, depends

closely on studying vectors spread. Thus, after the report of several outbreaks of *X. fastidiosa* in Europe and Asia, a survey of the potential vectors of this bacterium was carried out in Lebanon in 2018. The aim of this survey was to identify any xylem feeding Auchenorrhyncha potential vectors of the bacterium and to assess their presence in olive orchards and vineyards in Lebanon. Field inspections and sampling occurred mainly in Bekaa valley, South Lebanon and North Lebanon. Insect sampling was periodically carried out in olive orchards and vineyards during spring and summer of 2018. Insects were collected from the canopies of the trees, surrounding weeds and border plants using sweep netting technique. Collected specimens were morphologically identified under binocular. In parallel, representative samples of plant materials were collected from trees showing declining symptoms to ensure they are pathogen-free. As per our results, all plant materials collected in 2018 were free from the pathogen. Several species of leafhopper (Hemiptera: Cicadellidae) and planthopper (Hemiptera: Fulgoroidea) were identified. Interestingly, three species were identified: *Mesoptylus impictifrons*, *Mesoptylus* sp and the meadow spittlebug *Philaenus spumarius*. The latter considered the most important vector of *X. fastidiosa* in Europe. The presence of *P. spumarius* which plays the major role in transmitting *X. fastidiosa* subspecies *pauca* in the Apulia region (Italy) ensure that the bacterium dissemination will occur if the inoculum becomes available. Thus, further monitoring and control measures for local and imported propagative materials as well as the continuous assessment of the potential vectors of *X. fastidiosa* are necessary measures to prevent introduction and dissemination of this pathogen in Lebanon.

B16**MOLECULAR CHARACTERIZATION OF SOME STRAINS OF THE BACTERIA *PSEUDOMONAS SAVASTANOI* PV. *SAVASTANOI* ISOLATED FROM SEVERAL HOST PLANTS.**

Maysaa Aljoudi, Randa Abou Tara and Eyhab Ajour, Faculty of Science, Damascus University, Syria, Email: randaaboutara@hotmail.com

Pseudomonas savastanoi pv. *savastanoi* was identified as the causal agent of olive knot disease that affects olive trees, causing great damage that leads to the death of the plant. These bacteria parasitize on other plants as well. In this study, the bacterial strains were isolated from 65 knot samples collected from *Olea europaea*, *Jasminum humile* and *Punica granatum*, from naturally infected trees from the governorates of Damascus, Suweida, Hama, Tartous and Latakia. Identification of the bacterial strains *Pseudomonas savastanoi* pv. *savastanoi* was made by a number of biochemical tests and fluorescent pigment production test on the King B medium. The identity of the bacterial strains of *P. savastanoi* pv. *savastanoi* was confirmed by detection of the virulence genes *ptz*, *Iaal* using PCR technique and a pathogenicity test. Based on these results, the yellow jasmine plant was reported for the first time as a new host for olive knot disease, and confirmed the spread of olive knot disease in Damascus and its countryside. The comparison of the morphology of the knots formed naturally on the three studied plant hosts showed clear differences in the size,

shape, color and number of knots produced on the branches. The strains isolated from pomegranate and jasmine were able to infect olives. The biochemical tests applied and the fluorescent pigment production test on the King B medium were not conclusive in establishing the identity of *P. savastanoi* in our study.

B17

THE CURRENT STATUS OF ASIATIC CITRUS CANCKER CAUSED BY *XANTHOMONAS CITRI* PV. *CITRI* IN SAUDI ARABIA. Yasser E. Ibrahim, Arya Widyawan, Anwar H. Sharafaddin and Mohammed A. Al-Saleh. Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, P.O. Box: 2460, Riyadh, Saudi Arabia, Email: yasereid@ksu.edu.sa

Asiatic citrus canker (ACC) caused by *Xanthomonas citri* pv. *citri* (*Xcc*) is a disease that affects most main varieties of commercial citrus crops in tropical and subtropical areas. ACC was first observed in Saudi Arabia on Mexican lime at the end of 1983, in the Jazan region. Three years later, in 1985, additional observations of the disease were reported on the same citrus species in orchards and several nurseries in the Najran region. The pathogen isolated from these regions at that time was identified as *Xcc* pathotype A*. An eradication campaign was recommended at that time. However, action plans were ineffective, and reports suggested that the disease has continued to spread geographically. In this study, we investigated the distribution of *Xcc* pathotypes in citrus-growing areas of Saudi Arabia. Our results indicated that the two pathogenic variants (A and A*) co-exist in the southwestern region of Saudi Arabia which could facilitate the development of new genetic variants via recombination and horizontal genetic exchange. Our results represent the first report of citrus canker in a commercial nursery in the Hail region, highlighting the necessity for more comprehensive disease monitoring in citrus nursery stocks as part of Hail's ACC prevention efforts.

VIRAL DISEASES & PHYTOPLASMA

V1

DISTRIBUTION OF TOMATO BROWN RUGOSE FRUIT VIRUS AFFECTING TOMATO CROP IN RIYADH REGION, SAUDI ARABIA. Ahmed Sabra^{1,2}, Mahmoud A. Amer^{1,3}, Khadim Hussain^{1,4}, Muhammad Zaman¹, Ibrahim M Al-Shahwan¹ and Mohammed A. Al-Saleh¹. (1) Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Saudi Arabia, Email: asa25@fayoum.edu.eg; (2) Botany Department, Faculty of Agriculture, Fayoum University, Egypt; (3) Viruses and Phytoplasma Research Department, Plant Pathology Research Institute, Agricultural Research Center, Egypt; (4) Department of Bioinformatics and Biotechnology, Government College University Faisalabad Pakistan.

A total of 145 symptomatic tomato leaves and fruits were collected from different locations in Riyadh region, Saudi Arabia during the 2021-2022 growing seasons. Various disease symptoms on tomato plants were reported such as moderate to severe mosaic with dark green wrinkled,

blistering, narrowing and deformation with necrotic spots on tomato leaves. In addition, irregular brown necrotic lesions, deformation, and yellow spots were observed on tomato fruits, making them unmarketable. These samples were tested serologically against suspected important tomato viruses using enzyme linked immunosorbent assay (ELISA) and the results obtained showed that 52.4% of symptomatic tomato samples were found positive to Tomato brown rugose fruit virus (ToBRFV), with twelve out of 76 samples were singly infected, and 64 out of 145 had mixed infection. The host range experiments showed that sixteen out of the tested nineteen plant species were positive to ToBRFV using DAS-ELISA and reverse transcription-polymerase chain reaction (RT-PCR). Total RNA was extracted from selected ELISA positive samples and RT-PCR was carried out using specific primers F-3666 and R-4718 which amplified a fragment of 1052bp. RT-PCR products were sequenced in both directions and partial nucleotide sequences were obtained from selected samples were submitted to GenBank and preserved under the following accession numbers: MZ130501, MZ130502, and MZ130503. BLAST analysis of Saudi isolates of ToBRFV showed that the sequence shared nucleotide identities ranged between 98.99% to 99.50% among them and 98.87-99.87% identity with ToBRFV isolates from different hosts and countries available in the GenBank database. A Saudi Arabian ToBRFV isolate (MZ130503) was selected to evaluate symptoms responses and severity to mechanical inoculation of thirteen commonly grown tomato cultivars in Saudi Arabia. All tomato cultivars tested showed a wide range of symptoms including mosaic, mottling, leaf deformations, leaf narrowing, leaf rolling, blistering and shoestring. Disease severity index of tested cultivars ranged between 52% to 96%.

V2

NUTRITIONAL MANAGEMENT AND PREDICTION OF TOMATO LEAF CURL VIRUS DISEASE.

Muhammad Ahmad Zeshan¹, Muhammad Aslam Khan² and Safdar Ali². (1) Department of Plant Pathology, College of Agriculture, University of Sargodha, Sargodha, Pakistan, Email: Muhammad.ahmad@uos.edu.pk; (2) Department of Plant Pathology, University of Agriculture Faisalabad, Pakistan.

Tomato leaf curl virus disease (TLCVD) is a serious biotic stress for the production of tomato in the tropical and subtropical regions, commonly in South and Southeast Asia. It causes 70-100% crop losses in case of severe attacks. TLCVD is caused by a complex of viruses that are transmitted by grafting and by the whitefly *Bemisia tabaci* (Genn.) in persistent and circulative manner and under natural conditions. As no viricides are available, different insecticides are commonly used for the management of TLCVD. Frequent use of insecticides created serious environmental issues and resistance in insects. In the present study, plants were sprayed with aqueous solution of nutrients and salicylic acid as an eco-friendly approach for the management of TLCV. Furthermore, a disease predictive model was developed based on environmental factors to find out the probability of disease outbreaks. Precise prediction of TLCVD could be helpful in deciding the timely application of treatments. Predictive model for TLCVD

incidence based on two years environmental variables was developed using stepwise regression analysis. The accuracy of developed model was studied by the influence of environmental conditions on TLCVD incidence by comparing the observed disease incidence with those values predicted by multiple regression models. Nutrients and salicylic acid gave significant reduction in TLCVD incidence i.e. 49% and 51%, respectively. A disease predictive model based on 2 years of epidemiological data was developed for the prediction of TLCVD $Y = 0.532 + 0.053x_1 + 0.97x_2 - 0.081x_3 + 0.15x_4 R^2 = 0.85$, where Y = TLCVD incidence, x_1 = Maximum temperature, x_2 = Minimum temperature, x_3 = Relative humidity, x_4 = Rainfall. This would help the farmers to recognize, evaluate and choose proper disease management approaches.

V3

FIRST RECORD OF TOMATO BUSHY STUNT VIRUS (TBSV) AND TOMATO SPOTTED WILT VIRUS (TSWV) ON *RANUNCULUS ASIATICUS* L. IN IRAQ. Hameed Hamoud Ali Kanoo, Department of Plant Protection, College of Agriculture and Forestry, University of Mosul, Iraq, Email: hameedkanoo@yahoo.com

Ranunculus asiaticus L. (Persian buttercup) is one of the ornamental plants native to the eastern Mediterranean region and grows in many regions of the world including Iraq. This plant is used for the production of bulbs in gardening and horticulture or as tuber ornamental plants as well as the production of cut flowers. Viral diseases are among the serious threats to ornamental plants production, especially because these plants are propagated vegetatively, which is a method effectively transmit plant viruses, although the effect of viral infection on the crop has not been carefully evaluated yet. During the 2018/2019 season, a total of 100 samples of *R. asiaticus* were collected from different nurseries located in Nineveh province (Mosul city center). Collected samples showed suspected viral symptoms such as stunting, mosaic or yellow mosaic, deformation, leaves with parsley-like shape, vein yellowing, necrotic spots, petal and stem necrosis and/or premature death of the plants. Several tests were conducted, including mechanical transmission on indicator plants such as cucumber (*Cucumis sativus*) and tobacco (*Nicotiana tabacum*) and serological test DAS-ELISA using polyclonal antibodies of Tomato bushy stunt virus (TBSV) and Tomato spotted wilt virus (TSWV) (Bioreeba, Switzerland). Results showed that mosaic symptoms on leaves and vein-yellowing symptoms appeared one week after inoculation of cucumber plants, whereas mottling symptoms developed on new tobacco leaves 10 days after inoculation. Results of DAS-ELISA confirmed the presence of the two viruses in the tested samples. TBSV was detected in samples that showed symptoms of severe deformation, stunting and mosaic, whereas TSWV was found in samples that showed necrotic spots symptoms and necrosis on both stems and petals. In spite of the wide diversity in symptoms associated with the presence of these viruses, which suggested the possible occurrence of other viruses, results obtained showed a wide distribution of TBSV and TSWV on *R. asiaticus* in Nineveh province. To the best of our knowledge, this is the first record of TBSV and TSWV on *R. asiaticus* in Iraq.

V4

DETECTION OF TOMATO RINGSPOT VIRUS (ToRSV) INFECTION IN HAKKARI PROVINCE OF TURKEY BY REAL-TIME RT-PCR METHOD. Nevin Akdura¹ and Murat Şevik². (1) Hakkari University, Faculty of Education, Department of Mathematics and Science, Hakkari, Türkiye, Email: nevinakdura@hakkari.edu.tr; (2) Mustafa Kemal University, Faculty of Veterinary, Department of Virology, Antakya, Türkiye.

Tomato ringspot virus (ToRSV) belongs to the *Nepovirus* genus in the family *Secoviridae*. ToRSV is positive sense single-stranded RNA (ssRNA) virus and has bipartite genome. This virus has a wide range of plant hosts, and it is in the quarantine list in Turkey. The presence of ToRSV in Turkey was previously reported in different hosts. In this study, 80 leaf samples were collected from different vegetable crops and grapes in districts and city center of Hakkari (southeast corner of Turkey). Viral RNA was isolated by using RNeasy Plant Mini Kit (Qiagen, Germany) according to the manufacturer's instructions. One step real-time reverse transcription polymerase chain reaction (realtime RT-PCR) method was used for detection. Reaction mix included taqman probe, QuantiNova Probe RT-PCR kit (Qiagen, Germany) and a set of primers designed on 3'-UTR (untranslated region) of ToRSV which amplify a 182 bp segment. PV-0049 isolate (DSMZ, Germany) and nuclease pure water were used as positive and negative controls. ToRSV was detected in 13 out of 80 samples (representing 16.25% infection rate). Threshold cycle values (Ct) range was 23.9-37.4. All ToRSV infected samples were collected from several districts in Hakkari, whereas, ToRSV was not detected in the city center of Hakkari. Infected plant species included: pepper and cucumber from Çukurca district, and tomato, pepper, cucumber and grapevine from Şemdinli district. Results obtained encourage the development of programs to produce virus-free planting materials for several crops in the Hakkari region.

V5

POSSIBILITY OF CONVERTING THE FOOD SUPPLEMENT PRODUCED FROM THE FUNGUS *GANODERMA LUCIDIUM* INTO A NANOPARTICLE AND MEASURING ITS EFFICACY IN REDUCING THE EFFECT OF SQUASH MOSAIC VIRUS INFECTION OF ZUCCHINI CROP IN IRAQ. Maath Abdul Wahab Al-Fahad and Amjad Khalaf Zaidan, Department of Plant Protection, Faculty of Agriculture, Tikrit University, Iraq, Email: maadhdft@gmail.com

The study was conducted for the purpose of converting fungus powder of *Ganoderma lucidium* (ngl) into a nanoparticle liquid suspension (nangl) to increase its efficiency in reducing the effects of Squash mosaic virus (SqMV) on zucchini. NGL preparation was compared with *Monascus purpureus* (mp) and *Pseudomonas fluorescens* (pf) preparations. The mixed treatment (nangl+mp+pf) of the above-mentioned biological factors gave a significant effect, and the infection rate (%) with SqMV obtained was 56.94, 75, 75 and 83.3% for mixed treatment (nangl+mp+pf), nangl, mp and pf, respectively. The mixed treatment (nangl+mp+pf) was also better than the rest of the treatments

on other characteristics such as severity of infection, peroxidase enzyme activity and total yield. The cultivar Khatoon responded to stimulation of systemic resistance against virus more than other cultivars (Olivia and Razan), with a stimulus rate of 69, 65 and 57 protein units mg⁻¹, respectively.

V6

THE EFFECT OF TWO STRAINS OF IMPROVED ROOT PLANT GROWTH BACTERIA (PGPR) IN THE SPREAD AND SEVERITY OF INFECTION WITH TOMATO YELLOW LEAF CURL VIRUS (TYLCV) AND ESTIMATION OF SOME GROWTH CRITERIA OF TOMATO PLANTS IN PROTECTED AGRICULTURE. Ensaf Hassan Akel¹, Hanan Kawas¹, Qusay Al-Rhayeh¹ and Imad D. Ismail². (1) General Commission for Scientific Agricultural Research, Lattakia Center, Lattakia, Syria, Email: ensafakel5n4a@gmail.com; (2) Plant Protection Department, Faculty of Agriculture, Tishreen University, Lattakia, Syria.

This study was conducted to evaluate the efficiency of the two strains of plant growth promoting rhizobacteria (PGPR) *Pseudomonas chlororaphis* MA342 (MA), and *Bacillus subtilis* FZB27 (B27) in reducing infection with tomato yellow leaf curl virus (TYLCV) on tomato plants, by estimating the incidence and severity (%) of viral infection, peroxidase enzyme activity and some growth criteria of tomato plants. The experiment was conducted at the Agricultural Scientific Research Center in Lattakia under greenhouse conditions, during the 2018/2019 season. The experimental design followed was the complete randomized design. Bacterial suspensions were applied by treating the seeds, and later on, with root irrigation. Tomato seeds were immersed in suspension of each strain separately at a concentration 9x10⁹ cfu/ml before planting. Furthermore, tomato seedlings were watered after germination and before transplanting using the same bacterial suspension (5ml/seedling). After planting, additional 10ml/plant of bacterial suspension were added. Results indicated that the two bacterial strains could reduce viral infection incidence of treated plants 15-30 days after inoculation, as compared with the control, with a significant difference between the infected control and the treatment with the two bacterial strains, without significant difference between the two strains. The reduction in viral infection rate was 33.34%, using both strains and 15 days after inoculation, but the highest reduction was noticed on plants treated with the F27 strain (16.67%), 30 days after inoculation. In addition, the two strains reduced the severity of viral infection, and the highest reduction was with strain B27 (39.23%). The two bacterial strains increased the activity of the peroxidase enzyme in treated plants, compared to the untreated control. The highest increase was 15 days after inoculation with B27 strain (39.13%), however, 30 days after inoculation with the MA strain it was 204.34%. The two bacterial strains used in this study have increased the growth criteria in treated plants, compared with the untreated controls. By using MA bacterial strain, increase in plant growth parameters was as follows: plant height 39.12%, vegetative dry weight 47.26%, root fresh weight 18.42% and root dried weight 33.64%, as compared with the uninoculated control. Finally, treatments

with bacterial suspension has increased the vegetative fresh and fruit weight by 42.31% and 83.79%, respectively, when B27 strain was used.

V7

ANTAGONISM OF SOIL MICROORGANISMS AGAINST TOMATO MOSAIC VIRUS. Wazeer A. Hassan¹, Nabil A. Kassem² and Viyan J. Haji¹. (1) College of agricultural engineering sciences, University of Duhok, Kurdistan Region, Iraq, Email: wazir.ali@uod.ac; (2) College of agriculture and Forestry, University of Mosul, Iraq.

Tomato mosaic virus (ToMV), contain a coat protein composed of 2140 protein subunits which envelops the RNA genome. ToMV is transmitted by seeds but it does not infect the embryo or the endosperm. This work was conducted in two tomato fields in Duhok Province during October 2018. Fourteen soil samples (1Kg/ Sample) were collected from each field at 15 cm soil depth. The presence of ToMV in six out of 14 soil samples showed a positive reaction in Das-ELISA test (42.8%), whereas it reached 62.5% in irrigation water samples. Total microbial abundance in the contaminated soil exhibited high density of opportunistic fungi (24.33 cfu) during tomato bloom at 25 cm soil depth, 10 days after inoculation, compared to 16.44 and 22.56 cfu, 4 and 7 days after inoculation, respectively. In contrast, the bacterial population was more than 55 cfu when isolated from young plants at 15 cm depth 7 and 10 days after inoculation. Significant densities of actinomycetes were also isolated from young plants at 25 cm depth with 30 and 34 cfu 7 and 10 days after inoculation, respectively. The most important factors influencing the viral decline in soil are pH, temperature and soil moisture. These properties increased with the depth which led to high abundance of soil micro flora at 25 cm depth, particularly of fungi and actinomycetes. Inoculated tomato plants at bloom with each group of soil micro flora (fungi, bacteria and actinomycetes) depressed disease severity by 37%, 24% and 18%, respectively. The potential antagonism against ToMV in the soil showed the highest bacterial and actinomycetes abundance as 38.78 and 10.78 cfu in the soil of young tomato plants 10 days after inoculation, whereas fungal population was similar when isolated at 7 and 10 days after inoculation for both tomato stages.

V8

ENHANCING SYSTEMIC RESISTANCE IN FABA BEAN (*VICIA FABA* L.) TO BEAN YELLOW MOSAIC VIRUS VIA SOIL APPLICATION AND FOLIAR SPRAY OF NITROGEN-FIXING *RHIZOBIUM LEGUMINOSARUM* BV. *VICIAE*. Ahmed Abdelkhalek, Plant Protection and Biomolecular Diagnosis Department, ALCRI, City of Scientific Research and Technological Applications, Alexandria, Egypt, Email: abdelkhalek2@yahoo.com

Rhizobium sp. manifests strong nitrogen fixation ability in legumes; however, their significance as biocontrol and antiviral agents has rarely been investigated. Under greenhouse conditions, the molecularly identified nitrogen-fixing plant growth-promoting rhizobacteria, *Rhizobium leguminosarum* bv. *viciae* strain 33504-Alex1, isolated from

the root nodules of faba bean plants, was tested as a soil inoculum or a foliar application to trigger faba bean plants resistance against Bean yellow mosaic virus (BYMV) infection. Compared to the non-treated faba bean plants, the applications of 33504-Alex1 in either soil or foliar application significantly promoted growth and improved total chlorophyll content, resulting in a considerable reduction in disease incidence and severity as well as the accumulation level of BYMV particles in the treated faba bean plants. Furthermore, the protective activities of 33504-Alex1 were associated with significant reduction in non-enzymatic oxidative stress markers (H_2O_2 and MDA) as well as remarkably increased DPPH free radical scavenging activity and total phenolic content compared to the BYMV treatment at 20 days post-inoculation. Additionally, an increase in reactive oxygen species scavenging enzymes (SOD, CAT, and PPO) as well as induced transcriptional levels of pathogenesis-related proteins (PR-1, PR-3, and PR-5) were observed. Of the 19 polyphenolic compounds detected in faba bean leaves by HPLC analysis, gallic and vanillic acids were completely shut down in the BYMV treatment. Interestingly, the 33504-Alex1 treatment was associated with the induction and accumulation of the most detected polyphenolic compounds. Gas chromatography-mass spectrometry (GC-MS) analysis showed that hexadecanoic acid 2,3-dihydroxypropyl ester, tetraeurin-A-Diol, oleic acid, and isochiapin B were the major compounds in 33504-Alex1 culture filtrate ethyl acetate extract, suggesting it acts as an elicitor for the induction of systemic acquired resistance in faba bean plants. Consequently, the capacity of *R. leguminosarum* bv *viciae* strain 33504-Alex1 to enhance plant growth and induce systemic resistance against BYMV infection will support the incorporation of 33504-Alex1 as a biological fertilizer agent and provide a new strategy for crop protection and sustainability, and environmental safety in agriculture production.

V9

A REVIEW ON THE NOVEL DISCOVERIES OF BEGOMOVIRUSES IN OMAN. Muhammad Shafiq Shahid, Department of plant sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University, Al-Khod 123, Oman, Email: mshahid@squ.edu.om

Begomoviruses (family; *Geminiviridae*) consist of viruses with single-stranded (ss) and circular genome particles. They are transmitted by whiteflies, and represent a major constraint to agricultural crops in different parts of the world. In Oman, they have been causing huge losses to crops (tomato, cucumber, watermelon and beans). Research on begomoviruses in Oman over the past few years focused on molecular characterization, phylogenetic relationship, recombination analysis, pathogenicity test on model and host plants and the development of transgenic resistant plants to these viruses. Some studies focused on the association of satellite DNA (alphasatellite and betasatellite) molecules with begomoviruses. This review highlights the latest developments in begomovirus and associated satellite DNAs discovered in Oman over the last three decades. This period encountered changes in agricultural practices and developments in virus detection technologies from

morphological to the application of genome diagnostics to the emergence of high throughput DNA sequencing, capable to sequence multiple and diverse DNA molecules in parallel, enabling of millions of DNA molecules to be sequenced at a time. In addition, several tomato cultivars carrying different Ty genes of resistance to TYLCD complex were developed.

V10

SANITARY STATUS OF STONE FRUITS IN PALESTINE. Raed Alkowni¹, Imad Mohammad¹, Amina Mansour¹, Dina Najami¹, Duha Mousa¹, Riham Awad¹, Rasha Attawnah¹, Suad Aqqad¹, Tasneem Abdulkareem¹, Osama Alabdalla², MedhatWildAli² and Ala Lahlouh². (1) Department of Biology and Biotechnology, Nablus, Palestine, Email: ralkowni@najah.edu; (2) National Agricultural Research Center (NARC), Jenin, Palestine.

Stone fruits are one of the most rapid developing cultures worldwide and is a promising crop in Palestine. Even though they are still facing many challenges, and plant health is among them. This study focused on assessing the sanitary status of stone fruits addressing the diseases induced by intracellular infectious agents such as viruses that indeed represent a major threat to stone fruit industry as some of stone fruits viral diseases are considered quarantine agent. For that purpose, several field surveys and samples collection were carried out during two consecutive years 2018 and 2019 in ten governorates: Tubas, Jenin, Nablus, Tulkarem, Qalqilia, Hebron, Bethlehem, Ramallah, Jericho and Salfeet. The inspected stone fruit trees were tested in the lab using molecular (RT-PCR) and/or serological diagnostic (ELISA). techniques for the detection of any of the following viruses: Apple chlorotic leaf spot virus (ACLSV, genus *Trichovirus*, family *Betaflexiviridae*), Plum pox virus (PPV, genus *Potyvirus*, family *Potyviridae*), Prunus necrotic ring spot virus (PNRSV, genus *Illarvirus*, family *Bromoviridae*), American plum line pattern virus (APLPV, genus *Illarvirus*, family *Bromoviridae*), Apple mosaic virus (ApMV, genus *Illarvirus*, family *Bromoviridae*), Prune dwarf virus (PDV, genus *Illarvirus*, family *Bromoviridae*), Apricot latent virus (ApLV, genus *Foveavirus*, family *Betaflexiviridae*), Plum bark necrosis stem pitting-associated virus (PBNsPaV, genus *Ampelovirus*, family *Closteroviridae*). Field surveys and inspections for the detection of virus and other diseases that produce symptoms suggestive of virus infection such as. yellow spot, necrotic spot, shot hole, leaf curl, marginal leaf necrosis, shortened internodes, bushy appearance, discoloration and yellow mosaic of leaves. Almost one thousand samples were collected from all districts and tested individually for the presence of any of the above-mentioned viruses. The results showed 28.5% of the samples were positive for PNRSV. Positive ELISA result for viral disease was found in all tested districts. The level of viral infection was highest in the northern districts. Virus infection rates were 50, 43.8, 32, 27.7, 18.2, 17.6, 14.3 and 9%, in Nablus, Tulkarem, Tubas, Jenin, Ramallah, Hebron, Bethlehem and Salfeet districts, respectively. ACLSV tests showed low level of virus infection (3%); whereas only 1.6% were positive for ApLV. None of other viruses were tested positive in all fields surveyed. The survey concluded that the sanitary status of stone fruits with respect to viral infection was lower than that reported in neighboring countries. Even

though it is still higher than most countries of the Mediterranean. The study recommended the need for a certification program to prevent spread of detected viruses. In addition, it was recommended to maintain the stone fruits collection at NARC virus-free as a credible source for propagation materials.

V11

STOLBUR-BOIS NOIR IN THE NEAR-EAST: *CONVOLVULUS ARVENSIS* BINDWEED AND THE PLANTHOPPER VECTOR *HYALESTHES OBSOLETUS* HOST LOCAL 'CANDIDATUS PHYTOPLASMA SOLANI' STRAINS IN EGYPT AND LEBANON. Pascal Salar¹, Yasmen El-Sisi², Fouad Jreijiri³, Christina Mortada³, Jean-Luc Danet¹, Ayman Faisal Omar², Elia Choueiri³ and Xavier Foissac¹. (1) INRAE, University of Bordeaux, UMR BFP, 71 avenue Edouard Bourlaux CS20032, F-33882 Villenave d'Ornon, France, Email: xavier.foissac@inrae.fr; (2) Department of Plant Pathology, Plant Pathology and Biotechnology Laboratory, Faculty of Agriculture, Kafrelsheikh University, 33516 Kafrelsheikh, Egypt; (3) Department of Plant Protection, Lebanese Agricultural Research Institute, Tal Amara, P.O. Box 287, Zahlé, Lebanon.

In surveys for phytoplasma diseases in vegetable and grapevine in Egypt and Lebanon, '*Candidatus Phytoplasma solani*' was detected in diseased potato plants in northwestern Egypt and in grapevine in the Bekaa valley of Lebanon. Genotyping through sequencing the variable gene *stam* mainly revealed the presence of new '*Ca. P. solani*' genotypes *stam8* and *stam14* in Egypt and Lebanon, respectively. A '*Ca. P. solani*' strain related to strains found in western Europe was also detected in an Egyptian potato field seeded with tubers imported from Europe. Survey of wild plant reservoir and potential planthopper vectors led to the detection of '*Ca. P. solani*' genotype *stam8* in the field bindweed *Convolvulus arvensis* and in *Hyalesthes obsoletus* populations collected from this plant in two Egyptian governorates and of '*Ca. P. solani*' genotype *stam14* in *C. arvensis* and *H. obsoletus* in Bekaa valley. This data suggests that the local propagation of '*Ca. P. solani*' through an epidemiological cycle involving bindweed reservoir hosts and *H. obsoletus* planthopper vectors, is similar to what is happening in most of the European countries. Nevertheless, the European and Near-East epidemiological systems were different in two ways. First, the Egyptian '*Ca. P. solani*' strain corresponded to a *tufB2* genotype, a genotype spreading from *U. dioica* stinging nettles plant reservoir in Central Europe. Second, tomato plants which are common dead-end hosts for '*Ca. P. solani*' in Europe and Asia Minor were not found infected with '*Ca. P. solani*' in either Egypt or Lebanon. Instead, diseased tomato displaying stunting, proliferations, small purplish leaves and abnormal hypertrophic calyxes (big bud) turned out to be infected with '*Ca. P. australasiae*' in Egypt and '*Ca. P. trifolii*' in Lebanon. This suggests either a disconnection between adult vector flight and tomato plantations or difference in feeding behavior among *H. obsoletus* populations.

V12

'CANDIDATUS PHYTOPLASMA OMANENSE' AS AGENT OF GRAPEVINE YELLOWS IN LEBANON: INFECTED *CONVOLVULUS ARVENSIS* BINDWEEDS MAY ACT AS RESERVOIR AND THEY ALSO HOST INFECTED POLYPHAGOUS POTENTIAL VECTORS. Xavier Foissac¹, Fouad Jreijiri², Pascal Salar¹, Samer Wakim², Jean-Luc Danet¹ and Elia Choueiri². (1) INRAE, University of Bordeaux, UMR BFP, Villenave d'Ornon, France; (2) Department of Plant Protection, Lebanese Agricultural Research Institute, Tal Amara, Zahlé, Lebanon, Email: echoueiri@lari.gov.lb

"Bois noir" (BN) phytoplasma disease of grapevine is considered as one of the most economically important grapevine yellows (GY) in the Mediterranean area and is common in Lebanese vineyards. During an investigation on BN spread carried out in June 2014 in Mansoura municipality of West Bekaa, Lebanon, a phytoplasma related to '*Candidatus Phytoplasma omanense*' was detected in a grapevine sample of cultivar Syrah, showing leaf scorch and discoloration. The phytoplasma was detected using a phytoplasma universal nested-PCR and identified through sequencing of the 1.2 kbp 16S rDNA amplicon. In spring 2015, surveys were undertaken to collect *Convolvulus arvensis* bindweeds and specimens of *Hyalesthes obsoletus* and *Reptalus* spp. Cixiidae planthoppers which are known as BN plant reservoir and BN insect vector, respectively. Bindweeds displaying stunting and color alterations as well as symptomless controls were collected from various locations in West Bekaa. In addition to '*Ca. P. solani*' the agent of BN that was detected in all locations, the '*Ca. P. omanense*' related strain previously detected in grapevine was detected in the diseased bindweeds as well as in *H. obsoletus* and *Reptalus* sp. specimens in Aammiq municipality of West Bekaa. None of the symptomless plants produced the expected amplicon. In order to discriminate this phytoplasma from '*Ca. P. solani*' and '*Ca. P. phoenicium*' which are prevalent in the Bekaa region, a 16S rDNA RFLP assay was designed. To the best of our knowledge, this is the first report of '*Ca. P. omanense*' detected in grapevine and in Cixiidae planthoppers already known to host and vector '*Ca. P. solani*' strains associated with BN disease in grapevine, respectively. Based on these results, further accurate surveys of phytoplasmas associated with grapevine yellows in the Eastern Mediterranean basin are required to prevent the spread of '*Ca. P. omanense*'. As the ecological cycle of this phytoplasma certainly involves a common weed as reservoir and polyphagous insects as vectors, it may represent a potential new threat to Euro-Mediterranean agriculture.

V13

DETECTION AND DIFFERENTIATION OF PHYTOPLASMA IN SULTANATE OF OMAN. Ali M. Al-Subhi, Rashid A. Al-Yahyai and Abdullah M. Al-Sadi, Department of Plant Sciences, Sultan Qaboos University, Al Khod, Sultanate of Oman, Email: alsubhia@squ.edu.om

Extensive field survey in the last 30 years in Oman has yielded more than 25 host plants infected with phytoplasma. These hosts include wild and cultivated plant species such as lime, alfalfa, sesame, chickpeas, radish,

carrot, tomato and eggplant. Observed disease symptoms included witches' broom, stunting, phyllody, virescence and yellowing. Molecular techniques were adopted for identifying diseases caused by phytoplasmas. Typical symptoms of phytoplasma-infected lime (*Citrus aurantifolia*) showing witches' broom (LWB) were first reported in Oman during the 1970's. Based on RFLP and sequence analyses of 16S rDNA and other phytoplasma genes, phytoplasmas in Oman are grouped into six different phytoplasmas: 16SrII-B phytoplasma (*Candidatus Phytoplasma aurantifolia*), 16SrII-D phytoplasma, 16SrII-W phytoplasma, 16SrXXIX-A phytoplasma (*Candidatus Phytoplasma omanense*), 16SrVI-A phytoplasma and 16SrIX phytoplasma. The majority of these phytoplasmas belong to the 16SrII group, especially the 16SrII-D subgroup, as the widely spread group in Oman. Occurrence of all these groups have been reported from several host plants. The infection of non-crop plants, as well as native wild plant species, along with cultivated crop plants have increased the genetic diversity of phytoplasmas in Oman during the last 15 years. Unfortunately control and management strategies of phytoplasma diseases in Oman is hampered by the shortage and lack of information about vectors.

V14

PREVALENCE AND GENETIC DIVERSITY OF GRAPEVINE LEAFROLL-ASSOCIATED VIRUS-3 IN TUNISIAN GRAPEVINES. Ilhem Selmi, Amal Najahi and Naima Mahfoudhi, Laboratory of Plant Protection, National Institute of Agronomic Research of Tunisia (INRAT), El Menzah, Tunis, Tunisia, Email: ilhemselmi@hotmail.com

Grapevine leafroll disease (GLD) represents one of the most important grapevine diseases in the world. It is caused by a complex of five viruses that are named Grapevine leafroll-associated virus -1, -2, -3, -4 and -7 (GLRaV-1, -2, -3, -4 and -7), all members of the family of *Closteroviridae*. GLRaV-3, the type specie of the genus *Ampelovirus*, represents the most widespread in this group. Since, grapevine is one of the most important traditional crops in Tunisia, with a cultivated area of about 21500 ha (10000 ha of wine grapes and 11500 ha of table grapes), its protection against all phytosanitary problems that may arise, represents a priority for Tunisian viticulture. In order to provide more information about the prevalence and genetic diversity of GLRaV-3 in Tunisian grapevines, a total of 364 samples from wine (58) and table (128) grape varieties, rootstocks (38), autochthonous cultivated (77) and wild (63) grapevines, were tested by RT-PCR using specific primers. The study of its genetic diversity was carried out using Single Strand Conformation Polymorphism (SSCP) and sequencing of the CP gene fragment. The molecular results revealed the presence of GLRaV-3 in 39.3% of tested samples. According to grapevine typology, wine grapes were the most infected with an infection rate of 77.6%, followed by rootstocks (52.6%) and table grapes (37.5%). Autochthonous grapevine varieties were relatively less infected showing infection rates of about 35%. With an infection rate of 4.8%, wild grapes showed the least incidence. SSCP and sequencing showed an important genetic diversity among Tunisian isolates of GLRaV-3.

V15

SANITATION OF A LOCAL TUNISIAN GRAPEVINE CULTIVAR AND STUDYING OF SOME PARAMETERS OF 10 YEARS SANITIZED SOMACLONAL PLANTS. Badra Bouamama-Gzara¹, Mariam Ben Romdhane¹, Hassene Zemni¹, Arezki Lehad² and Naima Mahfoudhi³. (1) Center of Biotechnology of Borj-Cedria, Laboratory of Plant Molecular and Physiology, Hammam-Lif, 2050, University of Carthage, Tunisia, Email: badra_bouamama@yahoo.com; (2) Laboratoire de Phytopathologie et Biologie Moléculaire, Ecole Nationale Supérieure d'Agronomie, Rue Hacen Badi, Belfort, El Harrach, 16000 Alger, Algeria; (3) Laboratory of Plant Protection, National Institute of Agronomic Research of Tunisia, Rue Hedi Karray, 2049 El Menzah, University of Carthage, Tunisia

Tunisia is in possession of a great diversity of local grapevine cultivars. However, they are seriously affected by viral diseases. In fact, Grapevine leafroll associated virus-3 (GLRaV-3), Grapevine stem pitting associated virus (GRSPaV) and Grapevine virus A (GVA), were detected in cv. Hencha using serological and molecular analyses. Somatic embryogenesis (SE) was employed as a sanitation technique for virus elimination. SE technique allowed the elimination of the 3 viruses from all the tested somaclonal plants. The phenotypic profile of somaclonal plants was compared to the donor plant based on 30 OIV descriptors. The healthy state of 100% 'Hencha' somaclonal plants and the high percentage of phenotypically true-to-type plants demonstrated that SE is a promising technique to be adopted for grapevine sanitation. In addition, inter simple sequence repeat (ISSR)-PCR analysis was also employed to characterize the genotypes at the DNA level. Results obtained allowed the detection of high level monomorphism that confirmed the strong genetic stability despite of the *in vitro* culture conditions followed. On the other hand, transversal stem sections were explored during the environmental scanning electron microscope (ESEM) analysis to evaluate xylem vessels morphology of both somaclonal plants and the mother plant. Results indicated that somaclones xylem vessels were not obstructed by vascular occlusions. In contrast, mother plant showed significant blocked vessels. Furthermore, analysis of several physiological variables including transpiration, stomatal conductance, ABA concentration in the xylem sap and pH values indicated a significant difference between sanitized somaclonal plants and donor plant. Results confirmed the sensitivity of the infected Hencha donor plant. Whereas, sanitized somaclonal plants were better adapted because of the absence of viral diseases.

V16

THE CITRUS CERTIFICATION PROGRAM IN TUNISIA. Nebiha Metoui¹, Fethia Dhaouadi¹, Dorsaf Yahiaoui¹, Malika Meziane² and Asma Najar³. (1) Centre Technique des Agrumes (CTA), B.P.N°318, Zaouiet Jedidi 8099, Tunisie, Email: nabihabsaies@yahoo.fr; (2) Laboratoire Production et Protection des Cultures dans la région de Chlef. Université Hassiba Benbouali de Chlef, B.P 78C, Ouled Fares Chlef 02180 Algérie; (3) Institut National

de la Recherche Agronomique de Tunisie, 43 Avenue Hedi Karray, 2049 Tunis, Tunisie.

The Tunisian citrus certification program for sanitary improvement and production of healthy plants free from virus and virus like diseases started in 1994 and has the following objectives: a) virus sanitation of the local varieties by shoot-tip grafting *in vitro* (STG); b) introduction of foreign varieties from the San Giuliano Agricultural Research Station (INRA- IRFA, Corsica); c) introduction of new rootstocks tolerant to Tristeza such as *Citrus volkameriana*, *Citrumelo swingle* and *Citrango carrizo*. The organization and the steps of this program were established according to the Tunisian law of plant certification. This law has put the rules of sanitation controls that guarantee production of virus free certified plants mainly from *Citrus tristeza virus*, *Citrus psorosis virus*, virus like diseases (Impetratura, concave gum, blind pocket), *Citrus stubborn disease* caused by *spiroplasma citri* and viroids (mainly *Citrus exocortis viroid* and *Cahexia citrus viroid*). Healthy mother plants are conserved under screen-house and multiplied in order to obtain pre-basic and basic material that is delivered to nurseries. Since its establishment, this certification program allowed the sanitation of 18 local and 17 imported varieties. Nurseries are assisted and supplied with about 4000 basic plants grafted on tristeza tolerant rootstocks for the production of certified seedlings.

V17

THE SILENCING VECTOR BEAN POD MOTTLE VIRUS BREAKS RSV3-MEDIATED EXTREME RESISTANCE AGAINST SOYBEAN MOSAIC VIRUS. Mazen Alazem, Kristin Widyasari, John Bwalya and Kook-Hyung Kim, College of Agriculture and Life Sciences, Seoul National University, Seoul, Korea, Email: m.alazem@gmail.com

Studies on functional genomics necessitate the use of silencing vectors such as Bean pod mottle virus (BPMV) vector. Soybean cultivar L29, which carries the resistance gene *Rsv3*, exhibits extreme resistance (ER) against the G5H avirulent strain of Soybean mosaic virus (SMV), but not against the virulent G7H strain. This resistance is attributed to the induction of abscisic acid (ABA), the antiviral RNA silencing pathway, and callose deposition. In attempt to silence few genes important for ER in L29 plants, BPMV vector was employed. BPMV vector, however, highly induced the expression of many genes in the salicylic acid (SA) and the RNA silencing pathways in the control plants compared with the healthy untreated plants. *Rsv3* expression was reduced after BPMV infection, whereas genes involved in the ABA pathway remained unregulated in all soybean lines. Inductions of SA and RNA silencing genes were moderate in lines carrying *Rsv1* and *Rsv4* plants, and weak in *rsv*-null soybean plants. BPMV renders L29 plants more susceptible to G7H infection compared to untreated plants, but more interestingly, BPMV breaks the *Rsv3*-mediated ER of L29 against G5H allowing the latter to accumulate locally but not systemically. The coat protein large unit (CPL) of BPMV exhibited VSR activity in *Nicotiana* plants, and when CPL was expressed within the G5H genome, the latter accumulated locally but not systemically. Our findings suggest that the BPMV silencing vector breaks part of the

Rsv3-mediated ER against the SMV avirulent strain by impairing the antiviral RNA silencing pathway, and triggers SA-related defence in plants with antiviral *R*-genes. It can be also suggested that BPMV silencing vector might not be a useful tool to study plant-virus interactions, and that such observation might also occur for other similar viral vectors.

V18

VIRUSES CAUSING YELLOWING AND STUNTING SYMPTOMS IN CHICKPEA AND APPLYING INTEGRATED ECO-FRIENDLY APPROACHES FOR ITS EFFECTIVE CONTROL IN SYRIA. Nader Y. Asaad¹, Safaa G. Kumari², Amin A. Haj Kassem³, Abdul Rahman Moukahel² and Ertayad Y. Essa¹. (1) General Commission for Scientific Agricultural Research (GCSAR), Al-Ghab, Hama, Syria, Email: asaad_nader@yahoo.com; (2) International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beqa'a Valley, Zahle, Lebanon; (3) Department of Plant Protection, Faculty of Agriculture, Aleppo University, Aleppo, Syria

Chickpea (*Cicer arietinum* L.) ranks third among the pulse crops that attribute to global food security. Viruses that cause yellowing and stunting symptoms are considered a main threat to chickpea production worldwide. Currently, there is a great interest in applying eco-friendly smart technologies to achieve best control results. Results of serological [Tissue blot immunoassay (TBIA)] and molecular assays [Reverse transcription-polymerase chain reaction (RT-PCR)] used in field surveys carried out during four growing seasons (2006, 2007, 2017 and 2018) in chickpea fields, revealed that the polerovirus *Chickpea chlorotic stunt virus* (CpCSV) was dominant in all seasons. Thus, the objective of this study was to identify practices to reduce the effect of viruses causing yellowing and stunting of chickpea under Syrian ecology. This approach included screening 80 chickpea genotypes for virus resistance (obtained from ICARDA Gene Bank under open field conditions). To reduce virus incidence in the field several practices such as planting date, plant density, locations, cultivars (Ghab-3, Ghab-4, Ghab-5, promising variety FLIP95-65C and susceptible variety JG62), as well as intercropping between chickpea and other crops like flax (*Linum usitatissimum*), black cumin (*Nigella sativa*) and coriander (*Coriandrum sativum*) were evaluated. Results revealed that few chickpea genotypes (such as IG9000, IG69434, IG69656, IG69693, IG71832 and IG128651) were found resistant/tolerant for CpCSV and it could be used as a resistance source in chickpea breeding programs. Virus infection was decreased around 50-80% and crop yield was increased by 5-35% with high significant differences when chickpea was planted during the first half of December with plant density of 20-30 plants/m². In addition, yield was improved with low virus infection when chickpea was intercropped with flax in alternate lines or with coriander (1 line of coriander each 5-6 chickpea lines). Generally, the results confirmed the importance of the interaction between a number of practices which together formed an integrated system that influenced virus spread and can be considered a potential approach for sustainable virus diseases management.

V19

COMPARISON OF SEROLOGICAL AND MOLECULAR METHODS FOR DIAGNOSIS OF VIRUSES CAUSING YELLOWING AND STUNTING SYMPTOMS FOR THE PULSE CROPS. Abdul Rahman Moukahel¹, Safaa G. Kumari¹, Abdelmagid Adlan Hamed² and Murray Sharman³.

(1) International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beqa'a, Zahle, Lebanon, Email: a.moukahel@cgiar.org; (2) Agricultural Research Corporation (ARC), Wad Medani, Sudan; (3) Department of Agriculture and Fisheries, Brisbane, Queensland, Australia.

The diagnosis of plant viruses that belong to the families *Solemoviridae* and *Tombusviridae*, which cause yellowing and stunting symptoms, is very complicated due to the serological cross-reactivity among these viruses. The main objective of this research was to study the efficiency of serological assays (tissue-blot immunoassay-TBIA) using specific monoclonal antibodies (MAbs) versus molecular assays (RT-PCR and sequencing) using generic and specific primer pairs. Legume samples (faba bean, chickpea and lentil) were collected from five different geographic regions: Ethiopia (11 samples), Lebanon (8 samples), Morocco (5 samples), Sudan (33 samples) and Uzbekistan (34 samples). All these samples reacted positively by TBIA with one or more MAbs and amplified by one or more primer pairs by RT-PCR. The comparison of serological with molecular results revealed the similarity between detection methods for both Bean leafroll virus (BLRV) and Soybean dwarf virus (SbDV) (both belong to genus *Luteovirus*, family *Tombusviridae*), as BLRV was detected in samples from Uzbekistan, and SbDV was detected in samples from Ethiopia and Uzbekistan only. On the other hand, the results of the serological and molecular methods for the virus species that belong to the genus *Polerovirus* (family *Solemoviridae*) were not comparable, especially in the samples collected from Sudan and Uzbekistan, as a number of samples collected from the five countries reacted positively with specific MAbs of Beet western yellows virus (BWYV) and Chickpea chlorotic stunt virus (CpCSV), but CpCSV and BWYV were identified only molecularly in the samples collected from Ethiopia, Lebanon and Morocco. Based on the nucleotide sequences obtained, new virus species that belong to the genus *Polerovirus* was identified in the samples collected from Sudan and Uzbekistan [e.g. Cucurbit aphid-borne yellows virus (CABYV) and Cotton leafroll dwarf virus (CLRDV)], and CpCSV was not identified molecularly in the samples from Uzbekistan or Sudan, in spite of the fact that a number of samples did react serologically with CpCSV MAb. The results obtained clearly showed that molecular assays are essential along with serological assays for more accurate and specific identification of *Solemoviridae* members, which is highly needed for the development of management strategies based on virus vector control and breeding for virus diseases resistance.

V20

TRANSMISSION OF CUCUMBER MOSAIC VIRUS SUBGROUP IA ON PEPPER BY MAJOR APHID SPECIES IN CAP BON REGION. Wafa Khaled Gasmi^{1,2},

Rebha Souissi¹ and Sonia Boukhris-Bouhachem¹. (1) Plant Protection Laboratory, National Institute of Agricultural Research of Tunisia (INRAT), University of Carthage, Ariana, Tunisia, Email: wafakhaled@hotmail.fr; (2) Plant Protection Department, National Institute of Agronomy of Tunisia (INAT), University of Carthage, Tunis, Tunisia.

The transmission efficiency of Cucumber mosaic virus by the most abundant aphid species in pepper fields in Cap bon region on pepper plants was studied for the first time in Tunisia. Aphid identification was achieved by morphological criteria and double-checked by Cytochrome Oxidase I (COI) gene barcoding for ambiguous taxa. Twelve identified aphid species were found frequent: *Myzus persicae* Sulzer, *Aphis gossypii* Glover, *Aphis fabae* solanella Theobald, *Aphis spiraeicola* Patch, *Acyrtosiphon pisum* Harris, *Metopolophium dirhodum* (Walker), *Rhopalosiphum maidis* Fitch, *Aphis craccivora* Koch, *Aphis nerii* Fonscolombe, *Hyalopterus pruni* (Geoffroy), *Sitobiona avenae* (Fabricius) and *Rhopalosiphum padi* (Linnaeus). In addition, a CMV isolate was characterized based on the Coat Protein (CP) gene in the subgroup IA. This isolate was maintained on pepper plants by mechanical transmission and transmission trials were performed under controlled laboratory conditions. Interestingly, the twelve aphid species were able to transmit the CMV isolate with significantly different rates. Indeed, the most efficient aphids were *M. persicae* (60%) and *A. f. solanella* (50%). In addition, *A. gossypii* (40%) and *A. pisum* (40%) has a significant transmission potential. *A. spiraeicola* (23.33%) and *R. maidis* (23.33%) had reasonable ability to vector the virus, whereas *A. craccivora* (20%), *H. pruni* (16.67%), *A. nerii* (13.33%), *M. dirhodum* (10%) and *S. avenae* (6.67%) had less transmission efficiencies. Lastly, the least transmission rate was noted for *R. padi* (3.33%). This research leads to a better knowledge of the epidemiology of CMV on pepper.

V21

THE MOST IMPORTANT FACTORS WHICH INFLUENCE THE EPIDEMIOLOGY OF POTATO VIRUS Y (PVY) IN POTATO FIELDS IN ALGERIA. Linda Allala-Messaoudi¹, Laurent Glacis^{2,3}, Mohamed Kerkoud⁴, Sonia Boukhris-Bouhachem⁵ and Zouaoui Bouznd¹.

(1) Laboratoire de Phytopathologie et de Biologie Moléculaire- Département de Botanique- École Nationale Supérieure Agronomique, El-Harrach, Algiers, Algeria, Email: lallala@ensa.dz; (2) FN3PT/RD3PT, 43-45 rue de Naples, 75008 Paris, France; (3) IGEPP, Agrocampus Ouest, INRA, Université de Rennes 135650 Le Rheu, France; (4) Diag-gen, 8 Rue Le Notre, 79066 Angers, France; (5) INRAT, Laboratoire de Protection de Protection des Végétaux, rue Hedi Karray, 2049 Tunis, Ariana, Tunisia.

Limited data are available on the spread of potato viruses in Algeria. Accordingly, field surveys were carried out for three growing seasons from 2013 to 2016. Field inspections showed that a wide variation of symptoms were observed on potato plants in the main producing regions of Algeria. A total of 285 potato leaf symptomatic samples were collected and tested by DAS-ELISA to determine the relative prevalence of five major viruses: Potato virus Y (PVY), Potato leaf roll virus (PLRV), Potato virus X (PVX), Potato virus A (PVA), and Potato virus S (PVS). The results

obtained showed that a higher relative incidence of PVY was observed (93%) compared to other viruses. Two potential factors contributing to this infection have been studied in the region of Ain Defla, traditionally produces seed potato. These factors are aphids and weeds in and surrounding the potato crop. Under laboratory conditions, six aphid species were found to transmit PVY; *Myzus persicae* had the highest rate with a preference for a particular PVY^{NTN} strain that is most dominant in potato fields and is responsible for the tuber annular necrosis, a very serious disease because it leads to poor potato crop quality. Weeds also seem to play an important role in the conservation of the virus. 26 weed species mainly belong to the families *Asteraceae*, *Chenopodiaceae* and *Solanaceae* were identified and tested by DAS-ELISA. Results revealed the presence of PVY with the dominance of the PVY^N strain (36.41%), especially on *Solanum nigrum* and *Chenopodium* sp.

