Situation of Virus and Virus-Like Diseases of Stone Fruit Trees in the Mediterranean and Near East Countries

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Abstract

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Virus diseases of fruit trees induce important economic losses which are not easy to avoid by following control measures applicable to fungal diseases. The production and distribution of virus-free plant propagation material is considered to be the best approach to minimize losses inflicted by virus diseases which threatens stone fruit production in the region. In this paper virus diseases which affect stone fruits in the region and how to improve their health status will be discussed. The author will also discuss how some of the stone fruit viruses have been introduced and became endemic in the region, and the danger of not controlling them. A stress will be made on the importance of having trained personnel in virus diseases detection and the need for establishing national certification programs for the production of healthy propagation material.

1. Introduction

The major problems caused by virus and virus-like diseases of plants stem from the fact that the pathogen is systemically distributed in the plant and that no chemical curative treatment is available. The only possibilities of control are based on prevention and primarily consist of sanitation (i.e. production of virus-free plants and protection against re-infection) and breeding for resistance. Once infection is established, elimination of the pathogen is no longer possible unless infected plants are themselves eliminated. The success of sanitation or, in other words, the production and culture of virus-free plants, depends upon the environmental conditions, the general level of infection in the country, the presence of vectors and their efficiency, and the existence of available virus sources. In case of a non-naturally transmitted virus, a virus-free plant will remain free for years and probably for the whole of its life. When dealing with a naturally (Aphid, nematode, pollen) transmitted virus, control of transmission by various means, including pesticides, will only allow the slowing down of disease spread, which could be enough for annual plants but is often insufficient for perennial woody plants. Indeed viruses on woody plants, and especially on fruit trees, pose some specific problems. Once the disease is established, infection and sources of infection for further spread will remain for years. If infected trees have to be replaced it will take several years for the new plants to become profitable, which usually leads fruit growers to hesitate and to postpone replacement, even if it is really necessary. Many fruit tree species can harbour the same viruses. For instance, apple chlorotic leaf spot virus can infect all the fruit trees belonging to the Rosaceae family (apple, pear, peach, plum, cherry, apricot, etc.); necrotic ring spot and prune dwarf viruses can infect all species of the Prunus genus; tomato ring spot infects peach (peach yellow bud mosaic, stem pitting), plum (stem pitting), apple (apple union necrosis); plum pox infects peach, plum, apricot and most rootstocks of the Prunus genus. This means that, usually, the sources of infection are heavy and well distributed and that, if a virus enters a non-infected fruit tree growing area, it usually encounters a wide range of potential susceptible species. Another characteristic of fruit trees is the frequent vegetative propagation of all varieties which the majority of rootstocks which explains why several viruses have been widely distributed, throughout a given country and even all over the world.

Fruit trees consist of grafted plants and this characteristic has two consequences: firstly, if each of the components (cultivar and rootstock) is infected by different viruses, the grafted scion will harbour a virus complex. Virus complexes are frequent in fruit trees and often result in a synergistic effect (Dunez and Marenaud 1966; Scotto la Mesese et al. 1973). Secondly, viruses are known to be responsible for significant reduction of bud uptake and (more or less) delayed incompatibility. This results in a reduction of the productivity of the nurseries and also (in the case of delayed incompatibility) in an unexpected and rapid decline of the orchard (cherry leaf roll in walnut trees, apple chlorotic leaf spot in apricot trees, etc.).

Several viruses are unevenly distributed in the infected plants and this can make indexing unreliable of the difficulty of finding an infected sample from an infected tree even in a clear case of infection (Delbos et al. 1982, 1984; Dosba et al. 1986). Finally, because of their woody nature, plant extracts are rich in various virus inhibitors (oxydases, tannins, etc.) which cause a lot of difficulties in virus extraction and experimental work.

2. Main Virus and Virus-Like Diseases of Stone Fruits

The main characteristics of the major virus and virus-like diseases are described below. For a complete description, the reader can refer to the European Handbook of Plant Diseases (Eds. Smith et al., 1988). Graft-transmissible diseases listed and described below are caused by viruses or mycoplasma-like organisms; some are still of unknown origin but, because of their transmission and symptoms characteristics, are probably caused by one of these agents.

2.1. Virus diseases

Viruses affecting stone fruits belong to the Ilarvirus, Nepovirus, Closterovirus and Potyvirus groups.

Viruses of the Ilarvirus group

Virus of the Ilarvirus group (Isometric labile ring spot viruses) are characterized by a tripartite genome. They have quasi isometric particles varying in size (20 - 35 nm diameter). The type member is tobacco streak virus.

It can be assumed that most diseases caused by viruses of the Ilar virusgroup are caused by prunus necrotic ring spot (NRVS) and prune dwarf (PDV). Cherry chlorotic necrotic ring spot, described as an intermediate virus, is very close to prune dwarf. Plum (American) line pattern, described by Fulton (1984), appears to be very rare, most line pattern symptoms being induced by NRSV. Apple mosaic virus is also present in stone fruits, especially in almond trees (Lansac et al., 1980). Two of the characteristics common to viruses of this group are their transmission through pollen and propagation through seed. Except for a few exceptions, Ilarviruses infect all the Prunus species.

Prunus necrotic ring spot virus (NRSV). Usually the first infection is characterized by shock symptoms; subsequently, chronic symptoms develop although shock symptoms can recur at various intervals. Common symptoms are chlorosis, necrosis and deformation of leaves, local or extended necrosis of leaves and branches. Many trees can be completely destroyed. On peach, bud breaking is delayed and cankers develop; most buds and young shoots are destroyed. Fruit can be deformed and maturity is delayed. Similar symptoms develop on infected almond trees.

On sour cherry, leaf mottling develops followed by necrosis and often leads to typical tatter leaf disease. Flowers can be affected and do not produce fruit. Symptoms on sweet cherry are similar. Light green mottling of leaves can be followed by necrosis and a tatter leaf symptom. Cankers with gummosis develop. A more detailed description is given by Barbara (1988 b). Symptom severity may depend upon the strain: particular strains have been described inducing peach and almond calico, almond bud failure, and cherry rugose mosaic. Line pattern on plum is very often induced by strains of prunus necrotic ring spot, but a specific virus has been described as the «American plum line pattern virus», which causes line pattern on peach, plum, sour and sweet cherry, sometimes with oak leaf symptom. It can be differentiated from NRSV by differential indicator plants and serology.

A general characteristic of this NRSV group is their responsibility for significant reduction (up to 50%) of the bud uptake in the nursery. NRSV occurs worldwide: it is pollen- and seed- borne especially in sour cherry. It is a major cause of crop losses despite often being carried latently. Overall crop losses of 15% for a large area have been estimated in sweet cherry: up to 80% of trees dying have been reported in peach. The virus can be identified biologically by graft or mechanical transmission onto susceptible indicator plants, but it is generally detected serologically by ELISA.

Prunus dwarf (PDV). PDV infects all species of the genus Prunus. In sweet cherry, it causes chlorotic spots, rings and mottling on leaves sometimes with necrotic flecks. In sour cherry, it induces severe leaf yellowing followed by leaf abcission (the symptom has been described as the sour cherry yellows disease). Fruiting spur is reduced and the trees may develop a willowy growth pattern. Growth can be severely affected. Infected plum trees of some cultivars or species (Italian plum) have shortened shoot internodes and dwarfed growth. In peach, shoots also develop the same symptoms. Several strains have been described. The virus is distributed worldwide. It is seed and pollen-borne and is responsible for severe losses. It is known to reduce sweet cherry yield by up to 35%: sour cherry yellows cause yield losses exceeding 50%. PDV often occurs in combination with NRSV or with other viruses (Strawberry latent ring spot for instance): reduction of growth and yield is considerable and destruction of infected trees frequent. Diagnosis is through biological indexing or serologically by ELISA (Kunze, 1988).

Apple mosaic virus. Described on apple, it produces apple mosaic and rose mosaic. It is also responsible for a line pattern symptom on plum, almond and peach (Lansac et al., 1980). Both APMV and NRSV occur on these species: they are often difficult to distinguish by symptoms. APNV can be detected biologically but the most suitable test is by serology (Barbara, 1988 a).

Viruses of the Nepovirus group

Nepoviruses (nematode-borne polyhedral viruses) have a bipartite genome. Their two RNAs are encapsulated in a capsid made up of a single polypeptide of about 55.000 d. Virus particles are isometric, about 29 nm in diameter.

These viruses are transmitted by two genera of nematodes, *Xiphinema* and *Longidorus*. The type virus is tobacco ring spot virus. The most common viruses in fruit trees are tomato ring spot, tomato black ring, strawbery latent ring spot, cherry rasp leaf, arabis mosaic, raspberry ring spot, and cherry leaf roll.

Arabis mosaic - raspberry ring spot. Both viruses occur on sweet and sour cherry and are very difficult to differentiate. Symptoms are chlorotic spots on leaves, narrow leaves with enations, short internodes. The viruses are borne by *Xiphinema* and *Longidorus* (Davies 1988; Dunez 1988 a) respectively.

Cherry leaf roll (CLRV). CLRV causes typical yellowing and rolling of sour cherry leaves. Limited or extensive destruction can occur. On walnut, it is responsible for mosaic and ring spot on the foliage and for graft incompatibility of the English walnut (Juglans regia) grafted on *Juglans hindsii* or *Juglans nigra* (Delbos et al., 1982, 1984). Nematode transmission is probably of limited or no importance but the virus is pollen-borne. Efficient routine detection can be achieved by the ELISA test (Cooper, 1988).

Cherry rasp leaf. Cherry rasp leaf, raspberry ring spot, arabis mosaic, tomato black ring and myrobalan latent ring spot cause rasp leaf on cherry. The american cherry rasp leaf virus is different from the three previous viruses. On cherry it causes a severe rasp leaf symptom, and on apple it is responsible for the flat apple disease. It is borne by *Xiphinema americanum* and can be identified serologically.

Tomato black ring (TBRV). Particular strains, which are distinct from the typical strains, have been identified in fruit trees, especially in peach, plum and cherry (Dunez et al., 1976). Infection is associated with short internodes and rosetting in peach, and leaf enation on sweet cherry. Serological indexing is used (Dunez, 1988 c).

Strawberry latent ring spot (SLRV). SLRV has been described on cherry, plum and peach: many plants are symptomless. It occurs frequently in mixed infection with viruses such as necrotic ring spot and /or prune dwarf (Dunez 1988 b). A synergistic effect can be observed which can lead to rapid decline and death of the tree (Scotto la Mesese et al., 1973). Diagnosis is by serology. SLRV is borne by *Xiphinema diversicaudatum* and *X. coxi*.

Tomato ring spot (Tom RSV). Tom RSV has been reported in Europe on several species, but as far as woody plants are concerned, and in particular fruit trees, it still seems to be largely confined to N. America. It is responsible for severe diseases of woody perennial plants, especially yellow bud mosaic and stem pitting of peach, nectarine, almond and plum, rasp leaf in cherry, decline of apricot and almond and plum and union necrosis in apple.

Yellow bud mosaic disease causes buds to stop growing a few days after breaking: the small yellow leaves turn brown and die. In stem pitting-affected trees, bud break is delayed and leaves drop prematurely. Stem pitting develops in the wood, the intensity of pitting depending upon the variety. Disorganization of the central cylinder occurs. Because of incomplete lignification, trees are very fragile and tend to break at soil level. Fruits are usually reduced in size and unpalatable. The virus is transmitted by *Xiphinema americanum* and can be detected serologically (Bitterlin and Gonsalves, 1986.)

Viruses of the closterovirus group

Apple chlorotic leaf spot. One virus of this group, apple chlorotic leaf spot (CLSV), which belongs to subgroup A, is known to infect stone fruits. Its fexible, elongated particles contain an RNA molecule of 2.5 × 106 d. Some viruses of this group (subgroups B and C) are aphid-borne in a semi-persistent manner. So far, no vector of CLSV has been identified (Delbos and Dunez, 1988).

Most apple cultivars are symptomlessly infected. On pear, leaf mottle symptoms and ring mosaic are associated with CLSV. The virus remains symptomless or causes very faint symtoms on peach (dark green sunken mottle). However, it causes significant symptoms on the other stone fruit species: Pseudopox disease (with fruit deformation) of plums, bark splits on plum trees (Dunez et al., 1972, 1975; Marenaud et al., 1976), incompatibility and fruit symptoms on apricot. The virus occurs worldwide in all fruit tree and woody ornamental species of Rosaceae. In pome fruits, damage seems to be of limited importance, but in stone fruits serious losses have been reported in several areas. One of the major effects is the reduction of the productivity of nurseries due to the effect of the virus on bud uptake and graft compatibility (Dosba et al., 1986). Serological indexing with ELISA is the most suitable and sensitive indexing technique (Detienne et al., 1980).

Viruses of the Potyvirus group. So far, the only known representative of this group in fruit trees is plum pox virus (Kerlan and Dunez, 1976). The group contains more than 100 viruses, many of which are of major economic importance. The type member is potato virus Y. The virus particle is flexuous, 650 × 12nm and contains an RNA of 3.5×10^6 d with about 10 kb. Typical members are aphid-borne in the non-persistent (style-borne) manner, but some viruses with several characteristics of this group are mite or soil- (polymyxa) borne.

Plum pox virus (PPV). Plum pox virus infects all fruit tree species of the genus Prunus except cherry (sour and sweet). Severe symptoms are observed on apricot, plum and peach trees: the virus causes «Pox» disease on apricots, plums and peaches and frequently clearcut leaf symptoms (Dunez and Sutic, 1988). Almost all known apricot, peach and plum cultivars are susceptible but some remain symptomless when infected (Rankovic, 1983; Rankovic and Sutic, 1986; Hamdorf, 1983, 1986; Kegler et al., 1986; Syrgiannidis and Mainou, 1986). Resistance of two plum and two apricot cultivars has been described and can be used for breeding for resistance (Syrgiannidis, 1980).

Hundreds of millions of trees are infected in Europe (especially eastern Europe) and in the Mediterranean area. The effect of the virus on quality (external appearance, internal necrosis and /or gummosis, reduced sugar content, increased acidity, premature dropping) very often makes the crop unmarketable and even unusable for canning and distillation. In many countries, fruit can no longer be exported and, even in countries where the virus has been found but is not yet established, exportation of budwood and rootstocks has become very difficult. In terms of economic impact, PPV is one of the major plant viruses. It is transmitted by aphids in a non-persistent manner. More than ten vectors have been described, the most efficient being *Myzus persicae, Brachycaudus helychrisi* and *Phorodon humuli.* Others recently described, such as *Aphis citricola,* also appear to be important. Detection is based on biological assay carried out on susceptible indicator plants (especially peach seedlings in the greenhouse) and serological tests. The immunoenzymatic ELISA test is extensively used for PPV detection. As the antigenic variation (PPV has two closely related serotypes) is limited, the ELISA test provides a very efficient tool for the detection of the virus (Kerlan and Dunez, 1979). Immunoelectronmicroscopy also appears as to be a sensitive technique (Kerlan et al., 1981). Molecular hybridization using cloned DNA probes or transcript RNA probes gives a high level of sensitivity (Varveri et al., 1986, 1987, 1988), the radioactive RNA probes being the most sensitive of all the detection techniques. The major problems encountered in PPV detection result from the uneven distribution of the virus in the infected plants. Most of the cultivars of the different species exist as virus-free in several collections. The possibility of controlling the disease depends mainly on the level of infection: in highly infected areas where removal of the trees is no longer possible, growers usually replace susceptible cultivars by less susceptible ones or by tolerant cultivars which yield marketable and profitable crops. In countries where the disease is restricted to small areas, a policy of eradication has been carried out. New plantations must be established in uninfected areas and special attention should be paid to potential sources, particularly in the wild Prunus species. Future production will be based on breeding for resistance, including the use of genes from resistant species or cultivars and the use of viral sequences expressed in transgenic plants (especially the coat protein gene). From recent experiments with several other viruses, this strategy appears to provide a good level of resistance to viruses (van Dun et al., 1987; Ravelonandro et al., 1988).

2.2. Diseases due to MLOs

Only a few MLO diseases of major importance seem to occur in Europe and the Mediterranean area. Besides apple proliferation and pear decline on pome fruit, stone fruit can be affected by apricot leaf roll. Other MLO diseases, especially those common in America, should also be considered (Peach yellows and X-disease).

X - disease. Initially described on cherry trees and called cherry buckskin, this disease is known on peach, nectarine, plum and cherry and was described in North America. Symptoms on peach appear as yellow or reddish spots on the leaves, and rolling of the leaves which become brittle and necrotic. Leaves drop leaving bare twigs with a few rosettes. Trees can survive for a few years but young infected trees die within one to three years after the first symptoms appear. On cherry, the tips of many branches die and the fruits are small and do not ripen completely. Trees grafted on mazzard survive; those on *P. mahaleb* die soon after infection. The disease is due to an MLO which is leafhopper-borne (Purcell, 1986).

Peach yellows. This disease was first described in 1828. So far it has only been reported in North America. It is naturally present in peach, almond and apricot. The disease on peach is characterized by premature breaking of dormancy. The trees develop thin and willowy twigs. Leaves are chlorotic, rolled and then necrotic; mortality of the tips of the twigs is frequent and the trees die two to three years after appearance of the first symptoms. This disease is probably identical to little peach disease. Both diseases are leafhopper-transmitted.

Apricot chlorotic leaf roll. This disease, which was described more than 15 years ago, has been restricted to some locations of the Mediterranean, South France, Spain, Italy and probably Greece. It is now spreading and could become a very damaging disease in the coming years. It appears in spring as leaf rolling, yellowing and formation of a few witches brooms. As early as October and during winter, an off-season growth takes place with a premature development of shoots and leaves and a reduced number of flowers. As a consequence of the premature dormancy breaking, the phloem is very sensitive to frost, and this leads to phloem destruction and death of the branches. Plum rootstocks are tolerant and survive after the death of the apricot variety. In contrast, peach and apricot rootstocks are highly susceptible and usually do not survive in the case of infection. On such rootstocks, death of the tree occurs within one to two years after infection. In some cases, apricot leaf roll symptoms can be mistaken for effects of *Pseudomonas syringae.* The disease is probably due to an MLO and leafhopper-borne (Desvignes and Cornaggia, 1983; Morvan et al., 1986; Smith, 1988).

2.3. Diseases of unidentified origin

Several diseases of unidentified origin are present on stone fruit trees. