Biodiversity and Seasonal Occurrence of Insect Fauna Associated with Brassica Vegetables in Menoufia and Giza Governorates in Egypt

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Abstract

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The present study was conducted to explore the diversity of the insect fauna associated with five brassica vegetables at two locations (Menoufia and Giza) in Egypt. Insects were collected from the two sites, from November 2020 until January 2021. In total, 13 insect species belonging to 12 families and 6 orders were recorded from the two sites: 10 species of insect pests, 2 species of predators and one parasitoid species. Seasonal occurrence of three caterpillars (small white cabbage butterfly, *Artogeia rapae* L., diamond-back moth, *Plutella xylostella* L. and semiloopers, *Autographa gamma* L./*Trichoplusia ni* H. taking into consideration three weather factors (maximum and minimum temperatures, and relative humidity) were also recorded. The results obtained showed that the small white cabbage butterfly *Artogeia rapae* L. and diamond-back moth *Plutella xylostella* L. preferred cauliflower and cabbage as host plants, whereas semiloopers did not show any preference between cabbage, cauliflower and radish, and they were not recorded on turnip and rocket.

Keywords: Population density, Brassicaceae, caterpillars, natural enemies, agroecosystem.

Introduction

Brassica plants are among the most cultivated vegetables worldwide due to their high nutritional value. These plants provide humans with soluble fibers, essential minerals, vitamins and glycosylates (Das, 2020; Dias, 2012). In Egypt, brassica plants are cultivated in over 37,893 acres and yield around 468,002 ton/year (FAO, 2020).

Fifty-one different insect pest species that infest brassica vegetables have been identified worldwide (Bonnemaison, 1965; Das, 2020), Amongst all, diamondback moth, (*Plutella xylostella*), cabbage webworm (*Hellula undalis*), white cabbage butterflies (*Pieris brassicae* and *Artogeia rapae*), aphids (*Lipaphis erysimi* and *Brevicoryne brassicae*), leafhoppers (*Liriomyza brassicae*), semilooper worms (*Autographa gamma* and *Trichoplusia ni*), flea beetle (*Phyllotreta Cruciferae*) and turnip weevil (*Entomoscelis americana*) are the most common insect pests on these vegetables (Biever *et al*., 1992; Das, 2020; Srinivasan & Moorthy, 1991).

The crop's insect pest status has been recently changed due to climatic changes. Therefore, developing an effective management schedule will benefit from current knowledge of the seasonal occurrence of insect pests at various growth stages of brassica vegetables (Yadav *et al*., 2019). The aim of this work is to study the biodiversity of some insect pests and associated natural enemies and seasonal occurrence of caterpillars on five brassica vegetables in Menoufia and Giza governorates in Egypt.

Materials and Methods

Sampling sites

This study was conducted at two locations: Menoufia (30° 26' 22.704" N, 30° 54' 8.208" E) and Giza (29° 30' 31.608" N, 30° 0' 39.276" E), representing in Delta Nile and Nile Valley in Egypt. The samples were collected from each site for one growing season (November 2020 to January 2021). Five brassica vegetables were selected Cabbage, (*Brassica oleracea* L. var. *capitata*); Cauliflower, (*Brassica oleracea* L., var. *botrytis*); Turnip, (*Brassica. rapa* L. var. *rapa*); Radish, (*Raphanus sativus* L.); and Rocket, (*Eruca vesicaria* L. Cav.). The field at both sites was divided into 20 plots, each plot was 7 × 6 m and each brassica plant was cultivated in four plots as four replicates. All normal agricultural practices were applied without any pesticide application.

Experimental design and Statistical analysis

Ten plants were selected randomly from each plot according to the randomized complete block design (RCBD). Cabbage and cauliflower were directly examined in the field, whereas the other plants were collected by hand picking and transferred into paper bags to the laboratory for further examinations. The test of normality distribution was carried out according to method of Shapiro & Wilk (1965), by using SPSS v. 17.0 (2008) software.

Insect identification

Monitoring of insect fauna was initiated 15 days after cultivation and continued until the last picking. Different insect pests and their associated natural enemies were recorded weekly. After the field examination, all collected insect stages were kept in plastic cups under laboratory

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conditions and provided with food when necessary, until they reach the adult stage for identification in the Laboratory of Insect Ecological Research, Faculty of Agriculture, Cairo University.

Seasonal occurrence

All caterpillars found in the field were monitored weekly to study their fluctuations throughout the season in relation to the weather factors. Seasonal maximum, minimum temperatures and relative humidity were obtained from the central lab for Agricultural Climate, Agricultural Research Center, Ministry of Agriculture and Land Reclamation.

Results and Discussion

Biodiversity

Results obtained are summarized in Tables 1 and 2 and they represent the insect fauna on the selected brassica plants in Menoufia and Giza governorates during the growing season 2020/2021. The identified insect pests belonged to 10 species from 10 genera representing five different orders.

In India, *Artogeia rapae* (L.); *Autographa gamma* (L.); *Trichoplusia ni* (H.); *Plutella xylostella* (L.); *Hellula undalis* (F.); *Brevicoryne brassicae* (L.); *Thrips tabaci* (L.); *Aleyrodes proletella* (L.); *Phyllotreta Cruciferae* (G.); and *Liriomyza brassicae* (R.) recorded on brassica plants (Bhat, 2018; Das, 2020; Debbarma *et al*., 2017; Firake *et al*., 2013). These results are in agreement with the findings of this study. The gathered data were the same in Menoufia and Giza governorates except for *H. undalis* which was not observed at Giza governorate during the growing season 2020/2021.

Two species from two genera, *Syrphus corollae* (F.) and *Coccinella undecimpunctata* (L.) in two families; Syrphidae and Coccinellidae representing two orders, Diptera and Coleoptera were recorded as predators of *B. brassicae*; *Hyposoter ebeninus* (G.) (Ichneumonidae; Hymenoptera) a parasitoid on *A. rapae* was collected from five plants in Menoufia and Giza governorates.

Kolaib *et al*. (2009) in Menoufia governorate found three species of parasitoids on *A. rapae* (*Apanteles glomeratus* L.*; Brachymeria femorata* Panz.*;* and *Pteromalus puparum* L.) but did not report any observation about the parasitoid *Hyposoter ebeninus* (G.). Similar results were reported by Firake *et al*. (2013) at Northeast India, who recorded *Coccinella* spp.; *Syrphus* spp.; and *H. ebeninus*.

The parasitoid *H. ebeninus* was reported earlier as a larval parasitoid on *A. rapae* at Kafr El-Sheikh and Al-Gharbiya governorates (El-Fakharany & Hendawy, 2014) and also at Assiut governorate (Abdel-Galil *et al.*, 2021). Biodiversity at Menoufia and Giza governorates agroecosystems were presented. The two predators, *S. corollae* and *C. undecimpunctata* might play a role in decreasing the number of *B. brassicae*, as well as the parasitoid *H. ebeninus* in decreasing the number of *A. rapae*.

Seasonal occurrence

Lepidopterous insects (Small white cabbage butterfly (*Artogeia* (*Pieris*) *rapae* (L.)), Diamondback moth (*Plutella xylostella* (L.)), and Semiloopers (*Autographa gamma* (L.) and *Trichoplusia ni* (H.)) were recorded on five plant species (cabbage, cauliflower, radish, turnip, and rocket) at seasonal weather factors with mean of 25.60 max °C, 13.73 min °C and 60.61 R.H. % in Menoufia and 22.95 max °C, 10.81 min °C and 61.41 R.H. % at Giza governorates during the period November 2020 to January 2021. The results obtained (Figure 1) showed that the total number of larvae on cabbage were 96.62, 31.58 and 6.00 larvae for *A. rapae*, *P. xylostella* and semiloopers, respectively, in Menoufia governorate, whereas at Giza governorate were 53.75, 28.00 and 2.50 larvae for the same insect pests, respectively.

El-Fakharany & Hendawy (2014) found that *A. rapae* started to appear in the 3rd week of September 2013. The highest population densities of larvae were recorded on 25 September 2013, 23 October 2013, 27 November 2013 and 22 January 2014 on cabbage in both Kafr El-Sheikh and Al-Gharbiya governorates.

Bhagat *et al*. (2018) in India found that the highest numbers of diamondback moth larvae on cabbage were 6.85 and 5.25 in Rabi 2015-2016 and Rabi 2016-2017 at (max 33.13 °C, min 20.19 °C, and RH 60.21% and max 32.20 °C, min 17.19 °C, and RH 41.14%), respectively. During the same season, Lal *et al*. (2020) recorded 9.30 and 10.55 larvae of diamondback moth. Yadav *et al.* (2019) found that the highest number of diamondback moth larvae was 4.67 at (max temp. 21 °C, min temp. 6.8 °C, and RH 66%) on cabbage in the last week in December, 2017.

As shown in Figure 1, the recorded numbers of larvae on cauliflower were 140.00, 52.00 and 8.50 larvae for *A. rapae*, *P. xylostella*, and Semiloopers, respectively, at Menoufia governorate, whereas in Giza governorate, these numbers were 60.25, 76.58 and 1.25 larvae for *A. rapae*, *P. xylostella* and Semiloopers, respectively. These results showed that *A. rapae* was more abundant in Menoufia, whereas *P. xylostella* larvae was more abundant in Giza governorate. This might be mainly due to the effect of temperature on the growth and development of these insects. Das (2020) studied the relative abundance of insect pest complex of brassica crops during October-May 2019/2020 in India and found that *P. xylostella* was the most abundant insect (25.84 %) on cabbage, whereas *A. rapae* abundance was 0.78 % on cauliflower. These findings were consistent with those btained in Giza governorate on cauliflower where the numbers of *P. xylostella* larvae were higher than the *A. rapae*.

Sultana *et al*. (2019) found that *P. xylostella* larval population peaked in September and March. The lowest population of larvae on cauliflower obtained in this study was observed in July, whereas the highest population was observed in September.

On radish, the total numbers of larvae were 18.70, 29.50 and 1.25 for *A. rapae*, *P. xylostella* and Semiloopers, respectively, in Menoufia governorate, whereas in Giza governorate the numbers were 19.75, 24.00 and 2.00 larvae for *A. rapae*, *P. xylostella* and Semiloopers, respectively.

The total number of larvae on turnip recorded were 18.50 and 37.00 larvae for *A. rapae* and *P. xylostella*, respectively, in Menoufia governorate, whereas in Giza governorate the numbers were 3.00 and 5.50 larvae for *A. rapae* and *P. xylostella*, respectively. Larvae of Semiloopers were not found on turnip in both governorates.

Table 1. Biodiversity of insect fauna found on brassica vegetables in Menoufia and Giza governorates in Egypt, during the 2020-2021 season.

Common name	Scientific name	Order	Family	Stages	Host	Status
Menoufia governorate						
Small white cabbage butterfly	*Artogeia rapae* (Linnaeus)	Lepidoptera	Pieridae	Immature	Cabbage, Cauliflower,	Phytophagous
Silver Y moth	*Autographa gamma* (Linnaeus)	Lepidoptera	Noctuidae	Immature	Turnip,	
Cabbage semilooper	*Trichoplusia ni* (Hübner)	Lepidoptera	Noctuidae	Immature	Radish, Rocket	
Diamondback moth	*Plutella xylostella* (Linnaeus)	Lepidoptera	Noctuidae	Immature		
Cabbage webworm	*Hellula undalis* (Fabricius)	Lepidoptera	Pyralidae	Larva	Turnip, Radish, Rocket	
Cabbage whitefly	*Aleyrodes proletella* (Linnaeus)	Homoptera	Aleyrodidae	Larva	Cabbage, Cauliflower, Radish	
Cabbage aphid	*Brevicoryne brassicae* (Linnaeus)	Lepidoptera	Aphididae	Adult & Nymph	Cabbage,	
Cabbage thrips	*Thrips tabaci* (Lindeman)	Thysanoptera	Thripidae	Adult & Nymph	Cauliflower,	
Cabbage leaf miner	*Liriomyza brassicae* (Riley)	Diptera	Agromyzidae	Larva & Pupa	Turnip, Radish, Rocket	
Flea beetle	*Phyllotreta Cruciferae* (Goeze)	Coleoptera	Chrysomelidae	Adult	Turnip, Radish, Rocket	
Syrphids flies	*Syrphus corollae* (Fabricius)	Diptera	Syrphidae	All stages	Cabbage Aphid	Predator
Coccinellid beetles	*Coccinella undecimpunctata* (Linnaeus)	Coleoptera	Coccinellidae	All stages		
	Hyposoter ebeninus (Gravenhorst)	Hymenoptera	Ichneumonidae	Pupa	S.W.C. butterfly	Parasitoid
Giza governorate						
Small white cabbage butterfly	*Artogeia rapae* (Linnaeus)	Lepidoptera	Pieridae	Immature	Cabbage, Cauliflower,	Phytophagous
Silver Y moth	*Autographa gamma* (Linnaeus)	Lepidoptera	Noctuidae	Immature	Turnip,	
Cabbage semilooper	*Trichoplusia ni* (Hübner)	Lepidoptera	Noctuidae	Immature	Radish, Rocket	
Diamondback moth	*Plutella xylostella* (Linnaeus)	Lepidoptera	Plutellidae	Immature		
Cabbage aphid	*Brevicoryne brassicae* (Linnaeus)	Homoptera	Aphididae	Adult & Nymph		
Cabbage thrips	*Thrips tabaci* (Lindeman)	Thysanoptera	Thripidae	Adult & Nymph		
Cabbage whitefly	*Aleyrodes proletella* (Linnaeus)	Homoptera	Aleyrodidae	Adult & Nymph		
Flea beetle	*Phyllotreta Cruciferae* (Goeze)	Coleoptera	Chrysomelidae	Adult		
Cabbage leaf miner	*Liriomyza brassicae* (Riley)	Diptera	Agromyzidae	Larva & Pupa		
Syrphids flies	*Syrphus corollae* (Fabricius)	Diptera	Syrphidae	Larva & Pupa	Cabbage aphid	Predator
Coccinellid beetles	*Coccinella undecimpunctata* (Linnaeus)	Coleoptera	Coccinellidae	All stages		
	Hyposoter ebeninus (Gravenhorst)	Hymenoptera	Ichneumonidae	Pupa	S.W.C. butterfly	Parasitoid

When examining rocket plants in Menoufia governorate, the total numbers of *A. rapae* and *P. xylostella* larvae were 6.00 and 26.50, respectively, whereas in Giza governorate, the total numbers of larvae were 9.83 and 13.91 for *A. rapae* and *P. xylostella*, respectively. Semiloopers were not found on rocket in both governorates

In India, *A. rapae* and *Teichopsia ni* were considered minor pests, whereas *P. xylostella* was a major pest on brassicaceous crops during October-May of 2011-2012 growing season, and the peak activity for *A. rapae*, *T. ni*, and *P. xylostella* was in November, Mar, and March–April, respectively (Firake *et al*., 2013).

The small white cabbage butterfly, *A. rapae* had the highest population numbers in Menoufia governorate with 153.65, 240.75, 18.70, 18.50, and 6.00 on cabbage, cauliflower, radish, turnip, and rocket, respectively, whereas in Giza governorate the numbers were 85.25, 104.75, 19.75, 3.00 and 9.38 on cabbage, cauliflower, radish, turnip and rocket, respectively. Based on these results, cauliflower was the most preferred host plant followed by cabbage then radish, turnip and rocket at the two governorates (Figure 2).

The diamond-back moth, *P. xylostella* recorded the second highest number at Menoufia governorate with 31.58, 52.00, 29.50, 37.00 and 26.50 on cabbage, cauliflower,

radish, turnip, and rocket, respectively, while in Giza governorate were 28.00, 67.58, 24.00, 5.50 and 13.91 on cabbage, cauliflower, radish, turnip, and rocket, respectively. The highest numbers were recorded on cauliflower in the two governorates. The highest population density was recorded in Giza governorate.

Semiloopers were recorded at both Menoufia and Giza governorates on cabbage, cauliflower and radish with lower population density of 6.00, 8.50 and 1.25 in Menoufia, while in Giza the population density were 2.50, 3.75 and 2.00 on cabbage, cauliflower and radish, respectively (Figure 2). Semiloopers were not found on turnip and rocket in both Menoufia and Giza governorates.

It can be concluded from this study that climatic changes, geographical locations and host plants are important factors that affect and change the population density of insects. Therefore, studying and updating the biodiversity and population of insect pests and their associated natural enemies are necessary in order to benefit smart agriculture programs that are used to predict the onset of infestation and when it will reach its peak based on the cultivated area, host plants, and other weather factors.

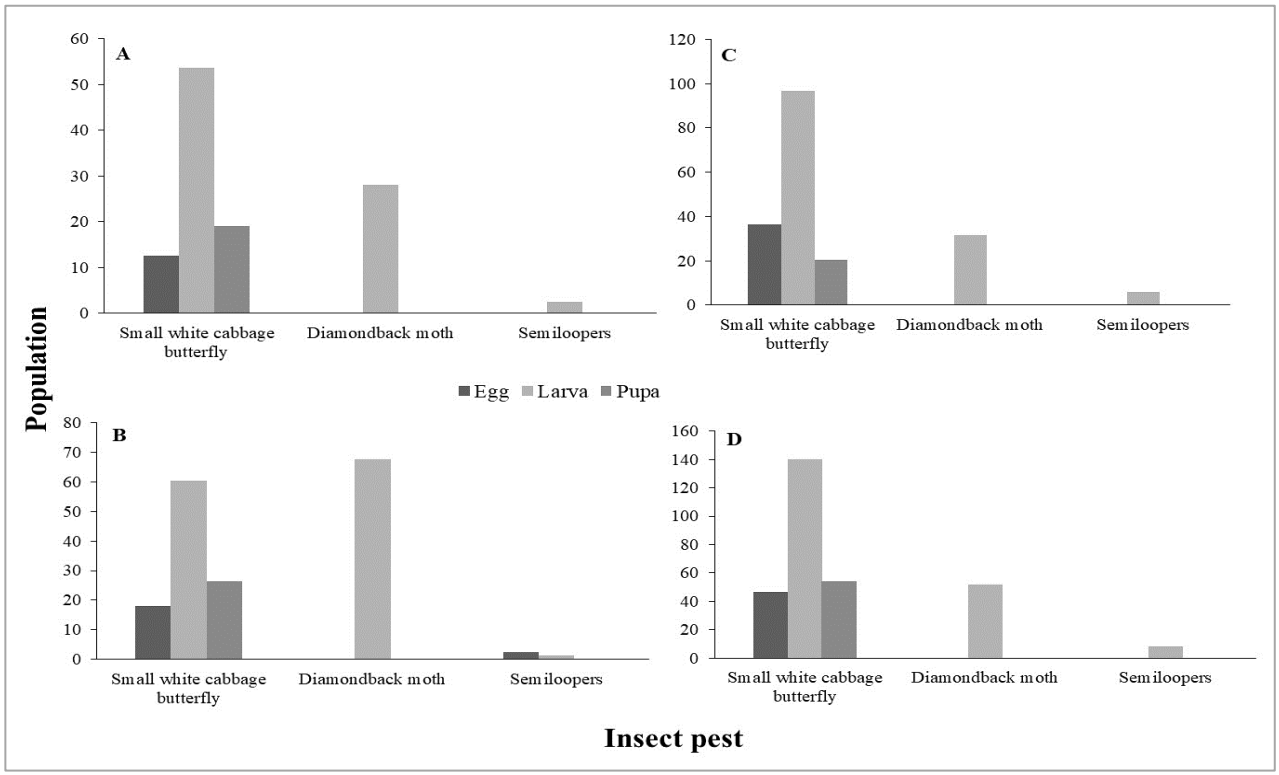

Figure 1. Population density of major caterpillars on cabbage (A) and cauliflower (B) in Giza governorate and on cabbage (C) and cauliflower (D) in Menoufia governorate, Egypt during the 2020-2021 season.

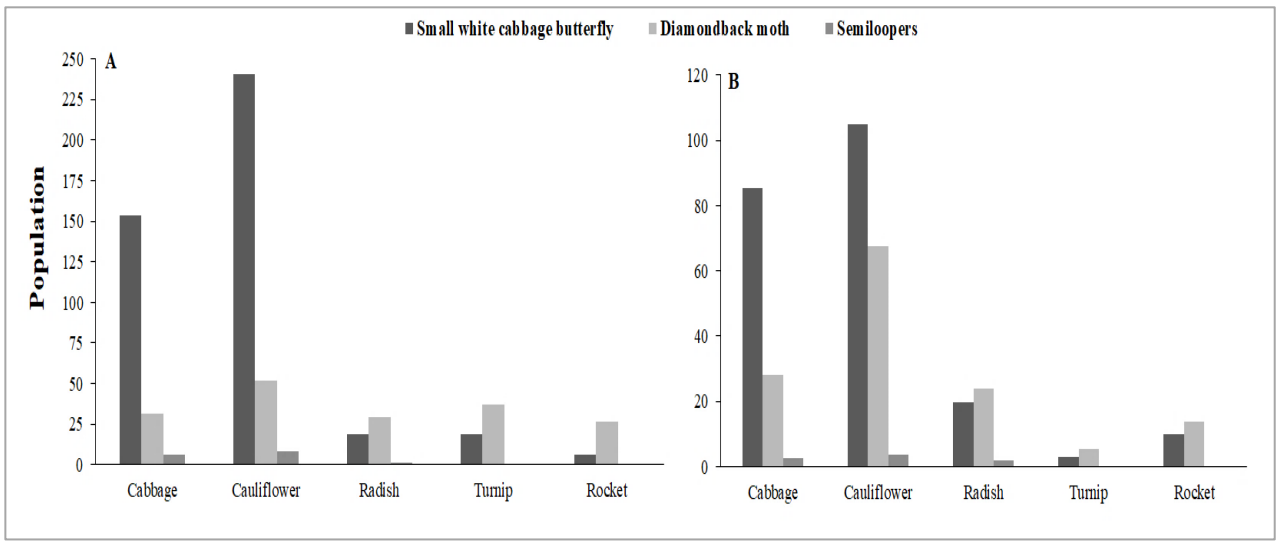

Figure 2. Population density of major caterpillars on five brassica vegetables in Menoufia (A) and Giza (B) governorates, Egypt during the 2020-2021 season.

الملخص

البدوي، أحمد ر.، حنان م. حمادة ورمضان أ.ك. سلامة. 2024. التنوع الحيوي والوفرة الموسمية لمجموعة الحشرات المصاحبة لخضراوات العائلة الصليبية في محافظتي المنوفية والجيزة في مصر. مجلة وقاية النبات العربية، 42(2): 162−167. https://doi.org/10.22268/AJPP-001223

أجريت دراسة لاستكشاف التنوع الحشري المرتبط بالنظام البيئي لبعض خضروات العائلة الصليبية Brassicaceae، وهي: الملفوف/الكرنب (*Brassica oleracea* L. var. *capitata*)، القرنبيط (*Brassica oleracea* L. var. *botrytis*)، اللفت (*Brassica. rapa* L. var. *rapa*)، الفجل (*Raphanus sativus* L) والجرجير (*Eruca vesicaria* L. Cav.) في موقعين بالمنوفية والجيزة في مصر، وذلك للمساهمة في الحفاظ على التنوع الحيوي وفي إدارة زراعة خضروات العائلة الصليبية في مصر. تمّ جمع الحشرات من موقعي الدراسة خلال تشرين الثاني/نوفمبر 2020 وحتى كانون الثاني/يناير 2021. أظهرت نتائج البحث تسجيل 13 نوعاً من الحشرات تنتمي إلى 12 عائلة و 6 رتب، من الموقعين كلتيهما. يتكون المجموع الكلي للحشرات المسجلة من 10 أنواع من الآفات الحشرية ونوعين من الحشرات المفترسة ونوعاً واحداً من المتطفلات. بيّنت هذه الدراسة أيضاً وجود تذبذبٍ موسمي ليرقات ثلاثة أنواع من الحشرات، وهي: فراشة الملفوف الصغرى (*Artogeia rapae* L.)، العثة ذات الظهر الماسي (*Plutella xylostella* L.) واليرقات نصف القيّاسة (*Trichoplusia ni* H./*Autographa gamma* L.) تحت تأثير ثلاثة عوامل جوية (درجة الحرارة القصوى، درجة الحرارة الدنيا، الرطوبة النسبية). كما أظهرت النتائج أن فراشة الملفوف الصغرى، والعثّة ذات الظهر الماسي تفضلان القرنبيط والملفوف/الكرنب؛ أما بالنسبة ليرقات نصف القيّاسة فكان وجودها بأعداد قليلة على كلٍّ من الملفوف/الكرنب، القرنبيط والفجل في حين لم يتم رصدها على كلٍّ من اللفت والجرجير.

كلمات مفتاحية: الكثافة العددية، نباتات العائلة الصليبية، اليرقات قارضات الأوراق، الأعداء الطبيعية للحشرات، النظام البيئي الزراعي.

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References

Abdel-Galil, F.A.K., S.M.A.R.M. Amro and M.A.B. Mahmoud. 2021. Parasitoid species associated with immature stages *Pieris rapae* (L.) inhabiting cabbage plantations in Assiut governorate, Upper Egypt. American Journal of Entomology, 5(2):27-31. https://doi.org/10.11648/j.aje.20210502.12

Bhagat, P., Y.K. Yadu and G.L. Sharma. 2018. Seasonal incidence and effect of abiotic factors on population dynamics of diamondback moth (*Plutella xylostella* L.) on cabbage (*Brassica oleracea* var. *Capitata* L.) crop. Journal of Entomology and Zoology Studies, 6(2):2001-2003.

Bhat, D.M. 2018. Incidence and diversity of lepidopterous insect pests and their parasitoids (natural enemies) on cole crops at Danderkhah location in Srinagar District (J&K, India). International Journal of Entomology Research, 3(2):107-113.

Biever K.D., R.L. G. Chauvin, L. Reed and R.C. Wilson. 1992. Seasonal occurrence and abundance of lepidopterous pests and associated parasitoids on collards in the Northwestern United States. Journal of Entomological Science, 27(1):5-18. https://doi.org/10.18474/0749-8004-27.1.5

Bonnemaison, L. 1965. Insect pests of crucifers and their control. Annual Review of Entomology, 10(1):233-256. https://doi.org/10.1146/annurev.en.10.010165.001313

Das, R. 2020. A field study on insect pest complex of brassicaceous crops in some areas of Cachar, Assam. Journal of Entomology and Zoology Studies, 8(4):2043-2045.

Debbarma, A., J. Jayaraj, P. Chandramani, N. Senthil, M. Ananthan and K. Prabakaran. 2017. A survey on occurrence and diversity of insect pests of cauliflower in Dindigul and Theni districts of Tamil Nadu, International Journal of Current Microbiology and Applied Sciences, 6(8):2495-2505. https://doi.org/10.20546/ijcmas.2017.609.307

Dias, J.S. 2012. Nutritional quality and health benefits of vegetables: A review. Food and Nutrition Sciences, 3(10):1354-1374.

El-Fakharany, S.K.M. and A.S. Hendawy. 2014. Field studies on cabbage white butterfly, *Pieris rapae* (Linnaeus) and its associated parasitoid and predatory species in Egypt. Egyptian Journal of Biological Pest Control, 24(2):437-444.

FAO. 2020. Economic Affairs Sector, Ministry of Agriculture and Land Reclamation. Arab Republic of Egypt. 140 pp.

Firake, D.M., D. Lytan and G.T. Behere. 2013. Biodiversity and seasonal activity of arthropod fauna in brassicaceous crop ecosystems of Meghalaya, North-East India. Molecular Entomology, 3(4):18-22. https://doi.org/10.5376/me.2012.03.0004

Kolaib, M.O., M.B. Attia, A. El-Naby, M. Laila and W.F. El-Madboh. 2009. On the parasitoids species of the cabbage worm, *Artogeia (Pieris) rapae* L. (Lepidoptera: Pieridae) at El-Minoufia Governorate, Egypt. Egyptian Journal of Biological Pest Control, 19(1):63-66.

Lal, J., R. Swaminathan, A.K. Meena and R. Nagar. 2020. Seasonal incidence of major insect pests of cabbage, *Brassica oleracea var. capitata* L. Journal of Entomology and Zoology Studies, 8(3):387-391.

Shapiro, S.S. and M.B. Wilk. 1965. Analysis of variance test for normality (complete samples), Biometrika, 52(3/4):591-611. https://doi.org/10.2307/2333709

SPSS Statistics 17.0. 2008. SPSS for Windows. SPSS Inc., Chicago, USA.

Srinivasan, K. and P.K. Moorthy. 1991. Indian mustard as a trap crop for management of major lepidopterous pests on cabbage. Tropical Journal of Pest Management, 37(1):26-32. https://doi.org/10.1080/09670879109371532

Sultana, M.S., M.F. Khatun, S.N. Alam and M.R.U. Miah. 2019. Population abundance of leaf-eating caterpillars of cabbage. Bangladesh Journal of Agricultural Research, 44(1):79-87. https://doi.org/10.3329/bjar.v44i1.40907

Yadav, N., N. Agrawal and R. Yadav. 2019. Influence of weather parameters on the population of different cabbage pests in organic cabbage field. Journal of Entomology and Zoology Studies, 7(3):551-553.

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