V22

CHARACTERIZATION OF PEPPER LEAFROLL CHLOROSIS VIRUS, A NEW POLEROVIRUS CAUSING YELLOWING DISEASE OF BELL PEPPER IN SAUDI ARABIA. A. Kamran¹, M.A. Amer^{1,2}, L. Lotos³, I.M. Shahwan¹, N.I. Katis³ and M.A. Al-Saleh¹. (1) Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia, Email: malsaleh@ksu.edu.sa; (2) Viruses and Phytoplasma Research Department, Plant Pathology Research Institute, Agricultural Research Center, Egypt; (3) Aristotle University of Thessaloniki, School of Agriculture, Forestry and Natural Environment, Faculty of Agriculture, Plant Pathology Lab, Thessaloniki 54124, Greece.

During the growing seasons 2014-2016, a total of 336 leaf samples were collected from bell pepper (*Capsicum annuum*) showing leafroll and interveinal yellowing and arable weeds grown close to the pepper crop from Riyadh region, Saudi Arabia. RT-PCR test, confirmed the presence of poleroviruses in the bell pepper samples. Sequencing of the generic amplicon revealed high similarity (87.6-98.1% in nt) with four poleroviruses; Tobacco vein distorting virus (TVDV), Pepper vein yellows virus (PeVYV), Pepper yellows virus (PeYV) and Pepper yellow leaf curl virus (PYLCV). To further characterize one of these isolates, a larger part of the genome (~1300 nt) spanning from RdRp to the middle of CP region was amplified and sequenced, exhibiting low similarity in amino acids and nucleotides in the CP and MP genes, with other poleoviruses deposited in GenBank. This divergence lead to the use of Next Generation Sequence (NGS) from which the partial genome (5496 nt) of isolate 105D was reconstructed and revealed the presence of a divergent polerovirus genome assembly tentatively named as Pepper leafroll chlorosis virus (PeLRCV). Using a specific RT-PCR assay for this isolate confirmed the presence of this new viral species in the symptomatic peppers. Aphid transmission experiments showed that PeLRCV is vectored by *Aphis gossypii* and that it can infect at least five out of the 15 different plants species tested. Based on our findings, PeLRCV is a new member of the genus *Polerovirus* in the family *Solemoviridae*.

V23

CHARACTERIZATION OF LETTUCE BIG-VEIN ASSOCIATED VIRUS AND MIRAFIORI LETTUCE BIG-VEIN VIRUS INFECTING LETTUCE IN SAUDI ARABIA. M. Umar¹, M.A. Amer^{1,2}, I.M. Al-Shahwan¹, N.I. Katis³ and M.A. Al-Saleh¹. (1) Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Saudi Arabia, Email: malsaleh@ksu.edu.sa; (2) Viruses and Phytoplasma Research Department, Plant Pathology Research Institute, Agricultural Research Center, Egypt; (3) Aristotle University of Thessaloniki, Faculty of Agriculture, Forestry and Natural Environment, School of Agriculture, Lab of Plant pathology, 54124 Thessaloniki, Greece.

Lettuce big-vein associated virus (LBVaV) and Mirafiori lettuce big-vein virus (MiLBVV) were discovered associated with lettuce big-vein disease in Saudi Arabia. During the 2014 and 2015 growing seasons, 97 lettuce and 7 weed plants that showed vein clearing, stunting, deformed leaves and thickening of the main veins were collected from the Oaynah area, Riyadh region, Saudi Arabia. Double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) results revealed that 25% of the lettuce plants were infected only with LBVaV, 9% were infected only with MiLBVV and 63% had mixed infection with both viruses. The presence of LBVaV and MiLBVV on selected positive samples was confirmed by multiplex reverse transcriptase-polymerase chain reaction (RT-PCR) using specific primers. Dot blot hybridization confirmed the DAS-ELISA results for lettuce field samples and host range experiments. The nucleotide sequence identity for the selected Saudi Arabian isolates of LBVaV and MiLBVV ranged from 94.3 to 100%. Overall, Saudi Arabian isolates of LBVaV and MiLBVV had high percentage similarities with other isolates selected from the GenBank database ranging from 93.9 to 99.6%. Our greenhouse and survey results demonstrated that *Olpidium* sp. was present in the roots of lettuce plants infected with big-vein disease and the vector transmission test proved that *Olpidium* sp. facilitated the transmission of both viruses.

V24

PRELIMINARY CHARACTERIZATION OF POTATO VIRUS Y (PVY) POPULATIONS IN ALGERIAN POTATO FIELDS. Linda Allala-Messaoudi¹, Laurent Glacis^{2,3}, Mohamed Kerkoud⁴, Sonia Boukhris-Bouhachem⁵ and Zouaoui Bouznd¹. (1) Laboratoire de Phytopathologie et de Biologie Moléculaire-Département de Botanique- École Nationale Supérieure Agronomique, El-Harrach, Algiers, Algeria, Email: l.allala@ensa.dz; ; (2) FN3PT/RD3PT, 43-45 rue de Naples, 75008 Paris, France; (3) IGEPP, Agrocampus Ouest, INRA, Université de Rennes 135650 Le Rheu, France; (4) Diag-gen, 8 Rue Le Notre, 79066 Angers, France; (5) INRAT, Laboratoire de Protection de Protection des Végétaux, rue Hedi Karray, 2049 Tunis, Ariana, Tunisia.

The high incidence of Potato virus Y (PVY) in all the regions studied and its symptomatological variability, led to the study of the diversity of PVY populations in potato fields in Algeria, given the continued emergence of new strains worldwide, especially in neighbouring Tunisia. From a group of 185 samples, serologically confirmed as being

infected only with PVY, of which 96.7% belong to the serotype N, and only 3.2% of serotype O. A series of 31 PVY isolates were analyzed by biotyping on tobacco and by molecular typing (RT-PCR, and sequencing), targeting nucleotide sequence polymorphism in the 5'NTR/P1 region and recombination within the junction of three HC-Pro/P3 (RJ2), VPg/NIa (RJ3) and CP (RJ4). 28/31 serotype N isolates which induced rib necrosis on tobacco were identified as recombinant PVY^{NTN} isolated for the first time in Algeria. The other three strains were of serotype O, two of which were identified as PVYN-wi which also induced rib necrosis on tobacco. To our knowledge, this is the first report of PVYN-Wi isolate from North Africa.

V25

STUDY OF SOME GRAPEVINE VIRUSES IN ALGERIA. Anfel Djenaoui¹, Aymen Mokeddem¹, Bader Eddin Talbi¹, Nour El-Houda Laidoudi², Imene Mahdid¹, Rahil Neggaz³, Benalia Haddad³, Lakhdar Khelifi³ and Arezki Lehad¹. (1) Laboratory of Phytopathology and Molecular Biology, ENSA, El-Harrach, Algiers, Algeria, Email: anfel.dje@gmail.com; (2) Faculty of Agriculture, University of Farhat Abbas, Sétif, Algeria; (3) Laboratory of Genetic Resources and Biotechnology, ENSA, El-Harrach, Algiers, Algeria.

The grapevine is considered an important cultivated plant worldwide. It occupies a strategic place in the agriculture of many countries. Several viral diseases affecting grapevine are reported to cause very important economic losses. We conducted this study to determine the presence of some viruses in the viticultural regions of central Algeria and their importance in relation to different grapevine varieties. The study focused on grapevine samples collected in central and western Algeria, from different grapevines and tested by enzyme-linked immunosorbent assay (DAS-ELISA) for the presence of GVA, GFLV, GLRaV-3, GLRaV-2 and GLRaV-1, with confirmation of the presence of GVA by RT-PCR.

V26

PREVALENCE OF THREE VIRUSES ON PEPPER AND CHARACTERIZATION OF CUCUMBER MOSAIC VIRUS ISOLATES FROM CAP BON REGION IN TUNISIA. Wafa Khaled Gasmi^{1,2}, Rebha Souissi¹, Awatef Gaïes Toueiti¹ and Sonia Boukhris-Bouhachem¹. (1) Plant Protection Laboratory, National Institute of Agricultural Research of Tunisia (INRAT), University of Carthage, Ariana, Tunisia, Email: wafakhaled@hotmail.fr; (2) Plant Protection Department, National Institute of Agronomy of Tunisia (INAT), University of Carthage, Tunis, Tunisia.

Surveys in open-field pepper crops were conducted in the beginning, the middle and the end of the growing season in Cape Bon region in Tunisia from 2016 to 2018, to investigate the disease spread of three viruses: Cucumber mosaic virus (CMV), Potato virus Y (PVY) and Alfalfa mosaic virus (AMV). Overall infections were absent in the beginning of the season, then appeared in the mid-season and increased until the harvest with a dominance of CMV followed by PVY and AMV. Moreover, CMV single infections were significantly the most prevalent in mid-

season with a 42% average, while at harvest, CMV+PVY mixed infections and CMV single infections had significantly the highest incidence with averages of 38.33% and 33%, respectively. Generally, AMV was detected only in pepper plants infected with CMV. Additionally, PVY occurrence was significantly increased in the presence of CMV. Border weeds infections were also studied during the same period. Interestingly, *Solanum nigrum*, the most frequent weed, was also the most infected with the viruses studied. Molecular characterization of CMV isolates from single infections in *Capsicum annuum* and *S. nigrum* showed that the isolates belong to the subgroup IA.

V27

EFFECT OF GROWTH BIOCATALYSTS ON THE RESISTANCE OF FABA BEAN PLANTS TO BEAN YELLOW MOSAIC VIRUS (BYMV). Mohammad Al Khalaf, Aleppo Research Center, Aleppo, Syria, Email: Malkhalaf72@yahoo.com

This study aimed to evaluate the effect of adding some growth catalysts (biochemical preparations containing bacteria) to reduce the effect of Broad bean yellow mosaic virus (BYMV) on faba bean yield. Faba bean plants were planted at the rate of 5 plants per pot of 30 cm diameter. Trial was conducted at the Scientific Agricultural Research Center in Aleppo during the 2018/2019 growing season. The Broad bean plants were infected with BYMV by mechanical inoculation, and un-inoculated plants served as control. Infection was confirmed based on the apparent symptoms produced by the virus. Bio-preparations were produced from sterile tree residues and enriched with the necessary growth elements in two and three batches with irrigation water at the rate of 1:100 liters of water, applied at 15 days intervals for all infected and non-infected broad bean pots, leaving pots without addition of bio-preparation as a control. *Trichoderma harzianum* was added to the faba bean pots at the rate of 1 g of commercial product (1X 10⁷cfu) in two ways: (i) only *Trichoderma harzianum* and (ii) with compost, leaving untreated pots as a control. All treatments were made in three replicates. Faba bean pods were harvested, weighed and counted, and seeds weighed and counted. Results were analyzed statistically using Genstat. The results showed that there were no significant differences (p < 5%) between treatments concerning the number of pods and their weight and the number of seeds and their weight. This may be due to heavy and frequent rainfall that led to the washing of Biocatalysts from the soil, and therefore the plants did not benefit from them. Therefore, it is recommended to repeat the experiment for more than a year to assess the effectiveness of these products.

V28

DIVERSITY AND INFLUENCE OF SOME APHID SPECIES AS VECTORS OF POTATO VIRUSES. N. Benramdane, N. Benbachir, F. Abbassi and A. Benzehra, National Higher School of Agronomy, Department of Agricultural and Forestry Zoology, El Harrach, Algeria, Email: Naila0011@gmail.com

The study of winged forms of aphid species was carried out on three varieties of potato. The trapping method of yellow pans filled 2/3 with water containing wetting agent

and salt. Aphids were collected by shaking the plants or by removing the leaves and numbers of five aphid species were counted: *Aphis nasturtii*, *Aulacorthum solani*, *Macrosiphum euphorbiae*, *Myzus persicae* and *Aphis fabae*. Twelve-winged aphid species were found in the following decreasing abundance rate: *M. persicae* (15.15%), *A. solani* (13.64%) and *A. fabae* (9.20%). The rank/frequency diagrams indicated that *M. persicae* and *A. solani* were associated with Spunta and Désirée potato varieties, whereas *A. gossypii*, *A. solani* and *M. euphorbiae* prefer the Fabula variety. The variation between the heights of protected and unprotected plants was important. The number of tubers and yield were better in protected plants of all varieties. The Elisa test showed that the Spunta variety was positive for Potato virus Y (PVY) and Potato leafroll virus (PLRV), unlike Désirée and Fabula, varieties which were negative for both viruses.

V29

FIRST SURVEY OF BEET VIRUSES AND THEIR RELATIVE VECTORS ON BEET (*BETA VULGARIS*) SPECIES IN TUNISIA. Sabrine Nahdi¹, Asma Khemissi¹⁻², Rabha Souissi², Raied Abou Kubaa³ and Sonia Boukhris-Bouhachem². (1) Higher School of Agriculture of Kef (ESAK), Tunisia, Email: nehdimah@yahoo.fr; (2) National Agricultural Research Institute of Tunisia (INRAT); (3) National Research Council (CNR), IPSP, Bari, Italy.

In Tunisia, Beet (*Beta vulgaris* var. *altissima*) is consumed in marginal quantities, either directly as food or to produce sugar. This crop is subject to numerous attacks of pests and diseases throughout its growth cycle. In 2017, some symptoms of stunting, leaf deformations, yellowing were observed on Beet plants in a commercial field located at Bousalem, Jendouba Governorate (North-West of Tunisia), which were suspected to be caused by a virus. A total of 200 samples were collected from symptomatic and asymptomatic beet plants (1 leaf/plant) and tested by DAS-ELISA for the presence of Beet mild yellowing virus (BMV) (genus *Polerovirus*, family *Solemoviridae*), a persistent aphid-transmitted virus, Cucumber mosaic virus (CMV) (genus *Cucumovirus*, family *Bromoviridae*), a non-persistent aphid transmitted virus, and for Beet necrotic yellow vein virus (BNYVV) (genus *Benyvirus*, family *Benyviridae*), responsible for 'rhizomania' disease, and transmitted by a plasmodiophoromycete fungus, *Polymyxa betae*. ELISA kits were provided by Sediag and Bioreba companies. Results of DAS-ELISA revealed the infection rates of 8%, 37% and 8%, of the three viruses, respectively. Mixed infections with two viruses in the same sample were detected. Most cases of viral mixed infections were reported on samples infected with CMV and BMV. In addition, a Moericke yellow water trap was installed in the same beet field (from March to early June). A total of 36 aphid taxa were identified using a stereomicroscope, among them, seven species: *Myzus persicae*, *Aphis pisum*, *A. spiraeicola*, *A. fabae*, *Aphis* spp., *Dysaphis tulipae* and *Hyalopteris amygdali*, representing 81.2% of the total captured aphids were found. Most of the detected aphids are known as vectors of BMV and CMV. To our knowledge, this is the first record of BMV, CMV and BNYVV infecting Beet in Tunisia. Furthermore, the presence of *P. betae* need to be confirmed in the soil samples.

V30

IN VITRO MERISTEM TIP CULTURE AND THERMOTHERAPY OF FIG MOSAIC SANITATION IN DOTTATO BIANCO FIG VARIETY OF COSENZA AREA. Vincenzo Roseti^{1,2}, Giovanna Bottalico¹, Michela Chiumenti², Antonia Campanale², Massimo Morano¹, Francesco Palmisano³, Pasquale Venerito³, Angelantonio Minafra² and Vito Nicola Savino¹. (1) Dipartimento di Scienze del suolo, della pianta e degli alimenti (DiSSPA), Università degli Studi di Bari "Aldo Moro", Bari, Italy, Email: vincenzo.roseti@uniba.it; (2) Istituto per la Protezione Sostenibile delle Piante – Consiglio Nazionale delle Ricerche (IPSP – CNR), Bari, Italy; (3) Centro di Ricerca Sperimentazione e Formazione in Agricoltura "Basile Caramia" (CRSFA), Locorotondo (BA), Italia.

Since ancient times, cultivation of fig (*Ficus carica* L.) played a crucial economic and commercial role in the Mediterranean basin either for fresh or dried fruit consumption. In the past in Italy, this crop was widely spread in southern regions, where it is still profitably cultivated for dried fruit production. One of the most popular variety is the "Dottato bianco" which is under the EU quality protection schemes with two Protected Designation of Origin (PDO). To date, fig is described to host 3 viroids and 16 different viruses, among which the most economically harmful ones, because of their association with the "Fig Mosaic Disease", are Fig mosaic virus (FMV), Fig leaf mottle-associated virus 1 (FLMV-1), Fig leaf mottle-associated virus 2 (FLMV-2), and Fig mild mottle virus (FMMaV). Since it is considered a minor crop, up to now no certification scheme, voluntary or mandatory, was established and all orchards, including new plantations, showed a heavy phytosanitary decay affecting quality and yield. In order to promote "Dottato bianco" cultivation in Cosenza area. The Camera di Commercio di Cosenza, with the technical support of Agenzia Regionale per lo Sviluppo dell'Agricoltura Calabrese (ARSAC) funded a project in collaboration with the University of Bari, the Institute of Sustainable Plant Protection (CNR) of Bari and the CRSFA of Locorotondo aimed to conduct a clonal and phytosanitary improvement of this variety. The project included the assessment of the phytosanitary status of more than 30 clonal selections in the Cosenza area and their eventual sanitation. *in vitro* meristem tip culture and thermotherapy sanitation treatments are currently used to free the plants from viral agents. The production of mother plants free from any virus causing Fig Mosaic Disease becomes a prerequisite for the development of quality fruit nurseries.

V31

A STUDY ON COMPARATIVE SALINITY TOLERANCE UNDER FIELD CONDITIONS OF CLEMENTINE (*CITRUS CLEMENTINA* L.) "HERNANDINA" AND ORANGE (*CITRUS SINENSIS* L.) "WASHINGTON NAVEL" GRAFTED ON FIVE NOVEL ROOTSTOCKS TOLERANT TO CITRUS TRISTEZA VIRUS. Hend Askri¹, Mouna Aouini², Amira Ben Ali³ and Asma Najjar⁴. (1) Laboratory of Valorisation of Non-conventional Water, National Research Institute for Rural Engineering, Water and Forestry (INRGREF), El

Menzah, Tunisia, Email: askrihend.inrgref@gmail.com; (2) Higher Institute of Biotechnology of Béja, Béja, Tunisia; (3) Faculty of Sciences of Bizerte, Bizerte, Tunisia; (4) Laboratory of Plant Protection, National Agricultural Research Institute, El Menzah, Tunisia.

In Tunisia, citrus faces salinity problems especially in coastal areas where several aquifers are reported to be affected by seawater intrusion. Citrus orchards are endangered by citrus tristeza virus (CTV) and consequently Tunisian growers are now replacing sour orange, the commonly used rootstock sensitive to this disease, by tolerant rootstocks. This work aims to study the response to saline water irrigation of two old years trees of *Citrus clementina* var. Hernandina and *Citrus sinensis* var. Washington Navel grafted on five CTV tolerant rootstocks (Citrango C35, Citrange Carrizo, Citrumelo Swingle 4475, Volkamer Lemon and Cleopatra Mandarin) and on sour orange as control, through symptomatic observations and morphological analysis. The experiment was performed under field conditions in a sandy loamy non saline soil at the experimental station of the INRGREF situated at the Cap Bon peninsula in Tunisia. Trees were irrigated twice a week according to citrus water requirements based on Penman Monteith equation and the electrical conductivity of irrigation water was about 4 dS/m. For the two citrus species, the intensity and frequency of chlorosis symptoms appeared after 6 months of saline water irrigation to assess the sensitivity of combinations grafted on different tolerant rootstocks were measured. The tree canopy volume estimated with hemispherical photography treated with CANY-EYE software showed that the greatest canopy was with Volkamer Lemon, followed by Cleopatra mandarin and Sour orange. The same trend was observed in relation to growth rate diameter, plant height and pruning wood biomass. Moreover, Washington navel orange showed more tolerance to chlorosis than Hernadina clementine. Differences between citrus combinations were more pronounced with Hernadina than with Washington Navel.

V32

MOLECULAR INSIGHTS INTO CITRUS TRISTEZA VIRUS (CTV) GENOTYPES RECOVERED FROM SYRIA. Raied Abou Kubaa¹, Insaf Akel², Elia Choueiri³, Rehab Hamdan², Ali El-Khatib², Imad Ismail⁴ and Maria Saponari¹. (1) CNR, Institute for Sustainable Plant Protection, via Amendola 122/D, 70126 Bari, Italy, Email: raied.aboukubaa@ipsp.cnr.it; (2) General Commission for Scientific Agricultural Research, Lattakia, Syria; (3) Department of Plant Protection, Lebanese Agricultural Research Institute, Tal Amara, PO Box 287, Zahlé, Lebanon; (4) Plant Protection Department, Faculty of Agriculture, Tishreen University, Lattakia, Syria.

Citrus tristeza virus (CTV) (genus *Closterovirus*, family *Closteroviridae*) is one of the most economically important citrus viruses threatening citrus industry, characterized by a large biological and molecular diversity, i.e. viral strains categorized from mild to severe according to the type and severity of symptoms. After the first finding of CTV in Syria in 2006, several subsequent studies have been carried out to identify the genotype(s) associated with the

viral infections occurring in the infected areas, either through molecular tests based on (1) reverse-transcription polymerase chain reaction (RT-PCR) with multiple molecular markers (MMM), (2) single-strand conformation polymorphism (SSCP) analysis of the coat protein (CP) gene, or (3) by biological indexing on indicator woody plants. In the present study, CTV isolates recovered from Lattakia, Jableh and Tartous (the Syrian coastal region) during 2017 were graft inoculated onto different indicator plants (*Citrus aurantifolia*, *C. aurantium* cv Madam vinous and *C. paradise* cv Duncan). Each isolate was grafted in three replications and the new shoots inspected for foliar symptoms and growth alterations, including stem pitting. The presence of CTV was confirmed by a TaqMan-based quantitative real-time RT-PCR (qPCR) for broad spectrum detection. Furthermore, to differentiate CTV genotypes, a one-step multiplex real-time RT-PCR assay was carried out using TaqMan probes and primers that can distinguish T3 and VT (virulent genotype) from T30 (mild genotype). Results showed different symptoms on indicator plants, particularly on leaves such as leaf cupping, yellowing and stunting. However, even up to one year, no severe stem pitting symptoms were observed. Molecular tests confirmed the occurrence of VT-like genotypes associated with several field infections. The VT-genotypes are generally associated with severe field symptoms in other citrus growing areas, as also confirmed by the development of severe stunting and yellowing detected in our bioassay on Madame Vinous and Duncan grapefruit. It is therefore important to monitor and prevent the further spread of the isolates harboring the VT-genotypes, which under different management conditions and in presence of different scion/rootstock combinations may cause severe damage to the citrus crops.

V33

CHARACTERIZATION OF FABA BEAN AND CHICKPEA VIRUSES CAUSING YELLOWING AND STUNTING SYMPTOMS IN TUNISIA. Samia Mghandef^{1,2}, Safaa G. Kumari² and Asma Najjar³. (1) Faculté des Sciences de Bizerte, Bizerte, Tunisia, Email: mghandefsamia91@gmail.com; (2) International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beka's Valley, Zahle, Lebanon; (3) National Agricultural Research Institute of Tunisia (INRAT), Ariana, Tunisia.

In Tunisia, faba bean (*Vicia faba*) and chickpea (*Cicer arietinum*) are considered as strategic crops because of their economic and social relevance and significant direct contribution towards the national food balance. However, production levels of these crops remain quite low which is often attributed to abiotic and biotic stresses that are prevailing in the major growing areas. Viruses causing yellowing and stunting symptoms represent one of the major constraints that reduce the genetic potential of most cultivated species and varieties. To characterize these viruses in Tunisia, field surveys were conducted in five main regions (Béja, Bizerte, Cap-Bon, Jendouba and Kef) during 2018 and 2019 growing seasons. A total of 389 faba bean and 182 chickpea samples with yellowing and stunting symptoms were collected and tested by tissue blot immunoassay

(TBIA) using specific monoclonal antibodies (MAbs). Laboratory results showed that Chickpea chlorotic stunt virus (CpCSV) was the most common virus detected in 47.6% of faba bean and 18.7% of chickpea tested samples, followed by Beet western yellows virus (BWYV) (28% in faba bean and 4.4% in chickpea). Whereas, only 8.8% of faba bean samples were infected with Faba bean necrotic yellows virus (FBNYV), and Bean leafroll virus (BLRV) in faba bean (6.7%) and chickpea (9%) samples. To confirm the presence of yellowing viruses in Tunisia, total RNA was extracted from 5 faba bean and 27 chickpea samples that showed positive reaction to BLRV MAb (8 samples: 2 faba bean, 6 chickpea), BWYV MAb (7 samples: 2 faba bean, 5 chickpea) and CpCSV MAb (17 samples: 1 faba bean, 16 chickpea). Reverse transcription-polymerase chain reaction (RT-PCR) was performed using specific luteovirus primer pairs. RT-PCR amplicons of the expected size of each primer were obtained from 32 samples and were sequenced in both directions. Molecular results showed that BWYV and CpCSV (both belong to genus *Polerovirus*, family *Solemoviridae*) and BLRV (belong to genus *Luteovirus*, family *Tombusviridae*) were identified in Tunisia, and the coat protein nucleotide sequence analysis of the Tunisian isolates showed 99% homology to Moroccan isolate (CpCSV), 97% homology to the French isolate (BWYV), and 98% homology to Argentina isolate (BLRV).

V34

OCCURRENCE OF STONE FRUIT VIRUSES IN TUNISIAN GERMPLASM COLLECTIONS. Ilhem Selmi and Naima Mahfoudhi, Laboratory of Plant Protection, National Institute of Agronomic Research of Tunisia (INRAT), El Menzah, Tunis, Tunisia, Email: ilhemselmi@hotmail.com

Stone fruit trees are traditionally grown in Tunisia, with a total cultivated area of 266,250 ha. However, stone fruits are affected by several viruses which cause damage whether in terms of yield or fruit quality. Among them *Ilarvirus* and *Foveavirus* occupy an important position due to their worldwide distribution. To assess the sanitary status of Tunisian stone fruit species, surveys were conducted in the stone fruit germplasm collections, which represent a rich patrimony and the budwood source for mother blocks for orchards and nurseries in Tunisia, thus indicated their potential role in spread of virus diseases into new plantings. A total of 268 samples collected from almond (62), peach (70), apricot (72), and plum (64), were tested for the presence of Prunus necrotic ring spot virus (PNRSV) (*Ilarvirus*), Prune dwarf virus (PDV) (*Ilarvirus*) and Apricot latent virus (ApLV) (*Foveavirus*), by RT-PCR using primers specific for each virus. Molecular analysis showed that 46.6% of tested samples were infected with at least one virus. Among infected samples, 42.9% were single infections and 3.7% were mixed infections. PNRSV was the most frequently encountered virus with an infection rate reaching 37.7%, followed by PDV (9.3%) and ApLV (4.5%). With an infection rate of 68.6%, peach was the most infected species, followed by apricot (51.4%) and almond (38.7%). Whereas plum was the least infected, with an infection rate of 28.1%.

V35

BARLEY YELLOW DWARF VIRUS IN MAIZE IN TUNISIA: DETECTION AND MOLECULAR CHARACTERIZATION. Imen Hamdi¹, Asma Najar¹, Hajer Ben Ghanem², Arvind Varsani³ and Ahmed Jemmali¹. (1) Laboratoire de Protection des Végétaux, Institut National de la Recherche Agronomique de Tunisie, El Menzah, Tunisie, Email: imenhamdi@yahoo.fr; (2) Laboratoire de Grandes Cultures, Institut National de la Recherche Agronomique de Tunisie, El Menzah, Tunisie; (3) The Biodesign Center for Fundamental and Applied Microbiomics, Center for Evolution and Medicine, School of Life sciences, Arizona State University, Tempe, USA.

Barley yellow dwarf virus (BYDV) complex causes one of the economically most important viral diseases of cereals worldwide, with significant yield losses in major cereal crops such as wheat, barley, rice, maize and oat. BYDV has been identified on barley and wheat in Tunisia since 2000. As summer crop, maize (*Zea mays*) could be an important reservoir of BYDV and may serve as a potential source of early virus infection to small grains. In this regard, a field survey was conducted during spring of 2018 in the northeastern region (El Alia, governorate of Bizerte) of Tunisia. A total of 140 samples were randomly collected from five maize fields and were tested by tissue-blot immunoassay (TBIA) using polyclonal antibodies provided by ICARDA's virology laboratory. Fifty-two maize samples (37%) were found positive for BYDV. In parallel, 38 out of 52 (73%) maize samples tested by DAS-ELISA using a polyclonal antibody raised against BYDV-PAV were positive, suggesting a prevalence of BYDV-PAV in maize in Tunisia. The occurrence of BYDV-PAV was further confirmed by RT-PCR using Total RNA and specific BYDV-PAV primer pairs. An amplicon of the expected size was obtained for all ELISA-positive samples. Then, four amplicons were randomly selected and used for Sanger sequencing. The four BYDV-PAV sequences (GenBank accession No#MK224487-MK224489 and MK224491) share >96% identity amongst them and with sequences of BYDV-PAV isolates from barley in Tunisia (KJ467220-23 and KJ410741) and Iowa-USA (KY593457), and from wheat in Kansas-USA (KU170668).

V36

STUDY OF FIG MOSAIC DISEASE IN TUNISIA: RELATION BETWEEN VIRUSES AND SYMPTOMS EXPRESSION. Manel Elair¹, Ikhlas Skhiri² and Naima Mahfoudhi¹. (1) Laboratoire de Protection des Végétaux, Institut National de la Recherche Agronomique de Tunisie, Université Tunis-Carthage, El Menzah, Tunis, Tunisia, Email: manel_elair@hotmail.com; (2) École Supérieure d'Agriculture du Kef, Université Jendouba, Tunisia.

Fig (*Ficus carica*L.) tree is a typical Mediterranean fruit crop of Middle eastern origin that is characterized by large adaptation to various ecological areas. In Tunisia fig tree has been cultivated traditionally since many decades and covers all areas throughout the country. Fig mosaic disease (FMD) is the most serious pathological constraint of fig production that affect figs worldwide. Affected trees show extremely variable mosaic symptoms on leaves and fruits, and can exhibit defoliation and premature fruit drop. To date,

different viruses have been identified to infect fig and classified as definitive or tentative species of the genera *Closterovirus*, *Ampelovirus*, *Alphacryptovirus*, *Emaravirus*, *Trichovirus* and *Badnavirus*. Viruses associated with the disease were detected in Tunisia. This work focused on a preliminary study of the symptoms associated with the fig mosaic disease, and the relation between viruses and symptoms. This study was realized through regular observation of symptoms produced on 25 clones of infected fig, and on the molecular identification by RT-PCR of the six most common viruses which infect fig (Fig mosaic virus (FMV), Fig leaf mottle associated virus-1 (FLMaV-1), Fig leaf mottle associated virus-2 (FLMaV-2), Fig mild mottle associated virus (FMMaV), Fig fleck associated virus (FFkaV) and Fig cryptic virus (FCV), which infected these clones. The results showed that on leaves, symptoms were manifested by mosaics, yellows, vein clearing, mottling, flecking and chlorotic ringspots. The leaves can also present different types of malformations. On fruits, symptoms included chlorotic ringspots. All leaf symptoms were produced from April, except chlorotic ringspots which appeared in May), and in June on fruits. The molecular analysis showed the presence of the six viruses in the analyzed clones. FMV has been detected in the majority of the clones (19/25), followed by the FLMaV-1 (11/25). The other viruses were present in a limited number of clones. The most severe symptoms were always associated with the presence of FMV. The presence of FLMaV-2 was associated with flecking and vein clearing symptoms.

V37

MOLECULAR DETECTION OF BLACK QUEEN CELL VIRUS (BQCV) AND NOSEMA CERANAE IN BUMBLEBEES IN LEBANON. Raied Abou Kubaa¹, Wael Yammine², Sabri Zaidat³, Yara El Khoury⁴ and Maria Saponari¹. (1) CNR, Italian National Research Council, Institute for Sustainable Plant Protection, Bari, Italy, Email: raied.aboukubaa@ipsp.cnr.it; (2) Lebanese University, faculty of Agriculture, Dekwaneh, Lebanon, (3) CIHEAM IAMB, Mediterranean Agronomic Institute of Bari, Valenzano, Bari-Italy; (4) CNRS-L, National Council for Scientific Research in Lebanon, National Center of Marine Sciences, Jounieh, Lebanon.

As in the case of honeybees, bumble bees species (*Bombus* spp.) are exposed to many factors affecting their health status, such as exposure to pesticides, viral and bacterial infections. Although there are few studies on pathogens infecting bumblebees, it is suspected that domestic honeybees can play a major role in spreading diseases that cause bumble bees decline. Some studies demonstrated that RNA viruses have been transmitted from honeybees to bumblebees by visiting the same flowers. In this study, the presence of several honeybee viruses (RNA and DNA viruses) and *Nosema* spp. was investigated in bumblebees collected from Lebanon by RT-PCR and conventional PCR. A total of 35 aging workers of symptomless bumblebees (including *Bombus terrestris* Linnaeus and *Bombus orientalis* Smith) were collected along roadsides and from garden spaces in Jezzine (South Governorate), Ehden (North Governorate) and Hasbaya (Nabatieh Governorate) in 2017. Total nucleic acid

(TNA) was extracted using the commercial reagent TRIZOL (Invitrogen). PCR products of the expected bands were purified by QIAquick purification kit (Qiagen) and sequenced in both directions. Overall, results showed that among the tested viruses, only Black queen cell virus (BQCV) was detected with an incidence of 34%. Moreover, *Nosema ceranae* was detected in 22% of the specimens. Multiple infections by BQCV and *N. ceranae* were found only in 4 samples collected from Jezzin and in 1 sample collected from Hasbaya. BQCV sequence shared 97% identity at nucleotide level with a Chinese isolate (Acc. No JN185929) found in *Apis ceranae*, whereas *N. ceranae* sequence shared a high-level identity (99.08%) with several isolates worldwide including a previous one reported from *A. mellifera* in Lebanon (Acc. No KC680637). Although a low number of samples were tested in this experiment, our work represents the first molecular detection of BQCV and *N. ceranae* in bumblebees in Lebanon. The finding of some honeybee pathogens in bumblebees, supports the hypothesis that flower resources could play a major role in the spread of these pathogens. Further studies on honeybee viruses and other pathogens in Lebanon are needed.

V38

CATEGORIZATION OF AVAILABLE CUCUMBER GENOTYPES AGAINST ZUCCHINI YELLOW MOSAIC VIRUS AND ROOT-KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*). Hira Manzoor Ahmed¹, Muhammad Ashfaq¹, Tariq Mukhtar¹ and Muhammad Azam Khan². (1) Department of Plant Pathology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Pakistan, Email: hirabajwa30@gmail.com; (2) Department of Horticulture, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Pakistan.

In the present study, fifteen cucumber genotypes were screened against Zucchini yellow mosaic virus (ZYMV) and root-knot nematode (*Meloidogyne incognita*) individually and in combinations. All the cucumber genotypes behaved differently regarding root and shoot lengths and weights, number of galls, egg masses and ZYMV infection when inoculated with *M. incognita* and ZYMV alone or in mixed infection. None of the fifteen cucumber genotypes was found immune, highly or moderately resistant to *M. incognita*. Two genotypes viz., Alpha Prime and Patio were found resistant to the nematode. In contrast, Max Pack and Beit-alpha were highly susceptible as witnessed by maximum galls on their roots and reduction in growth parameters. Similarly, the genotypes Best PIC, Songrooh, Northern Pack, C-7 and C-5 appeared as moderately susceptible, whereas Shaheen, Jackson, C-1, C-2, C-3 and C-9 genotypes showed susceptible reactions to the nematode alone. Similar trend was noticed when the genotypes were inoculated with both the nematode and the virus. Similarly, on the basis of disease rating scale, two genotypes viz., Alpha Prime and Patio were grouped as moderately resistant to ZYMV. On the other hand, eleven genotypes viz., Max Pack, Shaheen, Songrooh, Northern Pack, Jackson, Beit-alpha, C-1, C-2, C-3, C-5 and C-9 were classified as highly resistant, whereas two genotypes Best PIC and C-7 were considered as susceptible against ZYMV alone. Similarly, all the genotypes behaved in the same way when inoculated

with *M. incognita*. Two genotypes Alpha Prime and Patio were found resistant against both pathogens inoculated simultaneously and hence are recommended for cultivation.

V39

PREVALENCE OF FIG MOSAIC VIRUS (FMV) ON FIGS IN SOUTHERN IRAQ. Nabeel Abdalla Al-Kaeath^{1,2,3}, Manal Elair¹ and Naima Mahfoudhi¹. (1) Laboratory of Plant Protection, National Agronomic Research Institute (INRAT), 2049 Ariana, IRESA-University of Carthage, Tunisia, Email: nabeel.kaeat@gmail.com; (2) Department of Plant Protection, Higher Agronomic Institute of Chott-Mariem. Sousse University, Tunisia; (3) Department of Plant Protection, College of Agriculture, University of Al-Muthanna, Iraq.

Fig tree (*Ficus carica*) belong to Moraceae family, It is one of the oldest and most important fruit trees in many countries of the world with temperate climate. The fruits of this tree are consumed fresh or dry and are considered to have a high nutritional value. The growth and productivity of these trees is affected by many diseases, the most dangerous of which is Fig mosaic disease, caused by a group of viruses, the most prominent and most important of which is Fig mosaic virus, genus Emaravirus, which reduces crop yield and quality. A survey was conducted in southern Iraq, where figs are commonly planted to investigate the epidemiology of FMV incidence and to determine the severity of infection. Samples were collected from 100 trees from several locations such as the city of Al-Hashemiya (Babil province), Al-Diwaniyah city (Al-Qadisiyah province), Al-Samawah city (Al-Muthanna province), and Al-Suwayrah (Wasit province), and from several varieties planted in those areas, namely: Waziri, Aswad Diyala and Sultani. The samples were tested using RT-PCR technology in the Plant Protection Laboratory of the National Institute for Agricultural Research in Tunisia. Results obtained showed that FMV was present in 36% of the samples tested. The samples from the Hashemite region were the most affected (68%), followed by the Samawah region (35%), the Diwaniyah region (28%), and least in the city of Essaouira (24%). With respect to varieties, the highest relative infection rate was found in the Diyala black variety (50%), followed by the Waziri variety (42%), whereas the lowest relative infection rate was found in the Sultani variety (18%). This study showed the extent of the spread of the FMV virus, which is considered one of the most common viruses that cause fig mosaic disease. Necessary preventive measures to limit the spread of this disease in Iraq need to be taken.

V40

DETECTION OF GRAPEVINE FLECK VIRUS IN CENTRAL ALGERIA. Imene Mahdid¹, Anfel Djenaoui¹, Nour El-Houda Laidoudi², Rahil Neggaz³, Benalia Haddad³, Lakhdar Khelifi³ and Arezki Lehad¹. (1) Laboratory of Phytopathology and Molecular Biology, ENSA, El-Harrach, Algiers, Algeria, Email: mahdid.imene94@gmail.com; (2) Faculty of Agriculture, University of Farhat Abbas, Sétif, Algeria; (3) Laboratory of Genetic Resources and Biotechnology, ENSA, El-Harrach, Algiers, Algeria.

The grapevine is one of the oldest crops in the world and in Algeria in particular. The Algerian viticulture is facing many natural (climate, diseases and pests) and technical (inadequate cultural works, decrease in areas) obstacles that have caused damage to crops and reduced yield. The grapevine fleck virus (GFkV) is due to a virus belonging to the family *Tymoviridae*, and it is present in all vineyards around the world. The objective of this study was to evaluate the current epidemiological situation of the vineyards concerning the Grapevine Fleck Virus (GFkV) in central Algeria by using the enzyme-linked immunosorbent assay (DAS-ELISA) and molecular analysis by RT-PCR. The prevalence of GFkV (the percentage of vineyards with GFkV) was 72 %, and it was most common for the variety GROS NOIR which showed 100% infection and DATTIER which showed 95 % infection. Reverse transcription-polymerase chain reaction (RT-PCR) successfully amplified the partial CP gene product of the expected size (175 bp) after extraction by CTAB method.

V41

RDR6 AND COMBINED ACTIVITIES OF DCL2 AND DCL4 ARE INVOLVED IN RNAI-BASED RESISTANCE TO POTATO VIRUSES INDUCED BY TOPICAL APPLICATION OF DSRNA. K. Necira¹, M. Makki¹, H. Fakhfekh^{1,2}, N. Khamessi³, T. Canto⁴, F. Tenllado⁴ and F. Khouaja^{1,5}. (1) Molecular genetics, immunology and biotechnology, Faculty of Sciences of Tunis, University of Tunis, El Manar, Tunis, Tunisia; (2) Faculty of Sciences of Bizerte, Zarzouna, University of Carthage, Bizerte, Tunisia; (3) Laboratory of Horticulture, Potato Program, National Institute of Agronomic Research of Tunisia, Ariana, Tunisia, Email: khamassi.nouri3356@gmail.com; (4) Department of Microbial and Plant Biotechnology, Margarita Salas Center for Biological Research, Spanish Council for Scientific Research (CIB Margarita Salas-CSIC), Madrid, Spain; (5) Higher Institute of Biotechnology, BiotechPôle, BP-66, SidiThabet, Ariana, Tunis, Tunisia.

Exogenous application of double-stranded RNAs (dsRNAs) for inducing virus resistance in plants represents an alternative to transgene-based silencing approaches. However, improvement of dsRNA stability in natural conditions is required in order to provide long-term protection against the targeted virus. In this study, we tested the protective effect of topical application of *Escherichia coli*-encapsulated dsRNA compared to naked dsRNA against single and dual infection by Potato virus X expressing the green fluorescent protein (PVX-GFP) and Potato virus Y (PVY) in *Nicotiana benthamiana*. Under our conditions, it was found that the effectiveness of *E. coli*-encapsulated dsRNA in providing RNAi-mediated protection did not differ from that of naked dsRNA. Topical application of dsRNA against PVY provided a higher level of protection (60%) compared to that against PVX-GFP (40%). dsRNA vaccination was partly effective against a dual infection by PVX-GFP and PVY, manifested by a delay in the expression of the synergistic symptoms at an early period after inoculation. Using PVX-GFP as a reporter virus together with a suite of RNAi knockdown transgenic lines, provided evidence that RNA-directed RNA polymerase 6 and the

combined activity of DICER-like 2 (DCL2) and DCL4, likely along with DCL2- and DCL4-processed sRNAs, act to promote efficient resistance to virus infection conferred by topical application of dsRNA in *N. benthamiana*. Our results provided evidence that exogenous dsRNA molecules are processed by the RNA silencing pathways commonly used by the host in response to virus infection.

NEMATODES

N1

COMPARATIVE EFFICACY OF LEAVES POWDER OF FOUR PLANT SPECIES AGAINST MELOIDOGYNE JAVANICA ON TOMATO. Fahad A. Al-Yahya¹, Ahmad S. Al-Hazmi¹, Omeed A. AbdelRafaa² and Hamzeh A. Lafi¹. (1) Plant Protection Department, College of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia, Email: fayahya@ksu.edu.sa; (2) Al Mahalliah Trading and Agriculture Co., Ltd., Riyadh, Saudi Arabia.

A greenhouse study was conducted to compare the relative efficacy of dry leaves powder of four plant species to manage *Meloidogyne javanica* on tomato. The tested plants included: *Conocarpus erectus*, *Eucalyptus globulus*, *Lantana camara* and *Ficus retusa*. Powder of each plant was applied into the potting soil at three concentrations of 5, 10 and 20 grams per pot (0.005, 0.01 and 0.02% w/w). Two important parameters were considered: plant response (plant growth and root galling) and nematode reproduction (production of eggs and the reproduction factor Rf). The results showed that all materials were found to be effective against root galling, but with different levels of efficacy. Dry leaves of *L. camara* were the most effective, whereas those of *C. erectus* were the least effective in managing *M. javanica*. Based on three important criteria namely: gall index (GI), egg mass index (EMI), and nematode reproduction factor (RF), the treatments were categorized into three groups according to their relative efficacy under testing conditions. The three groups were as follows: 1) the relatively high effective group (GI=2.42, EMI= 1.56, Rf = 0.04), which included only the high concentration (20 g) of *L. camara*, 2) the relatively moderate effective group (GI =3.3-3.84, EMI= 2.7-3.38, Rf =0.12-0.2), which included all concentrations of *F. retusa*, 5 and 10 g of *L. camara*, 10 and 20 g of *E. globulus* and 20 g of *C. erectus*, and 3) the relatively least effective group (GI= 4.16-4.72, EMI= 3.46-4.22, Rf = 0.38-0.96), which included low concentration (5 g) of *E. globulus* and 5 and 10 grams of *C. erectus*.

N2

NATURAL ANTAGONISTS OF HETERODERA AVENAE IN VARIOUS CEREAL GROWING REGIONS IN ALGERIA. Djamel Smaha¹, Fouad Mokrini¹, Roza Daoudi-Assous¹, Amine Adimi¹, Aissa Mokabli¹ and Abdelfattah Amer Dababat². (1) Laboratory of Nematology, National High School of Agronomy (ENSA), El-Harrach, Algiers, Algeria, Email: nemaalg01@yahoo.fr; (2) International Maize and Wheat Improvement Center (CIMMYT), P.K. 39 06511, Emek, Ankara, Türkiye.

A study was carried out to determine the diversity of the microflora associated with the cereal cyst nematode,

Heterodera avenae, in four cereal regions of Algeria. The isolation mainly targeted fungi associated with the cyst nematode *Heterodera avenae*. The isolation resulted in the identification of six fungi: *Fusarium* spp., *Penicillium* spp., *Aspergillus* spp., *Rhizomucor* spp., *Rhizopus* spp. and *Ulocladium* spp. In all the prospected regions, *Fusarium* spp. was most frequently associated with the nematode cysts. The highest diversity was observed at Dahmouni with the genera *Aspergillus* spp., *Ulocladium* spp., *Rhizopus* spp. and *Rhizomucor* spp. The in vitro test showed that the metabolites of *Fusarium* spp., *Penicillium* spp. and *Aspergillus* spp. controlled the eggs well and thus constitute potential agents for the *H. avenae* management.

N3

NEMATICIDAL ACTIVITY OF TRICHODERMA SPP. AND FUSARIUM OXYSPORUM AGAINST THE POTATO CYST NEMATODE GLOBODERA ROSTOCHIENSIS (WOLL). Nawal Benttoui, Maissa Abba, Houda Bouregghda and Samira Sellami, Higher National School of Agronomy (ENSA), Department of Botany, Laboratory of Phytopathology and Molecular Biology, El Harrach, Algiers, Algeria, Email: n.benttoui@edu.ensa.dz

Cyst nematodes of the genus *Globodera* are among the most dangerous bioaggressors of potato crops in Algeria. The control of these quarantine organisms is mandatory. Actually, among control approaches, biological methods alternative to chemical nematicides are being actively investigated. Biocontrol of *G. rostochiensis* by fungal isolates of the genera *Trichoderma* and *Fusarium* were studied *in vitro* and *in vivo* on potato. An *in vitro* experiment with isolates of these two fungi showed a nematicidal effect on eggs of *G. rostochiensis*. The effect increased with the increase of spore suspension concentration and exposure time. An *in vivo* assay with spore suspensions of the same isolates showed that the soil treatments significantly reduced the reproduction of *G. rostochiensis* and improved the growth of potato plants. Therefore, the use of these antagonistic microorganisms appears as a very promising alternative approach in the management of potato cyst nematodes.

N4

PLANT PARASITIC NEMATODES IN IRAQ. Zuhair Stephan, Plant Protection Department, Abu-Ghreib, Baghdad, Iraq, Email: zuhainstephan@gmail.com

Twenty-three genera of plant-parasitic nematodes were identified to attack numerous plants, but 3 genera were considered most important because of the serious losses they cause. These are: Root-knot nematodes, *Meloidogyne* spp., Citrus nematode, *Tylenchulus seipenetrans* and wheat seed gall nematode, *Anguina tritici*. Root-knot nematodes were reported to attack 110 host plants including field crops, vegetables, fruit trees and weeds. Five *Meloidogyne* species were identified in Iraq: *M. arenaria*, *M. incognita* and *M. javanica* and were the dominant species in all Iraqi regions, in addition to *M. thamesi* and *M. hapla*. The latest was found in the northern region only due to low temperature compared to middle and south of Iraq. Citrus nematode *T. semipentrans* was found in every citrus nursery and orchard in the middle

and south of Iraq with high population density, whereas wheat seed gall nematode, *A. tritici* was found in all regions of Iraq attacking wheat only, whereas barley was immune and used to replace wheat, until more recently a different race of *A. tritici* was found in a field in the Shechan village area to attack barley. Some chemical nematicides such as Nemagon, Nemacur and Oxamyl (Vydate) were used on vegetables and citrus orchards to control nematodes. Other nematicides such as Furadan and Rugby were also used. More recently biological control products such as Forfural, *Trichoderma* and *Paecilomyces* were used and proved promising. Furthermore, soil solarization and biofumigation proved to be a promising environment friendly approaches to control plant parasitic nematodes.

N5

PATHOGENICITY OF ROOT-KNOT NEMATODE *MELOIDOGYNE JAVANICA* ON CUCUMBER PLANTS AS AFFECTED BY DIFFERENT INOCULUM LEVELS UNDER GREENHOUSE CONDITIONS. Sulaiman Naif Ami and Shireen Ghaib Ali Shingaly, Department of Plant Protection, College of Agricultural Engineering Sciences, University of Duhok, Dujok, Kurdistan Region, Iraq, Email: sulaiman.ami@uod.ac

Sterilized sandy loam soil was infested with different levels of inoculum of root-knot nematode *Meloidogyne javanica* included: 0, 1000, 2000, 4000, 8000 and 16000 eggs/pot 20 days after sowing cucumber seeds cv. Sayff F1 under greenhouse conditions at the College of Agricultural Engineering Sciences, Semel, University of Duhok, Kurdistan Region, Iraq. Results revealed that the growth criteria of cucumber plants (length, fresh and dry weight of roots and shoots, chlorophyll content of leaves) decreased with the increase of inoculum levels of nematode eggs, whereas infection level increased except at the inoculum level of 16000 eggs/pot at which infection level decreased. The rate of nematode reproduction decreased with the increase of nematode inoculum levels.

N6

RELATIVE SUSCEPTIBILITY AND TOLERANCE OF THIRTEEN EGYPTIAN WHEAT CULTIVARS TO THE CEREAL CYST NEMATODE (*HETERODERA AVENAE* WOLL.). A.M. Korayem and M.M.M. Mohamed, Plant Pathology Department, National Research Center, El-Tahrir St., Dokki, Egypt, Email: kor_asm@yahoo.com

Relative susceptibility and tolerance of thirteen Egyptian wheat cvs. (Seds-1, Seds-12, Seds-13, Seds-14, Misr-1, Misr-2, Misr-3, Sakha-8, Sakha-93, Sakha-95, Giza-168, Giza-171, and Shandaweel) to the cereal cyst nematode *Heterodera avenae* was determined under greenhouse conditions. Resistance/susceptibility was assessed as relative susceptibility (RS) to the standard susceptible control cultivar Sakha-93. The results showed that *H. avenae* infected and well reproduced on all tested cultivars, and all of them were designated as susceptible cultivars. Cultivars Misr-1, Misr-2, Misr-3 and Shandaweel were highly susceptible to *H. avenae*, as their RS were more than 92%. Data also indicated that cultivars Sakha-8, Sakha-93, Sakha-

95, Shandaweel and Giza-168 were ranked as less tolerant according to their tolerance index. Other wheat cultivars were ranked as intolerant (sensitive) cultivars, as their tolerance indices were more than one.

N7

THE IMPACT OF INTENSIFICATION PRACTICES AND SOIL PROPERTIES ON THE STRUCTURE AND DIVERSITY OF PLANT-PARASITIC NEMATODE COMMUNITIES INFESTING OLIVE ORCHARDS IN TUNISIA. Ilhem Guesmi-Mzoughi¹, Mariem Tabib², Farah Sellami², Fathia Hadj-Naser¹, Hajer Regaieg¹, Sadreddine Kallel² and Najet Horrigue-Raouani¹. (1) Développement de la Protection Biologique et Intégrée au niveau de la parcelle en agriculture biologique, Département des Sciences Biologiques et Protection des Plantes, Institut Supérieur Agronomique de Chott Mariem, 4042, Sousse, Université de Sousse, Tunisie, Email: guesmiilhem@yahoo.fr; (2) Bioagresseurs et Protection Intégrée en Agriculture. Département Santé Végétale et Environnement, Institut National Agronomique de Tunis, 43 avenue Charles Nicolle 1082 Tunis, Université de Carthage, Tunisie.

Olive trees serve as hosts to a large number of plant-parasitic nematodes (PPN), of which many are recognized as pathogenic to olive and can cause a serious damage to established olive orchards. Olive culture has a high agriculture and socio-economic importance in Tunisia, and accordingly this study aimed to unravel the PPNs community structure and diversity in olive orchards in relation to agronomical factors. Surveys were conducted in 123 olive orchards in the main producing areas from the north to the center of Tunisia. PPN were extracted from soil and root samples by the centrifugal flotation method. Nematodes were then identified and enumerated at the genus level. The structure and diversity of PPN communities were described using several ecological indexes. Seventeen genera of PPN were identified, among them, *Meloidogyne* spp., *Pratylenchus* spp. and *Helicotylenchus* spp. were the most dominant genera, whereas *Heterodera* spp. and *Rotylenchulus* spp. were scarcely present. The intensification of olive orchards with irrigation and the association of cover crops strongly impacted the PPN diversity especially for the harmful taxa *Meloidogyne* spp. and *Pratylenchus* spp. In fact, the presence of irrigated cover crops enhanced the multiplication of the root-knot nematodes (*Meloidogyne* spp.). However, the root-lesion nematodes (*Pratylenchus* spp.) prevailed in olive orchards under super-intensive management. Furthermore, soil properties have influenced the PPN community structure. Clay soils presenting high levels of conductivity and exchangeable potassium were more favorable for the multiplication of *Pratylenchus* spp., whereas *Meloidogyne* spp. prevailed in sandy soils poor in organic matter. The study identified the PPN communities infesting olive in Tunisia and highlighted the impact of intensification practices on PPN diversity and consequently olive production. Accordingly, such agronomical or environmental factors should be taken into consideration for the establishment of new olive plantations.

N8

SURVEY OF PLANT PARASITIC NEMATODES ASSOCIATED WITH WHEAT IN EGYPT. Ahmed M. Korayem, Mahmoud M.A. Youssef, Moawad M.M. Mohamed and Usama S. Elkelany, Plant Pathology Department, Nematology Laboratory, National Research Centre, Dokki, Post Code 11622, Cairo, Egypt, Email: Moawad_bondok@yahoo.co.uk

Distribution and diagnosis of phytonematodes infecting wheat in 12 governorates of Egypt was carried out during two seasons. In the first season (2016-2017), thirteen nematode genera and species viz., *Aphelenchoides*, *Criconeimoides*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hirschmanniella oryzae*, *Meloidogyne*, *Pratylenchus*, *Pisilenchus*, *Rotylenchulus reniformis*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema* were identified in the collected samples from wheat fields in four surveyed governorates (Beheira, Ismailia, Sharquia, and Kafr-El-Sheikh). *Tylenchorhynchus* was the most frequent genus in all samples with 38.3% occurrence followed by *Pratylenchus* (16.7%), *Helicotylenchus* (4.5%) and *Heterodera* (3.5%). *Heterodera* had the highest population density (48 juveniles/250 g soil) followed by *Tylenchorhynchus* (39) and *Pratylenchus* (10). *Heterodera* cysts and juveniles were extracted from soil samples collected only from Ismailia governorate. Occurrence of *Helicotylenchus*, *Heterodera*, *Meloidogyne*, *Pratylenchus* and *Tylenchorhynchus* was more in loamy than in clay and/or sandy soil. *Aphelenchoides*, *Ditylenchus*, *Hirschmanniella oryzae*, and *Pisilenchus* occurrence was high in clay soil, whereas *Criconeimoides* occurrence was high in sandy soil. Occurrence and population densities of nematodes seemed not to be related with the wheat crop. Data obtained in the second year of work (2017-2018) indicated the presence of eleven phytonematode genera and species associated with wheat grown in eight governorates (Beheira, Dakhalia, Gharbia, Monufia, Qalyubia, Giza, Fayoum and Minia). Nematodes were *Criconeimella* sp., *Hirschmanniella oryzae*, *Longidorus* sp., *Helicotylenchus* sp., *Hoplolaimus* sp., *Meloidogyne* sp., *Pratylenchus* sp., *Tylenchorhynchus* sp., *Tylenchus* sp. and *Xiphinema* sp. *Tylenchorhynchus* sp. and *Helicotylenchus* sp. *Pratylenchus* sp. had the highest frequency.

N9

INTERACTIVE EFFECT OF ROOT KNOT NEMATODE (*MELOIDOGYNE JAVANICA*) AND ROOT ROT FUNGUS (*RHIZOCTONIA SOLANI*) ON EGGPLANT (*SOLANUM MELONGENA* L.). Khalifa H. Dabaj, Amina A. Ghammoudi, Zainib Albozidy and Moad A. Alghondi, Plant Protection Department, Faculty of Agriculture, University of Tripoli, Tripoli, Libya, Email: dabajhk@yahoo.com

The goal of this experiment was to study the effect of single and combined inoculation with root-knot nematode (*Meloidogyne javanica*) and root rot fungus (*Rhizoctonia solani*) on eggplant seedlings in 6 different treatments, individually or combined. Each treatment precedes the others by a period of two weeks in addition to the control treatment. The nematodes inoculum was 4000 eggs + J₂/pot, and a weight of 5 g of barley grains contaminated with *R. solani*

which was added to the single and combined treatments. Each treatment was replicated 4 times and distributed according to the randomized complete design. Two months after the last treatment the results were recorded and showed a difference in the severity of infection of the eggplant seedlings with root-knot nematodes and root rot fungus in the co-infection treatments, especially in the treatment of nematodes two weeks before the fungus inoculation. Root rot and almost complete death of the root system were observed, which negatively affected the number of galls and egg mass, and thus the rate of reproduction of nematodes. This effect was less in combined simultaneous treatment with the fungus or fungus inoculation two weeks earlier than nematode inoculation as compared to treatment with nematodes only, when the highest rate of galls and egg mass was obtained. It was observed that the severity of root rot fungus in co-infection treatments was more serious than with fungus inoculation alone.

N10

THE EFFECT OF SOIL SOLARIZATION AND BIOFUMIGATION ON NATURALLY INFESTED SOIL WITH ROOT KNOT NEMATODE *MELOIDOGYNE INCOGNITA* UNDER PROTECTED CULTIVATION CONDITIONS. Mahmoud A. Musbah¹ and Khalifa H. Dabaj². (1) Higher and Intermediate Agricultural Institute in Ghiran, Tripoli, Libya, Email: sbad77@yahoo.com; (2) Plant Protection Department, Faculty of Agriculture, University of Tripoli, Tripoli, Libya.

The effect of soil solarization and biofumigation by adding animal residues (sheep manure) and green plant residues, cabbage (*Brassica oleracea* v. *capitata* L.) and radish (*Raphanus sativus* L.) at a rate 7.5 ton/h. to control root knot nematode *Meloidogyne incognita* on eggplant plant grown in plastic bags containing 2 kg of naturally infested soil at an average of 2,800 eggs + second stage juvenile of root knot nematode inside a greenhouse (360 m²). The experiment included five treatments (soil solarization alone, soil solarization + sheep manure, soil solarization + cabbage, soil solarization + radish) in addition to the control treatment. Each treatment was replicated 3 times in cultivation rows according to a completely randomized design. The results obtained showed that soil solarization and biofumigation increased soil temperature at the depths of 10 and 30 cm, with an average of 51.7°C. and 46.3°C. at the two depths, respectively, compared to 47.2°C. and 43.2°C. in the control treatment (uncovered soil) at the same depths, respectively. Soil solarization and biofumigation treatments reduced the density of root nematodes in the soil, thereby reducing the incidence of root nematode and final population density of nematodes compared to the control. Treating the soil with biofumigation promoted plant growth and increased the number of flowers, thereby increased productivity compared to the control treatment. Sheep manure + solarization, radish plants + solarization, and solarization increased eggplant yield by 168%, 153.7% and 135%, respectively, compared to the control treatment. All treatments significantly differed from the control at P = 0.05. Solarization and biofumigation can be incorporated into the integrated production management and root knot *Meloidogyne* spp. control

program in protected cultivation, as an alternative to methyl bromide gas to reduce health and environmental risks and promote sustainable agriculture.

N11

DEVELOPMENT OF AGRICULTURAL NEMATOLOGY IN ALGERIA. Nadia Tirchi¹, Holgado Ricardo², H. Tahar Karahaçane¹ and Aissa Mokabli¹. (1) University Djilali Bounaama of Khemis Miliana, Faculty of Natural and Life Sciences and Earth Sciences, Department of Agronomy, ERP Research Laboratory, Road Theniet El Had 44225, Algeria, Email: tirchin1977@yahoo.fr; (2) Norwegian Institute of Bioeconomy Research, Division of Biotechnology and Plant Health, Norway.

This is an analysis of the available information at libraries of universities, and research articles obtained by visiting web pages and Google scholar. All pertinent information was collected until the end of 2021. This revision showed three periods for Algerian agricultural nematology: First period includes the years of French colonialism, and two decades after independence (until end of 1970s). Publications on plant parasitic nematodes started on the late 19th and early 20th centuries by French and Italian researchers, such as *Tylenchus devastatrix* Kühn = *Ditylenchus dipsaci* (1896) on beans, *Tylenchulus semipenetrans* (1915) on citrus, and *Meloidogyne* spp. (1928) on horticultural crops. The second period (1980-1990) is characterized by the emergence of Algerian researchers. They successively became senior researchers having the responsibility to educate graduate students. The research topics focused on geographical distribution and evaluation of damage caused by cyst nematodes (*Heterodera* spp., *Globodera* spp.), root knot nematodes (*Meloidogyne* spp.) and to a less extent studies on *D. dipsaci*, *Xiphinema* and *T. semipenetrans*. The third period (2000 until today) is characterized by diversification on research topics such as biology, molecular identification; chemical and cultural control. During this period, 19 PhD thesis and 49 research papers were published. Universities, National Institute of Agronomic Research and National Institute of Plant Protection were the organizations who contributed to nematology science development. During last period, collaboration between Algerian universities and European research institutes was also noted. From the end of 19th century until today, 38 genera and 43 species of plant parasitic nematodes of economic importance such as *Globodera rostochiensis*, *G. pallida* and *Ditylenchus dipsaci*, *D. gigas*, *Tylenchulus semipenetrans*, *Heterodera avenae*, *Meloidogyne* spp. were reported. It should be noted that there is a need to coordinate further the Algerian research activities for the continuation of the development of Nematology; to give solutions to farmers to improve yield and contribute to food security.

N12

THE EFFICIENCY OF OLIVE POMACE IN CONTROLLING ROOT-KNOT NEMATODES MELOIDOGYNE SPP. ON IMPATIENS WALLERIANA IN SYRIA. Zeina Tarek Balady¹ and Khaled Al-Assas². (1) Department of Plant Protection, Ministry of Agriculture

and Agrarian Reform, Damascus, Syria, Email: zeinabalady@yahoo.com; (2) Plant Protection Department, Faculty of Agriculture, Damascus University, Syria.

Root-Knot Nematodes (RKN) are plant- parasitic nematodes from the genus *Meloidogyne*. They are recognized worldwide as a major production constraint in crops of primary economic importance. They exist in the soil of hot climate areas or areas with short winters. The colorful impatiens (*Impatiens walleriana*), a species of the genus *Impatiens*, native to eastern Africa, is similar to many other plants subject to attack by RKN. Nematodes can produce galls, or swellings on the roots of the plant. Affected plants will look stunted and wilted and then die. In the present study two replications of colorful impatiens plants showing infection symptoms with RKN were used. Each replication consisted of 15 plants and was treated with: (1) the olive pomace using dosages of 10 gram for each plant; (2) by “Vydate” pesticide (common name Oxamyl). Control plants were treated with water. Plants were left for 179 days. Results showed a significant reduction of nematode population on plant roots as well as in the soil when olive pomace was used. Furthermore, the vegetative parts became improved and increased significantly. Moreover, we also observed that the residual effect of organic matters on the plant was less compared to the pesticide (Vydate). As a result, the olive pomace was better than the pesticide in terms of plant growth, but it has the same effect in terms of infection control but safer than chemical pesticides.

N13

DISCRIMINATION BETWEEN SEED GALL NEMATODE ANGUINA TRITICI ON WHEAT AND BARLEY BY PCR-RFLP TECHNIQUE. Fateh Khatib and Fatima Al Zahraa Tabban, Department of Plant Protection, Faculty of Agricultural Engineering, Aleppo University, Aleppo, Syria, Email: khatib_fateh@yahoo.com

The seed gall nematode on barley was considered a biotype that infects barley but doesn't infect wheat. Furthermore, the morphological study didn't show any differences in biometric measurements between the two types. The present research aimed to use the polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) technique to distinguish between the seed gall nematode on wheat and barley. DNA was isolated by four different methods from second juveniles dormant in wheat and barley galls and stored under laboratory conditions for a prolonged period. The primers pair TW81 and AB28 were used to amplify a segment of the ITS1 region in the nematode genome by polymerase chain reaction (PCR), then digest the reaction products by eight restriction enzymes, and separate the digestion products on a 2% agarose gel. The results showed the efficiency of three DNA extraction methods from old samples more than 25 years old, as it was possible to obtain 800 bp fragment from wheat galls, and two fragments 800 and 300 bp from barley galls. The results of enzymatic digestion showed the possibility of distinguishing between seed gall nematodes on wheat and barley by the enzyme *HhaI*. The digestion process resulted in two fragments of length 500 and 300 bp from wheat gall nematodes, and three fragments of length 350, 300 and 200 bp from barley gall

nematode. This technique can be used to investigate seed gall nematodes in fields intended for cultivation of both wheat and barley crops.

WEEDS

W1

EFFECT OF AQUEOUS EXTRACTS ON GERMINATION AND DEVELOPMENT OF THE PARASITIC PLANT *CUSCUTA CAMPESTRIS*.

Abdelmoumen Taoutaou, Nadjia Zermane and Zouaoui Bouznad, Department of Botany, Ecole Nationale Supérieure Agronomique, Algiers, Algeria, Email: abdelmoumen.taoutaou@edu.ensa.dz

In the attempt to find a dodder seed germination inhibitor, several aqueous plant extracts (31) from 29 plant species were tested. Germination of dodder seeds was highly inhibited *in-vitro* by the extract of *Inula* (70%), followed by the lemon zest extract (24%). The speed of germination was also affected by certain extracts: in the case of *Inula*, in the 2nd day, only 1% of seed germinated, 9% in the 4th day and 8% by the 6th day. The garlic extract also demonstrated a reduction in the germination rate of *cuscuta* seed in the 2nd day by 27% and 14% by the 3rd day. The extract of orange zest was also efficient, when only 42% of seed germinated by the 2nd day, followed by the onion extract (47%) compared to the control where 60% of seed germinated by the 2nd day. The length of dodder seedlings was also affected by the extracts of garlic (74% shorter than the control), onion (48%), orange (55%), lemon peel (59%), and *Inula* (55%). The germination of three crops was slightly reduced when treated with *Inula*'s extract: tomato, pepper, and barley. Field assay showed that the extract obtained from *Inula* and peppermint were efficient to control dodder reducing the dry matter weight of dodder by 91%.

W2

DIVERSITY AND EFFECT OF WEEDS ON WHEAT CROP GROWN UNDER THE CENTER PIVOT IRRIGATION SYSTEM IN ZAOUJET KOUNTA REGION, ADRAR, ALGERIA. M'hammed Bouallala¹, Ahmed Boulal¹, Mebrouk Rafai² and Mourad Zaouadi². (1) Laboratory of Saharan Natural Resources, Ahmed Draia University, Adrar 01000 Adrar, Algeria, Email: alim39hammed@yahoo.fr; mha.bouallala@univ-.adrrar.dz; (2) Department of Natural and Life Sciences, Faculty of Science and Technology, Ahmed Draia University, Adrar, Algeria.

Weeds are considered one of the plants that cause losses in agricultural crops, which leads to lower production and therefore economic losses that vary according to the percentage of damage. In order to estimate the percentage of damage to strategic crops, the wheat plant was chosen as the most consumed crop in Algeria. This study was carried out in Zaoui et Kounta area in Adrar state, which is considered one of the drier areas in the Algerian desert, where a center pivot irrigation system with an area of 20 hectares was chosen. Depending on the systematic sampling pattern, 22 field investigations were achieved, which made it possible to identify 19 plant species belonging to 18 genera divided into

6 families. The predominant family was Poaceae (36.84%), followed by Asteraceae (21.05%) and Amaranthaceae (15.79%). The study also showed that all weeds found in the study area are annual plants. The biogeographic spectrum showed that the most common weeds were plants of the two biogeographical types, Mediterranean and cosmopolitan, 21.05% each. The partial invisibility index allowed the identification of 4 species that represent the plants most harmful to wheat in the studied area, namely: *Lolium multiflorum*, *Polypogon monspeliensis*, *Chenopodium album* and *Phalaris paradoxa*. This study is a source for identifying the most dangerous weeds on the wheat crop grown under the center pivot irrigation system in the desert areas.

W3

THE EFFECT OF *PROSOPIS FARCTA* FRUIT RESIDUES ON GERMINATION AND SEEDLINGS GROWTH OF WILD BARLEY (*HORDEUM VULGARE*). Nada Mohammad Eid Albarni¹, Alaa Baune² and Bahaa Alrahban¹. (1) General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria, Email: albarninada@hotmail.com; (2) Faculty of Science, Damascus University, Syria.

Syrian Mesquite *Prosopis farcta* (Banks & Soland.) J. F. Macbr. species is one of the most dangerous pastoral plants in Syria. It has been able, according to its environmental and biological characteristics, to invade all agricultural and non-agricultural environments. In laboratory, the effect of the residues of Syrian mesquite matured fruits on the germination and seedling growth of wild barley was investigated in two ways: (1) by chemical study to detect secondary metabolites in fruits and soil containing fruit residue extracts by using precipitating reagents, (2) bio-testing of the effect of aqueous extracts of matured fruits at three concentrations on germination and seedling growth of wild barley during 2018 and 2019 seasons. The chemical study indicated that the extracts of Syrian mesquite fruit and the soil which had fruit residues of this weed contained phenolics and tannins. The results also showed that *P. farcta* extracts had negative significant role on studied properties, as it reduced germination rate of barley seed, increased the average germination time and decreased radicle and arial parts length, wet and dry weight of wild barley seedling, and the value of Tolerance Index was less than 100 with clear appearance of phytotoxicity. It also decreased pigments content (chlorophyll, carotenes and xanthophil) in leaves of wild barley 15 days old seedlings. This effect increased with increasing concentration. In conclusion, the inhibition effect of *P. farcta* fruit residues on germination and growth of wild barley is due to presence of some secondary chemicals, soluble in water, such as phenolics and tannins, which have toxic effect that may contribute to its invasiveness and extreme competitiveness. The use of these inhibitor chemical compounds as bio-herbicides is an important factor of biological control in the integrated pest control system.

W4 (Please see Page E-126)

CHEMICAL PESTICIDES

PC1

IMPROVED PERFORMANCE OF PESTICIDE'S INJECTION FOR CONTROLLING RED PALM WEEVIL VIA DIRECT ESTIMATION OF WATER CONTENT FOR THREE PALM SPECIES. Hasanain Al-Shalchi¹, Francesco Porcelli² and Ibrahim Al Jiboory³. (1) Arab Centre for the Studies of Arid zones and Dry lands (ACSA), Damascus, Syria, Email: hasaneinyousif@gmail.com; (2) University of Bari Aldo Moro, University of Bari, Department of Soil, Plant and Food Sciences (Di.S.S.P.A.), Italy; (3) College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

The objective of this trial is to improve the performance of pesticide's injection to control Red Palm Weevil by estimating the water content of three types of palm trees, Canary Palm (*Phoenix canariensis* Chabaud), Date palm (*Phoenix dactylifera* Linnaeus) and Fan palm (*Washingtonia filifera*) by estimating the total amount of water in the canopy and trunk to determine the accurate lethal dose of injected insecticides. Samples were taken from different parts of the palm trees (trunk, frond base (carba), frond midrib and leaflet). The results of the canopy of *P. canariensis* showed that the average water content was 0.514 ml/cm³ and for date palm *P. dactylifera* was 0.503 ml/cm³ and for Fan Palm was 0.532 ml/cm³. Whereas, the mean water content of the trunk samples of *P. canariensis*, *P. dactylifera* and *W. filifera* was 0.86 ml/cm³, 0.797 ml/cm³ and 0.752 ml/cm³, respectively. The results revealed the highest total water content was in *P. canariensis* and the lowest total water content was in the palm tree *W. filifera*. The total amount of water content and the evaluation of the lethal dose of the insecticides were discussed in this study. This pioneering trial will contribute to determining the precise dosage of the insecticide for any type of application for all of the mentioned palm species. The dilution of pesticides is a major factor in the process of injecting the palm with chemicals to control the red palm weevil, *Rhynchophorus ferrugineus*, which is one of the most harmful pests of these three types of palms.

CP2

RESIDUES OF THE PESTICIDE FENTHION AFTER QUELEA-BIRDS CONTROL OPERATION ON SORGHUM AND MILLET IN SUDAN. Rawda Yaagoub EL Habieb and Ihsan Ali Abbas, Agricultural Research Corporation, Integrated Agricultural Pests Management Research Center, Pesticides Residues Laboratory, Wad Medani, Sudan, Email: rawdaelhabieb@gmail.com

The pesticide Fenthion (Iproquelea 600 UL) at a dose rate of 600 g/ha was used by the Vertebrate Section, Plant Protection Directorate in the Sudan to control of quelea-birds on sorghum and millet during the 2016-17 season in two regions of conventional breeding in quelea zone. Quelea-birds are known to be an important and dangerous pest of sorghum and millet in the Sudan. The first region was Eldindir area (south Sinnar) and the second region was Elhawata (south Elgadarif). These two locations

were known by their heavy production of sorghum and millet. One day after application, samples of dead birds as well as leaves of sorghum and millet were collected from the treated regions for residue analysis. In the laboratory, triple samples of brain and liver tissues of the dead birds in addition to leaves of sorghum and millet (50 g each) were taken for extraction and clean-up. Determination of the samples was carried out by gas liquid chromatography (GLC) attached with flame photometric detector (FPD). A confirmatory test was done by thin-layer chromatography (TLC). The data obtained indicated that the parent compound of fenthion was present in both brain and liver samples. Also, traces of three degradation products were detected. Such data confirm that fenthion has been transported in both organs. On the other hand, fenthion compound was not detected in all samples of sorghum and millet leaves. However, two of the degradation products were detected in such samples.

CP3

EFFICACY OF SOME CHEMICAL AND BIOLOGICAL PESTICIDES IN CONTROLLING SPINY BOLLWORM *EARIAS INSULANA* (BOISD.) ON OKRA. Atie Arab¹, Ebraheem Aljouri², Narjes Alali¹ and Eman Okasha¹. (1) Agricultural Research Center, Lattakia, Syria, Email: atiearab@hotmail.com; (2) General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria.

Spiny bollworm *Earias insulana* (Boisd.) is the most serious pest that affects okra and causes direct damage to tender fruits. A field experiment was carried out at Lattakia Research Center in 2018 season, in order to determine the efficacy of some synthetic chemical insecticides and commercial bio-insecticides in controlling spiny bollworm on okra. The tested insecticides were flubendiamide (WDG20), alpha-cypermethrin (EC 10%), thiacloprid (100g/l) + deltamethrin (10g/l), azadirachtin (EC 1%) and Btk. 32000 I.U./mg. The recommended field application rates were used and the effectiveness of the insecticides in reducing the infestation of the spiny bollworm was evaluated 3, 7, 15 and 30 days after treatment. The results showed that all the synthetic chemical insecticides were significantly superior to commercial bio-insecticides in reducing the okra fruit infestation due to spiny bollworm, 7 days after treatment. The reduction rate of spiny bollworm infestation was 89.32%, 75.77% and 68.57% for alpha-cypermethrin, thiacloprid+deltamethrin and flubendiamide, respectively, whereas it was 55.89% and 43.97% for azadirachtin and Btk., respectively. Alpha-cypermethrin was the most effective insecticide 3, 7 and 15 days after treatment. Results also indicated that there was a decrease in the effectiveness of the chemical pesticides in controlling spiny bollworm population, while there was an increase in the effectiveness of bio-pesticides 30 days after treatment. The reduction rate of spiny bollworm infestation was 31.63%, 23.73% and 23.35% for flubendiamide, thiacloprid+deltamethrin and alpha-cypermethrin, respectively, whereas this rate was 41.64% and 64.15% for Btk and azadirachtin, respectively.

CP4

DETECTION OF MUTATIONS LINKED TO INSECTICIDE RESISTANCE IN THE GREEN PEACH APHID *MYZUS PERSICAE* (SULZER) COLLECTED FROM PEACH AND POTATO IN TUNISIA. Amen Hlaoui^{1,2}, Emanuele Mazzoni³, Olga Chiesa³, Michela Panini³, Rebha Souissi¹ and Sonia Boukhris-Bouhachem¹. (1) Laboratoire de Protection des Végétaux, INRAT, Rue Hédi Karray, Ariana 2049, Tunisie, Email: hlaoui_amen@hotmail.com; (2) Département Santé, Végétale et environnement, INAT, 43 Avenue Charles Nicolle, Cité Mahrajène 1082, Université de Carthage, Tunisie; (3) Dipartimento di Scienze delle Produzioni Vegetali Sostenibili, Università Cattolica del Sacro Cuore, Via Emilia Parmense, 84, I-29122 Piacenza, Italy.

Myzus persicae (Sulzer) (Hemiptera: Aphididae) is a polyphagous pest that can colonize a wide range of plants and it is classified as one of the most injurious insect feeding on more than 400 species belonged to 50 plant families. Its harmful effects are produced through direct damage by feeding on plant leaves and indirectly by transmitting viruses. In Tunisia many studies reported the impact of *M. persicae* on seed potato with high (80-100%) transmission efficiency of Potato virus (PVY) and Potato leaf roll virus (PLRV), and renowned as efficient vector of Sharka disease caused by Plum pox virus (PPV) to peach trees. Recent study dealt with the variation in population structure and genetic diversity of *M. persicae* in three Tunisian localities (Cap Bon, Jendouba and Kairouan), where seed potato is cultivated, and peach orchards are prevalent. As a complementary work to what has been described previously regarding aphid biology and its distribution using microsatellite markers, we have analyzed variation in *M. persicae* populations, obtained from the same prospected regions mentioned above during different past surveys, using target site mutations linked to insecticide resistance. In these areas, *M. persicae* exhibited a strong resistance to several classes of insecticide (neonicotinoids, pirimicarb and pyrethroids), widely used by growers to prevent aphid vector propagation. Aphids were collected from peach and potato, preserved in absolute alcohol until DNA extraction from single specimens. Using a qualitative real-time PCR assay, each sample was analyzed to detect wild type and mutant alleles. Results revealed that 3.52% of samples were heterozygous (SR) and 96% were homozygous sensitive (SS) for MACE resistance to pirimicarb. The mutation in *kdr* locus conferring target site resistance to pyrethroids was found with the following percentages: 87% SS and 12% SR. Interestingly, all samples tested for imidacloprid resistance (mutation R81T) were susceptible. Distribution of insecticide resistance according to locality, host and temporal changes will be discussed.

CP5

EFFICACY OF SELECTED INSECTICIDES ON THE GRAPEVINE MEALYBUG *PLANOCOCCUS FICUS* AND THEIR SIDE EFFECTS ON ITS NATURAL ENEMIES *LEPTOMASTIX DACTYLOPII* AND *CRYPTOLAEMUS MONTROUZIERI*. Rabeb Brahmi¹, Khaled Abbes¹, Ahlem Harbi¹, Ridha Rahmouni² and Brahim Chermiti¹. (1) University of Sousse, High

Agronomic Institute of Chott-Mariem, Department of Biological Sciences and Plant Protection, Sousse, Tunisia, Email: Brahmirabeb@yahoo.com; (2) Citrus Technical Centre (CTA), Beni Khalled, Zaouiet Jédidi, Tunisia.

The grapevine mealybug (GVM) *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae) is an economic pest of vineyards. In Tunisia, its management is still exclusively dependent on the repeated applications of broad-spectrum chemical insecticides. Two efficient natural enemies of the GVM are present in Tunisia which are the parasitoid *Leptomastix dactylopii* (Howard) and the predator *Cryptolaemus montrouzieri* (Mulsant) and can be immediately used to develop an integrated pest management program (IPM). In this study, we assessed, under laboratory conditions, the efficiency of four insecticides frequently used in Tunisian vineyards to control *P. ficus* which are Prev-Am® (disodium tetraborate), Movento 150 OD® (spirotetramat), Perfecthion (dimethoate) and Lorvec 5G (chlorpyrifos-ethyl) and their lethal and sublethal side effects on the natural enemies *L. dactylopii* and *C. montrouzieri*. Dimethoate, chlorpyrifos-ethyl and spirotetramat were very efficient against the first, second and third larval stages of *P. ficus* with a maximum mortality of 100% reached after two days of exposure. Di-sodium tetraborate had a very reduced efficacy against adults with mortality rate not exceeding 8%, whereas spirotetramat caused 46% mortality rate. Furthermore, dimethoate and chlorpyrifos-ethyl were the most toxic to adults with 85% mortality. The assessment of lethal side effects of insecticides against *L. dactylopii* revealed that dimethoate and chlorpyrifos-ethyl have high toxicity compared to disodium tetraborate and spirotetramat with mortality rate reaching 100%, one day after exposure. It was found that spirotetramat and di-sodium tetraborate could be compatible with augmentative releases of *C. montrouzieri* in vineyards to control *P. ficus*. Conversely, chlorpyrifos-ethyl and dimethoate were very toxic and seriously affect female fertility, longevity and survival until the adult stage. The possible use of these insecticides alongside the parasitoid and the predator to control *P. ficus* in Tunisian vineyards will be discussed.

CP6

PESTICIDES RESISTANCE MONITORING AND BIOCHEMICAL IMPACT ON FIELD POPULATIONS OF *SPODOPTERA LITTORALIS* (BOISD.) IN EGYPT. Eman A. Fouad¹, Fatma Sherif², Norhan A.E. El-Morsy² and Moataz A.M. Moustafa². (1) Bioassay Department, Central Agriculture Pesticides Laboratory, Agriculture Research Centre, 12618, Egypt, Email: emansoliman28@hotmail.com; (2) Department of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University, 12613 Giza, Egypt.

Cotton leaf worm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) is a key pest affecting many field crops and vegetables in Egypt. *S. littoralis* management was achieved by various insecticides with different modes of action. In the current study, the sensitivity of the 2nd instar larvae of *S. littoralis* laboratory strain to eight insecticides was investigated and the insecticide resistance levels on two

field populations were monitored. The two populations were collected from two governorates in Egypt namely El-Fayom and El-Monofeya. Resistance monitoring showed that the El-Fayom field population was highly resistant to chlorantraniliprole, emamectin benzoate (EMB), spinetoram and spinosad. In contrast, El-Monofeya field population exhibited only high resistance to chlorantraniliprole and spinosad. The relative toxicity investigation showed that the laboratory strain was highly sensitive to EMB ($LC_{50}=0.001$ ppm) followed by spinetoram ($LC_{50}=0.006$ ppm), chlorantraniliprole ($LC_{50}=0.008$ ppm), spinosad ($LC_{50}=0.008$ ppm) and indoxacarb ($LC_{50}=0.021$ ppm), whereas chlorfenapyr, fipronil and alpha-cypermethrin exhibited low toxicity to 2nd instar larvae of *S. littoralis* laboratory strain. Moreover, the biochemical determinations revealed that carboxylesterase activity, glutathione S-transferase (GST) and mixed-function oxidases (MFOs) showed different values between the experimental populations tested.

CP7

TOXICITY OF IMIDACLOPRID AND NANO-IMIDACLOPRID ON *SAISSETIA OLEAE*. Magda Mahmoud Amin Sabbour, Department of Pests and Plant Protection, Agriculture Division, National Research Center, Egypt, Email: sabbourm@yahoo.com

Olive trees attacked by the harmful pest *Saissetia oleae* (Hemiptera: Coccidae), which causes a serious damage to the trees. Imidacloprid is a broad-spectrum neonicotinoid insecticide, with excellent systemic and contact activity. Data obtained on the usage of imidacloprid and nano-imidacloprid against *S. oleae* are promising. Results obtained indicated that the LC_{50} of imidacloprid and nano-imidacloprid were 133 and 31 ppm, respectively. Under field conditions, a significant decrease of the number of eggs/female was revealed for both imidacloprid (55 ± 6.1 eggs/female) and nano-imidacloprid (5 ± 7.2 eggs/female) compared to the control (289 ± 6.9 eggs/female). The hatching rate, larval mortality, production of malformed pupae and adults decreased significantly following imidacloprid treatments and fully reduced after nano-imidacloprid treatment. The olive fruits yield increased significantly to 2566 ± 43.01 and 1210 ± 40.09 kg/feddan as compared to 1780 ± 55.43 and 1200 ± 33.11 kg/feddan in the control during the 2017 and 2018 seasons, respectively.

CP8

EVALUATION OF THE ENVIRONMENTAL IMPACT OF PESTICIDES USED BY PERI MODEL: CASE STUDY OF BISKRA ZIBAN, ALGERIA. Nafissa Soudani¹, Mohammed Belhamra^{1,2}, Yunusa Ugya Adamu³, Nagashvar Patel⁴, Laura Carretta⁴, Alessandra Cardinali⁴ and Khaoula Toumi⁵. (1) Department of Agricultural Sciences, Laboratory of the Diversity of Ecosystems and Dynamic Systems of Agricultural Production in Arid Zones (DEDSPAZA), Mohamed Khider, University of Biskra, Algeria, Email: nafissa.soudani@univ-biskra.dz; (2) Scientific and Technical Research Centre on Arid Regions C.R.S.T.R.A, Compus of Mohamed Khider University of Biskra, Algeria; (3) Department of Environmental

Management, Kaduna State University, Kaduna, Nigeria; (4) Department of Agronomy, Food, Natural resources, Animals and Environment (DAFNAE), University of Padua, Italy; (5) Gembloux Agro-Bio Tech- University of Liege, Belgium-Laboratory of Pesticide Science.

Chemical pesticides are widely used on vegetable crops in Algeria to control different pests. A questionnaire was carried out among vegetable growers located in communes of Ain Naqa and Doucen, Biskra, southeastern Algeria to better understand local agricultural practices and to define the potential environmental risks of the most pesticides used. Pesticide risk indicators were elaborated to assess the potential risks of the tested pesticides that may cause environmental damage, and environmental risk scores under local conditions have been evaluated for eighteen of the common used pesticides. The results showed that six active ingredients within the tested compounds reached the highest environmental risk category (score of 5 or more). In addition, most of the tested pesticides showed very toxic effects to aquatic life, particularly with long-lasting effects for ecosystems and the environment. Therefore, farmers should be trained and made aware of the importance of rational use of agricultural pesticides, in order to reduce the risks to the environment.

CP9

EVALUATION OF CERTAIN NEONICOTINOID INSECTICIDES AGAINST THE SUBTERRANEAN TERMITES, *ANACANTHOTERMES OCHRACEUS* (BURMEISTER) WORKERS UNDER LABORATORY CONDITIONS IN EGYPT. Mahmoud Faker Mohamed Ali, Plant Protection Department, Faculty of Agriculture, The New Valley University, Egypt, Email: mahmoudfakeer@yahoo.com

The subterranean termites, *Anacanthotermes ochraceus* (Burmeister) (Isoptera: Hodotermitidae) is the most important pest causes damage to buildings, furnitures, rural grain stores, papers and almost any materials containing cellulose in the New Valley Governorate, Egypt. Herein, the toxicity of four selected neonicotinoids [Imidacloprid (20% SL), Thiacloprid (40% SC), Nitenpyram (10% SL), Clothianidin (42% SC) and one organophosphate pesticide [chlorpyrifos (48% EC)] were evaluated against *Anacanthotermes ochraceus* workers. The experiments were carried out at the laboratory of the Plant Protection Department, Faculty of Agriculture, the New Valley University. The termite workers-dip bioassay method was used. The mortality rate (%) of the termite workers were recorded 1, 6, 12 and 24-h after exposure periods. Results obtained showed that Chlorpyrifos (48% EC) was the most toxic insecticides among all insecticides tested. Whereas, among the four neonicotinoid insecticides tested against termites, Imidacloprid (20% SL) was found the most potent among all insecticides. It was concluded that using neonicotinoid insecticides were the most effective in reducing the subterranean termite populations in the New Valley Governorate, Egypt.

CP10

EFFICACY OF 2,4-D, GLYPHOSATE AND THEIR MIXTURES ON CONTROL OF MESQUITE TREE (*PROSOPIS JULIFLORA* SWART). Thoria Ab-Talab¹, Mahmoud S. Zaroug² and Dafalla A. Dawoud¹. (1) Agricultural Research Corporation, Plant Protection Center, Weed Research Program, Wad Medeni, Sudan, Email: a.talab2010@hotmail.com; (2) University of Gezira, Faculty of Agriculture, Wad Medeni, Sudan.

Mesquite (*Prosopis juliflora*) is one of the worst weeds that at present cause significant threat to agricultural production in Sudan. It was introduced into the country to curb desertification, but meanwhile it became a serious weed. Experiments were conducted at Hantub, east Wad Medani town in Gezira state, Sudan, during 2015–2017. The efficacy of 2,4-D (Diolina®720 SL), glyphosate (Glyolina®41% SL) and their mixtures with or without adding saysalic acid on the control of mesquite trees was investigated in comparison with the recommended herbicide Triclopyr (Trilina® 48EC). The herbicides were dissolved in diesel and applied as basal bark treatment. The herbicide 2,4-D was applied also as foliar application using knapsack sprayer. All treatments were arranged in a completely randomized block design (CRBD) with four replicates. In basal bark treatment, sole application of glyphosate at the rate of 3 and 5 % showed poor performance compared to the sole application 3 and 5% of 2,4-D, whereas tank-mixed application of both produced effective control. Adding 10g/l saysalic acid to sole dose of 2, 4-D, glyphosate and their combinations increased the herbicides efficacy. Basal application of 5% 2, 4-D + 5% Glyphosate in the 2015/2016 and 2016/2017 seasons gave excellent control of 88-100% leaves mortality comparable to the standard treatment of Triclopyr 1.66% which gave 89-100% leaves mortality, 90-120 days after application. Application of 2,4-D as single dose was more effective than split dose, whereas 2,4-D at 7 and 9% gave 100% leaves mortality after 60 days similar to the standard Triclopyr at the rate of 2% as foliar spray. Diesel alone applied as basal bark treatment or foliar spray gave 10-15% leaves mortality in comparison to the untreated control.

CP11

EFFORTS TO USE SOFT PESTICIDES FOR THE CONTROL OF INSECT PESTS AS CONTRIBUTION TOWARDS GREEN CHEMISTRY. Hayder Abdelgader, Agricultural Research Corporation, Integrated Agricultural Pests Management Research Center, PO Box 126, Wad Medani, Sudan, Email: Abdelgaderh@yahoo.com

In the last decades during the post-war period, agriculture has developed towards methods that are more intensive. Among these is increased use of agrochemicals. In the Sudan Gezira, as an example, cotton spraying started as early as the 1945/46 season, when only 1% of the cotton area was sprayed once with pesticides. By the 1978/79 season, the problem caused by the cotton insect pests, particularly the cotton whitefly (*Bemisia tabaci*) flared up, and the number of sprays per season reached 9.25 sprays. This might be attributed partly to the rapid resurgence of insects' pests as a result of the use of non-selective insecticides, which badly affected the natural enemies of these pests. The joint use of natural enemies and selective pesticides might solve this

problem. Studying the side effects of pesticides is of prime importance to save natural population and encourage their role as biological control agents. This study focused on the various methods which can be used to study the side effects of pesticides on natural enemies, both at small and large scale levels in Sudan. The study includes testing the side effects of some insecticides and their impact on bio-safety (Talstar, Polo, Metasystox, Marshal and the mixture Reldan + Endosulfan) on two predators at small-scale level at the Gezira Research Farm, Wad Medani. The Impact of Polo (diafenthion) on natural enemies in the cotton-based ecosystem of the Gezira Scheme (Large Scale) was also tested in this Study. The results obtained indicated that Polo was relatively safe both at small scale and large-scale levels to the natural enemies observed during the study. This study can be considered as a beginning of a regional testing program in Africa with the collaboration of international organizations interested in conserving bio-agents.

CP12

AGRICULTURAL WORKERS' KNOWLEDGE, ATTITUDES, AND PRACTICE TOWARD PESTICIDES. Ali S. Al-Sarar¹, Alaa E. Bayoumi², Yasser Abobakr¹, Ali A. Alzabib¹ and Ahmed Horab¹. (1) Department of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia, Email: asarar@ksu.edu.sa; (2) Faculty of Agriculture, Ain Shams University, Egypt.

Pesticides are chemical substances that are extensively used in the agricultural sector to control pests and boost agricultural production. It is known that the misuse of pesticides has detrimental effects on the environment and human health. This study aimed to evaluate the knowledge, attitude, and practice (KAP) related to pesticide use among agricultural workers in the Kingdom of Saudi Arabia (KSA). A cross-sectional study among 58 agricultural workers was carried out in Al-Kharj and Al-Qassim regions. A designed KAP questionnaire was offered to the respondents and the data were collected by face-to-face interviews. The age of participants ranged between 18 and 65 years, with an age mean of 40 years. With respect to educational level, it was found that 12.1% of the workers have a university degree, 25.9% have a secondary education, 20.7% have primary education, 17.2% were able to read and write, and 24.1% were illiterate. Concerning the use and handling of pesticides, it was found that 22.4% of the workers apply pesticides, 23.8% wash the devices after applying the pesticides, 18.2 % transport the pesticide containers, 16.8% mix the pesticides, 9.8% their work is to store the pesticides, and 9.1% dispose the empty containers. Majority (97.5%) of the workers did not undergo any training course in the field of agricultural pesticides. The most important sources of information they rely on are other farm workers, relatives, friends, neighbors, and means of social communication. The sample members had, to a large extent, a positive attitude towards the pesticide label. Burning in the open air was the main method for disposal of the pesticide containers. Inappropriate disposal of pesticides and their containers can cause environmental adverse effects. Inadequate awareness of the respondents toward pesticide handling was noticed.

CP13

LETHAL AND SUBLETHAL EFFECTS OF INSECTICIDES ON LEPIDOPTERAN INSECT PESTS. Moataz A. M. Moustafa¹, Eman A. Fouad² and Fatma S. Ahmed¹. (1) Department of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University, Giza, Egypt, Email: moataz.moustafa79@gmail.com; (2) Bioassay Department, Central Agriculture Pesticides Laboratory, Agriculture Research Centre, Giza, Egypt.

Lepidopteran insects are a polyphagous group of insect pests which include the Egyptian cotton leafworm, *Spodoptera littoralis* Boisduval, and the black cutworm, *Agrotis ipsilon* Hufnagel. These pests attack field and several vegetable crops. Frequency of use of chemical insecticides as a rapid method for control of these pests led to the emergence of insecticide resistance problem, as well as the harmful impact of these insecticides on animal health and the environment, and accordingly the world has tended to reduce the use of chemical insecticides as much as is practically possible. Therefore, there was a need for alternative insecticides that are more efficient and environmentally safe. Biopesticides and new mode of action chemical insecticides could play a useful role as an alternative approach in crop protection. Studies related to the lethal effect of bioinsecticides and new insecticides on insect pests were examined through mortality data. However, several recent studies estimated the sublethal effects of insecticides on biological traits of insect pests. Generally, the sublethal concentrations of an insecticide can affect insect biology, behavior, and physiological and demographic parameters. Accordingly, this study investigated the lethal and sublethal effects of different insecticide formulations on the development, reproduction and enzymatic activity of different lepidopteran species.

CP14

EXPOSURE OF TUNISIAN FARM WORKERS TO PESTICIDE RESIDUES DURING RE-ENTRY AFTER APPLICATION. Khaoula Toumi¹, Laure Joly², Neji Tarchoun³, Christiane Vleminckx² and Bruno Schiffers¹. (1) Laboratoire de Phytopharmacie, ULg/Gembloux Agro-Bio Tech, Université de Liège, Gembloux, Belgium, Email: dr.khaoula.toumi@gmail.com; (2) Institut Scientifique de la Santé Publique, Bruxelles, Belgium; (3) Université de Sousse, Sousse, Tunisia.

The aim of the present work is to evaluate possible exposure of farm workers to pesticide residues when re-entry after application. The investigation was carried out in the Sahel region of Tunisia. A cotton glove samples were distributed to farm workers who wears them for two consecutive half-days during harvesting of chili peppers or tomatoes to estimate their dermal exposure. The systemic exposures (SE) of workers were estimated at the median concentration of residues in glove samples. Four and six active ingredients respectively exceed the acceptable operator exposure level (AOEL) for each of tomatoes and chili peppers. These results confirmed higher risks of worker exposure to pesticide residues, with possible side-effects on their health. There is a need for education among workers on the use of personal protection equipment's (PPE) during re-entry activities to avoid exposure and health hazards.

CP15

IMPACT OF PHYTOSANITARY PRACTICES ON THE SUSTAINABILITY OF THE GREENHOUSE PRODUCTION SYSTEM - THE CASE OF BISKRA PROVINCE IN SOUTHEAST ALGERIA. Abdelaali Bencheikh¹ and Farida Bettiche². (1) Nature and Life Sciences Department, Ahmed Draya University, Adrar, Algeria, Email: bencheikh1400@gmail.com; (2) Scientific and Technical Research Center on Arid Regions (CRSTRA), Campus Universitaire; Mohammed Kheider, Biskra, Algeria.

The greenhouse vegetable production system has been developed considerably in the south of Algeria. However, the agrochemical practices adopted by farmers have not yet been improved for the protection of the environment and human health. The main aim of this study was to characterize and evaluate the phytosanitary practices carried out in greenhouse vegetable production in Biskra province (southeast of Algeria). A survey was conducted in the studied region with 85 vegetable farmers in the six most productive municipalities namely: M'ziraa, Ain Naga, Sidi Okba, ELgrous, Doucen and Lioua. This study focused on greenhouse vegetable production system mainly: tomato, chili, pepper, eggplant, zucchini, and melon. Because of its particularity of high yield and intensive use of chemical inputs, the survey covered the description of the following practices: products used, total number of products, quantity, frequency, target, mode of application, precautions for use (during and after application), reasons for choosing the product, management of residues, maintenance of treatment equipment, time, labor and cost. A farm typology was developed based on six variables that are the most determining phytosanitary practices in the Biskra region. In addition, the results obtained showed that these practices had a negative influence on the human health and the environment, which threatens the sustainability of the system.

PLANT EXTRACTS

EX1

BIOLOGICAL AND BIOCHEMICAL EFFECTS OF CUMINUM CYMINUM L. EXTRACT ON BLACKCUT WORM AGROTIS IPSILON (HUFN.). Adel Mohamed El-Rawy and Soad Mohamed Osman, Plant Protection Research Institute, ARC, Dokki, Giza, Egypt, Email: adel_elrawy69@yahoo.com

The effect of the plant extract of cumin, *Cuminum cyminum* L., on the 4th instar larvae of the blackcut worm *Agrotis ipsilon* (Hufn.) (Lepidoptera: Noctuidae) was studied in regard to certain biological and biochemical aspects. Ethyl alcohol was used as a solvent at a rate of 2 ml/1 gm material for 48 hrs extraction period. Solvent extract was evaporated to dryness under reduced pressure by a rotary evaporator in a water bath adjusted at 60 °C. The residue was weighed and used to obtain different concentrations using water as diluent. The test concentrations were 2.5, 5, 10, 15 and 20%. Fresh castor oil leaves were dipped in each concentration for 1 minute and left to dry. Forty 4th instar larvae were allowed to feed on the treated leaves for each concentration with 4

replicates (ten larvae/replicate). A similar number of larvae were fed on fresh castor oil leaves as control. The LC₅₀ value resulting from plant extract was estimated. One hundred 4th instar larvae were allowed to feed on the treated leaves with LC₅₀ (7.4%). A similar number of larvae were fed on fresh leaves as control and examined daily to determine the different biological aspects such as larval and pupal durations and pupal weight. Forty newly molted 4th instar larvae were treated with LC₅₀ and similar number of larvae were fed on fresh leaves as control to determine the change in acetylcholine esterase (A chE), amino acid transferases (GOT and GPT) and the total protein content. The plant extract caused an increase in larval and pupal durations (23.25 and 10 days, respectively) and decrease in pupal weight (0.286 mg) compared with control (21 and 9.29 days and 0.384 mg, respectively). In addition, it caused reduction in the acetylcholine esterases (A chE) activity (-54.85 %), activity of glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) (-7.21 and -12.12 %, respectively) and level of total protein (- 28.35%) compared with the control.

EX2

EVALUATION OF THE EFFICIENCY OF SOME PLANT EXTRACTS AGAINST TWO AGRICULTURAL PESTS (*TETRANYCUS URTICAE* AND *TUTA ABSOLUTA*) OF GEOTHERMAL CROPS IN SOUTHERN TUNISIA. Ali Ben Belgacem, Chaker Bennour and Hammadi Hamza, Arid and Oases Cropping Laboratory, Arid regions Institute Medenine, Tunisia, Email: benbelgacem5@yahoo.fr

This study aimed to investigate the application of biological control on two agricultural pests (*Tetranychus urticae* and *Tuta absoluta*) in heated greenhouses in southern Tunisia by using aqueous plant extracts of cleome (*Cleome amblyocarpa*) and parthenocarpic dates. The two aqueous extracts studied showed a biocidal potential against the different developmental stages of the two pests: egg and adult stages of *T. urticae* and the “young larvae” and “old larvae” of *T. absoluta*. The aqueous extract of parthenocarpic dates showed greater biocidal efficacy than that of cleome on all the development stages studied of these two pests. In addition, the adult stage of the mites showed a much greater sensitivity to the two extracts than that of the eggs. Similarly, the young larval stage was more sensitive than the old larval stage to both aqueous extracts. It can be concluded that aqueous extracts of *C. amblyocarpa* and parthenocarpic dates can be used as biological control components in the management of the two pests studied.

EX3

EVALUATION OF SOME BOTANICAL EXTRACTS FOR THE MANAGEMENT OF TOMATO LEAFMINER (*TUTA ABSOLUTA*) (MEYRICK) OF TOMATO IN SUDAN. E.S.I. Mohamed¹, M.E.E. Mahmoud², S.A. Mohamed³ and S. Ekesi³. (1) Shambat Research Station, Agricultural Research Corporation, Khartoum North, Sudan, Email: ensafmohamed1@gmail.com; (2) Kassala and Gash Research Station, Agricultural Research Corporation,

Kassala State, Sudan; (3) International Centre of Insect Physiology and Ecology, Nairobi, Kenya.

The tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a serious pest worldwide to tomato production. Its control in tomato open-fields has relied heavily on synthetic insecticides, which caused problems of insecticide resistance and chemical residues. This has been favoring the development and growing interest in the use of biopesticides and biorational pesticides, as an alternative to conventional insecticides. This study was conducted in greenhouse at Shambat Research Station, Khartoum State, Sudan to assess the insecticidal potential of the aqueous extract of five plants each with two concentrations against *T. absoluta*. These plants included *Azadirachta indica* A. Juss., *Allium sativum* L., *Coriandrum sativum* L., *Solenostemma argel* and *Ammi visinga* L. All tested plant aqueous extracts reduced the percentage of mined leaflets, percentages of infested fruits and number of mined leaflets per plant compared with untreated tomato plants. The neem treatments were more effective than other tested plants and the standard insecticide, Biotrine 1.8% EC (abamectin). According to these results, the neem seeds aqueous extract could serve as an alternative for management of *T. absoluta* in green house tomato, as it is cheap, safe and environment friendly.

EX4

EFFECT OF SOME BOTANICAL OILS ON THE CONTROL OF THE COTTON JASSID, *JACOBASCA LUBICA* (DE BERG) ON EGGPLANT AT GEZIRA AND KHARTUM STATE, SUDAN. Mohamed B. M. Hassan, Faiza E.E. Salah and Adil Khodor, Department of Crop Protection, Faculty of Agricultural Sciences, University of Gezira, Sudan, Email: faizaruba2@gmail.com

Eggplant, *Solanum melongena* L., is one of the major vegetable crops in the Sudan. Eggplant is infested by different species of insect pests. However, the cotton jassid (*Jacobiasca lybica*) (Hemiptera: Cicadellidae) is considered as the major pest. This study was conducted to investigate the effects of 3 botanical oils; castor bean seed oil, cotton seed oil and sunflower seed oil on the population of the cotton jassid in eggplant, cultivar Wizzo. Two field experiments were conducted during the 2015/2016 season at two sites, the experimental farm in the Faculty of Agricultural Sciences, University of Gezira and Elalafoon at the eastern Bank of the Blue Nile, in Khartoum state. The experiments in both sites were arranged in a randomized complete block design (RCBD) with four replications. The botanical seed oils at a concentration of 5% were applied at 7 days interval with four sprays. Post-treatment observations on number of jassid were taken 2 days after the application. The results indicated that all oil treatments were apparently effective against the cotton Jassid compared to the untreated control. The study found that the cotton seed oil was more effective in reducing the number of Jassid on eggplant (64 insects/100 leaves) followed by sunflower seed oil (132 insects/100 leaves), castor bean seed oil (140 insects/100 leaves) and the untreated control (312 insects/ 100 leaves) at Wad Medani site whereas at Khartoum Site, the cotton seed oil caused highest reduction to jassid population (92 insects/100 leaves) followed by castor bean seed oil (140

insects/100 leaves), sunflower oil (208 insects/100 leaves) and the untreated control (608 insects/ 100 leaves). This study recommended that cotton seed oil can be used to reduce the number of cotton jassid on the eggplant crop.

EX5

PHYTOCHEMICAL STUDY AND INSECTICIDAL ACTIVITY OF TUNISIAN *MENTHA PULEGIUM* L. ESSENTIAL OIL AGAINST *TRIBOLIUM CASTANEUM* (HERBST) AND IMPACT ON FLOUR QUALITY DURING STORAGE. Olfa Bachrouch¹, Soumaya Haouel Hamdi⁴, Jazia Sriti², Majdi Hamami², Emna Boushah⁴, Manef Abderraba³, Ferid Limam² and Jouda Médiouni Ben Jemâa⁴. (1) Laboratoire de Protection des Végétaux, Institut National de la Recherche Agronomique de Tunisie (INRAT), Rue Hedi Karray, Ariana, Tunis, Email: bachrouch_olfa@yahoo.fr; (2) Laboratoire des Substances Bioactives, Centre de Biotechnologie à la Technopole de Borj Cedria, Hammam Lif, Tunisia; (3) Laboratoire Matériaux- Molécules et applications, IPEST, route Sidi Bou Said, La Marsa, Tunisia; (4) Laboratoire de Biotechnologie Appliquée à l'Agriculture, Institut National de la Recherche Agronomique de Tunisie (INRAT), Rue Hedi Karray, Ariana, Tunis, Université de Carthage, Tunisia.

In Tunisia, cereal grains are the most important food components, and they constitute a major source of energy of high biological value, roughage and vitamins, and insect pests represent a major threat for food security. Worldwide, 10 to 20% of all grain produced is lost due to stored product pests before it reaches the consumer. The control of these pests in storage depends mainly on synthetic fumigants, even though they cause damage to human and environmental health. These problems imposed the need for the development of safer alternatives. This study was conducted to determine insecticidal activity of essential oil from *Mentha pulegium* (L.) against *Tribolium castaneum* (Herbst) adults and its impact on wheat flour quality under storage conditions. Insect mortalities, occupied space conditions, and wheat flour quality were investigated one and two months after storage. The results of GC/MS analysis showed that p-menthone (35.66%), pulegone (39.15%) and piperitone (3.55%) were the major oil components. Furthermore, the lethal concentration of *M. pulegium* essential oil used for the trial was 196.6 µl/l air. In fact, results revealed that mortality rate depended on two parameters which are occupied space and storage duration. The highest mortality rate corresponds to 50% of occupied space and reached 32.78% and 72.22% one and two months after storage, respectively. In addition, physicochemical characteristics were investigated on treated wheat flour to evaluate its quality. This study demonstrated that the optimization of the occupied space and the storage period could contribute to the success of *T. castaneum* management during storage.

EX6

EFFECT OF SOME INERT DUSTS AGAINST COWPEA WEEVIL *CALLOSBRUCHUS MACULATUS* (F.). Rehab Esber¹, Ebraheem Aljour² and Ziad Chikh-Khamis¹. (1) Plant Protection Department, Agricultural Engineering Faculty, Al-Baath University,

Syria, Email: aljour²@uni-hohenheim.de; (2) Institute of Phytomedicine, Faculty of Agricultural Sciences, University of Hohenheim, Germany.

This study aimed to assess the effect of some inert dusts namely kaolin, silica and zeolite, against cowpea weevil *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae) adults using five concentrations: 5, 10, 20, 40 and 80 g/kg cowpea seeds. The study was carried out within the incubator at a constant temperature and relative humidity at the Biotechnology Research Center at Al-Baath University. Mortality rates were calculated after 3 days and effectiveness to reduce loss of seed weight damage rate and the reduction of adult emergence were calculated, in order to benefit from these results to implement an initial experiment at the warehouse level. The results obtained showed the effectiveness of three inert dusts, and highest mortality rate was obtained by using Kaolin (85.49%) followed by Silica (81.72%) and Zeolite (82.93%) and the effectiveness increased with increase in concentration. The relationship was positive between increasing concentration and increasing effectiveness of dusts in reducing seed loss, damage ratio and adult emergence. The effectiveness at concentration of 10 g/kg were 91.48, 91.35 and 90.35% respectively, and the effectiveness increased at concentration 40 g/kg to 95.71 and 95.35 and 94.65% respectively. Kaolin dust was superior to Silica and Zeolite and it reduced weight loss, damage and adult emergence by 99.71, 99.70 and 99.77%, respectively, and for all the concentrations used. Whereas in case of zeolite, it reached 87.06, 87.76 and 86.56%, respectively. Based on these results, kaolin dust was chosen for use in an initial experiment at the warehouse level. This experiment gave promising and significant results in reducing the loss in seed weight 8 months after treatment and increased the amount of good seeds compared to the untreated control, and it can be recommended for use to protect seeds from infestation with the cowpea weevil.

EX7

THE LANTANA CAMARA PLANT AS A RESOURCE OF BIO-FUNGICIDE AGAINST *BOTRYTIS CINEREA* IN STRAWBERRY FRUITS. Messaouda Benabdelkader¹, Hadjer Saifi² and Rayane Saifi³. (1) Laboratory of Applied Microbiology, Setif University and Laboratory of Jijel University, Algeria, Email: yamina_messaouda@yahoo.fr; (2) Biotechnologies and Nuclear Technologies Laboratory, National Center for Nuclear Sciences and Technologies, Department of Biological Sciences, University of Tunis El Manar, Tunisia; (3) Diversity of Ecosystems and Dynamics of Agricultural Production Systems in Arid Zones Research Laboratory, University of Biskra and University Center of Tamarasat, Algeria.

Beneficial effects of extracts from wild plants, used in folk medicine, have opened a portal for scientific research. The objective of this study was to evaluate the effect of the extract of a wild plant species *Lantana camara* extract on the mycelial growth of the fungus *Botrytis cinerea*, the causal agent of gray mold of strawberry fruits in the Jijel region in Algeria. The extraction from *Lantana camara* leaves was carried out by decoction, and the chemical composition of the extract was determined by the CPG-SM. The evaluation of the antifungal activity of this extract against *Botrytis*

cinerea, isolated from strawberry fruits, was carried out in vitro, by direct contact. This organic extract showed 75% fungal inhibition in the concentrated form and 50% inhibition in the diluted form. This significant antifungal activity may be due to the chemical compounds in the extract such as flavonoid monoterpene, phenol monoterpene, sesquiterpene, and biphenol. *Lantana camara* could be a resource for an environmentally friendly products alternative to chemical pesticides.

EX8

COMPOSITION AND ANTIFUNGAL ACTIVITIES OF THE METHANOL EXTRACTS OF *SALVIA MULTICAULIS* (VAHL) AND *SALVIA SPINOSA* L. Zakaria Al-Naser, Department of Plant Protection, Faculty of Agriculture, Damascus University, Syria, Email: zinzanasera@gmail.com

The present study was carried out to determine the chemical composition and antifungal activity of methanol extracts derived from the aerial parts of two aromatic plants *Salvia multicaulis* Vahl. and *Salvia spinosa* L. (family: Lamiaceae) growing under semiarid conditions in Syria. The aerial parts were collected, during 2016, and the methanol (MeOH) extract was prepared in a Soxhlet device and analyzed using Gas Chromatography-Mass Spectrometry (GC/MS). The antifungal activity of the methanol extracts was tested against five fungal species at concentrations of 250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2500 and 3000 ppm by using poison food technique. In total, 14 and 22 compounds were identified in the methanol extracts from the aerial parts of *S. multicaulis* and *S. spinosa*, respectively. The major components in the methanol extract of *S. multicaulis* were, 1,8-cineole (35.97%), *trans*-nerolidol (13.85%), trans-caryophyllene (11.50%), α -pinene (8.46%) and spathulenol (8.06%). Whereas, the major components in the methanol extracts of *S. spinosa* were, β -ocimene (27.23%), 1,8-cineole (13.17%), linoleic acid (11.25%) β - patchoulene (12.77%), bicyclo (10.1.0) tridec-1-ene (6.73%) and camphene (5.89%). The results obtained indicated that *S. multicaulis* extract exhibited antifungal activity against *Alternaria alternata*, *Fusarium oxysporum* f.sp. *lycopersici*, *Penicillium expansum*, *Sclerotium cepivorum* and *Botrytis cinerea*, whereas *S. spinosa* extract had antifungal activity against *P. expansum* and *B. cinerea*. The findings provide support for the use of these plants in the search for new natural bioactive compounds.

EX9

EFFECT OF METHANOL EXTRACTS FROM THREE PLANT SEEDS ON THE 3RD LARVAL INSTAR OF KHAPRA BEETLE (*TROGODERMA GRANARIUM* EVERT). Abeer Hashim Mohamed Ali, National Center for Research, Environment and Natural Resources and Desertification Research Institute, Sudan, Email: abeerhashim89@gmail.com

The present study was carried out under laboratory conditions at the Environment and National Resource Research Institute, Khartoum, Sudan, during the period April-May 2014. The objective of the study was to evaluate the effect of methanol extract of neem (*Azadirachta indica*), fennel (*Foeniculum vulgare*) and coriander (*Coriandrum*

sativum) on the 3rd larvae of Khapra beetle (*Trogoderma granarium*). Three concentrations (1.25, 2.5 and 5%) were used for each extract. Five gr of sorghum seeds were treated separately with each extract and fed to 10 larvae in a Petri dish. The parameters measured 28 days after treatment included mortality rate (%) of the larvae, number of adults emerged and weight loss of grains. The results showed significant increase in larval mortality. All treatments gave significant differences as compared to the control. The best result was obtained for Neem 5% extract which showed 43.8% mortality, followed by fennel (41.2%) and coriander (32.2%). The control showed 7.5% mortality. The lowest mean of adult emerged after treatment of larvae was obtained by Neem 5% (31.02%), followed by fennel 5% (41.9%), coriander 5% (54.4%) and finally 81.7% for the control. There were no significant differences between the three treatments. However, there were significant differences between the treatments and the control. There were no significant differences between treatments for mean weight of sorghum grain loss after treatment. The three treatments showed significant differences as compared to the control. The results obtained for seeds weight loss were: 0.14, 0.1, 0.09 and 0.9 gr for neem, fennel, coriander and control, respectively. It could be concluded that application of methanol extracts of neem, fennel and coriander were effective on Khapra beetle control. 5% Concentration for all extracts gave the best results. It is recommended to use both neem and fennel 5% methanol extracts against Khapra beetle control.

EX10

EFFECT OF AQUEOUS EXTRACTS OF HANZAL (*CITRULLUS COLOYNTHIS* L.), SENEMEKA (*SENNA ALEXANDRINA* MILL) AND UMMJELAJEL (*ARISTOLOCHIA BRACTEOLATE* L.) ON THE LEAFMINER (*LIRIOMYZA* SPP.) ON THE SNAKE MELON CROP. Muddather Salah Aldein Younis, Faiza Elgeli Elhassan Salah and Ahmed Eissa, Faculty of Agricultural Sciences, University of Gezira, Sudan, Email: faizaruba2@gmail.com

The ecological imbalance and negative effects of intensive use of chemical insecticides encouraged investigations on plant extracts as an alternative control measure. This study was conducted in the Agricultural Research Corporation Farm, Wad Medani, during two seasons (2014 and 2015) in order to evaluate the effect of water extracts of Hanzal *Citrullus coloyntis* L., Ummjelajel *Aristolochia bracteolate* L. and Sennameka *Senna alexandrina* Mill on vegetable leaf miners *Liriomyza* spp. infesting snake melon. Randomized complete block design (RCBD) with 4 treatments and 4 replications was used. Snake melon plots were sprayed weekly with water extracts of Hanzal, Sennameka and Ummjelajel at 10% concentration (w/v) and the control was sprayed by water with molasses and gum Arabic. The infestation rate on leaves and mean number of active mines were counted twice weekly. The aqueous extracts of Hanzal, Sannameka and Ummjelajel reduced significantly the infestation rate and number of active mines compared to the control. No significant differences were observed between Hanzal, Sannameka and Ummjelajel. Hanzal had lower mean leaf infestation rate

followed by Sannameka and Ummjelajel (first season). Hanzal extract reduced the number of active mines in the second season followed by Sannemeka. However, Hanzal extract was more effective in reducing the number of active mines than Sannameka extract, in the second season. Based on the results obtained in this study, it was recommended to use Hanzal at 10% w/v for control of leaf miner species on snake melon crop.

EX11

BIOINSECTICIDAL ACTIVITY OF THE CRUDE ETHANOLIC EXTRACT OF THE ALGERIAN ASCLEPIADACEAE SOLENOSTEMMA ARGEL AND ITS EFFECT ON MIDGUT AND NUTRITIONAL BEHAVIOR OF THE FIFTH INSTAR LARVAE OF THE MIGRATORY LOCUST.

Fatma Acheuk¹, Wassima Lakhdari², Messaouda Belaid¹ and Abderahmene Dehliz². (1) Laboratory of Valorization and Conservation of Biological Resources, University of Boumerdes, Boumerdes, Algeria, Email: f.acheuk@univ-boumerdes.dz; (2) National Institute of Agronomic Research, Station of Sidi Mehdi, Touggourt, Algeria.

The present study concerns the phytochemical screening of the plant *Solenostemma argel* and the evaluation of the insecticidal and the sublethal effect of the crude ethanolic extract of this plant. For bioinsecticidal potential. Toxicity tests were carried out by testing 5 doses ranging from 300 to 3000 µg/larva. The results of the toxicity tests revealed that the ethanolic extract tested exhibited potent insecticidal activity. The 100% mortality was obtained 24 h after treatment for the highest doses tested. For feeding behavior, the sublethal dose of 700 µg/larva was tested. Conventional nutritional indices of consumption and food use were evaluated, and those were the coefficient of digestive use (CUD), the efficiency of conversion of ingested (ECI), efficiency of digested food (ECD) and growth index (ICr) which showed that *L. migratoria* L5 larvae were significantly sensitive to the extract compared to controls. The study also showed alterations in the mesenteric epithelium. An extension of the duration of the larval stage was also observed in treated larvae. In addition, these last ones showed abnormal moults. The phytochemical tests carried out have made it possible to highlight the presence of saponosides, alkaloids, glycosides and certain phenolic compounds (flavonoids and tannins) as major compounds present in this plant.

EX12

THE POTENCY OF SIX PLANT EXTRACTS USING MARS 6 - MICROWAVE DIGESTION SYSTEM AS A BIOCONTROL AGENTS AGAINST THE STORED GRAIN INSECT PEST SITOPHILUS GRANARIUS L.

Nilesh Baburao Jawalkar¹, S.P. Zambare¹, Mohamed Izzat Al Ghannoum², Angharad Gatehouse² and Martin Edward². (1) Department of Zoology, Dr. Babasaheb, Ambedkar Marathwada University, India; (2) School of Natural & Environmental Sciences, Newcastle University, UK, Email: Mohamed.Izzat.Alghannoum@newcastle.ac.uk

This study was conducted on extracts of six different plants: *Vitex negundo* (Leaves), *Xanthium strumarium*, *Caesalpinia bonduc*, *Mucuna pruriens*,

Moringa oleifera (Seeds), *Tagetes erecta* (Petals). The powder of various parts of plants were extracted using the MARS6 microwave acid digestion system. Three different concentrations (20, 30, and 40%) of plant extracts were tested for their insecticidal activities against the stored grain pest *Sitophilus granarius* L. (Coleoptera: Curculionidae) under laboratory conditions. The results obtained showed good performance of all plant tested extracts, especially at high concentration, and produced high mortality rate and consequently significantly reduced insect population. The mortality rate ranged from 0-100% with *S. granarius* adults ($p < 0.01$). There was a significant correlation ($R=1$) between mortality rate and extracts concentration used. However, the extract of *Mucuna pruriens* with solvents (Acetone + Petroleum Ether) showed the highest mortality rate (100%) with the three concentrations ($p < 0.01$), whereas the lowest average mortality rate was 43.3% ($p < 0.01$) observed for the *Xanthium strumarium* and *Vitex negundo* extracts with methanol + n-hexane solvents, compared with 0% mortality for the control. All plant extracts have exhibited promising insecticidal and seed protective effect, and can be chosen as good alternatives to chemical pesticides.

EX13

ECO-FRIENDLY BIOCONTROL OF ROOT-KNOT NEMATODE MELOIDOGYNE INCOGNITA USING KHELLA (AMMI MAJUS) FRESH LEAF AND FLOWER RESIDUES EXTRACTS ON COWPEA.

Mahmoud M.A. Youssef and Wafaa M.A. El-Nagdi, Plant Pathology Department, Nematology Lab., National Research Centre, Dokki, Cairo, Egypt, Email: myoussef_2003@yahoo.com

Khella or bishop's weed (*Ammi majus*) residue extracts of mashed fresh leaves and flowers at 2.5, 5.0 and 10.0 g/100 ml distilled water were tested in the laboratory for controlling root-knot nematode, *Meloidogyne incognita*. The highest concentration (10g/100 ml water) exhibited 100% second stage juveniles (J_2) mortality after 72 hr of exposure, followed by the other concentrations and J_2 showed net mortalities ranged from 49 to 100%. Under screen house conditions, khella mashed leaf and flower residues were added at rates of 2.5, 5.0 and 10.0 g and the aqueous extracts at the same concentrations to pots planted with cowpea (*Vigna unguiculata* (L.) Walp.) cv. Baladi infected with *M. incognita*. The tested residues at the highest rate (10-g) achieved the highest mortality rate of 84.4 and 84.0%, respectively. In addition, the highest extract concentration (10g/100ml water) from the tested material gave the highest mortality rate of 78.2 and 86.1%, respectively. Number of galls was reduced proportional with the tested rates or concentrations. Consequently, plant growth and yield parameters increased proportionally with the tested khella rates and concentrations.

EX14

EFFECT OF SOME PLANT EXTRACTS AND BACTERIAL STRAINS OF BACILLUS THURINGIENSIS ON THE CONTROL OF NEMATODES WHICH ATTACK TOMATOES.

Kenda Hamade Al Mohammed, General Commission for Scientific

Agricultural Research (GCSAR), Lattakia, Syria, Email: kendaomar31@gmail.com

An infected area was chosen in Al khrabb (Banias), Tartous Governorate, Syria, during the 2017-2018 season. Plastic houses planted with tomatoes were selected for this study. Application of plant extracts and bacterial strains treatments were added as follows: (i) during planting, (ii) after planting, (iii) during + after planting, (iv) after every 15 days, and (v) after every month. In addition, comparison was made with solar sterilization and chemical sterilization treatments, which are methods commonly practiced in the region. The soil was examined before starting the experiment and the infection rate was determined. Plant extracts were prepared in a bio-fertilization laboratory and the bacterial strains were cultured in the Physiology Laboratory of the General Commission for Scientific Agricultural Research. The experiment was conducted following a complete randomized design with four replicates. Results obtained indicated that all treatments gave significant differences, and the best result was obtained from the application after every one month, where the incidence of nematodes was zero. As for the treatment before and after planting, the infection rate was 9-15%, and this incidence is below the economic injury level, which makes this treatment the most economical one.

EX15

ALLELOPATHIC EFFECTS OF PLANT EXTRACTS ON SEED GERMINATION OF SOME INVASIVE WEEDS. Mohammed Hafsi, Department of Biology, Faculty of Nature and Life Sciences, Mascara University, Mascara (29000), Algeria, Email: mohammed.hafsi@univ-mascara.dz

Laboratory experiments were conducted to study the allelopathic effects of leaf aqueous extracts from four plants *Artemisia herba-alba*, *Eucalyptus globulus*, *Schinus molle* and *Thymus vulgaris* on seed germination of four weed species *Chenopodium album*, *Melilotus officinalis*, *Portulaca oleracea*, and *Sinapis arvensis* in Algeria. Each aqueous extract was tested at four concentrations under controlled conditions, and distilled water was used as control. Results obtained showed significant effects of aqueous extracts on the seed germination of the four tested weeds.

EX16

EFFECTIVENESS OF ESSENTIAL OILS ON FILAMENTOUS FUNGI “CASE OF ROSMARINUS OFFICINALIS L. AGAINST FUSARIUM OXYSPORUM F. SP. ALBEDINIS. Noureddine Boulenouar^{1,2}, Abdelkrim Cheriti¹ and Zohra Kadri². (1) Phytochemistry & Organic Synthesis Laboratory, Tahri Mohamed Mohamed University, Bechar, Algeria, Email: noureddine.boulenouar@gmail.com; (2) Biological Sciences Department, Nour Bachir University Center, El-Bayadh, Algeria.

Aromatic plants are an important source of bioactive compounds, especially essential oils (EO). However, the evaluation of antimicrobial effect of EO poses many problems to get significant results. *Fusarium oxysporum* f. sp. *albedinis* (Foa) is the causal agent of a deadly disease of date palm (*Phoenix dactylifera* L.) called

“Bayoud”. Till now, no efficient treatment is available for this disease. In this study, the antifungal effect of *Rosmarinus officinalis* L. essential oils from South-West Algeria was evaluated on *Foa*. Contrary to antifungal evaluation based only on Percentage of Growth Reduction (PGR) and/or Growth Rate (GR) (case of filamentous fungi); the antifungal effect was evaluated using Relative Growth Reduction (RGR) by referring to inoculum and EO volume to get more significant data. Regarding the characteristics of EO, two methods were used, direct contact and micro-atmosphere. In addition, the evaluation was carried out following two periods (7 and 10 days) after treatment to get information on interaction between EO and *Foa* (sensitivity, detoxification,...). The highest effect was obtained by 40µL EO from leaves (GR= 3.19±0.13 mm/day, PGR= 65.24±1.38%) and stems (GR= 3.19±0.37 mm/day, PGR= 65.24±4.05%). Nevertheless, the efficient effect was observed for 10µL EO from leaves and stems (RGR=0.398, RGR=0.383, respectively). It can be concluded from this study that *R. officinalis* EO produces –initially- an important effect on this telluric fungus (after 7 days). After that, a possible development of resistance (detoxification) decreased the effect (after 10 days). On the other hand, RGR has given more significant information on antifungal effect to facilitate comparison between results and focus on efficient compounds.

EX17

SEED COATING WITH PLANT EXTRACTS AND BENEFICIAL MICROORGANISMS, STIMULATES DEFENCE RESPONSE AGAINST SEPTORIA LEAF BLOTCH AND FUSARIUM CROWN ROT IN DURUM WHEAT. Maissa Ben Jabeur, Zaneb Kthiri, Chadha Moussa and Walid Hamada, Laboratory of Genetics and Cereal Breeding, National Agronomic Institute of Tunisia, Tunisia, Email: w_hamada@yahoo.com

The Septoria leaf blotch and the Fusarium crown rot are two of the main limiting diseases of wheat production in Tunisia. Priming seeds via coating with biostimulants is among the novel and integrated approaches in plant protection to increase crop productivity and to overcome fungicide resistance. In this context, seed coating with a wide range of biostimulants was performed, under controlled conditions, on durum wheat seeds of the sensitive cultivar ‘Karim’ in order to investigate their effects on seed germination, plant growth promotion, as well as resistance to Septoria leaf blotch and Fusarium crown rot, followed by biochemical analysis. The tested biostimulants included three beneficial bacteria; *Bacillus thuringiensis*, *Bacillus subtilis* and *Enterobacter cloacae*, and five plant extracts; tannin-based plant extracts and two essential oils-based plant extracts (lemongrass and thyme essential oil), and finally a commercial product; Panoramix, used as reference (association of *Trichoderma*, mycorrhizae and PGPR bacteria). Results showed that almost all treatment promoted the seed germination and plant growth. When challenged with Fusarium, all of them reduced the disease incidence and its detrimental effect of on shoot and root growth and induced higher phenolic content and peroxidases activity. The bacteria *B. subtilis* and *E. cloacae* as well as essential oils of Thyme and Lemongrass were both the most effective

in reducing the Fusarium crown rot. Regarding Septoria leaf blotch, all seed coating treatments reduced the disease severity in leaves with Tannin-based product, Panoramix, and the bacteria *B. subtilis* being the most effective treatments. Overall, the seed coating with biostimulants constitutes a promising approach for a sustainable agriculture since all the seed coating treatments promoted the defensive response of wheat against soil borne as well as aerial pathogen. The variability in the effectiveness of treatments is most likely due to their different mode of action. The seed coating treatments in this study could be considered as potential biostimulant treatment to be explored in-depth for the induced systemic as well as the localized defense.

EX18

EFFECT OF BOILING AND COLD-WATER EXTRACTS OF *CITRULLUS COLOCYNTHIS* AGAINST *TRIBOLIUM CASTANEUM* (HERBEST).

Salama SalimAlbireeki¹ and Halluma Kerre². (1) National Center for Plant Protection and Plant Quarantine, Tripoli, Libya, Email: salmaelbrike@gmail.com; (2) Department of Plant Protection, Faculty of Agriculture, University of Tripoli, Tripoli, Libya.

Stored products insect *Tribolium castaneum* (Coleoptera: Tenebrionidae) is one of the most destructive pests, sharing human food and affects its economics. Due to the broad use of chemical insecticides which leads to the emergence of insect generations resistant to insecticides and their residues. The study was conducted to evaluate the effect of boiling and cold water extracts of *Citrullus colocynthis* against *Tribolium castaneum* larvae at concentration of 5, 10 and 15%. Mortality rates 24, 48 and 72 hours after treatment was determined. Results obtained showed that the cold-water extract of seed endocarp of *C. colocynthis* produced the highest larvae mortality which reached 71% at 15% concentration 72 hours after treatment, followed by leaf extract (60%) and the seed extract gave least effect on larvae mortality.

EX19

INHIBITORY ACTIVITY OF SOME PLANT EXTRACTS AGAINST *HARKNESSIA EUCALYPTI* CAUSING BLIGHT AND LEAF SPOTS ON *EUCALYPTUS* SPP. IN LIBYA. F.A. Abouzkhari¹, I. Yangui^{2,3} and M.H. Ben Jamâa². (1) Plant Protection Department, INRAT, Tunisia, Email: farhatabouzkhari@gmail.com; (2) Laboratory of Forest Resources Management and Valuation, National Research Institute of Rural Engineering, Water and Forests in Tunisia, University of Carthage, Tunisia; (3) Laboratory of Nanobiotechnology and Valuation of Medicinal Plant Resources, National Institute of Applied Sciences and Technology, University of Carthage, Tunisia

The study was conducted *in vitro* during 2016 to test the antifungal activity of 4 hot and cold aqueous extracts of *Asphodelus ramosus*, *Thymus capitatus*, *Hyoscyamus albus*, *Artemisia herba-alba* which belong to different plant families on the growth of the fungal pathogen *Harknessia eucalypti*. This fungus was identified for the first time in Libya to infect *Eucalyptus stricklandii* leaves. The inhibitory

activity of different plant extracts on the pathogen *H. eucalypti* was tested by using different extract concentrations (0.05, 0.1, 0.2 and 0.4%). The results obtained showed that the fungus failed to produce mycelium compared to the control treatment. The study recorded that hot aqueous extract concentrations of *A. herba-alba* leaves inhibited 47.7, 55.6, 55.6 and 71.2% of the development of *Harknessia eucalypti*, respectively. The aqueous extract from the leaves of *A. ramosus* caused an inhibition rate of 0 to 55% (0, 0, 11.1 and 55.5%, respectively), whereas the flower extract produced 22.2, 22.2, 27.8 and 38.9% inhibition rate, respectively. The cold root aqueous extract inhibited the fungus development at 11.1, 11.1, 22.3 and 33.4%, respectively. The cold aqueous extracts of leaves and flowers *A. ramosus* were not efficient, whereas cold root aqueous extract at the concentrations 0.2 and 0.4% concentration showed 6.7 and 5.6% inhibition of the mycelium growth, respectively. Inhibition rate of hot leaf aqueous extract of *T. capitatus* was 0, 5.5, 87.1 and 100%, respectively, and that of the cold leaf aqueous extracts of *Thymus capitatus* was 70, 20, 55.6 and 55.6%, respectively. Inhibition rate of the hot leaf aqueous extracts of *A. herba-alba* of the fungus development was 47.7, 55.6, 55.6 and 71.2 %, and that of the cold leaf aqueous extracts of *A. herba-alba* was 16.6, 20, 55.5 and 55.5%, respectively. Inhibition rate caused by the hot leaf aqueous extracts of *H. albus* was 13.4, 21.2, 33.4 and 33.4% to *H. eucalypti* development. No antifungal activity was observed for the cold leaf aqueous extracts of *H. albus* as compared with the control treatment, one week after incubation. The cold leaf aqueous extracts of *A. herba-alba* was responsible of the separation of the appendages of the spores and their distortion and the destruction of the cell walls of the treated spores.

EX20

INSECTICIDAL ACTIVITY AGAINST *RHYZOPERTHA DOMINICA* (FABRICIUS, 1972) STORED CEREALS INSECTS BY THE USE OF *MENTHA ROTUNDIFOLIA* ESSENTIAL OIL Amina Leblalta and Daoud Harzallah, Laboratory of Applied Microbiology, Faculty of Science of Nature and Life, University of Ferhat Abbas, Setif 1, Algeria, Email: amina8319@yahoo.fr

Plant extracts and in particular essential oils currently represent an alternative strategy for the protection of stored products. In this context, the aim of this work was to assess the insecticidal activity of the essential oil of *Mentha rotundifolia* against the stored grain pest *Rhyzopertha dominica* by two methods: contact (5 days) and inhalation (during 8 days). Results showed that at 15 µl/ml and 30 µl/ml concentrations, the essential oil produced mortality rates of 95% and 100%, respectively, on the first day of exposure to this oil through contact. The highest LC₅₀ obtained on the first day after treatment (1.31 µl/ml) and it was 0.37 µl/ml on the 5th day after contact treatment. The insecticidal activity by inhalation of *M. rotundifolia* essential oil with the dose of 8µl produced a mortality rate of 91.65% after 8 days of exposure to this oil. The fumigant effect recorded a LD₅₀ and a LD₉₀ of 3.82 µl and 8.88 µl, respectively, after the 4th day of exposure to the oil and a LD₅₀ and a LD₉₀ of 1.18 µl and 4.39 µl, respectively, the 8th

day after treatment. The insecticidal properties of the essential oil extracted from *M. rotundifolia* suggest that it can be used as an alternative component in integrated control of the stored grain pest *R. dominica*.

EX21

LARVICIDAL ACTIVITY OF HYDRO-ALCOHOLIC EXTRACT OF *URTICA MEMBRANACEA* POIR. ON *TUTA ABSOLUTA* IN VITRO. Farial Krache¹, Malika Boualem¹, Fouzia Benourad¹, Djilali Benabdelmoumene², Mohamed Bouchareb¹ and Nacer Defous¹. (1) Plant Protection Laboratory, Department of Agronomic Sciences, University Abdelhamid Ibn Badis, Mostaganem 27000, Algeria, Email: farial.krache.etu@univ-mosta.dz; (2) Laboratory of Applied Animal Physiology, Department of Agronomic Sciences, University Abdelhamid Ibn Badis, Mostaganem 27000, Algeria.

Tomato culture occupies the second place after potato, in terms of production or consumption all over the world. Since 2008, this culture has been threatened by the leafminer *Tuta absoluta*, whose larvae can attack all phenological stages and cause significant damage. This study focused on assessing the effectiveness of a bio-insecticide treatment with a plant extract from the leaves of *Urtica membranacea* Poir., from the Mostaganem region to control the larvae of this leafminer. The insecticidal activity of nettle extract against *T. absoluta* larvae was studied in vitro under laboratory conditions. Six doses were used (5, 10, 15, 20, 25 and 30%). The controls were treated with distilled water and acetone diluted to 10%. Results obtained indicated that concentrations 15% and 30% were the most effective, giving a high mortality rate. A maximum mortality rate of 92% was noted four days after the treatment.

EX22

EFFICACY OF NEEM TREE *AZADIRACHTA INDICA* A. JUSS EXTRACTS ON ROOT KNOT NEMATODE *MELOIDOGYNE JAVANICA*, *FUSARIUM* SPP. AND *RHIZOCTONIA* SPP. UNDER LABORATORY CONDITIONS. Mohamed Najeb El-Naas¹, Kahlifa Hussein Dabaj² and Saleh Abdelhadi El-Shareif². (1) Ministry of Agriculture, Khoms, Libya, Email: naas_j80@yahoo.com; (2) Plant Protection Department, Faculty of Agriculture, University of Tripoli, Libya.

A laboratory study was conducted to assess the efficacy of three different concentrations of seed oil, leaf and root extracts of neem tree *Azadirachta indica* on egg hatching and mortality of the second stage juveniles of root knot nematode *Meloidogyne javanica* and on inhibiting *Fusarium* spp. and *Rhizoctonia* spp. growth under laboratory conditions. The results showed that treatment with neem seed oil at all concentrations had an effective mortality effect on the second stage juvenile, and prevented hatching of nematode eggs, and inhibited *Fusarium* spp. and *Rhizoctonia* spp. growth. The differences were significant between seed oil treatments and leaf and root extracts. The effect of the leaf extract treatment was significant on the mortality of the second stage juveniles of *M. javanica*, with no effect on hatching of eggs, whereas treatment with root extract had a significant effect on the mortality of second stage juveniles and inhibited nematode hatching at the standard and half-

standard concentrations. The results also showed that treatment with leaf extract inhibited the growth of *Fusarium* spp. at the standard and half-standard concentrations, with no effect of these two concentrations observed on *Rhizoctonia* spp.

EX23

ASSESSMENT OF THE INSECTICIDAL, REPELLENT AND ANTIBACTERIAL PROPERTIES OF TWO MELLIFEROUS PLANTS, *MENTHA SPICATA* (L.) AND *EUCALYPTUS GLOBULES* (LABILL.). Kaissa Boudieb, Hakima Oulebsir-Mohandkaci and Farida Tihar-Benzina, Laboratory of the Valorization and Conservation of Biological Resources, Faculty of Sciences, University M'hamed Bougara of Boumerdes, Algeria, Email: k.boudieb@univ-boumerdes.dz

This study focused on two species of aromatic plants, *Mentha spicata* and *Eucalyptus globulus*. The plants used were collected from the Lakhdaria region located in the Northeast of Algeria. First the main classes of these plants' secondary compounds were identified, followed by a study of their essential oils bactericidal, insecticidal and repellent effect. The plant extract has shown its richness in phenolic compounds. The physicochemical properties of the essential oils of the plant such as the acid index, density, pH and sensory parameters were consistent with recommended standards. The results of the biological activity of the essential oils of the plant studied showed significant antibacterial activity against phytopathogenic bacterial strains of *Pseudomonas savastanoi*, the causal agent of olive knot disease. The results of the insecticidal and repellent activity of essential oils have shown a considerable activity against larvae of the olive fly *Dacus olea* and weak activity against *Trogoderma* sp. isolated from an apiary causing remarkable damage to a part of the beeswax.

EX24

EVALUATION OF THE TOXICITY OF THREE ESSENTIAL OILS AGAINST *SPODOPTERA LITTORALLIS* USING A MIXTURE DESIGN. Mey Jerbi¹, Ikbal Chaieb¹, Faten Hamdi² and Asma Laarif¹. (1) UR13AGR09, University of Sousse, IRESA, Regional Research Centre on Horticulture and Organic Agriculture, P.O. Box 57, Chott-Mariem, 4042, Sousse, Tunisia, Email: ikbal_c@yahoo.fr; (2) Control Med, Résidence La Colombe, rue Ibn Batouta - Le Kram, 2015, Tunis, Tunisia.

Spodoptera littoralis (Lepidoptera: Noctuidae) is one of the major pests of many greenhouse crops. These insects are treated for a long time with synthetic insecticides. In recent years, interest in biopesticides derived from plants has increased considerably because of environmental concerns and pest population resistance to chemical pesticides. The present study aimed to evaluate the toxicity of a mixture of three essential oils extracted from *Salvia officinalis*, *Mentha piperita* and *Origanum majorana*. Essential oils were obtained by Clevenger-type water distillation. The mixture design used was simplex lattice design performed by the software "Minitab. The insecticidal activity of the tested essential oils against the third instar of *S. littoralis* was assessed by vapor-phase toxicity bioassay using closed container method. The fumigant effect of the

three essential oils and their combinations were performed with different doses of 25, 50, 100 and 200 µl/L. The mortality rate was calculated using the Abbott correction. Fumigation test showed that the mixture containing 65% of *Origanum majorana* essential oil, 48% of *Mentha piperita* essential oil and 1% of *Salvia officinalis* essential oil was the combination having the best insecticidal activity. In conclusion, the mixture of the three oils may be exploited as a potential natural insecticide for *Spodoptera littoralis* management.

EX25

CONTROL ASSAY OF SOME FUNGI INFECTING STORED WHEAT USING AQUEOUS EXTRACT FROM CAPER (*CAPPARIS SPINOSA* L.). Soumia Sekkal and Keltoum Bnaissa, Department of Agronomic Sciences, University of Mohamed Khider, Biskra, Algeria, Email: soumia.sekkal@univ-biskra.dz

Caper (*Capparis spinosa* L.) is a medicinal bush plant in Algeria called "Kabbar", generally found in mountainous regions. It is a species that plays an important ecological role. The objective of this work was to investigate the potential of this local plant which is a typical plant of arid and semi-arid zones. Secondary metabolites in plant extracts were tested for their possible effect against fungi which attack stored wheat grain. For this purpose, an experiment was carried out at the University of Biskra (Algeria) during the season 2017/18, based on the preparation of the aqueous extract and use of the caper ethyl acetate fraction against the above-mentioned fungi. The results obtained showed that treatment with the 20 % concentration of the aqueous extract and 2 mg/ml of ethyl acetate fractions, had significant inhibitory efficacy on the fungi *Aspergillus terreus*, *Alternaria alternata* and *Alternaria tenuissima*.

EX26

STUDY OF THE BIO-INSECTICIDAL PROPERTIES OF THE RAW EXTRACT OF SAGE *SALVIA OFFICINALIS* L. AGAINST THE PESTS OF STORED FOOD STUFF. Leila Bendifallah, Laboratory of Soft Technologies, Valorization, Physico-chemistry of Biological Materials and Biodiversity, Faculty of Sciences, M'hamed Bougara University of Boumerdes, Avenue de l'Indépendance, 35000, Boumerdes, Algeria, Email: Leila.bendifallah@gmail.com

As part of the enhancement of natural substances, the essential oils extracted by hydro-distillation from the aromatic plant *Salvia officinalis* L. were tested for their bio-insecticidal effect against two different insect pest species affecting stored cereals: wheat weevil *Sytophilus granarius* Linnaeus, 1758 (Coleoptera; Curculionidae) and confused flour beetle *Tribolium confusum* Jacquelin du Val, 1863 (Coleoptera; Tenebrionidae). A batch of adult insect individuals was introduced into each petri dish and placed in their respective oven. The test results showed that the aerial part of Sage has a toxic effect on weevil adults (90%) and *Tribolium* (90%). In conclusion, the aromatic and medicinal plant has naturally occurring substances that act as insecticides to control effectively the stored cereals insect pest species.

EX27

STUDY OF THE ANTI-FUNGAL AND ANTI-BACTERIAL ACTIVITY OF THE ESSENTIAL OILS EXTRACT FROM *MORINGA OLEIFERA* IN THE SOUTHWEST OF ALGERIA. Ahmed Boulal¹, M'hammed Bouallala¹, Kamel Kaidi² and Abdelkader Maknaci². (1) Laboratory of Saharan Natural Resources, Faculty of Science and Technology, Ahmed Draia University, 01000 Adrar, Algeria, Email: boulal19@yahoo.fr; ahm.boulal@univ-adrar.dz; (2) Research Unit of the Renewable Energies in the Saharan Environment, 01000 Adrar, Algeria.

Medicinal plants currently occupy a large position in various fields, including agricultural and industrial production, since it is an essential source in the pharmaceutical industry. Products from such have no side effects on human and plant health and they are environment friendly. In this study essential oils were extracted from the leaves of *Moringa oleifera* planted in the southwest of Algeria (Adrar), by the water distillation method. The GC-MS analysis of the chemical composition of the essential oils showed the presence of 22 compounds. On the biological level, it was found that the extracted essential oils negatively affected plant fungal pathogens such as *Penicillium* sp. and *Aspergillus niger* as well as bacterial pathogen such as *Escherichia coli*. *Staphylococcus aureus* showed resistance to the extracted oils. The results obtained suggest that further research in this field is still needed to identify bio-products that are healthy, economic and safe.

EX28

ANTIFUNGAL ACTIVITY OF ESSENTIAL OILS EXTRACTED FROM LEAVES OF *SALVIA OFFICINALIS* (L.) AND *LAVANDULA DENTATA* (L.) ON THE FUNGUS *RHIZOCTONIA SOLANI*. Kaouter Ben Mahmoud, Noura Jemai, Samia Gargouri and Ahmed Jemmali, National Institute of Agronomic Research of Tunisia, University of Carthage, Tunisia, Email: kaouterbenmahmoud@gmail.com

The phytogenetic resources of aromatic and medicinal plants (AMP) constitute a deposit of biologically active molecules that can be exploited in the agronomic and biomedical fields due to their antimicrobial properties against bacterial, fungal and viral pathogens. Among these AMP, *Salvia officinalis* (L.) and *Lavandula dentata* (L.) are known for their multiple medicinal properties attributed to their richness in phenolic compounds and in essential oils (EO). In this context, the present study was carried out in order to evaluate the effect of these EO on the mycelial growth of *Rhizoctonia solani*, a fungus causing considerable losses for in vitro growth of fruit trees rootstocks during the acclimatization phase. These EO were extracted from dry leaves using the hydro-distillation method and four concentrations (800, 1000, 2000 and 3000 ppm) were tested for their inhibitory effect on *R. solani* mycelial growth. 72 hours after incubation, *S. officinalis* and *L. dentata* EOs inhibited, with varying degrees, *R. solani* mycelial growth. It should be noted that lavender EO is more effective than that extracted from sage, as at the same concentration, pathogen growth inhibition was significantly higher with lavender EO. In addition, this inhibition was positively correlated with the

concentration of EO used, where the 3000 ppm concentration was found to be the most effective. Thus, these essential oils could be used as eco-friendly and safe alternatives for controlling fungal plant pathogens.

EX29

BIOINSECTICIDE POTENTIAL OF ESSENTIAL OILS AND ALCOHOLIC EXTRACTS OF THE AROMATIC PLANT *MENTHA PULEGIUM* L. HARVESTED FROM TWO DIFFERENT REGIONS OF ALGERIA FOR THE CONTROL OF *TRIBOLIUM CASTANEUM*. Fatma Ali Acheuk, Amrane Houria, Bouheddi Sarra and Ouchefoune Fatma Zohra, Laboratory of Valorization and Conservation of Biological Resources, Faculty of Sciences, M'Hamed Bougara University of Boumerdes, Algria, Email: f.acheuk@univ-boumerdes.dz

The excessive use of pesticides caused numerous damages to ecosystems and to human health and made the situation more worrying. For this, the search for other alternative methods taking into consideration biological control through the use of natural insecticide substances is more than a necessity. Among these natural substances are the extracts and essential oils extracted from aromatic plants. The objective of this work is to highlight the insecticidal power of essential oils and the alcoholic extract of *Mentha pulegium* (Lamiaceae) harvested from the North and the South of Algeria. The oil was obtained by hydrodistillation of the aerial part of the plant, whereas the extract was obtained by Soxhlet extraction using methanol as solvent. Contact toxicity and repulsion tests, at different doses, were carried out on adults of *Tribolium castaneum*, the pest of stored cereals. *In vitro* insecticidal tests have revealed that the essential oils and extract of *M. pulegium* has interesting insecticidal properties (contact test and repellent) against *Tribolium castaneum* adults. The results showed that 24 hours after treatment by direct contact at the dose of 20%, a mortality of 86.66% was obtained with the essential oils of *M. pulegium* from the North and 80% with the oil from the South. The LD₅₀ was 1.290% and 1.576%, respectively for north and south essential oils of *M. pulegium*. The essential oils of *M. pulegium* has therefore proven to be toxic by contact with adults of *T. castaneum*. For the alcoholic extract of the same plant, the results showed a mortality of 40% for the extract from the north with an LD₅₀ of 5.422 µg/insect. For the south extract, the rate was estimated at 55% with an LD₅₀ of 3.417 µg/insect. The highest repellent activity was obtained with the essential oils of *M. pulegium* from the north and it was 96.66%, resulted from the highest dose of 20%, 4 hours after exposure. It seems that *M. pulegium* has very interesting insecticidal and repellent activities against *T. castaneum*. This activity could be attributed to different chemical compounds in the essential oils. Some of these insecticidal components can be used as the active raw material in the formulation of botanical insecticides.

EX30

CHEMOTHERAPY OF GRAPEVINE VIRUS USING ANTIVIRAL PLANT EXTRACT: AN INTERESTING APPROACH TO FOLLOW. A. Lehad¹, I. Djennaoui¹, I. Mahdid¹, A. Amrani¹, L. Ghait¹, N. Aiter², L. Khelifi³, B. Bouamama⁴ and N. Mahfoudhi⁵. (1) Laboratoire de

Phytopathologie et Biologie Moléculaire, Ecole Nationale Supérieure d'Agronomie, Belfort, El Harrach, Algeria, Email: a.lehad@ensa.dz; (2) Laboratoire de culture in vitro, Département central, Institut Technique de l'Arboriculture Fruitière, et de la Vigne, ITAFV, Algiers, Algeria; (3) Laboratoire Ressources génétiques et Biotechnologiques, Ecole Nationale Supérieure d'Agronomie, Rue Hassan Badi, Belfort, El Harrach, Algeria; (4) Laboratory of Plant Molecular Physiology, Centre of Biotechnology of Borj-Cedria, Hammam-lif, Tunisia; (5) Institut National de Recherche Agronomique de Tunisie, Laboratoire de Protection des Végétaux, Rue Hedi Karray, El Menzah, 1004, Tunisie.

For a long time, the essential method used to control grapevine virus diseases was using the healthy plant material obtained by several biotechnological techniques and/or by chemotherapy using antiviral substances. Our study focused on obtaining sanitized plants by micro-culturing associated with a natural anti-viral agent (garlic extract). The preliminary results obtained showed that the garlic extract has an antiviral effect on micro-plants grown on modified MS medium 8 weeks after subculturing against GLRaV-3 and GFKV ranged from 80% to 100%. Several studies have shown the effectiveness of garlic as anti-viral agent against several diseases.

EX31

CONTRIBUTION TO THE STUDY OF THE ANTIFUNGAL EFFECT OF THE AQUEOUS EXTRACT OF *CAPPARIS SPINOSA*. Sekkal Soumia, Benaissa Keltoum and Mezerdi Farid, Université de Biskra, Département des Sciences Agronomiques, faculté des sciences de la nature et de la vie, Algeris, Algeria, Email: soumia.sekkal@univ-biskra.dz

As part of the development of phylogenetic resources in Algeria, we studied a local plant *Capparis spinosa*, was studied to investigate its important therapeutic properties. The anti-fungal effect of aqueous extract of *Capparis spinosa* on the inhibition and sporulation rates of the fungal species *Aspergillus terreus*, *Aspergillus niger*, *Alternaria alternata* and *Alternaria tenuissima* was investigated on durum wheat (Vitron). The results showed that the proportion of different *Capparis spinosa* aqueous extract concentrations, especially 20 %, had a significant inhibitory effect on isolated fungal species (*Aspergillus terreus*, *Alternaria alternata* and *Alternaria tenuissima*). In addition, phytochemical examination indicated that the plant extract was rich in secondary metabolites such as alkaloids, tannins, sterols and saponins.

EX32

BIOACTIVITY OF ESSENTIAL OILS AGAINST FUNGAL SPECIES ASSOCIATED WITH CORK OAKS. Hadil Khadraoui^{1,2}, Islem Yangui^{1,2}, Olfa Ezzine², Mohamed Lahbib Ben Jamâa² and Chokri Messaoud¹. (1) Institut National des Sciences Appliquées et de Technologie, Laboratoire de Nanobiotechnologie et Valorisation des Phytoressources Médicinales, Université de Carthage, Tunis Cedex, Tunisie, Email: khadraoui.hadila@gmail.com; (2) Université de Carthage, Institut National des Recherches en

Génie Rural, Eaux et Forêts. Laboratoire de Gestion et Valorisation des Ressources Forestières, Tunisie.

Tunisian cork oak forests have suffered for many years from a worrying decline. Recently, this phenomenon is becoming alarming as it affects several plant species. Fungal pathogens were reported to be highly involved in this decline. The fungi *Biscogniauxia mediterranea* and *Pestalotiopsis* spp., causing cankers and necrosis, are very common on cork oak trees throughout the northwestern Tunisian forest. In view of their increasing occurrence and impact on cork oaks, measures of control should be implemented in order to limit their spread. In this context, the use of essential oils extracted from aromatic plants could present a sustainable approach to fungal biocontrol. Accordingly, in this work, essential oils from *Plectranthus caninus* were tested for their efficacy against *Biscogniauxia mediterranea* and *Pestalotiopsis* spp. The results of in vitro tests showed interesting antifungal activity by inhibiting mycelial growth. The use of natural substances such as essential oils, as an alternative to chemical pesticides, ensures a safer environment as well as reducing risk of pesticides resistance development.

INTEGRATED PEST MANAGEMENT

IPM1

THE EFFORTS OF THE ARAB ORGANIZATION FOR AGRICULTURE DEVELOPMENT(AOAD) IN THE INTEGRATED CONTROL OF THE RED PALM WEEVIL. Fida'a Ali Rawabadeh, Arab Organization for Agricultural Development, P.O. Box 19082, Amman 11196, Jordan, Email: f_rawabdeh@aoad.org

Palms and dates culture are of great economic importance throughout the Arab world. It is estimated that around 160 million date palms producing more than 6.6 million tons of dates, representing 78% of the total world production are planted in the Arab region. Arab countries export around 70% of the total world exports of dates. However, this region still follows traditional practices that leads to low productivity and quality, and faces several problems that require considerable developmental efforts. Palm tree is attacked by various pests and diseases that represent an important challenge and leads to losses of around 30% of the world production. The most serious insect pest is the red palm weevil, which causes great loss and difficult to control by using traditional methods. AOAD believed in the need to adopt an integrated management strategy to control this pest through the integration of several components such as phytosanitary measures, detection and monitoring, agricultural practices, capacity building, extension, research, information and expertiseetc, to achieve better results. AOAD implemented important regional projects such as "biological control of red palm weevil" during the period 1997-2009. Other research projects were carried out during 2018-2019 such as "The Value Chain of Date Palm in the Arab World", "The Regional Strategic Framework for Developing the Value Chain for the Date Palm Sector in the Arab Region", and "Evaluating the Red Palm Weevil Insect in Jordan". AOAD is preparing to lead an international alliance in coordination with FAO, KIAAI, ICARDA, ICBA and others to face the

challenges of date palm sector to develop a comprehensive strategic approach to enhance the value chain of palm and dates and its sustainable development in the Arab region.

IPM2

EFFICACY OF SOME ATTRACTANTS AGAINST MEDFLY (DIPTERA: TEPHRITIDAE) AND NON-TARGET INSECTS IN SYRIAN CITRUS ORCHARDS. Shadi Mahmoud Faskha¹ and Mohammad Ahmad². (1) Tartous Agriculture Research Center, General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria, Email: Shadifaskha5@gmail.com; (2) Department of Plant Protection, Faculty of Agriculture, Tishreen University, Latakia, Syria.

Attraction of Mediterranean fruit fly, *Ceratitis capitata* (Wied.) (Diptera: Tephritidae), and non-target insects to some attractants was studied in a citrus orchard in Syria, 2012, using McPhail traps. Results obtained showed that trimedlure (TML) was significantly more attractive to *C. capitata* males than protein hydrolysate, ammonium biphosphate and NuLure traps (total mean=677.75, 96.75, 9.5 and 5.75 male/trap, respectively). Whereas, ammonium biphosphate lure was the most effective attractant for females followed by protein hydrolysate, NuLure and TML traps (total mean= 396.75 females/trap, respectively). On the other hand, seven non-target insect orders were captured in the traps, Diptera and Hymenoptera captures were highest for NuLure, followed by protein hydrolysate. Very few predators, parasitoids and pollinators were attracted to trimedlure and ammonium biphosphate lures. However, the results suggest that TML and ammonium biphosphate could provide a suitable tool in Mediterranean fruit fly management program.

IPM3

INSECT PESTS MANAGEMENT ON VEGETABLES CROPS AND STORED PRODUCTS: ACHIEVEMENTS, CHALLENGES AND FUTURE PROSPECTS IN SUDAN. Omer A. Elnour¹, Hassan O. Kennan¹ and Elamin M. Elamin². (1) Entomology Research Program Coordinator, ARC, Wad Madani, Sudan, Email: omslm@yahoo.com; (2) Research entomologist, ARC, Wad Madani, Sudan.

An integrated pest management cooperative program was implemented between the Agricultural Research Corporation and the Food and Agriculture Organization of the United Nations with financial support of the Netherlands government. The main outputs of this project were: establishment and adoption of integrated pest management (IPM) approach among agricultural researchers, plant protection specialists in national schemes, Sudanese universities professors and various extension workers. For the first time, demonstration fields among farmers were implemented, and the economic injury threshold levels of the most important cotton insect pests was raised, thus reducing the number of sprays in cotton. *Trichogramma* parasite on African cotton worm eggs in Gezira and Rahad schemes was introduced and released. A clear reduction in the number of pesticide sprays in tomato and onion crops was achieved, which led to an increase in both quantity and quality of agricultural products. Training

of all crop protection workforce in integrated pest management approach was achieved. The Entomology Research Program is now expanded to all the stations of the Agricultural Research Corporation (ARC) to cover all regions of Sudan, with each region focusing on its most important insect pests which attack field and vegetable crops, fruit trees including citrus. The results of this research is reviewed by the National Insect Pests and Diseases Committee, twice a year, in June and December. In spite of all the efforts exerted to develop research work in the field of entomology, there are many challenges facing this program, mainly weak research coordination in the field of insect science in different research centers and bodies. The IPM approach is not sustainable for many reasons such as limited resources, lack of proper agricultural policies, climate change and the consequent emergence of new insect pests, including transient and invasive pests.

IPM4

IPM PRACTICES FOR THE MANAGEMENT OF COTTON PINK BOLL WORM IN PAKISTAN. Muhammad Tariq Sultan, Institute of Plant Protection, MNS University of Agriculture, Multan, Pakistan, Email: iamtariqsultan92@gmail.com

The pink bollworm *Pectinophora gossypiella* (Lepidoptera, Gelechiidae), is the major pest of cotton in Pakistan, similar to other cotton growing countries, and causes economic damage worldwide. The rising costs of chemical control, ongoing economic losses, secondary pest issues, and environmental concerns all point towards a need for economically and environmentally focused PBW management. Comprehensive research has yielded a diverse set of monitoring, biological control, cultural, behavioural, genetic, and host plant resistance methodologies that can be used to develop integrated PBW management strategies. The PBW's life cycle characteristics, particularly the high mobility of adults, point to the use of combinations of selected integrated pest management components established across wide geographical areas. The main objectives of management are to keep infestations below damaging levels in the current season without creating secondary outbreaks of other pests and to reduce the overwintering population that will threaten the following season of cotton crop. Cultural control methods such as late sowing of cotton crop, grow short season varieties, use of traps crops, crop rotation, animals grazing after crop harvest, removal of left-over bolls and crop residues, ploughing soil to expose larvae to sunlight and use of resistant varieties. Installation of large numbers of pheromone traps for mass trapping and destruction of pink boll worm is an additional tool. Spray of neem seed extract, which provides anti feedant and ovicidal effect on PBW proved useful. Natural enemies of pink bollworm such as *Trichogramma abrasiliensis* (egg), *Chelonus* sp. (egg-larval), *Campoletis chlorideae* (larval), *Chrysoperla carnea*, Coccinellids, Reduviid bug and Pentatomid bug should be maintained. Use of pesticides such as Quinolphos, Thiodicarb, Chlorpyrifos, Fenprophate and Cypermethrin as one of the components to manage PBW should be encouraged. Repeating use of same pesticides over many seasons should be avoided, because it renders them noneffective against pink bollworm.

IPM5

ROLE OF INTEGRATED PEST MANAGEMENT IN ECOLOGICAL BALANCE. Khatera Qane¹, Rohtas Kumar¹ and Sova Yadav². (1) Department of Soil Science, CCS Haryana Agricultural University, Hisar, India, Email: khatereh.qane7@gmail.com; (2) Department of Entomology, CCS Haryana Agricultural University, Hisar, India.

Recent investigations of growth in human populations and food supply suggest that there will be a need to substantially increase food production in the near future. One possible approach to meeting this demand, at least in part, is the control of pests and diseases, which currently cause a 30–40% loss in crop production. Integrated pest management (IPM) is the coordinated use of pest and environmental information to design and implement pest control methods that are economically, environmentally and socially sound, promotes prevention over remediation and advocates integration of at least two or more IPM components to achieve long-term solutions or it is a concept that uses a multidimensional approach for minimizing pest damage, empowering farmers, increasing the income and production of the farmer, and restoring a balance to the ecosystem. Many conservation practices present a promising prospect for sustainable agricultural development and environment friendly strategies for increasing agricultural yields and raising profits for farmers, especially those in developing countries. The increased adoption of these practices may provide greater hope for the future and for food security around the world. Adoption of IPM strategies provides economic benefits due to sustained development, increased productivity and reduced pest damage. The options that IPM can offer make sole reliance upon synthetic pesticides a thing of the past. In the long-term, everyone benefits through a healthier environment. IPM has been called the common sense approach to pest management and it costs no more than conventional pest management methods yet it protects the environment, helps maintain or restore the ecological balance while maintaining the productivity, appearance and quality of our environment.

IPM6

BIOPESTICIDES AS A FUNDAMENTAL TOOL FOR INTEGRATED PEST MANAGEMENT. Sova Yadav¹, Lomash Kumar¹, Khatera Qane² and Shweta Yadav¹. (1) Department of soil science CCS Haryana Agricultural University, Hisar, India, Email: sovyadav11@gmail.com; (2) Department of Social science, CCS Haryana Agricultural University; India.

Bio-pesticides are key components of integrated pest management programs receiving much practical attention as a mean to reduce the load of synthetic chemical products. Biopesticides are ecofriendly and encompasses a broad array of microbial pesticides, biochemically derived from micro-organisms and other natural sources, and processes involving the genetic incorporation of DNA into agricultural commodities that confer protection against pest damage. Biopesticides are target-specific and relatively safer for human beings and non-target organisms/vertebrates. Biopesticides include entomopathogenic viruses, bacteria,

fungi, nematodes, and plant secondary metabolites. Currently, biopesticides comprise $\approx 5\%$ of the Indian pesticide market, with at least 15 microbial species and 970 microbial formulations registered through the Central Insecticides Board and Registration Committee (CIBRC). As of 2017, over 200 products based on entomopathogenic fungi (*Beauveria bassiana*, *B. brongniartii*, *Metarhizium anisopliae*, *Lecanicillium lecanii* and *Hirsutella thompsonii*) and nematocidal fungi (*Purpureocillium lilacinum* and *Pochonia chlamydosporia*) are registered for use against various arthropods and plant-parasitic nematodes. The virulence of various biopesticides such as Nuclear polyhedrosis virus (NPV), bacteria, and plant products were tested under laboratory conditions very successfully and the selected ones were also evaluated under field conditions with major success. The overall aim of biopesticide research is to make these biopesticide products available at the farm level at an affordable price, and thus become a possible component in integrated pest management. Neem-based pesticides, *Bacillus thuringiensis*, NPV, and *Trichoderma* are the major biopesticides produced and used in India. Biopesticides also play an important role in providing pest management tools in areas where pesticide resistance, niche markets, and environmental concerns limit the use of chemical pesticide products. Since bio-pesticides are eco-friendly it has no harmful residues causing health hazards, substantially low impact on non-target species, cheaper than chemical pesticides and more effective than chemical pesticides in the long-term.

BIOLOGICAL CONTROL

BC1

BIO-AGENTS ASSOCIATED WITH THE INSECT "LICHTENSIA VIBURNI" ON OLIVE TREES IN SABRATA WEST OF TRIPOLI, LIBYA. Afaf Rajab Hamza¹ and Halluma Mohammed Kerra². (1) Ministry of Agriculture and Livestock, Tripoli, Libya, Email: afafhamzahamza@gmail.com; (2) Plant Protection Department Faculty of Agriculture, University of Tripoli, Libya.

Olive scale insect *Lichtensia viburni* belongs to Order Hemiptera, Family Coccidae, and is one of the important olive scale insects in Libya. A study was conducted to determine the bio-agents associated with the insect *L. viburni* on olive trees at Sabrata, west of Tripoli. Associated bio-agents were collected and identified and the following natural enemies were found: predator *Eublema scitula* (Lepidoptera: Eriibiidae) was found feeding on the eggs of the insect (Ovifeeders), larvae of ant lion (*Chrysoperla carnea*) and lady beetle (*Chilocorus bipustulatus*) were found feeding on nymphs and adults of *L. viburni*. Other predators were found such as *Scutellista cyanea* (Hymenoptera: Pteromalidae) as ovifeeders. In addition, a mite (*Amblyseius* spp.) was found feeding on nymphs and adults of the insect. Parasitoids were also found in association with *L. viburni*, and all were of the order Hymenoptera and family Aphelinidae. These parasitoids were: *Coccophagus scutellaris*, and *C. lycimnia* (first record) in Libya on *L. viburni* and four parasitoids in the family Encyrtidae, such as: *Microterys purpureiventris*, *M. flavus*,

Metaphycus sp. and *Diversinervus* sp. in addition to *Pachyneuron* sp. (Pteromalidae). The parasitism rate ranged from 2 to 60% during the study period.

BC2

THE DEFENSIVE APHID SYMBIONT HAMILTONELLA DEFENSA AFFECTS HOST QUALITY FOR THREE WASP SPECIES. Sabine Attia¹, Nina Hafer-Hahmann², Kaouthar Grissa-Lebdi¹ and Christoph Vorburger². (1) LR14AGR02 of Bioaggressors and Integrated Pest Management in Agriculture National Agronomic Institute of Tunisia, 43 avenue Charles Nicolle 1082 Tunis, Tunisie, Email: sabine_bio5@yahoo.fr; (2) Eawag, Swiss Federal Institute of Aquatic Science and Technology & Institute of Integrative Biology, ETH Zürich Überlandstrasse 133, 8600 Dübendorf, Switzerland.

Symbiotic relationships between insects and bacteria are a widespread phenomenon in nature and can play a major role in Evolution. In this context, aphids represent a valuable model to study interactions between insects and symbionts. In addition to their obligate bacterial endosymbiont *Buchnera aphidicola*, aphids can also harbour secondary endosymbionts such as *Regiella insecticola*, *Serratia symbiotica* and *Hamiltonella defensa*, which have been demonstrated to have a defensive role against parasitoid wasps. *Hamiltonella defensa* is one of the most frequent endosymbiont species of aphids in general, and of the black bean aphid *Aphis fabae* in particular. The aim of the present work was to determine whether *Hamiltonella defensa* protect their host from parasitism by 3 species of parasitoid wasps and to assess whether parasitoids alter their behaviour in response to the presence of *Hamiltonella* in their hosts parasitoid performance parameters such as antennal contact, ovipositor insertion and the number of eggs deposited in hosts, and those were measured in aphids with and without *Hamiltonella*. Our findings showed that the presence of *Hamiltonella defensa* in their hosts could change the behaviour of the three wasps. These results highlight the often far-reaching effects that *Hamiltonella* can have in ecological systems.

BC3

ISOLATION OF ENTOMOPATHOGENIC FUNGI FROM AGRICULTURAL SOIL FROM CONSTANTINE, ALGERIA, AGAINST THE APHID METOPOLOPHIUM DIRRHODUM. Ouidad Abdelaziz^{1,2}, Mohamed Morad Senoussi² and Amar Oufroukh³. (1) Mentouri Brothers Constantine 1 University, Faculty of Science of Nature and Life, Departement of Microbiolgy, Constantine Algeria, Email: az_wided@yahoo.fr; (2) Oum-El-Bouaghi University, Department of Natural Sciences and Life, Laboratory Plant Biomolecules and Plant Improvement, 04000 Algeria; (3) National Institute of Agronomic Research Constantine, Algeria.

During the period 2013/2014 and 2014/2015, 62 isolates of fungi were isolated from soil of 6 regions at INRA/SRPV in Constantine, Algeria. Thirty-six isolates belonged to 8 genera: *Aspergillus*, *Beauveria*, *Botrytis*, *Fusarium*, *Metharizium*, *Penicillium*, *Trichoderma* and *Verticillium* that were collected from three regions in 2014. Whereas, the remaining 26 isolates belonged to 6 genera:

Alternaria, *Aspergillus*, *Cladosporium*, *Fusarium*, *Penicillium* and *Rhizoctonia* that were collected from other three regions in 2015. The Pathogenic characterization of identified strains was determined through the evaluation of their ability to induce infection and to cause death to aphids. Eleven entomopathogenic strains found to cause death of the aphid *Metapolophium dirhodum*. A high mortality rate was caused by *Beauveria* (90%) followed by *Cladosporium* (60%) and *Verticillium* (50%). However, the remaining fungi showed less mortality rate of *M. dirhodum*: *Aspergillus* and *Metharizium* (41.67%), *Trichoderma* (31.94%), *Penicillium* (27.78 %), *Fusarium*, (20.83%) and *Alternaria*, *Botrytis* and *Rhizoctonia* (13.83%). Difference obtained were statistically significant three days after application.

BC4

STUDY OF THE LARVICIDE EFFECT OF TOXINS OF TWO LOCAL STRAINS OF *BACILLUS* SP. AGAINST THE GREATER WAX MOTH *GALLERIA MELLONELLA*. Hakima Oulebsir-Mohandkaci¹, Farida Tihar-Benzina¹ and Nabila Kabli². (1) Laboratory of the Valorization and Conservation of Biological Resources, Faculty of Sciences, University M'hamed Bougara of Boumerdes, Algeria, Email: mohandkacihakima1@gmail.com; (2) National Institute for Agronomic Research INRAA, Algiers, Algeria.

To reduce the dependence of the agricultural sector on chemical pesticides, the use of biopesticides is proving more and more effective. Moreover, the formulation of biocides based on micro-organisms becomes more and more efficient. Our study was established to investigate the larvicidal potential of two bacterial strains of the genus *Bacillus*; B11 and B8 by their use against the larvae (L5) of the wax moth *Galleria mellonella* (Linnaeus, 1758). Their effect on haemolymphatic metabolites (proteins, lipids and carbohydrates) of the larvae has also been studied. For this purpose, insect was reared under controlled conditions. Bacteria were isolated from the rhizosphere of a cultivated soil in the Boumerdes region, northern Algeria. Their characterization and taxonomic identification were performed based on their morphology and their physiological and biochemical characteristics. In addition, a molecular study was carried out by sequencing 16S RNA followed by phylogenetic sequence analysis. This study allowed us to identify both strains as *Bacillus mycoides* strain B11 and *Bacillus clausii* strain B8. The acid and alkaline extraction of toxins from both bacteria was followed by a study of the toxicity of these secondary metabolites on the insect. Three concentrations 15, 30 and 60 µl/ml were tested, and control larvae were treated with sterile distilled water. In light of the results obtained, it was found that toxins extracted from the two bacterial strains B11 and B8 had a significant effect on *Galleria mellonella* L5 larvae. They caused severe morphological and behavioural alterations such as a strong antifeeding effect and malformations with mortality rates which varied based on the dose used. On the other hand, the determination of hemolymphatic metabolites revealed an increase in protein and carbohydrate levels and a decrease in lipid levels.

BC5

FIRST RECORD OF TWO NEW SPECIES OF *BEAUVERIA* ENTOMOPATHOGENIC FUNGUS FROM HIBERNATING SITES OF SUNN PEST (*EURYGASTER INTEGRICEPS* POTUN) IN GARA MOUNTAIN, IRAQ. Feyroz Ramadan Hassan¹, Lazgeen Haji Assaf² and Samir Khalaf Abdullah³. (1) Plant Protection Department, College of Agricultural Engineering Sciences, Duhok University, Kurdistan Region, Iraq, Email: feyroz.hassan@uod.ac; (2) General Directorate of Agriculture-Duhok, Kurdistan region, Iraq; (3) Medical Laboratory Technology Department, Alnoor University College, Nineva, Iraq

The occurrence of *Beauveria* spp. isolated from the soil under 17 plant species at Gara Mountain, Duhok governorate, Iraqi Kurdistan region is considered as the most frequent location for sunn pest *Eurygaster integriceps* hibernation. This was determined by using *Galleria mellonella* larvae as a bait together with three selective media (oat, oat + CTAB (Cetyl Trimethyl Ammonium Bromide) and oat + CTAB + Cyclohexamide). By using this bait, *Beauveria* spp. were isolated from the soil collected from under the plants milk vetch *Astragalus brachycalyx* and Aleppo oak *Quercus infectoria* Olive with recovery rates of 45.22 and 34.45%, respectively. The most suitable medium for *Beauveria* spp. isolation from soil was oat amended with CTAB which succeeded to isolate *Beauveria* from the soil under 12 plants out of 17. Molecular identification using ITS- rDNA, sequences exhibited high sequence homology to the fungi *Beauveria bassiana*, *B. varroae* and *B. pseudobassiana*. The present study reports two of Ascomycota that were previously unknown in Iraq, namely *Beauveria varroae* and *B. pseudobassiana*.

BC6

EFFECT OF *CAMPSILURA CONCINNATA* ON POPULATION DYNAMICS OF *ORGYIA TRIGOTEPHRAS* IN THE NORTH OF TUNISIA. Sonia HAMMAMI^{1,2}, Olfa Ezzine², Cezary Bystrowski³, Samir Dhahri² and Mohamed Lahbib Ben Jamâa². (1) University of Carthage, Faculty of Sciences of Bizerte, Bizerte, Tunisia, Email: sonia.hamamii@gmail.com; (2) National Research Institute of Rural Engineering, Water and Forests (INRGREF), Ariana, Tunisia; (3) Forest Research Institute (IBL), Sękocin Stary, Raszyn, Poland.

The biological particularities of Tachinids and especially the diversity of the modes of infestation are an extraordinary asset mainly for *Campsilura concinnata* (Diptera: Tachinidae) that was used as biocontrol against *Lymantria dispar* in North America. This work aimed to study the effect of *C. concinnata* on larvae of *Orgyia trigotephras* in Tunisia. Experiments were performed in Jebel Abderrahmane (JA) in northeastern Tunisia and in Dam Ziatine (DZ) in northwestern Tunisia. Larvae collection was made from April to June of each study year, from 2013 to 2018, on *Quercus coccifera* (Qc) and *Pistacia lentiscus* (Pl). Larvae were then sorted and reared on young still-expanding leaves of *Q. coccifera*. Daily monitoring of caterpillars was allowed to follow the emergence of parasitoids. A polyphagous Diptera species was identified (*C. concinnata*) emerging from the 3rd, 4th and 5th instars

collected on both host plants in the two studied sites. This tachinid was observed during all the study years. In 2013, percentage of parasitized larvae of the 3rd instar by *C. concinnata* was high on both host plants (100% on Qc and 88% on Pl) in DZ and low on Pl (14.2%) in JA. For the 4th instar, *C. concinnata* was observed only in JA on Pl (40%) and on Qc (16.3%) in DZ. In 2014, on both sites, percentage of parasitized larvae was higher only on Pl (100%) for the 3rd and the 4th instars. For the 5th instar it was observed only in JA on Qc (60%). In 2015, parasitism was higher in JA for all instars larvae on both host plants. In DZ, it was higher only on Qc for the 3rd and the 4th instars. In 2016, 2017 and 2018 *C. concinnata* parasitized all instars on both host plants but only in JA. As parasitoids, Tachinids are important natural enemies particularly of Lepidoptera larvae, but also the action of Hymenoptera is very important for the regulation of the pest density.

BC7

THE ROLE OF VOLATILE ORGANIC COMPOUNDS (VOC) PRODUCED BY CITRUS LEAVES INFESTED WITH *AONIDIELLA AURANTII* ON THE ATTRACTION OF THE PREDATOR *CHILOCORUS BIPUSTULATUS*. Qasim Ahmed¹, Ahmed Alsabte² and Ruaa Alobaidi³. (1) Department of Plant Protection, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq, Email: qasim.h@coagri.uobaghdad.edu.iq; (2) Date Palm Research Unit, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq; (3) Pharmacy College, Mustansiriyah University, Baghdad, Iraq

This study aimed to identify volatile organic compounds (VOCs) produced by uninfested and infested lemon and orange leaves with California red scale *Aonidiella aurantii* using the headspace solid-phase micro extractions (HS-SPME) technique in conjunction with gas chromatography-mass spectrum (GC-MS) analysis. The target of the study is to identify compounds that attract the predator *Chilocorus bipustulatus* to infested citrus leaves and how they work to increase *C. bipustulatus* attraction. According to the GC-MS results, 20 VOCs were produced by uninfested and infested citrus leaves. Some compounds were increased in both lemon and orange leaves infested with *A. aurantii*, whereas other compounds decreased. The attractiveness of the predator *C. bipustulatus* to VOCs was measured using a Y-tube olfactometer. *Chilocorus bipustulatus* was responsive to infested citrus leaves and synthetic compounds such as D-limonene and methyl salicylate at the concentrations of 1 and 10 µL/ml using a Y-tube olfactometer. This study shed light on how the predator *C. bipustulatus* activity is influenced by chemical signals.

BC8

RELATIVE OCCURRENCE OF COCCINELLID PREDATORS ASSOCIATED WITH OKRA CROP AT MEROWE AREA, NORTHERN SUDAN. Abdalla A. Satti and Nazar A.A. Bilal, Environment, Natural Resources and Desertification Research Institute, National Centre for Research, Khartoum, Sudan, Email: satisattisat@yahoo.com

This study was conducted at two locations (Noori and Shiba) near Hamdab dam in Merowe locality, Northern State, which lies within Sudan arid zone. Such locality is expected to witness an expansion in irrigated agricultural land that might affect the ecology of the whole area, including biodiversity. Therefore, in an attempt to provide some base-line data on natural enemies of agricultural pests, the current research aimed to survey the prevalent coccinellid predators and their relative seasonal occurrence on okra crop grown in the two mentioned locations, during a one-year period (August 2009 to July 2010). Results obtained showed the occurrence of four coccinellid species on okra, i.e., *Hippodamia variegata* (Goeze), *Coccinella undecimpunctata* L. and *Scymnus* spp. (two species). They seemed to prey on various pests, including *Aphis gossypii*, *Bemisia tabaci*, *Thrips tabaci* and other soft insects. Seasonal counts revealed that most species showed their buildup during the end of winter season and onset of summer, but *H. variegata* and *Scymnus* spp. sustained high population levels all year round ($7.50 \pm 3.79 - 30.80 \pm 20.21$ and $22.34 \pm 4.28 - 22.88 \pm 5.74/10$ plants, respectively). Findings proved that these two predatory genera are adapted to the prevailing conditions of the study area, which designate them for further research as promising bio-agents in pest management.

BC9

STUDY AND ANALYSIS OF SELECTION INDEX VALUES OF THE PREDATOR *CRYPTOLAEMUS MONTROUZIERI* MULSANT USING FIVE LINES OF ARTIFICIAL SELECTIONS THROUGH 12 CROSS-BREEDING GENERATIONS. Louai Asslan¹, Nadia Al-Khateeb², Ghassan Ibrahim¹ and Ahmed El-Heneidy³. (1) Faculty of Agriculture, Damascus University, Damascus, Syria, Email: louaiasslan@yahoo.com; (2) Department of Biological Control, Directorate of Agriculture, Lattakia, Syria; (3) Department of Biological Control, Plant Protection Research Institute, Agricultural Research Center, Ministry of Agriculture, Giza, Cairo, Egypt.

The research was carried out at the Laboratories of Biological Control Department in Lattakia, Syria during 2017 on the predator, *Cryptolaemus montrouzieri* Mulsant. The numerical changes of the selection index were estimated in five lines of artificial selections through 12 cross-breeding generations. The first line (control) was chosen randomly without selection. The second line was selected according to the highest female fecundity. The third line was selected according to the highest preying potential of the 3rd larval instar. The fourth line was selected according to the larval development speed. The fifth line was selected according to the highest value of the selection index. Results showed that the highest values of the selection index (I) and response (r) was found at the end of F6 generation and were 306.38 and 28.10%, respectively, with significant differences with the other lines, followed by the selection effectiveness value based on fecundity that reached 283.12 and 18.38%, respectively, meanwhile it decreased to 247.5 and 3.59%, respectively, in the line selected on the basis larval development speed.

BC10

THE PREDATORY EFFICIENCY OF THE SCOLOTHRIPS SEXMACULATUS (PERG.) ON THE STAGES OF ORIENTAL CITRUS MITE EUTETRANYCHUS ORIENTALIS (KLEIN). Hala K.J.J. Al Jboory and Sindab S.J. Aldahoui, Plant Protection Determent, College of Agriculture, University of Baghdad, Baghdad, Iraq, Email: hala.kj@gmail.com

The oriental citrus mite *Eutetranychus orientalis* (Klein) (Acari: Tetranychidae) is an important pest and causes economic losses in citrus nurseries and orchards in Iraq. This mite lives on the upper surface of citrus leaves, and its mobile stages suck the plant sap from leaves and fruits. It affects citrus trees of all ages, from young seedlings in the nursery to the large trees in the orchard. The Predatory thrips *Scolothrips sexmaculatus* (Perg.) is one of the important insect predators common in the Iraqi environment. Its competence is noted on all the stages of the citrus mite. Therefore, its predatory efficiency was studied in vitro. Predator *Scolothrips sexmaculatus* larvae feeding on all stages of Eastern citrus mite were observed and the total consumption rate of eggs, larvae, nymphs and adult mite were 217.2, 119.7, 104.6 and 99.3 individuals/larva, respectively, during the duration of the larval stage. The quantity of prey consumed by the female predator varied from that of the male, as the total consumption of eggs, larvae, nymphs and adult mite were 1509.0, 1310.1, 1113.5 and 667.0 individuals/female, respectively when fed on any of these separate stages. Whereas it was 257.6, 321.3, 259.9 and 118.3 individuals/male, respectively. Thus, females consumed the largest amount of prey during the period of laying eggs and the least during the period after laying eggs. The number of preys eaten by predator adults decreased with increasing age and size of prey.

BC11

EFFECT OF THE GENETIC SELECTION BASED ON FECUNDITY ON IMPROVMENT OF THE QUANTITATIVE TRAITS OF THE PREDATOR, CRYPTOLAEMUS MONTROUZIERI (MULSANT) (COLEOPTERA: COCCINELLIDAE) THROUGH TWELVE CROSS-BREEDING GENERATIONS. Nadia Al-Khateeb¹, Louai Asslan², Ghassan Ibrahim² and Ahmed El-Heneidy³. (1) Department of Biological Control, Directorate of Agriculture, P.O. Box 2012, Lattakia, Syria, Email: nadia@arabscientist.org; nadia4@scs-net.org; (2) Faculty of Agriculture, Damascus University, Damascus, Syria; (3) Department of Biological Control, Plant Protection Research Institute, Agricultural Research Center, Ministry of Agriculture, Giza, Cairo, Egypt.

The research was carried out at Biological Control Department in Lattakia, during 2016 on *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae). The genetic improvement of fecundity was done for twelve generations of cross-breeding and compared with the control. The numerical changes of the quantitative traits (QTs) were studied across the generations and according to the improvement in the tested progeny in comparison with the control progeny. The evaluated quantitative traits were: length of females, fecundity, reproduction, survival rate,

preying potential of the 3rd larval instar, preying potential of female, larval period, developmental period and sex ratio. Estimations were made for each selection cycle in F3, F6, F9 and F12 generations. Statistical analyses of fecundity value showed significant increase from 148.13±37.03 in Po to 232.80±27.70 in F9 and insignificant increase between F9 and F12 generations. Whereas insignificant differences decrease in fecundity of the F9 to F12 generations that reached 133.33±35.12 to 119.80±31.96, respectively. Progenies selection contributed to increase in values of female length, reproduction and survival rate which increased significantly from 4.68±0.33 mm, 132.73±38.87, 88.82±5.83 in Po generation to 4.98±0.17 mm, 227.53±27.40, 94.53±2.21 in F12 generation, respectively. Whereas there were no significant differences in all other quantitative traits (preying potential of the 3rd larval instar, preying potential of female, larval period, developmental period and sex ratio), during the studied generations. Fecundity increased in the selected progenies and reached 62.31% compared to 19.13% in the control.

BC12

FIELD OBSERVATIONS OF SPODOPTERA FRUGIPERDA AND THE NATURAL ENEMIES FAUNA ON WINTER SOWING MAIZE CROP IN GEZIRA, SUDAN. Sara A.A.G. Kehail, Omyma E. Ahmed and Abdel Gader M. Abdellah, Agricultural Research Corporation, Integrated Agricultural Pest Management Research Centre, Entomology Research Program, Wad Medani, Sudan, Email: saraagric@yahoo.com

Maize (*Zea mays* L.) is a cereal crop grown widely throughout the world and considered as one of Africa's dominant food crops. In Sudan stem borers were the main and key pests on maize crop which cause a serious economic damage. The fall army worm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae) was recorded in many African countries since 2016 on the maize crop. FAW was first observed on maize in Sudan (Southeast area) in 2017. During February 2017 in a survey of pests and their natural enemies on winter sowing maize crop in the ARC, Gezira Research Station Farm (Central Sudan). The objective of this study aimed to observe the time of appearance of fall army worm and evaluate the damage caused on maize crop and the natural enemies fauna throughout two winter seasons, from December to April (2017/18 and 2018/19). The study was conducted at Gezira Research Station Farm, Sudan. The observations were taken from the seedling stage until harvest. The eggs and larvae of FAW and the pupae found in the crop were collected from the field and reared in the laboratory until adult stage. the dead larvae which had disease symptoms were taken to the laboratory. The beneficial insects, either predators or parasitoids were sent to the taxonomy unit for identification. The results obtained showed that the pest appeared early in the season starting from the seedling stage, and two weeks later the spiders and the parasitoid *Bracon hebetor* appeared. The FAW attacked the leaves, stem, flowers and cubs of maize plants.

BC13

THE USAGE OF NON-CROP HABITATS BY APHIDS AND THEIR PARASITIDS IN BISKRA PROVINCE (ALGERIA). Souad Tahar-Chaouch¹ and Malik Laamari².

(1) Department of Agronomy, Faculty of Exact and Natural Sciences, University of Biskra, Algeria, Email: souadhouda@gmail.com; (2) Laboratory of ATPPAM, Department of Agronomy, Institute of Veterinary and Agronomy Science, University of Batna, Algeria.

A survey of the tritrophic associations (parasitoid-aphid-host) of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) was carried out in the southeastern part of Algeria (Biskra province) to determine the nature of these associations and to explore non-crop habitats (adjacent and natural) in order to identify plants that might be considered as key reservoirs of aphids and parasitoids activity. In this study, a total of 40 aphid host taxa were identified on plants. Twenty-four parasitized aphid species were recorded from non-crop plants and fourteen taxa of parasitoids were found on aphid hosts. Results obtained suggest that natural habitats are clearly distinguished by a number of trophic interactions. The number of nonspecific interactions was 32% less than all parasitoid-aphid trophic relations which support the persistence of the parasitoid species *Aphidius matricariae*. Several spontaneous plant species such as *Malva parviflora*, *Calendula aegyptiaca*, *Hedysarum carnosum* and *Carduus pycnocephalus* were found reservoirs of generalist parasitoids which are potential regulators of many aphid pest species.

BC14

MORPHOLOGICAL AND MOLECULAR CHARACTERIZATION OF *PSYTTALIA* SP. (BRACONIDAE) A PARASITIC HYMENOPTERA OF PEACH FRUIT FLY *BACTROCERA ZONATA* SAUNDERS. Manal H. Elbashir¹, Sumaia M. Abukashawa² and Mohamed E.E. Mahmoud³:

(1) Agricultural Research Corporation (ARC), IPMRC National Insect Museum, Sudan, Email: manalhamed86@hotmail.com; (2) University of Khartoum, Faculty of Science, Department of Zoology, Sudan; (3) Agricultural Research Corporation (ARC), Kassala Research Station, Sudan.

The fruit fly *Bactrocera zonata* (Diptera: Tephritidae) is a serious pest of horticultural crops causing severe losses in production and affects adversely the economic growth by hindering exportation. Different species of parasitoids were found very effective against fruit flies in biological control programs. This study was carried out to characterize *Psytalia* sp., a parasitoid reared out from *B. zonata* in Sudan, based on morphological and molecular data. The parasitoid was identified morphologically using specific key up to the genus level. The molecular identification of *Psytalia* species using PCR technique gave 700 bp DNA fragment. The absence of *Psytalia* species from the entomological records of Insect Collection Unit, Agricultural Research Corporation suggest that this wasp is likely a recent introduction and calls for more surveys to identify the native and introduced wasp parasitoid species in Sudan.

BC15

NATURAL OR CLASSICAL BIOLOGICAL CONTROL? NATIVE AND IMPORTED EGG PARASITIDS AND THEIR POTENTIAL TO CONTROL POMEGRANATE BUTTERFLY *DEUDORIX LIVIA* KLUG. Abdulhamid Al-Riyami^{1,2} and Ian CW Hardy³.

School of Biosciences, University of Nottingham, Sutton Bonington Campus, LE12 5RD, UK, Email: aa.alriyami@gmail.com; (2) Ministry of Agriculture, Fisheries Wealth and Water Resources, P.O. Box 467, P.C. 100, Muscat, Oman; (3) Department of Agricultural Sciences, P.O. Box 27, University of Helsinki, FI-00014, Finland.

In this study, the relative performance of, and interactions between, imported and indigenous species of natural enemies in biological agricultural pest control was considered. Attempts to control the pomegranate butterfly, *Deudorix livia* (Lepidoptera: Lycaenidae), in Oman using two imported and mass-reared species of egg parasitoids, *Trichogramma brassicae* and *Trichogramma evanescens*, were not very successful. Field surveys and laboratory rearings showed that almost no pest eggs were parasitized by these imported species. However, a naturally occurring parasitoid, *Telenomus nizwaensis*, attacked around 40% of pest eggs in the field. At present, this native parasitoid cannot be cultured and thus mass-reared for release. Laboratory experiments based on enforced competition indicated that the *Trichogramma* species can disrupt reproduction by *Telenomus nizwaensis*. Furthermore, *Telenomus nizwaensis* typically achieved parasitism too late in the fruiting season to prevent economic damage. A recent field study identified biotic and abiotic factors that affect the seasonal dynamics of butterflies which attack pomegranates, and the parasitism of pest eggs by *T. nizwaensis*, with the ultimate goal of developing methods for improving the native parasitoid's contribution to conservation of biological control.

BC16

TROPHIC RELATIONSHIPS BETWEEN APHIDS AND THEIR PRIMARY PARASITIDS IN NON-CULTIVATED AREAS OF GUELMA, EASTERN ALGERIA. Hayet Aggoun, Nacer Tarai and Souad Tahar Chaouch, Laboratory LDESPAZA, Faculty of Exact Sciences and Natural and Life Sciences, Department of Agricultural Sciences of University of Biskra, Algeria, Email: aggoun_hayet@yahoo.fr

Aphids represent very important group of plant pests with high reproductive potential through parthenogenesis and viviparity. They are causing direct (sucking) and indirect (transmission of viruses and honeydew secretion) damages on cultivated and wild-growing plants. Aphid population can be controlled in different ways, but because of the great damage they cause, farmers control them mostly with synthetic insecticides. Over the last few decades, the release of insect parasitoids in biological control programs has increased all over the world against phytophagous pests in open fields, greenhouses and even in forestry. The present study was carried out to investigate the trophic relationship between aphids and their primary parasitoids in Khenchela, between September 2018 and September 2019. 10 species of aphids were recorded

from 13 host plants. The aphids were parasitized by 8 species of primary parasitoids. The latter are: *Aphidius ervi*, *Aphidius funebris*, *Aphidius matricariae*, *Binodoxys angelicae*, *Binodoxys* sp., *Lysiphlebus fabarum*, *L. testaceipes* and *Praon volucre*. These species are new for the region of study. These natural enemies were able to establish 22 tri-trophic associations. The genus *Lysiphlebus* was the most abundant. The higher trophic relationship between aphids and their primary parasitoids is obtained from the species *Lysiphlebus testaceipes* (8 associations). In turn, these primary parasitoids are parasitized by hyperparasitoids (secondary parasitoids) belong to the families Encyrtidae, Figitidae, Megaspilidae and Pteromalidae.

BC17

EFFECT OF DIFFERENT TEMPERATURE REGIMES ON SOME BIOLOGICAL ASPECTS OF THE PARASITOID *Goniozus claripennis* FÖRSTER REARED ON LARVAE OF GREATER WAX MOTH AND MEDITERRANEAN FLOUR MOTH. Anwar Jassam Allallah¹, Jasim Khalaf Mohammed², Saadoon Hameed Abid³ and Enas Fadel Abbas⁴. (1) Ministry of Education, Baghdad, Iraq, Email: jasim_aljanabi1968@yahoo.com; (2) Plant Protection Directorate, Ministry of Agriculture, Baghdad, Iraq; (3) College of Education for Girls Al-Anbar University, Iraq; (4) Plant Protection Directorate, Ministry of Agriculture, Baghdad, Iraq.

This Study was carried out to investigate the effect of different constant temperatures 20, 25, 30 and 35°C on some life aspects of the parasitoid *Goniozus claripennis* reared on the larvae of greater wax moth, *Galleria mellonella* and Mediterranean flour moth, *Ephesia kuehniella* under laboratory conditions. Results obtained indicated that the highest pre-oviposition period of females was 8.83 days at 20°C and the shortest was 3.5 days at 35°C. However, the post-oviposition period ranged from 3.5 to 1.17 days at 20-35°C for both hosts. Females laid the highest egg number (105.5 eggs/female) on the greater wax moth larvae compared to 91.81 eggs/female laid on larvae of the Mediterranean flour moth at 30°C. The longevity was influenced by temperature and host. Indeed, the longest adult longevity was 53.5 and 49.5 days for males and 11 and 12.67 days for females at 20°C for *G. mellonella* and *E. kuehniella*, respectively. Moreover, the sex ratio ranged from 1:0.25 to 1:0.47 (female: male) at different temperatures and hosts. In addition, the highest eggs number laid by females was 11.5 and 10.33 eggs/ larvae on day 13 and 7 of its life span when reared on the greater wax moth and Mediterranean flour moth at 30°C, respectively. The highest general number of eggs laid by females was 4.58 and 3.52 eggs/larvae at 30°C, reared on *G. mellonella* and *E. kuehniella*, respectively.

BC18

VARIOUS ANALYSES OF *PTEROCHLOROIDES PERSICAE* (HEMIPTERA: LACHNINAE) AFTER EXPOSURE TO THE SPECIALIZED PARASITOID *PAUESIA ANTENNATA* IN PEACH ORCHARDS. Rihem Adouani Beltaief¹, Lassaad Mdellel², Monia Kamel Ben Halima¹ and David Martinez³. (1) Higher Agronomic Institute of Chott Mariem (ISA CM), University of Sousse,

Tunisia, Email: rihemadouani@gmail.com; (2) Higher School of Agriculture (ESAK), University of Jendouba, Kef, Tunisia; (3) Institute for integrative systems biology, University of Valencia, Spain.

The specific parasitoid *Pauesia antennata* (Hymenoptera: Aphidinae) was released for the biological control of the brown peach aphid *Pterochloroides persicae* (Hemiptera: Lachninae) on peach crops in different sites in Tunisia. It was observed that the parasitoid can accept or reject this aphid species. The relationship between aphid and parasitoid was studied to explain this behavior. Comparative biology (Antibiosis and Antixenosis tests), morphological and molecular analyses of *P. persicae* were done on individuals collected from two zones, one of acceptance and a second of rejection of the aphids by the parasitoid. The principal components analysis (PCA) was applied to find out if morphological, biological and genetic variation of peach aphid samples were correlated with the observed parasitoid information. Results demonstrated a significant difference of four morphological characters (body length, body width, total antennal and hind femora length), larval longevity and the fecundity of *P. persicae* between the two zones. Molecular analysis using the mitochondrial COI gene revealed the presence of two haplotypes corresponding to the two different sites. However, the cytochrome b gene (cytb) and the nuclear gene elongation factor-1 alpha (EF1α) failed to reveal any variability in this species.

BC19

SUPPRESSION OF SEVERAL PLANT PATHOGENS USING BIOLOGICAL CONTROL AGENTS AND PLANT EXTRACTS. Omran Youssef, Ralf Thomas Voegelé and Abbas El-Hasan, Department of Phytopathology, Institute of Phytomedicine, University of Hohenheim, Stuttgart, Germany, Email: om_youssef@yahoo.com

Ten fungal isolates belonging to the genus *Trichoderma* (To1, To2, To3, To4, To5, To6, To7, To8, T16 and T23) and three isolates of *Bacillus* spp. (Bo2, Bo3 and Bo5) were evaluated regarding their potential to inhibit mycelial growth and spore germination of several plant pathogens including *Fusarium culmorum*, *F. moniliforme*, *Alternaria alternata* and *Helminthosporium sativum*. The results obtained from dual culture test indicated that four isolates (T16, T23, To4 and To7) were able to inhibit mycelial growth of all pathogenic fungi under laboratory conditions with an inhibition rate exceeding 85%. On the other hand, leaf extracts of *Hedra helix*, *Lantana camara* and garlic prepared using different solvents (ethanol, acetone, acetonitrile and water) were evaluated at different concentrations in suppressing spore germination of *Puccinia striiformis* f. sp. *tritici* (Pst.). The results indicated that all concentrations of plant extracts with ethanol, acetone and acetonitrile blocked germination of Pst. urediospores after 6 h of treatment. While the percentage of Pst. urediospores germination in plant extract prepared in water, as well as in the fungal (To16, To23, To4 and To7) and bacterial extracts ranged 5-10% compared to a germination rate of 50% in the control (distilled water). Moreover, biological control agents (BCAs) and plant extracts efficacy was evaluated on wheat infected with yellow rust (YR) in the greenhouse. Results

obtained showed that YR severity was reduced when treatments were applied 24 h before inoculation with YR urediospores. Fifteen days post-inoculation, rust severity was 5% for To16, To4 and HG77 and 10% for To23, To7 and *Hedra helix* ethanol extract compared to 20% in the control. In contrast, the biological control agents were unable to reduce YR development when they were applied 48 h post-inoculation. In conclusion, our results showed the importance of biological control agents as well as some plant extracts in reducing the growth of different fungal pathogens.

BC20

DYNAMICS AND COMBINED EFFECT OF SOIL NUTRIENTS AND BIOTIC FACTORS ON SEVERITY OF CHICKPEA *FUSARIUM* WILT. Moutassem Dahoua¹, Bellik Yuva¹, Rouag Noureddine¹ and Ziouche Sihama². (1) Laboratory of Characterization and Valorization of Natural Resources (L.C.V.R.N), Faculty of Nature and Life Sciences, University of Bordj Bou Arreridj, Algeria, Email: moutassemdahou@gmail.com; (2) Department of Agronomy, Faculty of Nature and Life Sciences, University of Ferhat Abbas Sétif 1, Sétif, Algeria.

Fusarium wilt caused by the fungus *Fusarium oxysporum* f. sp. *ciceris* (Foc), is one of the most frequent diseases resulting in severe economic losses of chickpea production around the world. The present study was performed to investigate the dynamic and combined effects of some soil biotic (*Trichoderma* spp., *Pseudomonas* spp.) and abiotic factors (Nitrogen, Phosphorus) on the disease severity of *Fusarium* wilt. Chickpeas were harvested 180 days after planting, from eight naturally infested soils during 2016 and 2017. Nitrogen (N-TotalR) and phosphorus (Olsen-P) availability in chickpea rhizosphere was assessed in relation to *Fusarium oxysporum* f. sp. *ciceris* inoculum density (ID-Foc), *Trichoderma* spp. and *Pseudomonas* spp. as well as nitrogen (N-TotalPL) and phosphorus (P-TotalPL) plants uptakes. Results showed that high level of ID-Foc significantly increased AUDPC values. It was found that ID-Foc was negatively correlated with Olsen-P and positively correlated with N-TotalR. Accordingly, AUDPC values were positively correlated with high concentrations of N-TotalR ($r=0.77^{**}$ in 2016, $r=0.94^{***}$ in 2017) while negatively correlated with high concentrations of Olsen-P ($r=-0.73^{**}$ in 2016, $r=-0.79^{**}$ in 2017). In addition, chickpea seedlings undergo nutrient status changes in relation to AUDPC values. The AUDPC values showed negative interactions with N-TotalPL ($r=-0.80^{**}$ in 2016, $r=-0.78^{**}$ in 2017), whereas positive interactions with P-TotalPL ($r=0.80^{**}$ in 2016, $r=0.87^{**}$ in 2017). Moreover, AUDPC values were negatively associated with *Pseudomonas* spp during the two years of study and for one-year 2017 with *Trichoderma* spp. Results demonstrated that wilt disease severity is strongly associated with nutrients and biological soil properties. In addition, it was found that soils with highest Olsen-P levels, *Trichoderma* spp. and *Pseudomonas* spp. can help *Fusarium* wilt suppression.

BC21

UTILIZATION OF RHIZOBACTERIA AND SPENT MUSHROOM COMPOST FOR THE MANAGEMENT OF BACTERIAL WILT OF POTATO. Raees Ahmed¹,

M. Inam-ul-Haq² and Adeela Altaf². (1) Department of Plant Pathology, University of Poonch Rawalakot, Pakistan, Email: raees@upr.edu.pk; (2) Department of Plant Pathology, PMAS-Arid Agriculture University Rawalpindi, Pakistan.

Potato (*Solanum tuberosum* L.) is the fourth most important staple food in the world after wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and maize (*Zea mays* L.). In Pakistan, potato crop is cultivated over an area of 159.4 thousand hectares with 3491.7 thousand tons production. *Ralstonia solanacearum* causing bacterial wilt is a major threat to potato production. Management through biocontrol agents is one of the best methods that can replace synthetic chemical-based formulations. In current study, combine effect of antagonist rhizobacteria as biocontrol agent and spent mushroom compost as biofertilizer were tested for the control of bacterial wilt pathogen. Potato plant samples infected with *R. solanacearum* and rhizobacteria were collected from potato growing fields in Rawalpindi. Out of twenty tested antagonistic rhizobacterial isolates, only three viz., Rh10, Rh12 and Rh 15 showed maximum inhibitory effect against *R. solanacearum*. In another experiment different combinations of treatments containing rhizobacteria alone or combined with fresh and spent mushroom composts were also tested against the bacterial wilt pathogen under laboratory conditions. Combination of rhizobacteria along with weathered compost (T5) reduced the disease incidence to 15.92% when compared to 77.81% in the control after six weeks. Significant increase in plant height up to 41.83cm was also observed as compared to 35.5 cm for the control. Similarly, T2 (only fresh compost), T3 (containing fresh compost along with rhizobacteria) and T4 (rhizobacteria along with weathered compost) also showed better results as compared to the control (T0) where there was no application of rhizobacteria and compost. Application of rhizobacteria along with spent mushroom compost can significantly reduce the disease incidence along with the improvement in plant growth parameters.

BC22

BIOLOGICAL POTENTIAL OF *BACILLUS SUBTILIS* V26 FOR THE CONTROL OF *FUSARIUM* WILT AND POTATO TUBER DRY ROT CAUSED BY *FUSARIUM* SPECIES AND PROMOTION OF PLANT GROWTH. Saoussen Ben Khedher^{1,2}, Boutheina Mejdoub-Trabelsi² and Slim Tounsi¹. (1) Laboratory of Biopesticides, Centre of Biotechnology of Sfax, Sfax, Tunisia, Email: saoussen.benkhedher@gmail.com; (2) Agronomical Institute of Kef, Kef, Tunisia.

Fusariosis of potato caused by the *Fusarium* spp. is one of the most destructive soil-borne diseases throughout the world. This study aimed to investigate the growth-promoting and biocontrol potential of *Bacillus subtilis* V26 against the causal agents of *Fusarium* wilt and *Fusarium* dry rot diseases on potato. Characterization of plant growth promoting traits was assessed *in vitro*. The strain V26 was able to fix nitrogen, to produce indole-3-acetic acid, siderophore, hydrolytic enzymes and to solubilize inorganic phosphate. The PCR detection of *ituC*, *fenA*, *fenB*, *fenD*, *srfAA*, *bmy*, *mnlA*, *bae* and *bac* genes coding for iturin, fengycin, surfactin, bacylomycin, macrolactin, bacillaene

and bacilysin indicated a potential for lipopeptides, polypeptides and dipeptide production, respectively by the strain V26. *In vitro* antagonism test showed that this strain can effectively inhibit *F. oxysporum*, *F. solani*, *F. graminearum* and *F. sambucinum* growth by 54.7 to 85.3% as compared to the untreated control, in a dual method. Antifungal activity was demonstrated against the dry rot potato tubers caused by *Fusarium* species. The preventive application of V26 significantly decreased the *Fusarium* dry rot disease severity by 42.8–63.8%, 21 days after fungi inoculation. 15 days after seedling emergence, plants were irrigated with V26 spore suspensions (10^8 CFU/mL), prior to infection with *Fusarium* species. *Fusarium* wilt severity was reduced by 54.8 to 60.8% and plant growth parameters were improved, compared to the untreated ones, 60 days post-inoculation. Therefore, this strain could be a promising candidate to be developed as commercial biofertilizer and biocontrol formulation for sustainable agriculture.

BC23

ASCOPHYLLUM NODOSUM EXTRACT AND MYCORRHIZAL COLONIZATION SYNERGISTICALLY TRIGGER IMMUNE RESPONSES IN PEA PLANTS AGAINST RHIZOCTONIA ROOT ROT AND ENHANCE PLANT GROWTH AND PRODUCTIVITY. Younes M. Rashad¹, Hany H. A. El-Sharkawy² and Nahla T. Elazab³. (1) City of Scientific Research and Technological Applications (SRTA-city), Alexandria, Egypt, Email: younesrashad@yahoo.com; (2) Agricultural Research Center (ARC), Giza, Egypt; (3) Faculty of Science, Mansoura University, Egypt.

Rhizoctonia root rot is one of the most destructive diseases affecting pea crops, resulting in up to 75% loss. In this study, the biocontrol activity of seaweed (*Ascophyllum nodosum*) extract at 1, 2, and 3% and/or mycorrhization of pea roots was investigated against Rhizoctonia root rot under greenhouse conditions. In addition, their effects on the transcriptional, physiological, ultrastructural, and growth status of pea plants were also studied. The results showed that the mycorrhizal colonization of pea roots and the application of the seaweed extract at 3%, synergistically overexpressed the responsive factor (*JERF3*) recording 18.2-fold, and the defense-related genes peroxidase (23.2-fold) and chitinase II (31.8-fold). In addition, this treatment improved the activity of the antioxidant enzymes POD and PPO, increased the phenolic content in pea roots, and triggered multiple hypersensitive reactions at the ultrastructural level of the cell, leading to a 73.1% reduction in disease severity. Moreover, a synergistic growth-promoting effect on pea plants was also observed. The photosynthetic pigments in pea leaves were enhanced in response to this dual treatment, which significantly improved their yield (24 g/plant). The inducing effect of mycorrhizal colonization on plant resistance and growth has been extensively studied. However, developing improved and synergistically acting biological agents for plant disease control and growth promotion as alternatives to the chemical fungicides is crucial for food safety and security. Based on these results, it can be concluded that the mycorrhizal colonization of pea roots and soaking their seeds in the *A. nodosum* extract at 3% have a promising and improved

biocontrol activity against *R. solani*, and a growth-promoting effect on pea plants. However, field applications should be evaluated prior to any general recommendation.

BC24

EFFECTIVENESS OF SECONDARY METABOLITES PRODUCED BY PLANT-ASSOCIATED BACILLUS STRAINS IN CONTROLLING FIRE BLIGHT DISEASE. Dorra Ben Abdallah¹, Slim Tounsi¹, Faten Hamdi² and Olfa Frikha-Gargouri¹. (1) Laboratory of biopesticides, Centre of Biotechnology of Sfax, Tunisia, Email: benabdallahdorrah@yahoo.fr; (2) ControlMed, Production of Biocontrol Agents industry, Sidi Thabet, Tunisia.

Fire blight caused by *Erwinia amylovora* is the most destructive bacterial disease of apples and pears worldwide. To develop an effective biocontrol method against the pathogen, a total of 180 bacteria were isolated from soil rhizosphere and screened for *in vitro* antagonistic activity. Twelve isolates, strongly inhibited the growth of *E. amylovora*, were identified by partial sequencing of 16S rRNA as *Bacillus* strains. Molecular characterization of anti-*Erwinia* metabolites produced by the selected strains using PCR assays showed that most isolates harbored genes of difficidin, macrolactin and bacillaene polypeptides and bacilysin dipeptide. Biochemical characterization of these metabolites showed that they were effective over a wide range of pH and temperature and are not affected by proteolysis. The potential of these compounds to reduce the severity of fire blight disease on detached pear leaves was also tested and confirmed. This study suggests that instead of live bacteria, secondary metabolites derived from *Bacillus* strains can be used as novel biocontrol agent against fire blight disease.

BC25

ENDOPHYTIC BACTERIA NATURALLY ASSOCIATED WITH TWO WILD SOLANACEOUS SPECIES SHOWING GROWTH PROMOTION AND FUSARIUM WILT BIOCONTROL ABILITIES IN TOMATO. Rania Aydi Ben Abdallah¹, Hayfa Jabnoun-Khiareddine¹, Fakher Ayed^{1,2}, Imene Mensi^{1,3} and Mejda Daami-Remadi¹. (1) UR13AGR09-Integrated Horticultural Production in the Tunisian Centre-East, Regional Research Centre on Horticulture and Organic Agriculture, University of Sousse, Chott-Mariem, Sousse, Tunisia, Email: raniaaydi@yahoo.fr; (2) Higher Agronomic Institute of Chott-Mariem, University of Sousse, Chott-Mariem Sousse, Tunisia; (3) Technical Centre of Organic Agriculture, Chott-Mariem, Sousse, Tunisia.

Wild *Solanum* species are extensively used as potential sources of bioactive molecules and/or as natural sources of beneficial microorganisms isolation. In this study, twenty-three endophytic bacterial isolates, recovered from *Solanum sodomaeum* and *S. bonariense*, were evaluated for their ability to suppress *Fusarium* wilt disease caused by *Fusarium oxysporum* f. sp. *lycopersici* (Fol) in tomato and to promote plant growth. Selected endophytic isolates were evaluated *in vivo* using the root-dipping and the culture substrate drenching methods. The most active isolates were morphologically and biochemically characterized and

identified using 16S rDNA sequencing genes. The *in vitro* antifungal activity of the selected isolates was assessed using the dual culture and the sealed plate methods. Their plant growth promoting traits and their antagonistic potential were assessed using agar plates and/or spectrophotometric analyses. Six isolates (*Stenotrophomonas maltophilia* S23, S24 and S28, *Bacillus* sp. SV81, *Azotobacter chroococcum* S11 and *Serratia marescens* S14) were found to be the most efficient in suppressing disease severity by 82-96% and in increasing plant growth parameters by 45.5-61% and 24.2-70.5% in tomato plants infected or not infected with Fol, respectively. Diffusible and volatile metabolites from these bacteria had significantly inhibited Fol radial growth. All isolates were found able to produce the indole-3-acetic acid (IAA). *S. marescens* S14, *S. maltophilia* S28 and *Bacillus* sp. SV81 displayed positive phosphate solubilization activity. Production of chitinase, protease, pectinase, and hydrogen cyanide were also demonstrated. This study clearly demonstrates that these two wild solanaceous species may be explored as promising sources for the isolation of biocontrol and growth-promoting agents.

BC26

EFFECT OF TREATMENT OF TOMATO SEEDS WITH VESICULAR-ARBUSCULAR MYCORRHIZA (VAM) IN IMPROVING PEROXIDASE ACTIVITY AND CONTROL DAMPING-OFF OF TOMATO ALONG THE SYRIAN COAST. Mohammad Imad Khriebe¹, Ibtissam Ghazal², M. Fawaz Azmeh¹ and Wafaa Choumane³. (1) National Commission for Biotechnology (NCBT), Damascus, Syria, Email: imadkhriebe@gmail.com; (2) Plant Protection Department, Faculty of Agriculture, Tishreen University, Lattakia, Syria; (3) Biotechnology Center at Tishreen University, Lattakia, Syria.

The effect of vesicular-arbuscular mycorrhiza (VAM) in improving the peroxidase enzyme activity and its role in controlling tomato damping-off caused by *Pythium ultimum* was studied in a pot experiment during the 2014 growing season. Five treatments representing different methods of soil infestation with the damping off pathogen and VAM were used. In the first treatment, soil was infested only with *Pythium* (Py), in the second, with Mycorrhiza only (My), in the third with *Pythium* and Mycorrhiza at seed planting (My+Py), in the fourth, with *Pythium* and two weeks after seed planting with Mycorrhiza (Py-My), and in the fifth, with Mycorrhiza and two weeks after seed planting with *Pythium* (My-Py). The results obtained showed that peroxidase concentration in plant tissues 14 days after seed germination in the treatment (My) (361.91 $\mu\text{mole/mg}$) significantly exceeded the other treatments. Peroxidase enzyme activity in tissues of plants treated with VAM before adding the fungal pathogen (Py-My) was 183.73 micromole/mg and was significantly 41% than the MY +Py treatment which reached 108.27 micromole/mg. The concentration of peroxidase increased significantly 28 days after seed germination in My treatment (687.52 $\mu\text{mole/mg}$) compared to Py treatment (10.52 $\mu\text{mole/mg}$). Enzyme concentration reached 98.67 $\mu\text{mole/mg}$ when the pathogen was added together with VAM when planting the seeds (My+Py). Results also showed that 35 days after seed

germination, the enzyme concentration was significantly higher in the treatment of My-Py treatment (763.39 $\mu\text{mole/mg}$) compared with the My+Py treatment (143.5 $\mu\text{mole/mg}$). The differences were significant between the two treatments.

BC27

ACTIVITY ASSESSMENT OF SOME BIOLOGICAL CONTROL AGENTS AND ZINC AND MAGNESIUM OXIDES NANOPARTICLES AGAINST *MACROPHOMINA PHASEOLINA* CAUSING CHARCOAL ROT DISEASE OF SESAME. Hurria H. Al-Juboory and Sara W. Abd, Department of Plant protection, College of Agriculture Engineering Sciences, University of Baghdad, Iraq, Email: hurria98@coagri.uobaghdad.edu.iq

The study was carried out to evaluate the activity of the bacteria *Bacillus subtilis* and *Streptomyces* sp. and zinc oxide (ZnONPS) and magnesium oxide (MgONPS) nanoparticles to inhibit the growth of *Macrophomina phaseolina* on PDA and reduce infection of sesame plants with charcoal rot caused by *M. phaseolina* in a pot experiment. High antagonistic activity of *B. subtilis* and *Streptomyces* sp. was observed against the pathogenic *M. phaseolina* Mp-4 isolate on PDA. The results of the MgONPS and ZnONPS test against the Mp-4 isolate at concentrations 1, 2, and 3% each, proved that all concentrations of ZnONPS led to an increase in the inhibition rate, whereas the MgONPS completely inhibited the growth of the Mp-4 isolate. The results of an experiment evaluating *B. subtilis*, *Streptomyces* sp., ZnONPS and MgONPS in controlling the causative agent of charcoal rot disease in pots, showed that the factors used had a positive effect in controlling the pathogenic fungus by reduction in the incidence and severity of infection and increase in dry weight. The results also showed that soaking sesame seeds in ZnONPS and MgONPS together with contaminated soil with Mp-4 isolate was found the most effective against disease incidence and severity of infection which reached 14.1% and 9.7%, respectively. The incidence and severity of infection in sesame plants treated with *B. subtilis* and *Streptomyces* sp. separately were 26.1%, 19.9% and 37.9, 32.1%, respectively, whereas they were 21.9 and 15.8%, respectively, in *B. subtilis* and *Streptomyces* sp. combined treatment. The disease incidence and severity in treatments of sesame seeds soaked in ZnONPS and MgONPS separately was 19.3, 11.6% and 30.3, 24.7%, respectively, compared with 100 and 93.4% in the treatment with soil contaminated with Mp-4 isolate.

BC28

CONTROLLING THE WHITE MOLD DISEASE OF EGGPLANT BY USING LOCAL FORMULAS OF *METARHIZIUM ANISOPLIAE* AND *BEAUVERIA BASSIANA* UNDER GREENHOUSE CONDITIONS. Neran Salem Aljarah and Haneen Abdulhalim Ali, College of Agricultural Sciences, University of Baghdad, Iraq. Email: neranaljarah@yahoo.com

The study was conducted in horticulture laboratories of the Abu Ghriab Center and College of Agricultural Sciences, Plant Protection Department,

Baghdad, Iraq, during the 2017 season. The aim of this study was to assess the efficacy of three local bio-control agents *Metarhizium anisopliae*, *Beauveria bassiana* and *Trichoderma harzianum* to control the white mold disease, caused by *Sclerotinia sclerotiorum*, on eggplants under plastic house conditions. The results of the laboratory experiments showed that 72.81, 69.06 and 55.00% inhibition of *S. sclerotiorum* mycelium growth was obtained when *M. anisopliae*, *T. harzianum* and *B. bassiana* (5g/L) were used in dual culture method, respectively. The study demonstrated the effectiveness of all three products in reducing the sclerotia germination and the apothecia formation 8 weeks after soaking. The lowest germination rate (%) was 33.33% in the *B. bassiana* treatment compared to 100% in the control (soaking in water). The treatment of the sclerotia with the two products *M. anisopliae* and *B. bassiana* caused a significant decrease in the number of apothecia to 1.58 apothecia/sclerotia compared to 3.67 apothecia/sclerotia in the control. The lowest diameter and the number of stalks were obtained in the two treatments of *B. bassiana* and *M. anisopliae* that reached 1.82, 2.00 mm, and 1.33 and 1.83 stalks/sclerotium, respectively, with significant difference with the control treatment which reached 4.66 mm and 3.58 stalks/sclerotium, respectively. The length of the stalks were 0.20 and 0.33 mm in treatment with *B. bassiana*+ *M. anisopliae* and *T. harzianum*, respectively, with a significant difference from the control treatment (3.23 mm). In the plastic house experiment, the results obtained indicated that disease severity in plants sprayed with *M. anisopliae* was reduced by 40.62% compared to 100% in the control (pathogen only), 45 days after inoculation.

BC29

TRICHODERMA SPP. ISOLATES AS POTENTIAL HALOTOLERANT AGENTS FOR BIOCONTROL OF WHEAT ROOT AND CROWN ROT IN ARID REGIONS. Wassila Dendouga¹, Roumaissa Ouanoughi¹, Amina Ghedjmis¹, Houda Bouregghda² and Mohamed Belhamra³. (1) Laboratory of Biodiversity of Ecosystem and Dynamic Production of Agriculture System in Arid Regions, University of Biskra, Algeria, Email: wassila.dendouga@univ-biskra.dz; (2) Laboratory of Phytopathology and Molecular Biology, National High School of Agronomy (ENSA), El-Harrach, Algiers, Algeria; (3) Scientific and Technical Research Center for Arid Areas (CRSTRA), Algeria.

Root and crown rot of wheat caused by *Fusarium* species is a very common and economically important disease in many wheat-producing area of the world, especially in arid regions. Scarcity of fresh water and soil salinity in arid regions necessitate the search for halotolerant biocontrol agents that can tolerate these conditions. The objective of this study was to evaluate the potential of halotolerant strains of *Trichoderma* spp. isolated from Algerian desert soils for their biocontrol ability against the main causal agents of root and crown rot of wheat in Algeria, *Fusarium graminearum* Schwabe and *Fusarium culmorum* (W.G. Smith) Saccardo, focusing on the relationship between their ability to reduce disease index of pathogens and their natural bioactive products. Identity of halotolerant isolates was confirmed by combining phenotypic

characterization results and genetic analysis performed by sequencing the ITS1- 5.8S-ITS2 rDNA region using the primers ITS1 and ITS4. *In vitro* salinity tests have been carried to evaluate the sporulation of *Trichoderma* spp., their possible production of diffusible substances and volatile compounds. Results obtained with all *Trichoderma* spp. isolates showed significant decrease in colony diameter and sporulation of *Fusarium* species compared to the control. In direct confrontation, *Trichoderma harzianum* isolates were able to overgrow and sporulate above *F. culmorum* colonies which reflect their high mycoparasitic potential. *In vitro* antibiosis assays, *Trichoderma viride* and *T. hamatum* isolates were the most efficient due to their volatile secretions and reduced pathogen growth by around 50%. The seed treatment by *Trichoderma* spp. isolates before sowing in a soil already infested with the pathogens led to a significant decrease of disease severity compared to the untreated control. The highest disease index decrease (>70%) was obtained with two isolates of *T. harzianum* (Thr.4 and Thr.10) and *T. viride* Tv.6 against the three fungal pathogens.

BC30

USE OF TRICHODERMA SPP. ISOLATES AGAINST FUSARIUM OXYSPORUM ISOLATES IN VITRO AND UNDER GREENHOUSE CONDITIONS. Khayriyah Misbah Dayab¹ and Najat Khalifa El-Gariani². (1) National Center for Plant Protection and Plant Quarantine, Tripoli, Libya, Email: Karya8522@gmail.com; (2) Department of Plant Protection, Faculty of Agriculture, University of Tripoli, Libya.

This study was conducted to compare the efficacy of local isolates of *Trichoderma* sp. (TK), *T. longibrachiatum* (TNG₁, TNG₂) and *T. harzianum* to inhibit *F. oxysporum* *in vitro* growth and to evaluate the suppressive effect of TNG₁ and TNG₂ isolates on *F. oxysporum* development under greenhouse conditions. The study was based on quantitative analysis method using completely randomized design (CRD). The isolates of the biocontrol agent, *T. longibrachiatum*, inhibited *F. oxysporum* growth *In vitro* by 20.40-55.26 %, depending on the timing of the biological treatment. *T. longibrachiatum* made changes in the pathogen hyphae and produced granulated and malformed cytoplasm. The use of the biocontrol agent in liquid culture and formulation led to 25-28% disease reduction as compared to untreated plants. Disease incidence range was 40-41% with TNG₁ isolate, being the most effective in reducing disease infection in liquid and formulation forms. Accordingly, it is possible to introduce this biological agent as pre-planting treatment to control plant pathogens in the soil.

BC31

THE EFFECT OF ADDING FERMENTED MANURE AND TRICHODERMA HARZIANUM ON REDUCING CHICKPEA WILT DISEASE CAUSED BY FUSARIUM OXYSPORUM F. SP. CICERIS. Basima Ahmed Barhoum¹, Sabah Khairu Al Maghrabi² and Laila Abd Alrahim Alloush^{2,3}. (1) The General Commission for Scientific Agricultural Research, Lattakia, Syria, Email: d.basimabarhom@gmail.com; (2) Plant Protection

Department, Faculty of Agriculture, Tishreen University, Lattakia, Syria; (3) General Commission for Scientific Agricultural Research, Hama, Syria.

This research aimed to study the combined effect of fermented manure and *Trichoderma harzianum* fungi in reducing the incidence and severity of Chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceris* (Foc) in Al-Ghab Region, Syria. Polyethylene bags containing sterile soil or mixture (1:3) soil: manure were used. *T. harzianum* fungi was used as soil treatment (1×10^6 spore/g peat); and seeds treatment by soaking them in a spore suspension (1×10^6 spore/ml). Spore suspension (1×10^6 spore/ml) of Foc local isolate was added to the soil before planting. The semi-field experiment was carried out with a completely randomized design with four replicates and treatments were tested on the chickpea cultivar Ghab3. The disease incidence and infection severity (DII) were evaluated at the flowering and fruit-set stages. Analysis of variance and Least Significant Difference values were determined at the probability level 0.05. Results showed significant differences at the flowering stage. Addition of manure alone reduced disease incidence by 40%, and 23.8% by seed treatment. Soil treatment alone decreased the incidence significantly up to 11.2% compared to the infected control (81.7%). Soil treatment without or with manure decreased infection severity significantly (0.03 and 0.20 respectively), followed by seed treatment with and without manure (0.06 and 0.24, respectively). Addition of manure alone in the fruit-set stage had no reducing effect on infection rate (88.8%) compared to the infected control (93.8%), whereas adding *Trichoderma* as soil or seed treatment reduced incidence to 57.5 and 50%, respectively. Adding *Trichoderma* alone as a soil or seed treatment reduced infection incidence up to 26.2 and 27.1%, respectively. The infection severity decreased for all manure and *Trichoderma* treatments separately or combined with significant differences as compared to the control.

BC32

AN OVERVIEW ON THE TRICHODERMA SPECIES ISOLATED FROM ALGERIAN SOILS AND THEIR APPLICATION IN BIOLOGICAL CONTROL OF CROP DISEASES. Houda Bouregghda¹, Nora Abdallah¹, Ali Debbi^{1,2}, Wassila Dendouga³ and Zouaoui Bouznad¹. (1) Laboratory of Phytopathology and Molecular Biology, Department of Botany, the National Higher School of Agronomy (ENSA), El-Harach, Algiers, Algeria, Email: hou.bouregghda@gmail.com; (2) Laboratory of Mycology, Center of Biotechnology Research, Constantine, Algeria; (3) Faculty of Biological Sciences University of Biskra, Algeria.

The genus *Trichoderma* is considered to be the most biocontrol agent used in crop diseases protection. Its taxonomy was initially based on morphological criteria where five sections were described. In recent years, the classification based on DNA sequence analysis has placed *Trichoderma* species into phylogenetic clades. Currently there are more than 260 species, the majority of which have been described during the last two decades. In Algeria, 7 species (*T. atroviride*, *T. harzianum*, *T. longibrachiatum*, *T. viride*, *T. hamatum*, *T. ghanense* and *T. asperelleum*) have been identified. These species have been isolated from soil of the North (humid and sub-humid) and the South (arid) of

the country as well as from chickpea and tomato rhizosphere. Identification was based on ITS and elongation factors (EF-1 α) sequences analysis. These species have been tested on strategic crops fungal diseases such as *Fusarium* wilt of chickpea caused by *F. oxysporum* f. sp. *ciceris* (FOC), tomato *Fusarium* wilt and crown rot caused respectively by *F. oxysporum* f. sp. *lycopersici* (FOL) and *F. oxysporum* f. sp. *radicis lycopersici* (FORL), as well as wheat crown rot caused by *F. culmorum*. Antagonistic bioassays have shown inhibition of the pathogens. In Planta, significant diseases index reduction were recorded, 83.92% with regard to *Fusarium* wilt of chickpea by using *T. atroviride* (Ta.3), 53.10 and 48.30 %, respectively, with regard to the FORL and FOL causative agents of crown rot and *Fusarium* wilt of tomato conferred by *T. ghanense* (T8). *T. harzianum* (Th4) induced 89.81% of wheat crown rot disease index. It was also shown that *Trichoderma* spp. are associated with stimulation of chickpea growth. Indeed, *T. longibrachiatum* isolates induced the highest rates of chickpea growth. TL4 induced a stimulation rate of 18.85% of stem height while TL5 induced the highest rate of fresh and dry weight increase by 80.89% and 94.11%, respectively.

BC33

COMBINED APPLICATION OF FUNGAL BIOAGENT TOGETHER WITH NATURAL COMPOUNDS FOR PLANT GROWTH PROMOTION AND MANAGEMENT OF RHIZOCTONIA SOLANI INFECTING PEPPER. Petrisor Cristina¹, Zaharia Roxana¹ and Oltenacu Viorel². (1) Research and Development Institute for Plant Protection, Blvd. Ion Ionescu de la Brad, No.8, District1, Bucharest, Romania, Email: crisstop@yahoo.com; (2) Research and Development Station for Tree Fruit Growing Baneasa, Blvd. Ion Ionescu de la Brad, No.4, District 1, Bucharest, Romania.

Rhizoctonia solani is an important destructive soil-borne phytopathogenic fungus that causes severe loss of agricultural crops around the world. Priming of seeds pre-sowing is a very simple method to the farmers' to produce better growth, yield and disease management. Pepper seeds were subjected to combined application of *Trichoderma* isolate (T), chitin (CH) and salicylic acid (SA) for assessment of growth promotion and defense induction against *Rhizoctonia solani*. Effects of combined treatments with T+SA+CH, T+CH, T+SA, CH+SA on growth parameters, polyphenols, chlorophylls and carotenoids concentrations and on the activities of antioxidant enzymes, peroxidase (POX) and polyphenoloxidase (PPO), were examined in leaves of pepper seedlings. The treatment of pepper seeds with all combinations used had a beneficial effect on the growth and development of pepper plants both in the absence or in presence of the pathogen. Among the treatments used, the sequential applications of T+CH and T+SA+CH most effectively stimulated the plant's antioxidant system and thus resistance to the pathogen. The combination of salicylic acid and chitin had no obvious effect on plant growth and also on the antioxidant system. The use of natural compounds in combination with microbial suspensions may be recommended for application, particularly as seed treatment, to produce high quality crops due to the induction of disease resistance.

BC34

COMBINED APPLICATION OF ANTAGONISTIC *TRICHODERMA ASPERELLUM* AND SILICON NUTRITION TRIGGERS TOMATO RESISTANCE TO FUSARIUM CROWN AND ROOT ROT AND REGULATES RHIZOSPHERE MICROBES. Mahmoud H. El-Komy^{1,2}, Xuewen Gao³, Yasser E. Ibrahim¹ and Younis Y. Molan¹. (1) Department of Plant Protection, College of Food and Agricultural Sciences, King Saud University, Riyadh, Kingdom of Saudi Arabia, Email: malkomy@ksu.edu.sa, (2) Mycology and Plant Diseases Survey Department, Plant Pathology Institute, Agriculture Research Center, Giza, Egypt; (3) Key Laboratory of Integrated Management of Crop Diseases and Pests, Department of Plant Pathology, College of Plant Protection, Nanjing Agricultural University, Nanjing, China.

Fusarium crown and root rot of tomato (FCRR) caused by *Fusarium oxysporum* f. sp. *radicis-lycopersici* (Forl) is an increasing problem in Saudi Arabia, and currently, there are no effective and environmentally friendly control measures. Combining biological control agents with plant mineral nutrition has become a practical eco-friendly method for disease control. This work evaluated the ability of a bioformulation consisted of two native *Trichoderma asperellum* strains (TASMix) integrated with potassium silicate (KSi) to control FCRR in tomato plants in a naturally infested soil under greenhouse conditions. Two 2×2 factorial experiments, consisting of two TASMix treatments (no-TASMix and TASMix treated plants) and two KSi nutrition levels (no-KSi and KSi treated plants) were implemented in a randomized block design experiment with four replications. Tomato plants assessed 45 days after transplanting, showed that the application of the TASMix and KSi singly and in combination were effective in controlling FCRR disease and improved tomato plant growth parameters. Synergism between TASMix and KSi resulted in highest ($P < 0.05$) reduction of disease incidence, severity index, and rhizosphere populations compared with the non-treated infected control. Additionally, TASMix + KSi plants exhibited greater accumulation levels of defence-related proteins, chitinase (*SlChi3*), β -1,3-glucanase (*SlGluA*) and PR-1 (*SIPR-1a*). Interestingly, soil application with TASMix + KSi significantly improved bacterial and fungal communities in tomato rhizosphere ($P < 0.05$). Accordingly, a strategy based on the use of *Trichoderma* inoculum in association with KSi is proposed for the integrated management of FCRR in organically grown tomatoes.

BC35

BIOCONTROL OF THE CAROB MOTH *ECTOMYELOIS CERATONIAE* IN TUNISIAN OASES. Samah Ben Chaaban¹, Kamal Mahjoubi¹ and Chaaban Moussa². (1) Centre régional de recherches en agriculture oasienne, Degache, Tunisia, Email: Samah_bchaaban@yahoo.fr; (2) Direction Générale de la Protection et du Contrôle de la Qualité des Produits Agricoles, Tunisia.

The carob moth, *Ectomyelois ceratoniae* (Lepidoptera, Pyralidae) is a serious pest in Tunisian oases. It attacks mainly dates and pomegranate causing massive

losses. Insecticides seem to be inefficient against this specie due to its endophytic behaviour on the fruits. Therefore, there is interest in evaluating safe and effective alternative means. The purpose of this study was to evaluate the efficacy of the disruption mating technique in Tunisian oases. Field experiments were conducted in 2018 in a oasis of 38 ha located in Tozeur (southwest Tunisia). SPLAT EC (specialized pheromone-lure application technology) trade name dispenser containing 2% Z7 (E9-11-dodecatrienyl format pheromone mimic) was applied at 500g/ha throughout the season. The SPLAT EC was applied with a "gun" applicator, 2.5g dollop of material was applied per palm at each site (total of 5g per palm). The material was applied to date palm trunks, one meter from the crown near the top of the palm close to the bunches. Four replicates were applied, each containing a mimic-treated plot, a bagging date bunches-treated plot and a non-treated plot. The efficacy of the treatment was evaluated by assessing male captures in traps and fruit infestation rate (%). Results showed that the highest numbers of carob moth adults were captured in untreated oases. At harvest, dates infestation was highest in the control plots (20.5%) compared with mimic-treated plot (11.7%) and bagging date bunches-treated plot (5.14%). These results indicated that the application of the technique of mating disruption seemed promising.

BC36

ENHANCING THE SHARE OF ENTOMOPATHOGENIC NEMATODES IN THE PESTICIDE MARKET. Mahfouz M.M. Abd-Elgawad, Plant Pathology Department, National Research Centre, Dokki, Giza, Egypt, Email: mahfouzian2000@yahoo.com

One of the important pesticides in the control of insect pests is the entomopathogenic nematodes, but their high price and inconsistent efficacy have led to less commercialization. This review discusses the means and methods necessary to increase their effectiveness and reduce their price, starting with the methods of sampling that should be improved in order to acquire more effective species and strains of these nematodes with differential pathogenicity. In addition, the paper explains approaches for their cost-effective production while providing the optimal ecological and biological conditions. It is concluded that growers and stakeholders should be made more aware of the sound methods to use and preserve these nematodes.

BC37

OCCURRENCE OF *SPODOPTERA LITTORALIS* NUCLEOPOLYHEDROVIRUS (SPLINPV) AND ITS FIELD-BIOCONTROL APPLICATIONS IN SYRIA. Mayadah Haj Ali, Bassam Aloklah and Rudwan Badr Al-Deen, National Commission for Biotechnology (NCBT), Damascus, Syria, Email: mayyada.hajali@gmail.com

A serious polyphagous pest, *Spodoptera littoralis* can attack more than 112 cultivated plants belonging to 44 families all over the world. A Syrian *Spodoptera littoralis* nucleopolyhedrosis virus (SpliNPV) was among many viruses that have been identified and isolated from infected larvae with the aid of different techniques: purification, electron microscope (EM) and polymerase chain reaction (PCR). NPVs have been purified using sucrose gradients,

with a yield of 12.4 mg per larva for using them in the field applications. The main goal of this investigation was to compare the efficiency of virus detection by PCR and purification to use the purified product for the control of *Spodoptera littoralis* In Vivo and In Vitro.

BC38

APHIDS AND THEIR NATURAL ENEMIES IN PRUNUS ORCHARDS IN TUNISIA. Zouari Sana and Ben Halima-Kamel Monia, Research Unit, Conventional and Organic Vegetable Crops, Higher Agricultural Institute of Chott Mariem, University of Sousse, Tunisia, Email: zouarisana@ymail.com

During the monitoring of aphid populations on the genus *Prunus*, various species of aphids were identified on peach trees such as *Myzus persicae* and *Brachycaudus schwartzi* tree, and on plum trees, *Hyalopterus arundiniformis* (or *Hyalopterus persikonus*) on peach and apricot trees, *Hyalopterus amygdali* on almond and apricot trees, *Hyalopterus pruni* on plum, blackthorn and apricot trees, *Aphis spiraeicola* on plum trees and *Pterochloroides persicae* on peach, almond and plum trees. This survey showed a diversity of aphid species. In addition, monitoring of the aphid populations was accompanied by a collection of parasitoids associated with these aphids on peach and almond trees, where 5 species of parasitoids were identified. Moreover, the green peach aphid *M. persicae* was attacked by 4 species of primary parasitoids which are *Aphidius matricariae*, *Aphidius platensis*, *Ephedrus persicae*, *Diaeretiella rapae* and 2 hyperparasitoids *Coruna clavata* and *Asaphes* sp., whereas the mealy aphid *H. amygdali* was only parasitized by the specific parasitoid *A. transcaspicus* which is itself parasitized by 2 hyperparasitoids *C. clavata* and *Alloxysta* sp. It should be noted that the associations observed are Mediterranean, with the exception of that of *M. persicae* with *A. platensis*. In addition, the mealy aphid *H. amygdali* was attacked by an arsenal of predators such as *Episyrphus balteatus*, *Sphaerophoria scripta*, *Aphidoletes aphidimyza*, *Coccinella algerica* and *Chrysoperla carnea*.

BC39

BEAUVERIA BASSIANA ENDOPHYTICALLY COLONIZE PUMPKIN PLANT FOLLOWING DIFFERENT INOCULATION METHODS. Feyroz Ramadan Hassan¹, Samir Khalaf Abdullah² and Lazgeen Haji Assaf³. (1) Plant Protection Department, College of Agricultural Engineering Sciences, Duhok University, Kurdistan region, Iraq; (2) Medical Laboratory Technology Department, Alnoor University College, Nineva, Iraq, Email: samir.abdullah1947@gmail.com; (3) General Directorate of Agriculture, Duhok, Kurdistan region, Iraq.

Endophytic fungi colonize the internal plant tissues beneath the epidermal cell layers without causing any apparent symptoms in the host for many years. However, these fungi become parasitic when their hosts are stressed. Some of endophytes have shown potential to enhance their host's growth, tolerance to abiotic stress, or tolerance to insect pests and pathogens. Two isolates of *Beauveria bassiana* (*B. bassiana* EE, GenbankNo. MH374537 isolated from cucumber leaves as natural endophyte and *B. bassiana* ES Genbank No. MH374538 isolated from soil samples)

were introduced to pumpkin plants via different fungal inoculation methods such as foliar spray, soil drench and seed treatments. The results showed that the three inoculation methods were effective in introducing *B. bassiana* as endophyte into the pumpkin plant, although at different efficiency levels. In the foliar spray method, *B. bassiana* was recovered from leaves and stems, whereas it was recovered from leaves, stems and roots following seed treatment and was only isolated from stem when drench inoculation method was used. The highest colonization was observed with *B. bassiana* ES isolate in foliar spray, drench and seeds treatment with values of 33.34, 26.67 and 20.0%, respectively, compared to 13.33, 6.67 and 13.33% observed for *B. bassiana* EE isolate. In total, 7 out of 90 pieces of sprayed plants with both *B. bassiana* isolates yielded positive detection four weeks after inoculation at the rate of 1.33 and 0.22% for leaves and stems, respectively, compared to 4 out of 90 segments of drenched plants yielded positive detection following the same period after inoculation as 0.89% for stems and 5 out of 90 segments of plants grown from seed treated with *B. bassiana* which yielded positive detection as 2.22 and 0.44% for leaves and stems, respectively. It was clear also from the results that both isolates of *B. bassiana* used in this study have different capabilities for the infection and colonization of pumpkin plant tissues.

BC40

ISOLATION AND DIAGNOSES OF SOME BIO-CONTROL FUNGI AND EVALUATION OF THEIR EFFICACY AGAINST CHARCOL ROT DISEASE CAUSED BY MACROPHOMINA PHASEOLINA ON MUNG BEAN. Abdulnabi A. Matrood¹ and M.M.A. El-Amin². (1) Department of Plant Protection, College of Agriculture, University of Basra, Iraq, Email: abdu1988875@yahoo.com; (2) Faculty of Agriculture, Um Durman Islamic University, Sudan.

This study aimed to isolate *Macrophomina phaseolina* pathogenic fungus, the causal agent of Charcol rot disease on mung bean (*Vigna radiata* Wilczek (L), from Elgadisia governorate, Iraq, in order to assess its pathogenicity, and evaluate the efficacy of biocontrol fungi *T.koningi*, *C. globosum*, *A. carbonarius* isolated from the area surrounding the host plant, on the pathogenic fungus under laboratory and plastic house conditions. The results of isolation and microscopic diagnosis showed the presence of two isolates of *M. phaseolina* fungus in almost all samples of infected mung bean. The pathogenicity results showed the ability of *M. phaseolina* to attack the seed and cause seed rot. In the pots experiment, the fungus reduced seeds germination rate by 71.56% (isolate 1) and 63.75% (isolate 2) compared with the control (86.66%). Results obtained indicated the presence of significant difference between the two isolates in causing seedlings damping-off which reached 40% and 30%, for the two isolates, respectively, compared to the control (0%). The disease severity caused by isolate 1 reached 75.3% and isolate 2 reached 63.6%. The antagonistic effect of the biocontrol fungi *T. koningi*, *C. globosum*, *A. carbonarius* against the pathogenic fungus *M. phaseolina* varied from 3 for the fungus *A. carbonarius*, 2 for *C. globosum* and 1 for *T. koningi*. The results indicated that the treatment with the antagonistic fungi *T. koningi*, *C. globosum* and *A.*

carbonarius increased the growth parameter of the mung bean plant. The biocontrol fungus *C. globosum* increased the plant height, fresh and dry weight of roots and chlorophyll content compared to the control. The results also showed that the *T. koningi* increased the mung bean seed germination rate to 100% and decreased mung bean charcoal rot disease severity to 45.88% compared to the control (89.86%). The other biocontrol fungi *A. carbonarius* and *C. globosum* also increased the mung bean seed germination rate and decreased the mung bean charcoal rot disease severity rate.

BC41

A STUDY OF SOME ECOLOGICAL PARAMETERS FOR THE PARASITIDS OF MAIZE STEM-BORERS IN DEIR EZ-ZOR REGION, SYRIA.

Ebraheem Al Jouri, Institute of Phytomedicine, Faculty of Agricultural Sciences, University of Hohenheim, Germany, Email: aljouri@uni-hohenheim.de

This study was conducted during 2010-2011. Samples of maize stem borers larvae from different instars and different species *Sesamia cretica* (Lederer), *Sesamia nonagrioides* (Lefebvre), and *Ostrinia nubilalis* (Hübner)) were periodically collected from different sites in Deir Ez-Zor region to specify the genera of accompanying parasitoids, its emergence, availability and abundance. Taxonomy findings demonstrated the presence of four larval parasitoids during the activity period in both study years. These parasitoids belonged to four genera representing three different families of Hymenoptera and Diptera, namely: *Bracon hebetor* (Say), *Meteorus* sp., *Salmacia* sp. and *Osterus* sp. The parasitoid *Bracon hebetor* was recorded on the larvae of *Sesamia* sp. and *Ostrinia nubilalis*. Its emergence was in June, September and October during both study years. It was the most abundant species and reached 68 and 92 individuals for 2010 and 2011, respectively. Meanwhile, the other parasitoids were found only on *Sesamia* sp. The parasitoid *Osterus* sp. was the less abundant and existed only during July for both study years.

BC42

EFFICIENCY OF *TRICHODERMA* SPP. AND PLANT EXTRACTS AGAINST EAR-COCKLE DISEASE OF WHEAT CAUSED BY *ANGUINA TRITICI*. Azher Hameed Faraj Al-Taie, Faculty of Agriculture, University of Wasit, Iraq, Email: aaltaie@uowasit.edu.iq

Ear-cockle disease of wheat caused by the seed gall nematode *Anguina tritici*, is one of most important aerial diseases of wheat in Iraq. This study aimed to evaluate the efficiency of some bio-agents (*Trichoderma* spp.) and some plant extracts as alternatives substances to control seed gall nematode *Anguina tritici* under laboratory and field conditions. The effect of five treatments; a bio-pesticide Biocont-T-WP (*Trichoderma harizanum*), one isolate of *Trichoderma hamatum* (T-113) and two plant extracts, Bio Atlantis Nematic (Seaweed Extract) and Licorice extract on the viability of second stage juvenile (J2) of *A. tritici* and the incidence of ear-cockle disease, were investigated. The nematicide Rugby 100 was used only for comparison with other treatments. In the lab-bioassay, the the percentage of daily accumulated J2 mortality was evaluated at 1, 3, 5, 7, 9 and 11 days after incubation. Whereas in the field, the

following parameters related to wheat growth, yield and infection were evaluated: germination rate (%), number of tillers/plant, plant length (cm), spike length (cm), spike weight (g), number of seeds/spike, number of galls/spike and infection rate (%). Lab-Bioassay showed that all treatments have significantly affected the vitality of juvenile (J2) depending on average of juvenile's mortality rate. The bio-pesticide Biocont-T showed the highest mortality followed by plant extract Nematic with an average of 40.56 and 12.52 %, respectively. Results obtained revealed that accumulative J2 mortality rate increased gradually and reached a maximum at the 11th day of incubation. It is also found that J2 mortality rate in the bio-pesticide Biocont-T treatment gradually reached its peak at the 11th day of incubation with 92.8% and it was the best, followed by Rugby nematicide (88.05%). Regression analysis showed a positive relation between treatments and accumulated J2 mortality during incubation periods. Field-bioassay conducted in pots showed that the five treatments had an effect on J2 of *A. tritici* and was reflected on wheat growth and yield compared to the control treatment. It was found that seed treatment with bio-pesticide Biocont-T was the best treatment which improved wheat growth and yield. The plant extracts Nematic and Licorice caused a non-significant reduction in the infection criteria compared with other treatments, but they have a significant effect compared to non-sprayed treatment. Chemical control of *A. tritici* by mixing wheat seed (Ibaa 99) with Biocont-T revealed less infection rate (77.7%) compared to the control treatment (100 %), the number of galls/spike was 1.63 compared to 5.66 galls/spike for the control.

BC43

BIOLOGICAL CONTROL OF CHICKPEA FUSARIUM WILT USING *TRICHODERMA HARZIANUM* AND MYCORRHIZIA. Wissal Dhaouadi,

Sawssen Timoumi, Sameh Aouadi, Noura Jammezi and Noura Ben Youssef Omri, National Agronomic Research Institute of Tunisia (INRAT), Field Crop Laboratory, Ariana, Tunisia, Email: wissaldhaouadi4@gmail.com

Chickpea wilt diseases, caused by a wide range of fungal species, are currently among the most devastating chickpea crop diseases in Tunisia. Given the limitations of conventional control methods, most often ineffective and/or detrimental to the environment, the use of biological agents would be a promising alternative to supplement and overcome these limitations. In this context, the efficacy of two biological control agents; *Trichoderma harzianum* and a mycorrhizal formula have been tested on two chickpea lines (Beja 1 and ILC 482) inoculated with *Fusarium oxysporum* f. sp. *ciceris* under controlled conditions. The results obtained showed that the biological agents protected the two chickpea cultivars by reducing the severity measured by the MDI (Mass Disease Index). The best result was obtained with *Trichoderma harzianum* which induced a mean MDI value of 0.46% less than the inoculated control for the two chickpea lines. Use of Mycorrhiza and *Trichoderma harzianum* improved the root weight of chickpea line Beja 1 by 0.58 and 0.45 g, respectively, and 0.45 g and 0.54g of ILC482, respectively. In addition, some variations in the dynamics of the total soluble phenolic compounds content

were observed in presence of the biological agents which suggests an indirect mode of action of *Trichoderma harzianum* and mycorrhiza to protect chickpea against *Fusarium oxysporum* f.sp. *ciceris*.

BC44

EVALUATION OF THE ANTAGONISTIC ACTIVITY OF *TRICHODERMA GAMSII* AGAINST *FUSARIUM CULMORUM* THE CAUSAL AGENT OF WHEAT CROWN ROT. Hadjer Lasmer, Saliha Chihat and Houda Bouregghda, Laboratoire de Phytopathologie et de Biologie Moléculaire, Département de Botanique, École Nationale Supérieure Agronomique, Algiers, Algeria. Email: hadjerlasmer27@gmail.com

Due to the ability of *Trichoderma* species to control many phytopathogens, the antagonistic activity of ten isolates of *Trichoderma gamsii* has been studied against *Fusarium culmorum* (FC111 isolate) causing the crown rot of wheat. The tests were performed by *in vitro* and *in vivo* bioassay. In the direct confrontation test, the highest reduction rate in colony diameter were obtained with TG.26, TG.02, TG.30 and TG.10, causing a growth reduction ranking between 58.53% and 60.29%, whereas by the indirect confrontation, the highest reduction rate in colony diameter was obtained with TG.12 and TG.30 isolates which was estimated at 33.93% and 28.57%, respectively. The seed treatment by a mixture of *T. gamsii* isolates before sowing in a soil already infested with the pathogen (FC111) led to a significant decrease in disease severity compared to the untreated control. The highest disease index decrease (>60%) was obtained with four isolates: TG. 9, TG. 5, TG.12 and TG.30. The isolate TG.12 was chosen for liquid culture (PDB) crude extract application on the pathogen. The results obtained in the laboratory showed the ability of the crude extract to completely inhibit the growth of *F. culmorum* (FC111).

BC45

IN VITRO STUDY OF THE ANTAGONISM OF RHIZOBIUM AND TRICHODERMA AGAINST RHIZOCTONIA SOLANI. Noura Jemai¹, Imen Hemissi¹, Samia Gargouri¹, Kaouther Ben Mahmoud¹, Med Fakhri Ksouri² and Ahmed Jemmali¹. (1) National Institute of Agronomic Research of Tunisia, University of Carthage, 1004, Elmenzah-Tunis, Tunisia, Email: jemainoura92@gmail.com; (2) National Agronomic Institute of Tunisia, University of Carthage, Tunis, Tunisia.

Rhizoctonia solani is a pathogenic fungus responsible for seedlings damping-off observed on acclimatized plantlets of almond and peach rootstock 'Garnem' in which high mortality rate (more than 30%) has been reported in commercial nurseries. These study focused on root rot and stem necrosis occurred despite the fungicides applications adopted by the nurserymen. To contribute a solution to this problem, biological control approach was tested *in vitro* using natural antagonists such as *Trichoderma* spp. isolated from the peat used as a culture substrate in acclimatization and *Rhizobium* isolated from food legumes. Obtained Results obtained are quite encouraging, since the mycelial inhibition of the pathogen reached around 50% with *Trichoderma* and 60% with *Rhizobium*.

BC46

EFFICACY OF TRICHOGRAMMA RELEASES AND MASS TRAPPING IN REDUCING *ECTOMYLOIS CERATONIAE* ZELLER POPULATION IN TUNISIAN CITRUS ORCHARDS. Rafika Alloui, Sabrine Attia and Kaouther Grissa-Lebdi, Department of Plant health and Environment. LR14AGR02 of Bioaggressors and Integrated pest Management in Agriculture, National Agronomic Institute of Tunisia, University of Carthage, Tunisia, Email: rafika_al@outlook.fr

Ectomylois ceratoniae Zeller (Lepidoptera: Pyralidae) is already prevalent in Tunisia and it is considered as one of the most economic pests on citrus crops. The objective of this experiment was to evaluate the effectiveness of *Trichogramma* releases combined with mass trapping in reducing carob moth damages. Field study was conducted in 2018 in two citrus plots located in northern Tunisia. Biological treatment focused on releases of 25,000 *Trichogramma* combined with 12 delta traps per hectare. Our results indicated a significant reduction of the infestation rate compared to the control plot.

BC47

POTENTIAL BIOCONTROL AGENTS AGAINST *BISCOGNIAUXIA MEDITERRANEA* ASSOCIATED WITH *QUERCUS SUBER*. Islem Yangui^{1,2}, Sawssen Hlaïem², Olfa Ezzine², Chokri Messaoud¹ and Mohamed Lahbib Ben Jamaâ². (1) National Institute of Applied Science and Technology, Tunisia, Email: yanguiislam@gmail.com; (2) National Institute of Research on Rural Engineering, Water and Forestry, Tunisia.

Biscogniauxia mediterranea is a pathogen fungus that causes charcoal canker disease of *Quercus suber*. The potential for biocontrol of this pathogen by *Trichoderma* isolates was studied. *Trichoderma* strains were identified at the level of species through the analysis of four DNA regions. The results revealed two species: *T. harzianum*, and *T. saturnisporum*. Dual culture inhibition experiments were used to evaluate the antifungal activity of *Trichoderma* isolates against *Biscogniauxia mediterranea*. The results showed the efficacy of *T. harzianum* in comparison with *T. saturnisporum*, by inhibiting totally the growth of *Biscogniauxia mediterranea*. Microscopic observations showed a mycoparasitic relationship between *Biscogniauxia mediterranea* and *T. harzianum*. These findings might prove the possibility of applying the *Trichoderma* isolates in an eco-friendly way as biological agents against cork oak pathogens.

BC48

IDENTIFICATION AND IN VITRO ANTAGONISTIC EFFECT OF *TRICHODERMA* SPP. ISOLATES AGAINST SOME PHYTOPATHOGENIC FUNGI IN ALGERIA. Saliha Chihat and Houda Bouregghda, Département de botanique- Ecole Nationale supérieure Agronomique (ENSA), El Harrach, Alger, Algeria, Email: salihachihat@gmail.com

The *Trichoderma* Pers. includes a large number of species that act as biological control agents against a number of plant pathogenic fungi. In order to search for this genus

isolates in Algerian soils and to take advantage of their antagonistic potential, soil sampling was carried out from different regions of Algeria (North, South, East and West). Based on the microscopic features of the colonies, 46 isolates were identified and revealed to be belonging to the genus *Trichoderma*. Species identification of the obtained *Trichoderma* isolates was also confirmed by sequencing the ITS1 and ITS4 regions and completed by sequencing the EF-1 α gene. The majority of the identified isolates belong to the species *Trichoderma harzianum* and *Trichoderma atroviride*, a few isolates belong to the species *Trichoderma gamssii* and one isolate was identified as *Trichoderma orientale*. The antagonistic activity of these species isolates was evaluated *in vitro* against the following plant pathogens: *Alternaria solani*, *Botrytis cinerea*, *Fusarium culmorum* and *Rhizoctonia solani* by direct and indirect confrontation tests. Results obtained showed that the majority of *Trichoderma* isolates were able to inhibit mycelial growth of the four phytopathogenic fungi at the rate range between 43.89% and 80.95% for direct confrontation and between 0% and 88.89% for indirect conformation. Isolates that showed strong antagonistic activity against the four pathogens *in vitro* were selected for *in vivo* testing.

BC49

ECOBIOLOGICAL STUDY OF APHID CINARA MAGHREBICA MIMEUR, 1936 AND ITS NATURAL ENEMIES ON PINUS HALEPENSIS IN ALGERIA. Leila Bourouba and Maïk Laamri, Laboratory of ATPPAM, Department of Agronomy, Institute of Veterinary and Agronomy Sciences, University of Batna, Batna 05000, Algeria, Email: leila.bourouba@univ-batna.dz

Pinus halepensis trees cover approximately 800.000 hectares, corresponding to around 35% of the forest area in Algeria. This study was performed between 2019 and 2020 with the aim to determine the importance of *Cinara maghrebica* (Mimeur, 1936) and its natural enemies on *Pinus halepensis* (Miller, 1768) (Hemiptera: Aphididae) in Algeria. Specimens were collected from 3 areas in khenchela Regional Forest (Algerian East). Samples of young branches taken twice a month, showed the numerical importance of this pest and the positive impact of natural enemies especially the parasitoid *Pauesia silana*. This study showed that this parasitoid multiplies particularly on *Pinus halepensis* located in urban center compared to semi-urban and natural environments. Moreover, some predatory insects belonging to the family of Coccinellidae, Chrysopidae, Syrphidae as well as different types of Araneidae were also observed.

BC50

EVALUATION OF THE EFFECTIVENESS OF LACTOBACILLUS ACIDOPHILUS AND CALCIUM CHLORIDE IN CONTROLLING THE FUNGUS PENICILLIUM DIGITATUM CAUSING GREEN ROT DISEASE OF ORANGE FRUITS UNDER LABORATORY CONDITIONS. Saba Baqer Al-Guboori and Naba'a Salman Al-Aqili, Department of Plant Protection, College of Agricultural Engineering Sciences, Baghdad University, Iraq, Email: s_aljuboori@yahoo.com

The study aimed to isolate and diagnose pathogenic fungi *Penicillium digitatum* from healthy orange fruits and to examine the pathogenic ability of isolates, and to evaluate the effectiveness of both *Lactobacillus acidophilus* and different concentrations of calcium chloride in inhibiting the growth of pathogenic fungi on PDA culture medium. An isolate of lactic acid bacteria was imported and grown on the MRS culture medium. The filtrate of the bacterial filtrate was obtained by filtering the sample with Millipore microfiltration paper no 0.22. Likewise, three concentrations of the commercial liquid calcium chloride 1, 2 and 4%, were used. The results obtained showed that the inhibition rate of lactic acid bacteria was 87.5%, and that all concentrations of calcium chloride used inhibited the growth of pathogenic fungi, which amounted to 37.5, 56.5 and 75.5% for the concentrations 1, 2 and 4%, respectively, when tested on the culture medium PDA compared to the control treatment in which the inhibition rate was 0.0%.

BC51

THE ALTERNATIVE HOSTS OF SUNN PEST EURYGASTER INTEGRICEPS PUT. PARASITOIDS IN THE NORTHEAST OF SYRIA. Mohammed Quja Nehal¹, Mohammed Nayef Al-Salti¹, Randa Abou Tara² and Sultan Shiekhmoss¹. (1) Department of Plant Protection College, Faculty of Agriculture, University of Aleppo, Aleppo, Syria; (2) General Commission of Scientific Agricultural Research, Damascus, Syria, Email: randaaboutara@hotmail.com

The study was conducted in the summer and winter crop fields in the northeast of Syria (Al-Hassake governorate) during 2010/2011 and 2011/2012 seasons. This study aimed to survey sunn pest species and their hosts plants and their importance as hosts for natural enemies. Results showed four bug species: *Dolycoris baccarum*, *Carpocoris pudicus*, *Eurydema orantum* and *Nezara viridula* (family Pentatomidae, order Hemiptera) feeding on 38 plant species belonging to 6 families. In the 2010-2011 season 2196 individuals and in the 2011-2012 season 1451 individuals were collected. Parasitism rates on *D. baccarum* and *C. pudicus* adults were 9.49 and 8.75%, 6.61 and 5.43 % in 2010-2011 and 2011-2012 seasons, respectively. Results of this study showed that it may be possible to use these insects as hosts to sunn pest parasitoids in biological control of sunn pest.

BC52

THE LIFE CYCLE AND BIOLOGICAL CONTROL OF THE OLIVE PSYLLID EUPHYLLURA OLIVINA COSTA BY USING ENTOMOPATHOGENIC FUNGI UNDER LABORATORY CONDITIONS. Asmaa Guessab, Mouffok Elouissi and Fatiha Lazreg, Laboratory of Research on Biological Systems and Geomatics, Faculty of Natural Sciences and Life, University of Mascara, 29000 Mascara, Algeria, Email: guessab71@gmail.com

The olive psyllid, *Euphyllura olivina* Costa (Homoptera; Psyllidae), causes considerable damage in olive groves in the Mediterranean basin, thus affecting production. It is mostly abundant in spring when olive trees are flowering and causes up to 60% yield loss in some parts of the Mediterranean Basin. To assess the rate of infestation and

provide elements of integrated pest management, life cycle and bio-ecology of this pest through population counts on the leaves and twigs of the tree were monitored from 29 March 2019 to 27 March 2020 at two relatively distant olive farms (Ain fares and Oued taria) in the wilaya of Mascara, Algeria. *E. olivina* developed two generations per year, influenced by the climatic factors. This work was conducted to evaluate the effect of different concentration of three genera of entomopathogenic fungi, against *Euphyllura olivina*. The Bioassay trial was carried out by using one strain of *Verticillium lecanii*, one isolate of *Fusarium* sp and one isolate of *Paecilomyces fumosoroseus* against 4th and 5th larval stages of *Euphyllura olivina* under controlled laboratory conditions using five concentrations of 10⁴, 10⁵, 10⁶, 10⁷ and 10⁸ conidia/ml. All three fungi were highly virulent with a significant difference in the mortality rate was noticed on the 4th and 5th larval stages, 24 h after treatment. The *Fusarium* sp. isolate caused 86.66% mortality at the concentration of 10⁴ conidia/ml. However, mortality rate reached 100% with the other 4 concentration when used on the 4th larval stage. On the 5th instar the mortality rate varied from 80% to 100% for the 5 concentrations used, respectively. The *Paecilomyces fumosoroseus* isolate showed highest mortality on both larval stages 72 h after treatment, and varied from 73.33 to 100% on the 4th larval stage at the 5 concentrations used. On the 5th larval stage, the mortality rate varied from 66% to 100% at the 5 concentrations used. The *Verticillium lecanii* isolate caused a mortality rate of 93.33% to 100% on 4th stage larvae 86.66% to 100% on the 5th stage larvae at the 5 concentrations used.

BC53

PREDATORS WITH PESTS CONTROL POTENTIAL IN FUTURE IRRIGATED AREAS AROUND THE NEWLY CONSTRUCTED HAMDAB DAM, NORTHERN SUDAN. Abdalla A. Satti¹ and Nazar A.A. Bilal². (1) Environment, Natural Resources and Desertification Research Institute, National Centre for Research, P.O. Box 6096, Khartoum, Sudan; Email: satisattisat@yahoo.com; (2) Sudan Academy of Sciences, Khartoum, Sudan.

The Hamdab (Merowe) dam, which has been constructed on the Nile River is located in Northern State, an area lies within the desert arid zone of Sudan. This area is climatically suitable for growing several field and horticultural crops. Therefore, the dam is expected to irrigate thousands of hectares of arable virgin lands along the Nile in the near future. Regrettably, very little research has yet been carried out in that part of the country regarding agricultural pests, and particularly their natural enemies. In this study, regular surveys were carried out, continued for a full year, at three different locations near the dam; where the prevalent predatory species of agricultural pests were reported and counted on certain major crops. Moreover, the population densities of important predators were compared among the different crops and seasons. Since chemical insecticides are rarely practiced in the Northern State, numerous predatory species were found flourishing in the studied area, including mainly chrysopids, coccinellids, syrphids and spiders (e.g., thomisids, salticids and cob weavers) groups; some of them

(e.g., spiders and to some extent chrysopids) were active in dry and hot niches, while some others (e.g., syrphids and some coccinellids) seemed to prefer humid and cold locations. Consequently, promising predators were indicated through their highest sustainable prevalence and apparent impacts on major pests. These predators should receive great attention, as potent natural control agents, wherever agricultural expansion is realized in the State.

BC54

BIOLOGICAL CONTROL OF RHYNCHOPHOROUS FERRUGINEUS BY BACILLUS SPP. Mohsen Mohamed Elsharkawy, Mustafa Almasoud, Yasser Mohamed Alsuliman and Khaled Alhussaini, Palm and Date Center, Al Ahsa, Saudi Arabia, Email: mustafamasoud@hotmail.com

Many countries consider the red palm weevil *Rhynchophorus ferrugineus* Oliv. (Coleoptera, Curculionidae), to be a major pest. This pest arrived in Saudi Arabia in 1980. Using *Bacillus* spp., an insecticidal crystal protein-producing bacteria, might be one of the options for controlling *R. ferrugineus*. *Bacillus* spp. is an entomopathogenic bacteria characterized by the production of insecticidal crystal proteins. In this study, 20 species of *Bacillus* spp. were isolated from the rhizosphere of date palm trees in Al Ahsa Oasis, Saudi Arabia. The isolates were identified using 16S rRNA gene sequencing. *R. ferrugineus* larvae and adults were tested on a meridic diet that included *Bacillus* spp. that was active against Coleoptera insects. Bacteria was added to the food of the larvae and adults of the red palm weevil. The LC₅₀ value for adults was quite high. After 21 days, data on larval mortality, body weight, and the number of surviving larvae that did not acquire substantial weight were documented. The determined LC₅₀ values for *Bacillus* spp. based on practical mortality rate ranged from 0.43 to 0.45 mg/ml. It was revealed that *Bacillus*-treated diet had negatively influenced the weight of RPW larvae. This research evaluated the interaction between RPW larvae and *Bacillus* spp. and highlighted the potential of developing a microbial-based control strategy for this pest.

BC55

EFFECT OF ENDOPHYTIC BACTERIA ISOLATED FROM DURUM WHEAT ON ROOT CROWN ROT DISEASE UNDER DROUGHT STRESS. Imran Al-Sawalhah¹, Firas Abu-El Samen¹, Nehayah AlKarablieh², Yahya Othman³, Jamal Ayad³, Ayed M. Al-Abdallat³ and Kholoud M. Alananbeh². (1) Department of Plant Sciences, School of Agriculture, Jordan University of Science and Technology, Irbid, Jordan; (2) Department of Plant Protection, School of Agriculture, The University of Jordan, Amman, Jordan, Email: k.alananbeh@ju.edu.jo; (3) Department of Plant Sciences, School of Agriculture, The University of Jordan, Amman, Jordan.

Fusarium crown rot (FCR) caused by *Fusarium culmorum* is one of the most damaging soil-borne diseases that affect wheat yield. A direct relationship was observed between FCR and drought stress, as drought affects the relationship of *Fusarium* to plants, and the *Fusarium* itself is affected by drought stress. Recently, there has been more interest in endophytes and their potential for controlling soil-borne diseases, enhancing plant growth, increasing plant

tolerance and resistance to drought and salinity conditions. The objectives of this study were to: (i) test the antifungal activity of bacterial endophytes (n=60) isolated from durum wheat in Jordan against FCR aggressive isolate using the cross-streak method and the agar gel diffusion method, (ii) evaluate the ability of the selected bacterial endophytes to improve the tolerance of Hourani Jordanian durum wheat to FCR at seed and seedlings stages, and (iii) evaluate the ability of the selected bacterial endophytes to improve Hourani Jordanian durum wheat tolerance to drought stress at seed and seedling stages. There was high antifungal effect for the 60 bacterial isolates, with some variation. Promising results for 12 isolates with inhibition rate ranged from 41.17 to 44.62 % for isolate #38 and #4, respectively. Three bacterial isolates (#52, #37 and #17) exhibited drought tolerance. Based on the highest antifungal activity and drought tolerance, five isolates were selected to test their effect on *Fusarium* tolerance under drought conditions on Hourani seeds and seedling stages. Isolate # 50 showed the longest coleoptile (5.48 cm) in germinated seeds, followed by #52 (5.22 cm), and #32 (4.76 cm) compared to the control (3.74 cm). Isolate #52 had the longest radical length (8.35 cm), followed by #50 (7.79 cm), #32 (7.23cm), and #38 (7.03 cm) compared to the control (6.22 cm). No significant differences were noticed in the number of seminal roots as compared to the control (1.93). Isolate #52 had the longest seminal root (7.5 cm), followed by #50 (7.4 cm), and #38 (6.7 cm) compared to the control (5.99 cm). Chlorophyll content in the seedlings ranged from 305.3 to 332.9 in isolate #50 and #52, respectively compared to the control (248.3). Stem length ranged from 29.5 cm in isolate #38 to 33.1 cm in isolate #60 compared to the control (25.16 cm). Extended length was the highest in isolate #32 (48.2 cm), followed by #60 (48.0 cm), and #52 (47.7 cm) compared to the control (45.9 cm). Root length ranged from 52.4 cm to 55.5 cm for isolate # 32 and #38, respectively, compared to the control (46.70 cm). Dry weight was the highest for isolate #52 (1.42 g) followed by #50 (1.39 g) compared to the control (1.22 g). No significant differences were noticed in the fresh weight compared to the control. This study presented a potential for some bacterial isolates to alleviate the effect of *F. culmorum* and drought stress each or combined.

BC56

BIOLOGICAL CONTROL OF OLIVE TREES DIEBACK DISEASE USING THE ENDOPHYTIC BACTERIA *BACILLUS VELEZENSIS* OEE1. Manel Cheffi, Yaakoub Gharbi, Karim Ennouri, Samira Krid, Fathi Ben Amar and Mohamed Ali Triki, Laboratory of Genetic Resources of Olive tree, Characterization, Valorization and Phytosanitary Protection, Olive Tree Institute, University of Sfax, Sfax, Tunisia, Email: mohamedalitriki2@gmail.com

Olive is the most widespread cultivated tree in Tunisia. However, diseases can decrease stability and sustainability of olive trees. Crop losses caused by fungal diseases are widely spread and they can reduce or limit productivity. Fungal pathogens attacking olive twigs and branches include *Neofusicoccum austral*, *Phoma fungicola*, *Nigrospora* sp., *Biscogniauxia mediterranea* and *Lasiodiplodia* sp. which are reported for the first time to occur in olive trees in Tunisia in many regions. Pathogenicity

studies confirmed their virulence when inoculated on olive branches, and the same symptoms observed in the field were reproduced. To fight these pathogens and to limit the use of agrochemicals, different biocontrol strategies have been developed using beneficial bacteria. In this sense, the endophytic bacteria *Bacillus velezensis* OEE1 represented an efficient and effective alternative in the control of these pathogens and it was able to reduce mycelial growth up to 60 % due to the action of either diffusible or volatile compounds. The mechanisms used by this strain included competition for space and nutrients (siderophore), production of cell wall degrading enzymes (chitinase and glucanase) and several antimicrobial compounds (fungicin, utirin, surfactin, bacillomycin, macrolactin). *B. velezensis* OEE1 can also interact with the plant and activate its defensive responses. Besides biocontrol ability, *B. velezensis* OEE1 is an effective plant growth promoting bacteria due to atmospheric nitrogen fixation, phosphate solubilisation and phytohormones production.

BC57

ASSESSMENT OF *TRICHODERMA* SPP. AS BIOCONTROL AGENTS AGAINST MYCOTOXIGENIC FUNGI ASSOCIATED WITH STORED AGRICULTURAL PRODUCTS. Roxana Zaharia, Cristina Petrisor, Alexandra M. Marin, Ion Leveanu and Alin Gheorghe, Research and Development Institute for Plant Protection, Bucharest, Romania, Email: roxyanna_21@yahoo.com

Grain cereals postharvest contamination with spoilage fungi, both pathogenic and saprotrophic, poses a real threat for food safety worldwide causing important economic losses for global agriculture. Cereals are natural substrates for molds development. Among plant fungal diseases, those affecting stored cereals represent a serious problem in terms of food security and safety. The limited availability of physical methods and chemical pesticides to control mycotoxigenic fungi and to reduce food and feed mycotoxin contamination impose alternative approaches, such as the use of beneficial fungi as an active ingredient of biological control products. The use of specific microorganisms for the control of pathogens and plant pests is an environmentally friendly approach to overcome the inconveniences caused by the excessive use of chemical pesticides. Fungal species belonging to *Trichoderma* genus are filamentous imperfect saprophytic soil fungi, well known for their biotechnological potential due to their antagonistic capacity exerted either indirectly, by competing for nutrients and space, modifying the environmental conditions, or promoting plant growth and plant defensive mechanisms and antibiosis, or directly, by mechanisms such as mycoparasitism, thus are widely used as biopesticides. The present study aimed to assess the occurrence of fungi responsible for grain cereals spoilage and assess the biological control capacity of two local strains of *Trichoderma* spp., *T. viride* Tv20 and *T. harzianum* Td85, against the main phytopathogens associated with stored agricultural products. The assessment of *Trichoderma* spp. biocontrol capacity against twelve mycotoxigenic fungal strains was performed by dual culture method using *T. viride* Tv20 and *T. harzianum* Td85 strain from RDIPP collection.

A relatively high fungal diversity was observed across the analyzed grains samples, the mycotoxigenic mycoflora detected on stored cereals was dominated by three important genera: *Aspergillus*, *Fusarium*, *Penicillium*. Both *Trichoderma* spp. strains exerted a strong antagonistic activity against the selected phytopathogenic fungi, limiting their growth and development. The Tv 20 strain showed an inhibitory activity against *Fusarium* species ranged between 65.7% and 75.4%, *Aspergillus* species were inhibited by 68.2% to 95%, whereas *Penicillium* spp. were inhibited by 86.66% to 88.9%. When using the Td85 strain, *Fusarium* species were inhibited 62.6 %- 90%, and *Aspergillus* strains were inhibited 68.23 - 92%. The *Penicillium* species were very susceptible to Td85 fungicidal effect, as their mycelial growth was inhibited by 81.33%. Our study regarding the stored cereals associated mycoflora, established that *Aspergillus* spp., *Fusarium* spp. and *Penicillium* spp. are the predominant species. The detection of these fungal species is of major importance, as most isolated species are potentially producing mycotoxins such as: aflatoxins, fumonisins, ochratoxin A, zearalenone and deoxynivalenol which represent a serious problem worldwide, causing many negative effects on human and animal health. Indigenous *Trichoderma* spp. exerted an efficient biocontrol activity against the phytopathogenic fungi, limiting their growth and development. The use of biological control in disease management systems is a viable alternative to limit the incidence of spoilage fungi, in the context of European Commission Regulations regarding the restriction/limitation of chemical-based plant protection products uses.

BC58

BENEFICIAL INSECTS ASSOCIATED WITH FALL ARMY WORM IN LEBANON. Zinette Moussa, Laboratory of Entomology, Plant Protection Department, Lebanese Agricultural Research Institute (LARI), Fanar, Lebanon, Email: zmoussa@lari.gov.lb

A study of the beneficial insects associated with colonies of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in corn fields in Lebanon was conducted in 2021. Infested corn plants were visually checked, and insects associated were collected. Mass eggs of FAW were incubated, and larvae were reared on ear corns in the entomology laboratory at the Lebanese Agricultural Research Institute (LARI). A sweep net was used to collect insects randomly by sweeping through corn plants. No parasitoid has emerged from the eggs nor from the laboratory's larvae. A total of 8 parasitoids and 17 predators were collected in corn fields infested with FAW. Three parasitoids and seven predators were reported as biological agents for larvae of lepidopteran species. The most important collected parasitoid is *Habrobracon hebetor* (Braconidae), followed by *Gelis* sp. (Ichneumonidae) and one Diptera (Tachinidae). The others are parasitoids of aphids and flies such *Lysiphlebus fabum* (Braconidae), *Orthostigma* sp. (Alysiinae) and species that belong to the families Figitidae, Platigasteridae, and Mymaridae. The most encountered predators spotted feeding on FAW larvae were the minute pirate bug *Orius insidiosus*, the big eye bug *Geocoris erythrocephalus* (Heteroptera: Anthracoridae), the yellow jacket *Vespula pensylvanica* (Hymenoptera, Vespidae) and

the ant *Crematogaster scutellaris* (Hymenoptera, Formicidae). A new species *Orius minutus* was identified in Lebanon during this survey for the first time. Two species of earwig *Forficula smyrnensis* (Dermaptera: Forficulidae) and *Euborellia annulipes* (Dermaptera: Anisolabididae), were reported feeding on larvae of FAW in the laboratory. Other predators reported were associated in small quantities within the FAW colonies were: the green lacewing *Chrysopa carina* (Neuroptera: Chrysopidae), the Styrian praying lacewing *Mantispa styriaca* (Neuroptera: Mantispidae), the ladybeetles *Coccinella septempunctata*, *Oenopia conglobata*, *Hyppodamia variegata*, *Stethorus* sp. and *Scymnus frontalis* (Coleoptera: Coccinellidae), the mirid bug *Macrolophus caliginosus* (Heteroptera: Miridae) and a nymph of assassin bug (Hemiptera: Reduviidae).

BC59

STUDY ON SOME BIOLOGICAL ASPECTS OF ECTOPARASITOID *HABROBRACON CONCOLORANS* (MARSHALL) ON LARVAE OF GREATER WAX MOTH AT TWO CONSTANT TEMPERATURES. Anwar Jassam AliAllah¹, Jasim Khalaf Mohammed² and Enas Fadel Abbas². (1) Ministry of Education, Baghdad, Iraq, Email: anwarj1979@yahoo.com; (2) Plant Protection Directorate, Ministry of Agriculture, Baghdad, Iraq.

The present study was carried out to study some biological parameters of ectoparasitoid *Habrobracon concolorans* (Hymenoptera: Braconidae) in the laboratory at 25 and 30±2°C reared on *Galleria mellonella* larvae. The results showed that the pre-oviposition period of females was 4.33 days at 25°C and 3 days at 30°C. The highest reproductive rate was 82 eggs/female at 25°C compared to 38.17eggs/females at 30°C. The average longevity of females and males varied depending on temperature. Sex ratio of parasitoid progeny was slightly in favor of males. The shortest developmental time was 9 days when parasitoid was reared at 30°C and 11.5 days at 25°C. The life table parameter showed the highest net reproductive rate (Ro) was 31.58 female/female/generation at 25°C, whereas it was 11.7 female/female/generation at 30°C. The highest mean generation time (T) was 31.76 days at 25°C and the lowest was 20.63 days at 30°C. The intrinsic rate of natural increase (rm) was 0.108 and 0.118 female/female/day at both temperatures, respectively.

BC60

NATURAL ENEMIES RECORDED ON THE FALL ARMYWORM *SPODOPTERA FRUGIPERDA* (JE SMITH) IN SYRIA. Abdulnabi Basheer, The Arab Center for Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria, Email: basherofeckey11@gmail.com

The fall armyworm *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) is an important pest of sorghum and maize, which are important crops for food security. The sustainable management of this invasive pest requires the development and dissemination of environmentally friendly methods of crop protection, including biological control, using parasitoids and insect predators. This research was carried out in the corn fields in the Kharabo area in Damascus, Syria. In this study, many

insect parasitoids and predators were identified on the different stages of the insect, namely, egg parasitoids *Telonomus* sp., *Idris* sp. and *Platytenomus* sp. (Hymenoptera: Proctotropeidae, Scelionidae), and the larval parasitoids *Cotesia icipe* (Hymenoptera: Braconidae), *Campoletis* sp., *Charops* sp. (Hymenoptera: Ichneumonidae), *Palexorista zonata* (Diptera: Tachinidae). In addition, the following predators were also identified: *Podisus maculiventris* (Hemiptera: Pentatomidae), *Nabis rugosus* (Hemiptera: Nabidae), *Geocoris punctipes* (Hemiptera: Lygaeidae), *Pristhesancus plagipennis* (Hemiptera: Reduviidae), (Hemiptera: Lygaeidae), *Orius insidiosus* (Hemiptera: Anthracoridae).

BENEFICIAL INSECTS

BI1

METATAXONOMIC SURVEY OF BACTERIAL COMMUNITIES IN HONEYBEE COLONIES FROM TUNISIA AND ALGERIA. Chanez Naccache¹, Salma Djebbi¹, Safia Ben Amor², Haïtham Sghaier³, Afef Najjari⁴ and Maha Mezghani¹. (1) Laboratory of Biochemistry and Biotechnology, Faculty of Sciences of Tunis, University of Tunis El Manar, Tunisia, Email: chahneznaccache@yahoo.com; (2) Research Laboratory for Medicinal and Aromatic Plants, Department of Biotechnology, Faculty of Nature and Life Sciences, Saad Dahlab University Blida 1, Blida, Algeria; (3) Laboratory Energy and Matter for Development of Nuclear Sciences, National Center for Nuclear Sciences and Technology and Univ. Manouba, Biotechpole Sidi Thabet, Ariana, Tunisia; (4) Laboratory of Microorganism and Active Biomolecules, Faculty of Sciences of Tunis, University of Tunis El Manar, Tunisia.

All over the world, the honeybee *Apis mellifera* (Hymenoptera: Apidae) plays a major role in pollination and food production. Honeybee health is a multifactorial phenotype as it is related to the environment, host genetics and associated microbes (commensal, opportunistic and pathogenic). In several organisms, the core commensal microbiome can mediate disease susceptibility and the internal ecology of the host can greatly affect disease outcome. In this context, an improved understanding of the composition of bee-associated bacterial communities will help manage modern challenges to bee health. With recent significant reductions in the cost of high-throughput sequencing (HTS) methods, metatranscriptomics 16S rDNA sequencing could be a useful tool for analyzing the bee microbiota. In this study, metatranscriptomics (Illumina sequencing) were used to shed light on the bacterial composition of honeybee colonies from Tunisia and Algeria. Sequencing data advanced our understanding of core and specific microbial genera between honeybees in Tunisia and Algeria. Indeed, our results highlighted an abundant bacterial community in both colonies with significant differences in abundance. Factors such as colony health, host genotype, season and environmental stressors could be correlated with the composition of analyzed bee microbiota. Further analyses of metadata information can narrow this set of

hypotheses and link such changes in bacterial composition to appropriate factors.

BI2

THE ARMY ANTS *DORYLUS FULVUS* (DORYLINAE, FORMICIDAE, HYMENOPTERA) ATTACK HONEY BEE HIVES *APIS MELLIFERA* L. IN LIBYA. Hassan Al Mahdi Alfallah and Najat Ali Abuelnnor, Plant Protection Department, Faculty of Agriculture, University of Tripoli, Tripoli, Libya, Email: h_mahdi32@yahoo.com

The west honey bee colonies, *Apis mellifera* L. are attacked by the army ants *Dorylus* sp. which kill honey bee adults, larvae and brood and steals the stored honey. In addition they continue their attack and destroy hives. Such case was reported for the first time in Tajoura east of Tripoli, Libya where the ant army *Dorylus* (Hymenoptera, Formicidae, Dorylinae) had destroyed 46% of honeybee hives in that area. The preliminary identification of the ant samples was *Dorylus fulvus*.

BI3

EXPLORING THE ROLE OF *APIS* AND NON-*APIS* INSECT VISITORS TOWARDS CROSS POLLINATION, THEIR INFLUENCE ON YIELD, OIL CONTENT AND OTHER QUALITY PARAMETERS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) IN MARDAN, KHYBER PAKHTUNKHWA, PAKISTAN. Fazal Said¹, Asad Ali¹, Sakawat Shah¹ and Hussain Ali². (1) Department of Agriculture, Abdul Wali Khan University, Mardan, Pakistan, Email: dr.fazal@awakum.edu.pk; (2) Entomology Section, Agriculture Research Institute (ARI), Tarnab, Peshawar, Pakistan.

Field studies were carried out at Agricultural Research Farm, Abdul Wali Khan University, Mardan, Khyber Pakhtunkhwa, Pakistan, in order to identify different insect visitors including *Apis* as well as non-*Apis* insect visitors associated with sunflower, to assess their visitation pattern and to determine their influence on yield, oil content and other crop quality parameters. A total of fifteen different visitors were associated with sunflower. Hymenoptera were the most abundant that made 87% of the whole population, followed by Lepidoptera (8%) and Diptera (5%). The relative abundance of four major species, i.e. *Apis mellifera*, *A. dorsata*, *A. cerana* and *A. florea* were recorded on hourly and weekly basis. The peak densities of all honeybee species were recorded at 12:00 pm and 02:00 pm, whereas minimum densities were recorded at 08:00 am and 06:00 pm. Among honeybee species *Apis mellifera* abundance was significantly higher than other three species. Maximum seed production as well as oil content were obtained from sunflower plots kept under natural conditions, where bee visitors had access to sunflower blossoms. In contrast, sunflower plots covered with insect-proof bags gave minimum seed production and oil content, which most probably because of bee visitors denied foraging on flowers of the crop. Visitation/foraging of honeybee contributed significantly towards yield increase, oil content and other quality parameters of sunflower.

BI4

BEE VIRAL DISEASES PREVALENT IN SYRIA: A REVIEW AND STIMULATING THE IMMUNE SYSTEM OF THE HONEY BEE USING PLANT EXTRACTS. Ahmad M. Mouhanna^{1,2,3}, Nawras Al-Abrass⁴ and Mai Omar Sharaf¹. (1) Faculty of Agriculture, Damascus University, Syria, Email: A.M.Mouhanna@gmail.com; (2) Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria; (3) Faculty of Medicine - Syrian Private University (SPU)- Damascus, Syria; (4) National Commission for Biotechnology, Damascus, Syria.

During the past decade, honeybees in Syria have been subjected to great losses, as the number of beehives decreased by more than 20%. The study of viral diseases began in 2009 and aimed to detect the most common viruses that infect honeybees in Syria. The study included 40 apiaries in eight governorates (Damascus and its countryside, Quneitra, As-Suwayda, Homs, Hama, Tartous and Lattakia) during the period 2009-2020. The results showed the spread of four viruses: Deformed wing virus (DWV), acute bee paralysis virus (ABPV), Polycystic brood virus (SBV), and Chronic bee paralysis virus (CBPV). The infection rate increased over the years of study, for example, the DWV virus, the infection rate was 41.6% in 2009 to reach 85.01% in 2020. Five plant extracts were used to stimulate the immune system of honeybees, the oily extract of *Artemisia herba-alba*, *Thymus serpyllum*, *Citrus aurantium* and the aqueous extract of *Laurus nobilis* and *Aloysia citriodora*. The results obtained showed that there was stimulation of the immune system of worker bees by detecting antimicrobial peptides, which varied in their types depending on the type of extract, the concentration used and the time period. In addition, it was found that the lifespan of worker bees was increased by 5-7 days compare to others not treated with plant extracts.

BI5

CONTRIBUTION TO THE KNOWLEDGE OF APPLE POLLINATORS (ROSACEAE) IN THE REGION OF SOUTHERN ALGERIA (BISKRA). Leila Bendifallah¹, Afaf Ghettoche¹, Nicolas Leclercq² and Nicolas J. Vereecken². (1) Laboratory of Soft Technologies, Valorization, Physico-chemistry of Biological Materials and Biodiversity, Faculty of Sciences, M'hamed Bougara University of Boumerdes, Avenue de l'Indépendance, 35000, Boumerdes, Algeria, Email: Leila.bendifallah@gmail.com; (2) Agroecology Laboratory, Campus de la Plaine (CP 264/2), Université Libre de Bruxelles (ULB), 1050 Brussels, Belgium.

A survey was carried out to monitor beneficial and harmful insect species associated with the apple tree cv. Elhana in Sidi Khaled (Biskra) region, Algeria. Several insect traps were used: yellow and blue sticky platelets, colored cups (yellow, blue and white), the trap net, Japanese umbrella and direct contact. The results obtained showed the presence of natural enemies as well as auxiliaries, parasitoids, predators and pollinators with high abundance in the study area. The most abundant species in apple orchards were those belonging to the order Diptera (Agromizidae) with 61 taxa, followed by Hymenoptera where *Apis mellifera* occupied the first place, followed by Thysanoptera such as

members of the genus *Aeolothrips*. Important diversity for the order Hymenoptera with 9 families, was noted.

BI6

HAPLOTYPE CHARACTERIZATION OF THE COI MITOCHONDRIAL GENE IN *APIS MELLIFERA* FROM ALGERIA. Safia Ben amor¹, Salma Djebbi², Maha Mezghani², Leila Alla Benfekih¹ and Scherazed Mekious³. (1) Research Laboratory for Medicinal and Aromatic Plants, Department of Biotechnology, Faculty of Nature and Life Sciences, Saad Dahlab University Blida 1, Algeria, Email: safiabenor@hotmail.com; (2) Laboratory of Biochemistry and Biotechnology, Faculty of Sciences of Tunis, University of Tunis, ElManar, Tunisia; (3) University of Djelfa, Algeria.

Apis mellifera L. (Hymenoptera: Apidae) includes several subspecies distinguished according to their morphological and behavioral characteristics and their geographical distribution. Recently, honeybees have been affected by important colony mortalities, commercial breeding, queens import and honeybee movement from one location to another, which influence the distribution of the native populations. Preserving bee subspecies genotypes diversity is crucial for bee breeding and crossbreeding. However, distinguishing between honeybee subspecies is complicated. In the current study, we used the COI-COII (Cytochrome Oxidase I and II) intergenic region of the honeybee's mtDNA as a molecular marker to characterize diversity between and within 220 honeybee workers collected from 9 different areas in south Algeria. A PCR-RFLP (Polymerase Chain Reaction Restriction Fragment Length Polymorphism) analysis of the mtDNA allowed honeybee evolutionary lineages and mtDNA haplotypes discrimination. Our results showed the existence of six haplotypes belonging to the African lineage A: A1, A4, A8, A9, A27 and A28 among which A8 and A9 haplotypes are the most dominant representing 54.65% and the haplotype A27 and A28 are the rarest representing 8% each. Three new haplotypes were identified in this study. Our results showed high genetic diversity between individuals of the same population which is probably due to several beekeeping techniques such as displacement and purchase of queens and colonies from distant locations.

BI7

EFFECTIVENESS OF DIFFERENT FORMULATIONS AND METHODS OF TREATMENT WITH OXALIC ACID IN THE MANAGEMENT OF VARROA DESTRUCTOR PARASITE OF THE HONEYBEE IN ALGERIA. Nouredine Adjlane¹ and Mohammed Wafdi². (1) Department of Agronomy, Faculty of Sciences, M'hamed Bougara University, Boumerdes, Algeria, Email: adjlanenouredine@hotmail.com; (2) National Specialized Institute of Professional Training of Bougara, Department of small farms, Blida, Algeria.

Varroa is a very dangerous pest that affects honeybees and is one of the most important threats in Algerian beekeeping. There are several treatment methods used: chemical, natural and biotechnical. Today, chemical control with strips containing pyrethroid can only be used in

a limited way against varroa because these products are no longer effective (resistant mites). In addition, the intensive use of chemicals increased the risk of the presence of residues in the hives products. Accordingly, it is interesting to turn to other natural means of control. Oxalic acid is one of those natural products that may be a proper alternative. The purpose of this experiment was to contribute to the development of this approach of natural origin. Our study took place in an apiary of 100 colonies located in the Tizi ousou region. Four doses were used with two methods (spray and drip) of application between the frames of the bee colonies. Treatment with oxalic acid exerts a negative effect on bees which depends on the dose used. The 60 g solution of oxalic acid has a higher efficiency compared to that of 50, 40 and 30 g. At the same time, this high dose caused the brood production to stop for two colonies. Monitoring of these colonies treated with oxalic acid showed that the two doses of 60 and 50 g caused the bees to weaken. The spray method seems more effective than dripping. Other tests are necessary to be able to optimize the formulation, the dosage and the concentration of this treatment in the arid region, and especially to specify the most favorable period for carrying out the treatment.

BI8

CHARACTERIZATION OF INDIGENOUS FIG WASP POLLINATOR POPULATIONS, TIMING OF ADULT EMERGENCE, AND CLEPTOPARASITISM, ON *FICUS CARICA* IN THE NORTHWEST REGION OF LIBYA. Sana Etaieb Sherlala¹, Eman T. Zentane² and Saad M. Ahdaya². (1) Agricultural Research Centre, Tripoli, Libya; (2) Plant Protection Department, College of Agriculture, University of Tripoli, Libya, Email: emanzntn@yahoo.co.uk

Inflorescences (syconia) of the caprifig trees *F. carica* were collected from six sites along an altitudinal gradient (30 – 697m) in the northwest region of Libya in 2014. Two species of fig wasps emerged from syconia; the fig pollinator wasp *Blastophaga psenes* L. (Agaonidae), which represented approximately 99% of collected wasps, and the cleptoparasitic wasp *Philotrypesis caricae* (Hass.) (Pteromalidae) (recorded from four sites and representing a first record in the region). Overall, 84% of syconia yielded at least one female *B. psenes*, with a range of 2 – 720 emerging from these individual syconia. The lowest and highest mean numbers of *B. psenes* per syconium recorded for individual sites were 81 and 231, respectively. The lowest number was recorded at the highest altitude site, although there was no relationship between altitude and number of wasps. Overall, pollinator wasps emerged from individual caprifig syconia over a maximum period of 27 days. Wasps emerged from each syconia over maximum period of 15 days. The emergence was about 50% in the first day, 20% the 2nd day and 10% the 3rd day. The short period of emergence may limit the value of older caprifig syconia sold in markets as a source of pollinators. Nonetheless, a field experiment showed that in 80% of fig syconia, pollination with subsequent maturation of the fig, could be achieved by a single *B. psenes*.

BI9

BENEFICIAL INSECTS AND THEIR IMPORTANCE TO AGRICULTURE. Amina Al Houssari, Lebanese International University of Beirut, Beirut, Lebanon, Email: aminahoussari40@gmail.com

There are many insects in our world present in nature and agricultural lands. These insects do not act as a threat, but they are beneficial to the farms and plants in different ways as pollinators, scavengers, weed killers and soil builders. Every farmer's goal is to gain the maximum yield of crops, without adverse effects on human and health and the environment. Insecticides are good products to protect the crops from attack by pests, but the heavy and indiscriminate use of chemicals exposes human to serious health risks and negative impacts on beneficial insects. Thus, careful decisions and policies should be taken to manage the use of insecticides and spread awareness among farmers toward beneficial insects.

BI10

NESTING SITES OF HONEYBEES IN THE DINDER BIOSPHERE RESERVE, SUDAN. Lubna M. Abdalla¹, Ibrahim M. Hashim² and Siham K. Naji³. (1) Wildlife Research Centre, Shambat, Sudan, Email: lobnamoh2010@yahoo.com; (2) Sudanese Wildlife Society, Sudan; (3) The National Centre for Research, Apiculture Research Department, Sudan.

This study was conducted in the Dinder Biosphere Reserve (DBR) during the dry 2009 and 2010 seasons. Colonies of honeybees were counted, and the density was determined in the three ecosystems of the DBR: the Maya, the Riverine and the Dehra. Line transects each with a maximum length of 500 m were selected randomly in each ecosystem. Sixty-four line transects were sampled. All colonies in cavities and feral swarms, along the line transects, were counted in 200-m wide and 500-m long plots. The density was calculated as the total bee colonies counted in each transect divided by the area of the plots. Three tree species had high preference by the bees for nesting: Habil (*Combretum* sp.); Cuke (*Acacia siebriana*) and Higleig (*Balanites aegyptiaca*). Larger number of honeybee colonies was encountered in 2009 than in 2010. In 2009, however, about 70% of the colonies were well established and 30% absconded. In 2010, the numbers of established and absconded colonies were about equal (52% and 48%, respectively). The natural colonies were more common in tree cavities than in the form of feral swarms.

CLIMATE CHANGE & PLANT PROTECTION

CC1

IMPACT OF CLIMATE CHANGE ON PLNT DISEASE: A CHALLENGE TO PREVENT AND MITIGATE PLANT DISEASE RISKS IN AGRICULTURE. Khaled M. Makkouk, Arab Society for Plant Protection, Beirut, Lebanon, Email: virologist1974@gmail.com

Research on climate change (CC) over the past few decades points out towards negative impacts already emerging for natural and human systems. Changes in water quality and quantity, shifts in geographical ranges of pests

including plant diseases, seasonal activities, migration patterns, species abundance, all seems to have more negative than positive impact on the yield of most crops. Such changes are mainly triggered by increased emission of greenhouse gases due to intensification of agricultural and industrial activities, consumption of fossil fuel and changes in land use, mainly deforestation. Different experimental and theoretical approaches were designed for CC biology research such as experiments under controlled conditions, studies along an elevation gradient, studies along a latitudinal gradient (temperate to subtropical to tropical), data monitoring of long-term data sets of different parameters, in addition to modelling approach using one or several climate change scenarios. Consequently, pest risk simulation studies on the effect of CC scenarios on plant pathogens which attack different crops in different countries have been published. Selected case studies on the effect of CC on plant pathogens relevant to the Arab countries will be presented. Reviewing the available data, it is evident that there are still gaps in CC research related to plant disease, especially in the Arab region. Conducting research to fill gaps related to CC and pests is a key component to the maintenance of current and future food security.

CC2

IMPACT OF CLIMATE CHANGE ON SOME PATHOSYSTEMS AND ITS INTEGRATED MANAGEMENT IN SYRIA. Abdul Rahman Khafateh, Faculty of Agriculture, Tishreen University, Latakia, Syria, Email: Dr.Khafateh54@yahoo.com

Climate changes has a major impact on agriculture at the global level. It is known that agricultural systems in Syria, which include several sectors are sensitive to greenhouse gases, climate changes affect plant pathogens and create a new pathosystems which called for conducting a study to assess the changes in geographical distribution of different diseases and pests, and to develop an effective plant protection strategy, due to the temperature and rainfall increases. The warming in the region reached 3 ± 0.5 °C in winter and 5 ± 1 °C in summer, which makes the plant more vulnerable to attack by pathogens and consequently more yield loss. This study includes information on the annual averages of temperature and the total amount of rainfall during in Syria (1980 –2010). An increase in temperature was observed during the last 10 years (2001–2011). Certain pathosystems were selected and the effects of climate changes on some important diseases of fruit trees and field crops were studied, such as olive leaf spot (OLS) (*spiloea oleaginea*), apple decline cause by *Phytophthora cactorum* and other diseases. The incidence of OLS ranged between 20–74% and the disease index 16-61%, whereas apple decline reached 60% during the same period. As a result, the study indicated that temperature and precipitation change had an effect on the plant pathosystems which led to significant increase in the disease incidence and severity. Increased temperature also helped spread pathogens to more host plants. To reduce the impact of climate change on crop yield, more emphasis should be placed on integrated disease management and sustainable agricultural production.

CC3

EFFECT OF CLIMATE CHANGE ON WHEAT RUST DISEASE IN SYRIA. Mohammad A. Kassem¹ and Nader Y. Asaad². (1) Department of Plant Protection, Faculty of Agriculture, Aleppo University, Aleppo, Syria, Email: agromohammad@gmail.com; (2) General Commission for Scientific Agricultural Research (GCSAR), Al-Ghab, Hama, Syria,

Globally, the climate change has affected the distribution and virulence of wheat rust diseases. Whereas, the Intergovernmental Panel on Climate Change indicated that temperatures increased 2°C above its general average and succession of extreme phenomena such as drought and heavy rain during the growing season in Syria caused resistance breakdown of Syrian varieties against rust. Rising atmospheric CO₂ concentration increased virulence of rust populations. Wheat Yellow rust races (462E128, 238E96, 238E234, 230E134 and 163E150) was aggressive against 30 Yr gene(s) (1, 2, 3a, 3b, 4a, 4b, 5, 6, 7, 8, 9, 9+, 10, 11, 12, 17, 18, 22, 23, 23V, 24, 26, 27, A, Ck, Cle, CV, H, H Peko, Nd, Sd, Su, Sp), and only Yr15 was completely effective against all physiologic races identified. These virulent physiological strains were distinguished by their ability to adapt to high temperatures, as they could develop and cause infection at temperatures up to 33°C, forming dark yellow to light orange uridine pustules. These climatic changes also affected the timing of the spread of wheat stem rust, where it occurred from mid-April, whereas it was recorded earlier to start in mid-May, which has a negative impact on the productivity of wheat in Syria, especially the spread of highly virulent physiological races (DJTJN, PRSTT, TKTTF, TTPKT, TTTFT and TTTRT) were able to overcome the resistant genes (5, 6, 7a, 7b, 8a, 8b, 9a, 9b, 9d, 9g, 10, 11, 12, 15, 16, 17, 18, 19, 20, 23, 30, 31, 34, wld-1, 38), and only the resistance gene sr13 remained completely effective. While the spread of leaf rust in the Syrian wheat fields has receded, and in some years it has been completely absent, because the wheat leaf rust races were not adapted to the prevailing climatic conditions. In addition, these conditions encouraged the development and spread of the bacterial wheat leaf blight disease caused by *Pseudomonas syringae*, which forms the InaZ protein that prevents the development of *Puccinia triticina* fungus on wheat leaves.

CC4

POTENTIAL CLIMATE CHANGE IMPACT ON PRODUCTION OF IMEN BARLEY BYDV RESISTANT VARIETY IN TUNISIA Mlaouhi Saida¹, Hajer Ben Ghanem² and Asma Najjar³. (1) Rural Economic Laboratory; (2) Field Crops Laboratory; (3) Plant Protection Laboratory, National Institute of Agricultural Research of Tunisia, University of Carthage Street Hédi Karray, 1004 El Menzah, Tunisia, Email: saidamlouhi@gmail.com

Barley yields are generally considered less variable under changing weather conditions than those of wheat and most other small grains. Relationships between agroclimatic indices and average yields of BYDV resistant Imen barley variety compared to the most important spring barley (*Hordeum vulgare* L.) varieties (Manel and Rihane) in field trials conducted in Kef experimental station during twelve cropping seasons (2008-2019) are explored and then used to

estimate potential impacts of climate change scenarios on anticipated average yields and total production of these commodities in Kef region by 2058. Kef experimental region was selected to compare the climate change impact of various climatic and pedological conditions. In this paper, the agronomic crop model Cropsyst was used to assess the impacts of increased temperature on growth and development varieties mentioned below in Tunisia, and to examine possible adaptation strategies. The analysis was based on multi-year crop model simulations run with daily weather series 2020-2058 that allowed two average yield components: grain and biomass. The impact of 0.2°C temperature rise obtained by weather generator ClimGen included in Cropsyst on potential yields was positive and induced an increase of 14.6%/ha for Imen in comparison to 13.8% for Manel and 10.1% for Rihane. Based on a range of available heat units projected by multiple general circulation model (GCM) experiments, a climate change scenario representing +1°C temperature rise was also applied for the same period and using the same generator. With 1°C temperature rise, average yields achievable in field trials could decrease in the long term by around 1.6 qx ha⁻¹ (Rihane) and 4.6qx ha⁻¹(Manel) (4.7% and 14%). Cropsyst yield data, however, indicated an increase of 0.5% with + 1°C temperature rise suggesting the resilience of Imen barley grain production, compared to the two varieties Manel and Rihane.

PEST SURVEILLANCE

PS1

PRECISION SURVEILLANCE SYSTEMS FOR EARLY DETECTION OF REGULATED DISEASES OF FRUIT TREE CROPS IN THE MEDITERRANEAN REGION. Anna Maria D'Onghia, Stefania Gualano, Franco Valentini and Franco Santoro, Centre International des Hautes Etudes Agronomiques Méditerranéennes (CIHEAM) of Bari, Via Ceglie, 9 - 70010 Valenzano (BA), Italy, Email: donghia@iamb.it

The establishment of quarantine diseases in an area can cause serious losses of agricultural produce and limit the cultivation of fruit tree crops because they are highly destructive and for many of them there are no direct control measures. Early detection of these diseases is essential to prevent their establishment and spread. The integration of innovative tools and methods (e.g., geomatics, information technology, statistics, forecasting models, biotechnologies) is necessary for designing advanced pest defense systems on a territorial scale, even in inaccessible areas. These systems provide plant protection services with accurate and real-time data on disease status in the area in order to undertake targeted interventions and evaluate their effectiveness. Examples of technological applications are: the combination of satellite data in a GIS environment for Citrus tristeza virus; the photointerpretation of high-resolution aerial images and time series high-resolution satellite images for the olive quick decline caused by *Xylella fastidiosa*; rapid pathogen diagnostic technologies (e.g., real time LAMP). Some precision systems that can be applied in the Mediterranean region for the surveillance of main fruit tree diseases are: the integrated system (Remote sensing, GIS, IT)

for *X. fastidiosa*; the IT Multitrace prototype system for monitoring different diseases and their vectors (e.g., *Ca Phytoplasma vitis* & *Scaphoideus titanus*); the Agreed IoT system under development for pest surveillance and management at field and territorial scales for regulated and key pests. An important role in these systems is the accurate acquisition of data and real-time transmission through dedicated applications, most of which were initially developed for *X. fastidiosa* surveillance.

PS2

EARLY DETECTION OF EMERGING DISEASES: A FOCUS ON *X. FASTIDIOSA* OUTBREAKS IN THE MEDITERRANEAN BASIN. Blanca B. Landa¹, Miguel Román-Écija¹, María P. Velasco-Amo¹, Luis F. Arias-Giraldo¹, Manuel Anguita-Maeso¹, Pablo J. Zarco-Tejada^{1,2}, Carlos Camino³ and Juan A. Navas-Cortés¹. (1) Institute for Sustainable Agriculture (IAS), Spanish National Research Council (CSIC), 14004 Córdoba, Spain. (2) School of Agriculture and Food (SAF-FVAS) and Faculty of Engineering and Information Technology (IE-FEIT), University of Melbourne, Melbourne, Victoria, Australia; (3) European Commission, Joint Research Centre (JRC), Ispra, Italy, Email: blanca.landa@csic.es

Xylella fastidiosa (*Xf*) represents the major transboundary plant pest and one of the world's most damaging pathogens in terms of socioeconomic impact. Development of preventive strategies and methods for surveillance, early detection and monitoring and accurate diagnosis of *Xf* and its vectors is key to successfully monitor this detrimental plant pathogen and assist in their timely eradication or optimise containment measures. Some of the approaches that have been developed or implemented for early detection of *Xf* in Europe during outbreak surveys include: i) Development of regionalized climatic suitability risk maps for potential *Xf* establishment; ii) Airborne hyperspectral and thermal images from remote sensing and *in-situ* plant phenotyping to discriminate *Xf* infections from other biotic- and abiotic-induced spectral signatures; iii) New in field methods to quickly and accurately identify/quantify infected plants and vectors; iv) New molecular approaches to genetically characterize *Xf* strains in plant and insect vectors via hybridization-based capture and high-throughput sequencing technologies. Each of these approaches have some benefits and constraints, but the combination of several of them may help to contain the spread of *Xf* epidemics in Europe.

PS3

SURVEILLANCE AND PREPAREDNESS STRATEGIES FOR EXOTIC CITRUS PESTS IN THE EU. Antonio Vicent and Elena Lázaro, Centre de Protecció Vegetal i Biotecnologia, Institut Valencià d'Investigacions Agràries (IVIA), 46113 Moncada, Spain, Email: vicent_antciv@gva.es

Exotic pests and diseases such as the false codling moth (FCM), *Thaumetotibia leucotreta*, citrus black spot (CBS), caused by *Phyllosticta citricarpa*, and huanglongbing (HLB), caused by '*Candidatus Liberibacter spp.*' and their vectors *Diaphorina citri* and *Trioza erytreae* represent major threats for the citrus industry in the

Mediterranean Basin. Actually, outbreaks of FCM, CBS and the HLB vectors have recently been reported in several countries. The new EU plant health law (Regulation EU 2016/2031) establishes a proactive framework against the introduction of quarantine pests and pathogens. Those with the greatest potential socioeconomic impacts, such as FCM, CBS and HLB, are considered priority pests (Regulation EU 2016/2031). EU Member States should establish enhanced measures for priority pests concerning surveys, action plans for eradication, contingency plans and simulation exercises. Yearly surveys should be implemented following the guidelines for statistically sound and risk-based surveys developed by the European Food Safety Authority (EFSA). To calculate the sample size, method sensitivity integrates both the sampling effectiveness by the phytosanitary inspector and the diagnostic sensitivity in the laboratory. This latter is mainly based on the protocols by the European and Mediterranean Plant Protection Organization (EPPO). The outcome of the survey should not be defined simply as pest absence, but in a more transparent way as the confidence level that the pest is below a given prevalence. Commodity risk assessments and climate suitability studies are also developed by EFSA and EPPO to identify and quantify the risks associated with the entry, establishment and spread of exotic citrus pests in the EU.

PS4

FUSARIUM OXYSPORUM F.SP. CUBENSE TROPICAL RACE 4 ON BANANAS IN THE NENA REGION. Thaer Yaseen and Yosra Ahmed, Regional Office for the Near East and North Africa Region (RNE), Food and Agriculture Organization of the United Nations (FAO), 11 Al Eslah El Zerai St., Dokki, Cairo, Egypt, Email: Thaer.Yaseen@fao.org

Global production of bananas is seriously threatened by Fusarium wilt (FW), a disease caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *cubense* (Foc). The epidemic caused by the Foc Race 1 of the pathogen destroyed the Gros Michel banana industry in Central America and the Caribbean in the 1950s. The risk of Foc Race 1 was mitigated by a shift to resistant Cavendish cultivars, which are widely cultivated and are the source of 99% of banana exports. However, the disease re-emerged in Southeast Asia and Australia with the detection of a new race of Foc tropical race 4 (Foc TR4), causing mortality to Cavendish clones and other banana varieties. Since 2010, the disease has spread across Southeast Asia, and to the transcontinental level in the Middle East (Oman, Jordan, Lebanon, and Israel), Turkey and Africa (Mozambique). The likelihood that the pathogen may be present in other countries within the NENA region such as Palestine, Syria, Iraq, and Egypt should also be assessed. The spread of Foc TR4 is of great global concern due to the limited knowledge about the aspects of disease epidemiology, the absence of phytosanitary measures, lack of effective management approaches, and also the lack of awareness among banana growers and stakeholders. As a result, this led to staggering losses in banana production, impacting the livelihoods of farmers and compromising food security. It is estimated that by 2028, the disease will cause a worldwide loss of approximately 160,000 hectares and 2.8 million tons,

representing a 2% reduction in world banana production in addition to the loss of direct employment for approximately 240,000 banana workers. Prevention is the most effective mean of combating FOC through the implementation of appropriate plant health regulations and measures. Certain measures required to prevent spread include the use of certified disease-free tissue culture, regular surveillance, and the early detection. Developing new resistant genetic materials and making the banana production systems more resilient should also be considered in disease management. To help mitigating the risk and spread of Foc TR4, FAO has been providing technical assistance globally, and particularly in the NENA, through strengthening the disease surveillance, diagnosis, identifying risk pathways, and raising awareness. The regional FAORNE office recently launched a TCP project to develop national capacities to contain and manage Foc TR4 in Lebanon. The project intends to improve phytosanitary measures, disease surveillance, diagnosis, raising awareness and management of Foc TR4 in order to limit its spread into new areas and manage the disease in the infested banana plantations.

SOIL-BORNE PATHOGENS

SB1

SOIL HEALTH AND MICROBIOMES OF DRYLAND WHEAT IN THE PACIFIC NORTHWEST OF THE US. Timothy Paulitz, Daniel Schlatter, Jeremy Hansen, Bryan Carlson, Ian Leslie and David Huggins, USDA-ARS, Pullman, WA. Wheat Health, Genetics and Quality Unit and Northwest Sustainable Agroecosystems Unit, USA, Email: timothy.paulitz@usda.gov

With the development of next-generation sequencing, we can now look at the bacterial and fungal microbiome in the soil, rhizosphere and roots of wheat across the dryland Pacific Northwest of the US. These microbes play important roles in N and C cycles, nutrient availability, and resistance to biotic (disease) and abiotic (drought) stresses. Location (precipitation zone) and cropping systems are major drivers of bacterial communities, which may contain over 8000 species (OTUs). Despite this geographical variability, is there a core set of bacteria and fungi associated with wheat roots that are common across all locations that the plant has selected from the soil? We sampled four locations across a range of precipitation zones, and found a core set present in 95% of the rhizosphere samples. This included the bacteria *Bradyrhizobium*, Sphingomonadaceae, *Massilia*, *Variovorax*, Oxalobacteraceae, and Caulobacteraceae. There was also a large group of Actinobacteria present in the rhizosphere as well as the bulk soil. Core fungal taxa in the rhizosphere included Nectriaceae, Pleosporaceae, Trichocomaceae, and Mortierellaceae and *Ulocladium*, *Microdochium*, *Macroventuria*, and *Cadophora*. Bacterial communities are highly variable with soil depths. Shallow layers are dominated by copiotrophic Proteobacteria and Bacteroidetes, but deeper layers contain oligotrophic Actinobacteria. In long-term no till systems, where the N has been applied 10 cm below the soil surface without tillage, an acid layer has developed because of nitrification, and this layer is dominated by Acidobacteria. But are these bacteria

important for soil and plant health? At the Cook Agronomy Long Term Agriculture Farm, we sampled 120 locations on a long-term no-till farm and an adjacent conventionally tilled farm. At each sampled location, we had a long-term history of yield, biomass, pH, organic matter as well as soil properties, which extensively vary across the landscape of rolling hills with wind deposited loess soil. Using these variations across the landscape and correlation analysis, we found some groups of bacteria that were highly positively correlated with yield, such as Caulobacteraceae, Pseudomonadaceae, Flavobacteriaceae, and Mycobacteriaceae. Other families such as Sphingomonadaceae, Chthonomonadaceae and Armatimonadaceae were negatively correlated. Are these bacteria directly responsible for plant health? We are presently isolating representatives of these groups to test in the greenhouse for disease suppressiveness and plant growth promotion.

SB2

CEREAL NEMATODES IN CENTRAL AND WEST ASIA AND NORTH AFRICA (CWANA): CURRENT KNOWLEDGE AND FUTURE NEEDS. Mustafa Imren, Bolu Abant İzzet Baysal University, Faculty of Agriculture, Department of Plant Protection, Golkoy, Bolu, Türkiye, Email: mustafafaimren@ibu.edu.tr

Wheat is grown on roughly 230 million hectares worldwide, with 650 million tonnes of grain produced each year. It is the main staple food in many countries, particularly in Central Asia, West Asia and North Africa (the CWANA region), which has the world's highest per capita wheat consumption. Wheat is grown on 50 million hectares across CWANA, but average productivity in the region is only 1.5 t/ha, half of the global average. Wheat has its origin in West Asia, most likely in the Fertile Crescent, where productivity can be very high. However, the region suffers from heavy periodic disease incidence and insect pests outbreak that cause heavy crop losses. Cereals in the CWANA countries are constantly at high risk of soil-borne pathogens. Root diseases caused by soilborne plant-pathogenic fungi and plant-parasitic nematodes are favored by the dry summers and either winter wheat monoculture or short rotations. Comprehensive studies of soilborne fungal pathogens, cereal cyst nematodes (CCN), and root-lesion nematodes (RLN) conducted in the CWANA for 80, 40, and 20 years, respectively. The CCN *Heterodera avenae* and *H. latipons* are much more prevalent than *H. filipjevi*. The RLN *Pratylenchus thornei* is more prevalent than *P. neglectus*. Mixtures of CCN and/or RLN are found in some fields. The greatest economic damage is caused by *Pratylenchus thornei*, *P. neglectus*, *H. avenae*, and *H. latipons*. These species reduce the productivity of wheat by an estimated US\$50 million annually in the CWANA. The management studies for CCNs have included crop rotations, tillage intensity, screening of nematicides, screening of cultivars for tolerance and resistance traits, and management of weeds. The developed PCR tests such as PCR-RFLP, SCAR primers and sequencing could detect, identify and quantify these species quickly and accurately. The PCR tests revealed that a change from spring wheat to spring barley caused a change in dominance from *P. thornei* to *P. neglectus*. The PCR tests

also revealed that our collection of 'H. avenae' samples from different locations in CWANA countries and several from Morocco and Syria that were actually *H. avenae*, or were mixtures of *H. avenae* and *H. latipons*. Those tests, therefore, led to the first discoveries of *H. latipons* in North Africa, and they showed that the development of new RLN and CCN management strategies would be more complex than we had realized. These PCR tests, therefore, proved to be very valuable, and they are now being used routinely in several commercial nematode diagnostic laboratories and in many research laboratories internationally. Currently, wheat and barley cultivars that express resistance to *H. avenae*, *H. latipons*, *P. thornei* or *P. neglectus*, or combinations of resistance plus tolerance to *H. avenae*, *P. thornei* or *P. neglectus* were identified. Before this knowledge can become truly useful for commercial agriculture, it will be necessary to develop cultivars with pyramided resistance/tolerance genes for both species of *Pratylenchus* and to both species of *Heterodera*. Cultivars that express resistance but are not tolerant are unlikely to become widely accepted by farmers. Other future needs for nematode management will also be discussed.

SB3

WHEAT CROWN ROT IN ALGERIA: CURRENT STATUS AND DISEASE MANAGEMENT. Houda Bouregghda, Imane Laraba and Nora Abdallah, Laboratory of Phytopathology and Molecular Biology- Department of botany, The National Higher School of Agronomy (ENSA), El Harrach, Algiers, Algeria, Email: hou.bouregghda@gmail.com

Wheat crown rot (CR) is a worldwide disease, which may affect yield and also kernel contamination by mycotoxins. CR is a serious and chronic problem where dry climatic conditions are present and when continuous wheat cropping is adopted. Indeed, both conditions exist in Algeria, where wheat cultivation is much more concentrated in arid and semi-arid regions and practiced continuously. This disease was reported for more than two decades, in Algeria, but only recently large-scale surveys carried out in cereal growing regions in the north of the country have shown the presence of CR in almost all the surveyed regions. The investigation carried out lead to more information on wheat crown associated species identification and distribution. Indeed, in Algeria wheat is grown mainly in monoculture, which increases inoculum density in the soil and promotes the presence of crown rot. In addition, no-till has been adopted by farmers in some areas which had further favored CR development. Unfortunately, seed treatment is conducted in an inappropriate manner and does not take in consideration the pathogenic fungi associated with crown rot. Knowing that the presence of Fusarium head blight in the northern regions of the country can be a source of contamination in the following campaigns, where infested seed in the absence of appropriate fungicide treatment increases the soil inoculum concentration and cause damping-off of seedlings or make crown rot more severe later. To manage CR, first we should reduce the soil inoculum density, by making farmers more aware about adoption of non-cereal crop rotation and application of appropriate seed treatment. Second, screening for sources of

resistance among the wheat varieties cultivated and appreciated by farmers. Finally, the ideal approach is to adopt an integrated management by combining the methods mentioned above and including local microorganisms selected for their effectiveness.

SB4

VIBRANCE®DUO – A NOVEL SEED TREATMENT TO BOOST ROOT HEALTH IN CEREALS. Brigitte Slaats, Marc Besse and Monika Joss, Syngenta Crop Protection AG, Rosentalstrasse 67, 4058 Basel, Switzerland, website: <http://www.syngenta.com>; Email: brigitte.slaats@syngenta.com

Cereal seedlings and plants are affected by a range of seed- and soilborne diseases. The level of damage and its impact on yield are dependent on resistance genetics, agronomic and weather conditions. Among other control options, chemical seed treatments have been developed to shield the seedling from soilborne diseases and to eliminate seedborne pathogens. The immediate and lasting protection contribute to maximise the genetic yield potential of a plant. Syngenta Crop Protection AG has launched a new generation of cereal seed treatments based on the novel SDHI fungicide sedaxane which belongs to the class of Pyrazol-Carboxamide. It was specifically designed and developed for seed treatment use to control key cereal diseases, e.g. *Microdochium nivale*, *Rhizoctonia solani*, smuts and bunts such as *Tilletia caries* and *Ustilago* spp. The seed-applied fungicide VIBRANCE®Duo contains not only sedaxane but also fludioxonil which reinforces the fungicidal activity of sedaxane and extends the spectrum of performance to include *Fusarium* spp. providing first-class control against a range of key cereal diseases. In soils inoculated with *Microdochium* and *Fusarium*, results showed improved crop establishment for VIBRANCE®Duo of approximately 20%. Even in non-diseased soil, studies showed that sedaxane seed treatment led to faster root development. Improved water and nutrient uptake are the consequence of improved rooting, thus allowing the plant to make better use of available resources laying the foundation for higher yields even under stress conditions. In addition to its excellent protection against diseases and rooting power benefits, VIBRANCE®Duo has an outstanding seed safety profile.

SB5

PLANT PARASITIC NEMATODES ON CEREALS IN NORTH AFRICA: OUTLOOK AND MANAGEMENT. Fouad Mokrini¹ and Abdelfattah A. Dababat². (1) Biotechnology Unit, Regional Centre of Agricultural Research, INRA-Rabat, Morocco, Email: fmokrini.inra@gmail.com; (2) International Maize and Wheat Improvement Center (CIMMYT), P.K. 39 06511, Emek, Ankara, Türkiye.

Plant-parasitic nematodes (PPNs) are considered one of the most relevant biotic constraints limiting cereal production worldwide. PPNs have been overlooked in many countries around the world due to lack of expertise and funding. Globally, the crop losses value caused by nematodes is estimated at \$157 billion per annum. Among the PPNs, the cereal cyst nematodes (CCNs) on wheat are the most widely studied genera and have been reported from

many countries. The cereal cyst nematodes (CCN) (*Heterodera* spp.) and root lesion nematodes (RLN) (*Pratylenchus* spp.) are widely distributed pests to implicate significant economic yield loss in cereal crops worldwide. Therefore, this study aimed to review the current status and impacts of those two nematodes on cereals in North Africa. The earliest report of nematodes attacking cereals in North Africa (especially Morocco) was in 1984, who recorded the presence of both nematodes attacking wheat. Since then, several surveys of nematodes associated with cereals were conducted in different countries including Morocco, Algeria and Tunisia, and revealed the presence of RLN and CCN on wheat and barley roots. Several species of RLN and CCN were identified associated with wheat. *Heterodera avenae*, *Pratylenchus thornei* and *P. penetrans* were the most prevalent species. Etiological and epidemiological studies were performed including life cycle, virulence of geographical isolates, and effect of environment on the biology and pathology of this CCN. Cereal genotypes were screened against RLN and CCN in collaboration with experts from (CIMMYT). The current status of RLN and CCN knowledge on cereals in North Africa is primitive in spite of few initiatives, and much work is still needed on the distribution, epidemiology and the management of these nematodes.

RESEARCH COORDINATION

RC1

THE EUPHRESKO NETWORK AND ITS ROLE IN THE COORDINATION OF PLANT HEALTH RESEARCH ACTIVITIES IN THE MEDITERRANEAN AREA. Baldissera Giovani¹, Géraldine Anthoine², Sylvia Blümel³, Kris De Jonghe⁴, Elena Rodriguez⁵, Martijn Schenk⁶, Elspeth Steel⁷ and Silke Steinmüller⁸. (1) European and Mediterranean Plant Protection Organization, (EPPO) Paris, France. Email: bgiovani@euphresco.net; (2) French Agency for Food, Environmental and Occupational Health and Safety (ANSES), Angers, France; (3) Austrian Agency for Health and Food Safety (AGES), Vienna, Austria; (4) Flanders Research Institute for Agriculture, Fisheries and food (ILVO), Merelbeke, Belgium; (5) National Institute for Agricultural Research and Food Technology (INIA), Madrid, Spain; (6) National Plant Protection Organization (NPPO), Wageningen, The Netherlands; (7) Department for Environment Food & Rural Affairs (DEFRA) London, United Kingdom; (8) Julius Kühn Institute (JKI), Braunschweig, Germany.

Over the last few years, the rate of introduction and establishment of economically or environmentally damaging plant pests, diseases and invasive species has risen alarmingly. The Mediterranean basin in particular is home to 25,000 plant species, of which 13,000 are endemic (i.e. they are found nowhere else on Earth) and it was identified as a biodiversity hotspot experiencing exceptional loss of habitat. The threats associated with climate change and the increase in global trade open new pathways for the introduction and emergence of plant pests and the need to tackle them is more important than ever. The Euphresco network was initiated in 2006 as an EU funded ERA-Net project aiming at:

developing phytosanitary research policy at the EU-wide level; optimizing the research provision that underpins EU quarantine plant health policy development and policy implementation; increasing the capacity of European phytosanitary science and research, in order to prevent the disappearance of EU expertise. The benefits of phytosanitary research coordination and funding are not restricted to Europe, and since the end of the EU-funding period, Euphresco (2014) has developed into a self-sustainable network of phytosanitary research programme owners, programme managers, national plant protection organizations and research institutes in more than 50 countries in Africa, America, Australasia and Europe. By coordinating and funding phytosanitary research activities that provide scientific evidence to support policy, Euphresco is a platform for communication between scientists and policy makers. The activities of Euphresco, with a focus on Mediterranean plant health challenges, will be described.

RC2

PLANT HEALTH RESEARCH PRIORITIES FOR THE MEDITERRANEAN REGION. Anna Maria D'Onghia, CIHEAM of Bari (IAMB), via Ceglie 9, 70010 Valenzano, Bari, Italy, Email: donghia@iamb.it

Over the last few years, the rate of introduction and establishment of economically or environmentally damaging plant pests, diseases and invasive species has risen alarmingly. The Mediterranean basin in particular, is home to 25 000 plant species, of which 13 000 are endemic (i.e. they are found nowhere else on earth) and it was identified as a biodiversity hotspot experiencing exceptional loss of habitat. Mediterranean agriculture, forests and environment are seriously threatened by numerous quarantine and emerging pests, and their negative impacts on crops is expected to increase due to the acceleration of global trade and to climate change that respectively favor the movement of these organisms over long distances and facilitate their adaptation to new environments. In facing these challenges, the Mediterranean region is particularly vulnerable due to the weakness of national quarantine systems, limited qualified human resources, phytosanitary infrastructures, and not least the lack of funds for research activities in support to statutory plant health. Since 2019, experts from the Arab Society for Plant Protection (ASPP), the European and Mediterranean Plant Protection Organization (EPPO), the Food and Agriculture Organization (FAO-NENA), the Mediterranean Phytopathological Union (MPU), and the Near East Plant Protection Organization (NEPPO) have collaborated under the guidance of the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) of Bari and the Euphresco network for phytosanitary research coordination and funding on a compendium on the research priorities for the Mediterranean area. The Compendium on the 'Plant Health Research Priorities for the Mediterranean Region' was published in 2020 to celebrate the International Year of Plant Health (IYPH). The compendium was prepared on the basis of information and views collected from national experts from the Balkan-Mediterranean, Eastern Mediterranean, Maghreb, and Western Mediterranean sub-regions on the important pests, the research priorities, the research infrastructures and the capacity. A supplement to

the Compendium was organized in 2022. The results of the discussions with country representatives and the main recommendations as highlighted in the Compendium will be presented.

RC3

SET UP OF RELIABLE DETECTION PROTOCOLS FOR THE SPECIFIC IDENTIFICATION OF 'CANDIDATUS PHYTOPLASMA PHOENICIUM'.

Majid Siampour¹, Yusuf Abou Jawdha², Natasa Mehle³, Marianne Loiseau⁴, Luca Ferretti⁵, Yuri Shneyder⁶, Vicken Aknadibossian², Alessandro Passera⁷, Mohammad Jamil Kaddoura², Paola Casati⁷, Hana Sobh², Fabio Quaglino⁷, Baldissera Giovani⁸ and Piero Attilio Bianco⁷. (1) Shahrekord University, Shahrekord, Iran, Email: msiam57@yahoo.com; (2) American University of Beirut POBox: 11-0236, Beirut, Lebanon; (3) National Institute of Biology, Ljubljana, Slovenia; (4) French Agency for Food, Environmental and Occupational Health and Safety, Angers, France; (5) Council for Agricultural Research and Agro-economy, Rome, Italy; (6) All-Russian Plant Quarantine Center, Bykovo, Russian Federation; (7) Università degli Studi di Milano, Italy; (8) European and Mediterranean Plant Protection Organization, Euphresco, Paris, France

Almond witches'-broom (AlmWB) is a devastating phytoplasma disease which affects almond, peach and nectarine. The causal phytoplasma described as '*Candidatus Phytoplasma phoenicium*', has been identified for a long time in Lebanon and Iran, and recently, in Italy. Multiple gene coding regions have been used for the genotyping of '*Ca. P. phoenicium*' strains. In this regard, the *inmp* gene sequence analysis allowed the identification of genetically distinct AlmWB- phytoplasma strains from diverse host plants. Early and reliable detection of '*Ca. P. phoenicium*' is crucial for effective disease management. Several detection methods for '*Ca. P. phoenicium*' have been developed and include conventional and real-time RT PCR. The aim of the Euphresco project 2017-F-234 'Set up of reliable protocols for the detection and identification of '*Candidatus Phytoplasma phoenicium*' (DIPCAPP)' was to comparatively evaluate different diagnostic tests for the specific detection of '*Ca. P. phoenicium*' through a test performance study (TPS). The TPS was carried out using 12 blind samples on two different DNA concentrations (undiluted and 1:10 dilutions) and 2 controls (negative, positive). In the TPS, 6 different PCR-based tests were included: a specific conventional PCR test targeting the 16S-23S spacer region (EP1) and *inmp* gene (EP2); PCR-RFLP analysis of 16S rRNA gene using universal phytoplasma primers (EP3); PCR and sequence analysis of 16S rRNA gene using barcoding primers (EP4); real-time PCR test for the general detection of phytoplasmas (RT1) and for the specific detection of AlmWB phytoplasma (RT2). The TPS was carried out by 7 laboratories from 6 countries (FR, IT, IR, LB, RU, SI). The accuracy, specificity and reproducibility of the tests were evaluated for each laboratory and each test. Overall, the best result was obtained with the EP1 test closely followed by the RT1 test. Tests EP2 and RT2 were found to be satisfactory with high accuracy but lower reproducibility. Tests RT1 and RT2 had comparable ability in the detection of phytoplasma with very

similar error rates. Test EP3 and, especially, EP4 achieved unsatisfactory results with lower accuracy, specificity, and reproducibility values compared to other tests. The results obtained by the project partners were similar. The findings of this study were encouraging as the tests that achieved the best results (EP1, RT1, and even the RT2) are known to be less time-consuming and, especially in case of EP1, can be used in most laboratories without incurring significant expenses.

RC4

THE CITRUS BLACK SPOT IN TUNISIA: CURRENT STATUS, RESEARCH PROJECTS AND MAIN RESULTS TO DETECT THE INFECTION OF *PHYLLUSTICTA CITRICARPA*. Naima Boughalleb-M'Hamdi¹, Najwa Benfradj¹, Ibtissem Ben Salem¹, Sabrine Mannai¹, Amel Fathallah¹, Ahlem Bel Hajd Ali², Souad Mahmoud², Imed Jaouadi², Elena Lázaro³, and Antonio Vicent³. (1) High Institute of Agronomy in Chott Mariem, LR21AGR05, University of Sousse, Tunisia, Email: n.boughalleb2017@gmail.com; (2) Plant Health and Control of Agricultural Inputs Direction; Ministry of Agriculture, Water Resources and Fisheries, Alain Savary, Tunis 1002; (3) Institut Valencià d'Investigacions Agràries (IVIA), Centre de Protecció Vegetal i Biotecnologia, Moncada, 46113, Valencia, Spain.

Citrus products are economically important in Tunisia; they have a good share in the international trade of Tunisian agricultural crops. In March and April 2019, citrus black spot (CBS)-like symptoms were observed on *Citrus* fruit (*Citrus limon* and *C. sinensis*) in Nabeul Governorate, and an intensive survey was undertaken in many orchards located in this area. These surveys were conducted by many groups of Plant Health and Control of Agricultural Inputs Direction (NPPO) in collaboration with the plant pathology team of ISACM. Typical symptoms of CBS were observed in orchards of lemon and orange trees located in Bou Argoub, Beni Khalled, Menzel Bouzelfa, Soliman, Grombalia, Takelsa, Korba, Nabeul and Hammem Ghezaz areas. Symptomatic fruits showed freckle spots or hard spots bearing pycnidia and also typical symptoms were noted on leaves. For these reasons, international research collaborations was initiated to address this threat. The team of the plant pathology laboratory (ISA-CM, Tunisia) is a partner in an EFSA project entitled "Reduction in risk assessment uncertainty: suitability of Mediterranean citrus production areas for *Phyllosticta citricarpa*" (Call reference: GP/EFSA/ALPHA/2019/04). The general objective of the project is to reduce the uncertainties related to the risk of introduction of *P. citricarpa* in the Mediterranean citrus-growing areas, by improving the knowledge on CBS epidemiology and climate suitability in the Mediterranean Basin. ISA-CM is also involved in the Euphresco project "Sampling and analysis of asymptomatic *Citrus* fruits and leaf litter to detect infection with *Phyllosticta citricarpa*" (Call reference: 2019-A-318) to improve pathogen detection in asymptomatic samples. In fact, *Phyllosticta citricarpa* presents a latency phase whose duration varies based on climatic conditions. Within the Euphresco project, the activities were distributed in three tasks. The first task focusses on the evaluation of methods that stimulate early

development of symptoms and the production of pycnidiospores caused by *P. citricarpa* and *P. paracitricarpa*, on infected tissues, like ethephon fruit treatment. The second task focusses on the evaluation of the currently available molecular diagnostic methods on leaf litter or asymptomatic leaf and newly developed tests for their ability to detect and identify *P. citricarpa* on asymptomatic infected citrus tissues, including their validation through a test performance study; possibly this molecular method should include the separation of *P. citricarpa* from *P. paracitricarpa*. The third task focusses on identifying the best sampling strategy to be used for those purposes.

FOOD SECURITY & PLANT PROTECTION

FS1

DESERT LOCUST MANAGEMENT IN TUNISIA: A TRANSBOUNDARY PEST THAT CAN BE PREVENTED BY IMPLEMENTING A PREVENTIVE CONTROL STRATEGY. Mouna Mhafdhi, Mohamed Lahbib Ben Jemâa and Neji Aydi, General Directorate of Plant Health and Agricultural inputs Control, Ministry of Agriculture, Water Resources and Fisheries, Tunisia.

The desert locust is a transboundary agricultural pest that causes severe damage to agro-pastoral production during invasion periods. Around 1.3 billion inhabitants of 60 countries can be affected by the loss caused by locusts during invasion periods. The Desert Locust is monitored and managed by three regional commissions under the Food and Agriculture Organization of the United Nations (FAO) that are distributed according to the biology of the insect in each region. Its main role is to enhance cooperation and coordination among member countries and support countries' efforts in implementing the preventive control strategy by detecting early indications of locust populations and by quickly intervening to eliminate infestation before it causes damage to crops. These commissions are as follows: (1) Desert Locust Control in the Central Region "CRC"; (2) Southwest Asia Desert Locust Control Commission "SWAC"; and (3) The Desert Locust Control Commission in the Western Region "CLCPRO", which was established on February 25, 2002, after it was approved in the 119th session of the FAO Council (November 2000). Ten countries joined this commission during September 2016 (Algeria, Burkina Faso, Chad, Libya, Mali, Morocco, Mauritania, Niger, Senegal and Tunisia). This commission strengthens national, regional and international measures to ensure preventive control and to confront desert locust infestations in the African coast and northwest Africa. The international preventive control strategy represents the only economically sustainable and environmentally friendly strategy. This strategy is represented in the permanent monitoring of the areas of infestation (the breeding areas of the Desert Locust) and the eradication of the first populations through preventive control. Nine periods of general invasion followed the Tunisian country from 1860 to 2015. The last of which was the 2003-2005 invasion, when important swarms invaded several provinces (Tataouine, Medenine, Tozeur, Kebli, Gafsa, Gabes, Kasserine, Kairouan and Sidi Bouzid). Tunisia does not have desert locust breeding areas,

but it is considered as an invasion area. Therefore, all necessary preparations must be made, proactive measures to be taken, and the inventory of means and equipment needed must be taken to ensure the ability to immediately intervene in case of locust alert. It also allows defining the roles and tasks of the national actors concerned with locust control. The Tunisian legislator approved a number of legal texts to organize the anti-locust campaign and established the following different bodies: the Supreme Council for Locust Control (CSLA), the National Committee for Vigilance and Control of Locusts (CNV), the Regional Committee for Vigilance and Control of Locusts, the Urgent National Plan to Control Desert Locust, and the National Unit for the Control of Desert Locusts (UNLA). In the context of strengthening human capacities in the various fields of desert locust control, members of the national units benefit from the training courses and workshops organized by the Desert Locust Control Commission in the Western Region at the regional level. It organizes national training courses for focal points in the various concerned authorities in Tunisia.

FS2

CONTROL OF RED PALM WEEVIL IN TUNISIA.

Mohamed Habib Ben Jamaa, Directorate of Plant Health and Control of Agricultural Inputs, Tunisia, Email: benjamaaml@gmail.com

The red palm weevil was discovered in Tunisia at the end of 2011. The available logistic of Ministry of Agricultural and the technical cooperation project – FAO of the United Nations 2012-2014 were not able to control the insect in this zone. The lack of financial resources, means, equipment, and human resources prevented the achievement of the eradicating this insect, which caused the expansion of the geographical area of the affected places to reach new zones Ariana, Tunis, Ben Arous, Bizerte, Nabeul, Manouba and Zaghuan. In view of continued spread of the red palm weevil in the new zones and to preserve the ornamental palms and to prevent its spread in the Oasis which play an important economic and social role, a national strategy was approved in September 2015 and cover the period 2016-2019, to combat and prepare for the eradication of the red palm weevil. The tasks of this plan are: (1) Field control in the affected areas (apical treatment, treatment by injection, apical cutting, pheromone trapping), (2) Preventive measures to avoid spread of RWP from infested to healthy areas, (3) Preventive measures to avoid spread of RWP from infested to date production areas, (4) Training and supervision activities, and (5) Research activities. The plan aimed to contain the affected areas and limit their scope within two years and prepare for the eradication process. The areas of intervention were the governorates of Greater Tunis (Tunis, Ariana and Ben Arous), Bizerte, Manouba, Nabeul and Zaghuan. In addition, control measures were also carried out on trees located in public areas and private houses. In view of the continued presence of the insect and the registration of new infestations in several areas, in November 2019 the national plan to combat the red palm weevil in the north was extended for the period 2020-2022 and the national plan to prevent the spread of the red palm weevil to the dates production areas in southern Tunisia was approved for the period 2020-2023. Since the beginning of

the national plan to combat the red palm weevil in 2016, the presence of the insect has not exceeded the regions of Greater Tunis and the neighboring states. Rather, its prevalence has declined in recent years. Indeed, the number of ornamental palms in all intervention areas from 2012 to 2021 reached more than 47,000 palm trees, of which 9334 infestations were recorded. This means that the total loss of palm trees amounted to 19.6%. The continued technical, logistical and financial evaluation of the plan allowed to identify four major keys that help the success of controlling the red palm weevil on ornamental palms which included (1) Field Interventions, (2) collaboration among different public and private institutions, (3) Monitoring transfer of palm shoots, and (4) monitoring ornamental palms in private locations. On the other hand, the date sector in Tunisia is of great importance at the economic and social levels, as it ranks second in agricultural products exports to 85 countries (848 million dinars in 2020). In addition, it provides a source of livelihood for nearly 60,000 families, with an average of 2 million working days. Tunisia also ranks fourth in the world in exporting dates in terms of quantity (9%), and ranks first in the world in exporting dates in terms of value (20%). In November 2019, the national plan was approved to prevent the spread of the red palm weevil into the date production areas in southern Tunisia for the time period between 2020-2022.

FS3

OVERVIEW OF THE LOCUST CONTROL STRATEGY IN MOROCCO. Badreddine El Guennouni, National Locust Control Enter, Morocco.

The Desert Locust, *Schistocerca gregaria* has been considered a devastating plague for thousands of years. Its periodic invasions cause remarkable damage to crops, pastures and economically important crops. In periods of widespread invasion, Desert Locust swarms can invade an area of 29 million km² or 20% of the world's land area, populated by about 1.3 billion people in 65 countries in Africa and Asia. Direct crop losses in addition to the control cost can reach billions of US dollars. In Morocco, the Desert Locust is considered one of the most serious factors which affect agricultural production. Since 1914, Morocco has experienced five cycles of invasions of varying degrees of severity, representing 31 years of invasion since the beginning of the 20th century: 1914-1919, 1927-1934, 1941-1948, 1953-1961, 1987-1989, 2003-2005, that is 2 out of every 8 years. Sedentary locusts (grasshoppers) such as the Moroccan locust, make their appearance every year in the high and middle Atlas and the eastern highlands. They also threaten food and pastoral crops and can therefore negatively affect food security of rural populations. The evolution of the locust situation in Morocco depends essentially on the size of the locust populations and the ecological conditions prevailing in neighboring countries. To face the locust plague, Morocco adopts a global and efficient strategy to manage this risk. Morocco is well equipped with a highly developed surveillance and intervention network that has allowed it to avoid and/or limit the damage that can be caused by locust plagues. At times of crisis (locust upsurge and invasion), the management of the crisis is ensured by a national locust control system composed of the following

centers and units: Central Coordination Post (PCC) (national) in charge of the management and coordination of the campaign; National Locust Control Center of Ait Melloul (CNLAA), which is responsible for technical and logistical support and training; Regional Coordination Posts (PCR) (provincial) in charge of implementing control operations in their area of action; Sub-Regional Coordination Posts (S-RCP) in charge of conducting operations in the field; and Operational units (OU) also responsible for conducting field operations on the front lines of defense. CNLAA-Aghadir is the main locust control center for the country whose mission is: (1) Monitor the evolution of the different locust species throughout the national territory and conduct preventive and curative control campaigns, (2) To ensure the necessary logistics for the control system mobilized during times of crisis, (3) Ensure the maintenance and repair of locust control equipment and the management of the national pesticide stock, (4) Provide technical and scientific support to the RCPs, (5) Develop research and training programs on locust control and environmental monitoring, (6) Evaluate treatment operations, particularly the environmental impact of interventions, (7) Ensure the exchange of locust information with countries in the region and with regional and international organizations, (8) Ensure the medical follow-up of the personnel involved in the control and coordinate the health prevention activities carried out in the RCPs. To manage this heritage and maintain it in good working order, the CNLAA has a staff of about one hundred and five employees (including about twenty managers and technicians) to which is added at the appropriate time the seasonal staff recruited on site as part of specific operations. It should also be noted that a doctor assigned to and based at CNLAA provides full-time medical monitoring of locust control personnel.

MISCELLANEOUS

MI1

SAFE MOVEMENT OF FOOD AND FORAGE CROPS GERMPLASM: ICARDA'S EXPERIENCE IN THE ARAB REGION. Safaa G. Kumari¹, Abdul Rahman Moukahel¹ and Inaam El-Miziani². (1) International Center for Agricultural Research in the Dry Areas (ICARDA), Terbol Station, Beqa's Valley, Zahle, Lebanon, Email: s.kumari@cgiar.org; (2) ICARDA, Rabat, Morocco.

Germplasm exchange for research and breeding purposes is essential for crop improvement in the face of climate change and population growth. To contribute towards achieving sustainable development goals, the germplasm exchange need to accelerated to keep up with a world-changing food demand at an ever-increasing pace. However, the movement of living materials is not without the risk of inadvertent movement of associated organisms, including pests. Therefore, extreme care is required to ensure that exchanged germplasm is pest-free. The Consortium of International Agricultural Research Centers (CGIAR) is a global partnership that unites international organizations engaged in research about food security. CGIAR centers have established Germplasm health units (GHUs) to ensure the safety of exchanged plant materials, and compliance with

the FAO International Plant Protection Convention (IPPC) procedures and the International Standards for Phytosanitary Measures (ISPMs) used by National Plant Protection Organizations (NPPOs) to prevent the introduction and control the spread of pests along with plants or plant products. Within the framework of the CGIAR, ICARDA has the world mandate for the improvement of barley, lentil and faba bean. It also has a regional mandate for the improvement of wheat (bread and durum), Kabuli chickpea and pasture and forage crops in the dry areas, including the Arab region. The development of improved germplasm and elite genotypes for use by national, regional and international breeding programs is the major objective of the ICARDA crop improvement program. In order to safeguard countries from quarantine risks (insect pests, pathogens and weeds) associated with the movement of germplasm, ICARDA follows a regulatory and quarantine program working in close collaboration with competent institutions where ICARDA has platforms for crop breeding, germplasm multiplication and evaluation and genetic resources exchange in Lebanon and Morocco. ICARDA's GHU is responsible for the monitoring, clearance and documentation of safe germplasm movement at the center, to do so, all incoming and outgoing genetic resources and breeding germplasm must go through a strict quarantine monitoring system (seed health testing, quarantine clearance based on national and international procedures and rules). Annually, ICARDA's GHU tests more than 100,000 exchanged seed samples from ICARDA mandate crops to be distrusted for more than 70 countries, including Arab region. The center is fully equipped with a seed science and technology and data management staff, in addition to the necessary crop management and post-harvest seed operation facilities. The seed production process is monitored by an independent GHU in coordination with the quarantine systems of the host countries in which ICARDA operates. The role of ICARDA's GHU in the safe exchange of germplasm in the Arab region will be presented.

MI2

TRANS-BOUNDARY PLANT PESTS AND DISEASES IN THE ARAB REGION: PRESENT SITUATION AND FUTURE CHALLENGES. Taher Sadeh Elazzabi, FAO former Senior Plant Protection Officer for the Near East Region, Pesticide Management and Phytosanitary Consultant, Email: taherazzabi@gmail.com

In recent years, the world including the Arab region, has witnessed an increase in both frequency and severity of trans-boundary plant pests and diseases. Trade and movement of plant materials contributed to large scale pests outbreaks that affected vast crop areas. Extreme weather events associated with climate change also participated in spread of pests and diseases beyond their normal range. Genetic diversity in cropping systems can increase susceptibility to damage, if infestations or infections are not detected early, and thus may have consequences on overall agricultural production and food security. Plant quarantine and other schemes to ensure the safe international trade in agricultural commodities may be partly effective in limiting pests spread because they can move without human intervention, as in the case of pathogens vectored by insects

or carried by wind. At present a number of emerging insect pests and diseases that prey on staple crops are threatening food security and the livelihood of millions of people in the Arab Region. This occurs especially in countries that lack the capacity to develop practical and technical approaches to prevent their introduction, and when introduced to minimize their spread. Coordination and cooperation between the countries of the region, including the establishment of monitoring and timely information sharing system through an Arab region network is critical in order to reduce the impact of trans-boundary pests and diseases. The objective of this paper is to highlight the present situation of trans-boundary plant pests and diseases, with the emphases on the challenges and status of preparedness of the region countries; how well-equipped they are to respond effectively to these threats and to take actions needed to improve their response.

MI3

NANOBIOTECHNOLOGY APPLICATIONS IN PLANT PROTECTION Kamel A. Abd-El salam, Agricultural Research Center, Plant Pathology Research Institute, Giza, Egypt, Email: kamelabdelsalam@gmail.com

Traditional plant protection strategies often proved insufficient, and the application of chemical-based pesticides has negative effects on animals and human beings apart from causing a decline in soil fertility. Recent industrial advancements have led to the fabrication of nanomaterials of diverse sizes and shapes. Nanotechnology would deliver green and efficient alternatives for the management of plant diseases without harming nature, whereas the most favorable strategies, in the recent scenario, are the use of micro- and nanotechnology to promote a more efficient assembly and then release of specific and environmentally sustainable active principles. The wide range of nanotechnology applications in agriculture also includes nano-pesticides for the control of plant-pathogen interactions and provide new techniques for crop disease control. However, use in agriculture, especially for plant protection and production, is still an under-explored area. Nanotechnology will revolutionize agriculture and food industry by new techniques such as: precision farming techniques, enhancing the ability of plants to absorb nutrients, improving seed germination and growth via nano-fertilizers. These innovative methods are more efficient in many areas including plant protection, pathogen detection, mycotoxins management, disease control, pesticide/herbicide residue detection, withstanding environmental pressures and effective systems for food processing, storage and packaging.

MI4

PLANT PATHOGENS CULTURE COLLECTIONS: A PEREQUISIT FOR FOOD SECURITY AND FOOD SAFETY. Azza Rhaïem, Laboratory of Microorganisms-National Gene Bank, Tunisia, Laboratoire de Protection des Végétaux (LPV)- Institut National de Recherche Agronomique de Tunis, Tunisia, Email: azza_rh@yahoo.fr

Food Security is considered to be achieved when all people at all times have physical and economic access to sufficient, safe and nutritious food. Biosecurity encompasses all strategic approaches related to policies and

regulatory frameworks that analyze, predict and manage the risk in food safety, animal and plant life and health. At each country level, effective implementation of biosecurity measures depends upon a minimum of organizations and administrative units with clear lines of responsibilities and efficient communication. This is becoming a priority with the establishment of the WTO (World Trade Organization) and the requirements of trading rules set out in many international agreements including the application of Sanitary and Phytosanitary measures (SPS). Plant pathologists have the responsibility to inform decision-makers and community aware of putative risks related to plant diseases which constitute a real threat in reducing crops yield and affecting products quality resulting in industrial and economic losses. Intrusive non identified plant pathogens may threaten an entire ecosystem and many are likely to affect human and animal health through mycotoxins production. Management of these plant diseases is dependent on an enhanced capability of disease detection and diagnosis. In this context, Plant Pathogens Culture Collections become essential resource in the fight against plant diseases and in connecting past, present and future research endeavours. Such collections are being developed in many countries throughout the world in the last decades and include viable specimens associated with genotypic and phenotypic libraries. With the advent of DNA-based systematics and the adoption of “DNA barcodes”, culture collections are being supported by reference DNA libraries.

MI5

THE ROLE OF RESISTANCE INDUCTION AS A STRATEGY IN PLANT PROTECTION AND CROP PRODUCTIVITY IMPROVEMENT: CASE STUDIES FROM SYRIA. Ahmad M. Mouhanna^{1,2,3}, Aus A. Hasan⁴, Loubna S. Deibeh¹, Omar Hammodi⁵ and Majeda Mofleh⁶. (1) Faculty of Agriculture, Damascus University, Damascus, Syria, Email: A.M.Mouhanna@gmail.com; (2) Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria.; (3) Faculty of Medicine, Syrian Private University (SPU), Damascus, Syria; (4) National Commission for Biotechnology, Damascus, Syria; (5) Agricultural Scientific Research Center in Latakia, Latakia, Syria; (6) General Commission for Scientific and Agricultural Research (GCSAR), Damascus, Syria.

The effect of a number of resistance inducers on growth and productivity of some economically important crops in Syria and the role of these inducers in protecting plants from infection with a number of plant pathogens was investigated. The effect of different concentrations of the resistance inducer Acibenzolar-S-Methyl (ASM) on some plant growth indicators was studied on healthy tomatoes infected with the root-knot nematode *Meloidogyne* spp. The results showed that the treatment with a concentration of 50 ppm was significantly superior to other concentrations of resistance inducer. Assessing the effect on growth indicators of healthy plants treated with 50 ppm of resistance inducer gave 31.6%, 40.5%, 15.2%, 57.1% increase in plant height, number of flowers, fruiting rate, shoot weight, respectively, as compared to the control. The mean number of nematode nodules in plants treated with 50 ppm resistance inducer was significantly reduced by 35.5% compared to the control.

Studying the effect of some PGPR, *Pseudomonas chlororaphis* Ma342, showed high ability of this strain to protect the wheat crop from infection with a number of fungal diseases, in addition to increasing growth parameters and yield of treated plants. The incidence of rust diseases in bacteria-inoculated wheat plants was reduced by 62.8% compared to the control. The incidence of powdery mildew was reduced by 82.5% in wheat plants treated with *Pseudomonas chlororaphis* Ma342 compared to the control. The productivity of bacteria-inoculated wheat plants increased by 48.4%. Yield reached 3.8 tons/ha, compared to the control which was 2.6 tons/ha. By comparing the effectiveness of using a number of chemical resistance inducers Benzothiadiazole (BTH), and biotic resistance inducers *Pseudomonas chlororaphis* Ma342 and *Bacillus subtilis* B27 on the growth of two tomato cultivars (Ghalia and Fury), it was found that the use of the mentioned resistance inducers alone resulted in a better outcome in the studied growth indicators (plant length, number of flowers, the weight of the vegetative and root systems) compared to the control, but the highest significant increase was obtained when the three mentioned resistance inducers were used together, where the percentage increase in the above mentioned growth indicators was 33.7%, 50%, 39.1% and 41.7%, respectively, for Ghalia cultivar and 34.8%, 42.5%, 39.4% and 40.9%, respectively, for Fury cultivar compared to the control. The use of growth promoters also induced resistance of tomato plants infected with the *Botrytis cinerea*, and the highest percentage of induction of resistance was obtained when the three resistance inducers were used together, and the DSI decreased by 70.6% and 66.7% in Ghalia and Fury cultivars, respectively, compared to the control. Several concentrations of the resistance inducer *Piriformosporandica* on tomato plants in protected cultivations were tasted, the best results of promoting growth indicators were obtained when 0.4% fungus solution was used, which increased growth indicators by 37.7%, 16.8%, 71.2%, 116.2% in treated plants compared to the control. The effectiveness of number of chemical resistance inducers Benzothiadiazole (BTH), and biotic resistance inducers PGPR (*Pseudomonas chlororaphis* Ma342 and *Bacillus subtilis* B27) and mycorrhizal fungus (*Piriformosporandica*) on growth of two tomato varieties (Ourjoan and Neenar) and infection with Tomato yellow leaf curl virus (TYLCV) was evaluated. BTH concentration of 50 ppm showed a significant increase in promoting plant growth (plant length, stem diameter, number of flowers, the weight of the vegetative and root systems) by 22.6%, 15.7%, 24.4%, 12.6% and 32.8%, respectively, for Ourjoan variety and 21.6%, 12.9%, 32.6%, 14.3% and 24.3%, respectively, for Neenar variety, compared to the control. The infection rate with TYLCV decreased by 45% in Ourjoan variety and 47.37% in the Neenar variety in plants treated with BTH compared to the control. Using the two bacterial strains, plant growth indicators increased by 29.5%, 21.7%, 55.3%, 24.7% and 39.0% for Ourjoan variety and 25.4%, 14.8%, 37.0%, 13.9% and 22.7% for Neenar tomato variety, respectively. Using both bacterial strains together, infection rate with TYLCV decreased by 50% for Ourjoan variety and 63% for Neenar variety, compared to the control. The use of *Piriformosporandica* increased the growth indicators of

treated plants by 21.2%, 20.7%, 34.2%, 13.1% and 41.9%, respectively, for Ourjoan variety and 17.8%, 14.6%, 13%, 3.7% and 25.2%, respectively, for Neenar variety. The infection rate with TYLCV decreased by 55% for Ourjoan variety and 63.16% for Neenar variety, compared to the control. The use of these resistance inducers helped plants to have more sustainable resistance to pathogens by significantly increasing the different growth indicators, and reducing disease incidence, and consequently higher yield.

MI6

THE RELATIONSHIP BETWEEN BIODIVERSITY IN SOIL FAUNA AND CROP CULTIVATION WITH DIFERANT METHODS IN EGYPT. Hamdi S. Abd El-Karim¹, Ashraf A. Rahil² and Marguerite A. Rizk¹. (1) Plant Protection Research Institute, Agriculture Research Center, Dokki, Egypt, Email: reta19492001@yahoo.com, (2) Plant Protection Department, Faculty of Agriculture, Fayoum, Egypt.

Chamomile (*Matricaria chamomilla*) and calendula (*Calendula officinalis*) are considered among the most important medicinal and aromatic plants in Egypt, especially in Fayoum Governorate, which is one of the highest producing areas for these plants. This study was carried out at Fayoum Governorate, during two successive growing seasons, 2014/2015 and 2015/2016, to compare the effects of organic and conventional cultivation of chamomile and calendula on the occurrence, population density, seasonal fluctuation, relative abundance and species diversity of soil fauna. Nine insect orders were collected from chamomile and calendula fields using pitfall traps. In addition, isopoda, soil mites and spiders were also surveyed. The number of arthropods captured by pitfall traps from organic fields was higher than the arthropods captured from conventional ones. Furthermore, Collembola, ground beetles (Carabidae) and isopoda were found with higher numbers in organic cultivations than in conventional ones. The total population of spiders was higher in conventional plantation in two seasons. Total of 802 individuals (378 individuals for organic and 424 individuals for conventional) and 608 individuals (291 individuals for organic and 317 individuals for conventional) were collected in first and second season, respectively. The most dominant spider families were Linyphiidae and Theridiidae, and the most dominant genera were *Linyphiid* sp. and *Kochiura* sp.

MI7

THE EFFECT OF VERMICOMPOST TEA ON PLANT PROTECTION. Margit Olle, NPO Veggies Cultivation, Kesa 60, Tartu, 50115, Estonia, Email: margit.olle@gmail.com

The aim of this review is to describe the effect of vermicompost tea on plant protection. In the last two decades, the liquid solution of vermicompost, i.e., vermicompost tea, has been widely used for the management of plant diseases and pests. Vermicompost tea can also coat leaf surfaces, reducing available sites for pathogen infection, or increasing microbial diversity, which can kill harmful pathogens. Diseases and pests can be managed successfully without affecting human health or the environment by using vermicompost tea as eco-friendly organic amendments and

as a replacement for inorganic pesticides and fungicides, and chemical-free food can be provided to humanity in the future. As a result, these organic solutions are regarded as viable alternatives to chemical pesticides and fungicides, and they should be used more frequently to prevent disease and ensure food security and safety.

MI8

AGRICULTURAL LAND MOLLUSC PESTS IN SAUDI ARABIA. Yasser Abobakr, Ali S. Al-Sarrar, Amgad A. Saleh, Ali A. Alzabib and Al-Khair A. Abdelrahman, Department of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia. Email: yawadallah1@ksu.edu.sa

Land herbivorous molluscs (snails and slugs) are one of the most harmful threats to the sustainable agriculture in many areas of the world. They can cause economic losses to many agricultural crops. Moreover, they are potential vectors for many parasites and pathogens that pose a health risk to human and livestock. To study the occurrence of land mollusc pests in the Kingdom of Saudi Arabia (KSA), 115 different sites were surveyed in the northern (Tabouk), southern (Jazan and Abha), eastern (Al-Ahssa), western (Taif and Al-Madinah Al-Monawarah) and central (Riyadh) provinces of KSA during the period 2020-2021 using a direct visual search technique. Different habitats were inspected including open agricultural fields, greenhouses, horticultural orchards, nurseries, public parks, district gardens, and mountainous areas. Latitudes and longitudes as well as altitudes of each site were recorded. In total, 3250 mollusc specimens were collected and classified into 26 species (73% snails and 27% slugs) representing 22 genera and 18 families. Most of the collected molluscs belong to introduced and/or invasive species that are considered important agricultural molluscan pests. Here, we report the first record of eight mollusc species (4 snails and 4 slugs) along different provinces in the KSA. This study demonstrates the geographical distribution of land mollusc pests for the first time in the KSA.

MI9

GENETIC ENGINEERING: A PROMISING TECHNIQUE FOR PEST CONTROL. Lovneesh Choudhary, Mohinder Singh Dalal and Vikram Singh, Department of Genetics & Plant Breeding, India, Email: chouhdharylovneesh@gmail.com

Genetic engineering of inherent crop resistance to insect pests offers the potential of a user-friendly, environment-friendly and consumer-friendly method of crop protection to meet the demands of sustainable agriculture. Genetic engineering is a process that uses laboratory-based technologies to alter the DNA makeup of an organism. Introduction of DNA into an organism can be achieved by using various methodologies. Central to this work is the common crown gall bacterium, *Agrobacterium tumefaciens*. Genes can also be injected by physical methods such as microinjection, biolistic, and electroporation, or biological methods such as transposable elements, Sindbis viruses, and retroviruses as gene vectors. Early efforts to engineer useful genes into crops focused on the *Bacillus thuringiensis* endotoxin genes because of safety, efficacy,

biodegradability, selectivity, and relative simplicity of this protein insecticide. Many field trials of crops expressing these modified Bt genes have been conducted and the majority of those that have been published have yielded impressive results, such as, Cry1A-cotton for cotton bollworm (*Helicoverpa zea*) and pink bollworm (*Pectinophora gossypiella*); Cry3A-potato for Colorado potato beetle (*Leptinotarsa decemlineata*); Cry1A-elite maize for European corn borer (*Ostrinia nubilalis*). Apart from the Bt delta-endotoxin, other proteins that are efficient against insects, such as the vegetative insecticidal proteins (VIP), alpha-endotoxin, pea lectin, snowdrop lectin, a variety of secondary metabolites and other proteins of plant origin, can be used to produce genetically modified plants. Genetic engineering of crops has a number of advantages, including the ability to introduce a large number of different desirable genes in a single event and reducing the time required to introgress introduced characters into an elite genetic background, which can reduce insect attack and contribute to the long-term sustainability of modern agriculture. Although there are possible negative environmental implications on beneficial organisms, since pollen of transgenic plant includes the *Bt gene*, whose product is poisonous to bees and beneficial natural enemies of crop pests.

MI10

STATE OF PHYTOSANITARY PROTECTION OF DATE PALM CULTURE IN ALGERIA. Hamdi Bendif^{1,2,3}, Hanane Khalfa¹, Nabila Adoui¹, Mohamed Harir⁴, Fatima Zohra Hechaichi^{1,3} and Larbi Derbek^{1,3}. Department of Natural and Life Sciences (SNV), Faculty of Sciences, University of M'Sila, M'Sila, Algeria, Email: hamdi.bendif@univ-msila.dz; (2) Laboratory of Ethnobotany and Natural Substances, Department of Natural Sciences, Ecole Normale Supérieure (ENS), Kouba, Algeria; (3) Laboratoire de Biodiversité et Techniques Biotechnologiques pour la Valorisation des Ressources Végétales (BTB_VRV), Algeria; (4) Department of Biotechnology, University of Science and Technology - Mohamed Boudiaf (USTO-MB), Oran, Algeria.

In Algeria, date palm cultivation is experiencing intense activity; despite a phytosanitary situation which is considered sometimes worrisome. The date palm culture is currently estimated at more than 18 million plants, which in Algeria is seriously threatened by various pests, diseases and weeds, namely: heart rot, khmedj, bayoud, date moth, boufaroua, white cochineal, Bougassass, cetonie white worm in addition to the weeds diss, quackgrass and reed. All these threats represent constraints for the development and preservation of this important culture in Algeria.

W4

GENETIC DIVERSITY AND POPULATION STRUCTURE OF 18 TUNISIANS *OROBANCHE FOETIDA* POPULATIONS USING RADSEQ. Amal Boukteb^{1,2}, Shota Sakaguchi³, Yasunori Ichihashi⁴, Mohamed Kharrat², Atsushi J. Nagano⁵, Ken Shirasu⁶ and Mariem Bouhadida². (1) Faculty of Science of Tunis, University of Tunis El Manar, Tunis, Tunisia, Email: amal.boukteb@fst.utm.tn; (2) Field Crop Laboratory, National Institute of Agricultural Research of Tunisia,

Carthage University, Tunis, Tunisia; (3) Graduate School of Human and Environmental Studies, Kyoto University, Kyoto, Japan; (4) RIKEN BioResource Research Center, Tsukuba, Japan; (5) Faculty of Agriculture, Ryukoku University, Otsu, Japan; (6) RIKEN Center for Sustainable Resource Science, Yokohama, Japan.

Orobancha foetida Poiret is a holoparasitic plant that lacks chlorophyll and totally depends on its host for its growth. The fetid broomrape parasitizes host plant roots and extracts nutrients and water via a haustorium. *O. foetida* Poiret was described for the first time in 1786 by Poiret during his surveys in North Africa. Although *O. foetida* is distributed in the Mediterranean region as a wild plant parasite, it parasitizes faba bean crop causing serious damage which may reach 90% yield loss in Tunisia since 1992. Analysis of genetic diversity of the parasite is important to better understand its evolution and spread, which remained largely unknown. In this work, we present the first study on genetic diversity and population structure using the robust technique Restriction-site-Associated DNA sequencing (RADseq) for *Orobancha* spp. 244 samples of *O. foetida* were collected from 18 faba bean fields in the north of Tunisia including 17 populations from the north-west and one population from the north-east. To overcome the difficulty of SNP discovery in the *O. foetida* genome as a non-model and tetraploid plant, we utilized three different informatic pipelines, namely UNEAK, pyRAD and Stacks. This study showed that genetic differentiation occurred in the Tunisian *O. foetida* emphasizing the isolation by distance effect. However, no strong population clustering was detected in this work based on the three data sets and clustering methods used. The present study traces the current real situation of distribution of *O. foetida* populations in Tunisia and could be a valuable reference for the upcoming research projects focusing on this parasitic plant.

F66

SOURCES OF RESISTANCE AND ASSOCIATE QUANTITATIVE TRAIT LOCI OF LEAF RUST AT SEEDLING AND ADULT PLANT STAGES IN A GLOBAL BARLEY PANEL. Mariam Amouzoune^{1,2}, Rachid Benkirane², Sajid Rehman^{1,3*}, Swati Verma⁴, Sanjaya Gyawali⁵, Muamar Al-Jaboobi¹, Ramesh Pal Singh Verma^{1,6}, Zakaria Kehel¹, and Ahmed Amri¹. (1) Biodiversity and Crop Improvement Program, International Center for Agricultural Research in the Dry Areas (ICARDA), Rabat, Morocco, email: mariam.amouzoune@gmail.com; (2) Faculty of Sciences, University Ibn Tofail, Kenitra, Morocco; (3) Field Crop

Development Center, The Olds College, Lacombe, Alberta, Canada; (4) CCS Haryana Agricultural University, Hisar, India; (5) Washington State University, Mount Vernon North-western Washington Research & Extension Center, 16650 State Route 536, Mount Vernon, WA98273, USA; (6) Indian Institute of Wheat and Barley Research (IIWBR), Karnal, Haryana, India.

Barley is a major crop in the semi-arid regions and plays an important role as livestock feed and in human consumption, mainly in Morocco. Barley leaf rust (*Puccinia hordei*) is one of the most destructive diseases of barley worldwide causing substantial economic losses. Growing resistant varieties and search for new sources of resistance are crucial to combat the threat from the evolving pathogen population. Phenotyping evaluation and genome-wide association study (GWAS) were performed on a breeders constructed panel (AM-2017) composed of 320 entries including landraces, released varieties and elite germplasm, to identify sources of resistance and the associated molecular markers. AM-2017 was screened for LR resistance at the seedling stage using two *Puccinia hordei* (Ph) isolates (SRT-SAT and SRT-MRC) and at the adult plant stages at Sidi Allal Tazi (SAT) over the two seasons 2016-2017 and 2018-2019. The results indicated that only Fourteen barley genotypes were resistant (R) at the seedling stage to both isolates, SRT-SAT and SRT-MRC, and only twelve genotypes were either resistant (R) or moderately resistant (MR) at the adult plant stage, whereas only one genotype has expressed R at seedling stage and MR at adult plant stage. Based on the results of genome-wide association studies (GWAS) performed using 36,793 SNPs markers and phenotypic data. The genome scan revealed 58 significant MTA associated with Ph resistance, among which 34 were associated with seedling resistance (SR) and 24 with adult plant resistance (APR). Two common genomic regions respectively on 2H and 7H chromosomes were identified to confer resistance to Ph at both stages Among the 58 MTA identified, 26 loci have been reported in previous studies while the remaining 32 loci were regarded as novel. The resistant barley genotypes can be used by breeders and some of SNP markers from this study with high effects and R^2 can be converted into high-throughput functional markers for accelerated selection and pyramiding of leaf rust resistance genes in North African barley germplasm. Also, the panels constructed by breeders were able to provide sources of traits of interest including resistance to major diseases like leaf rust.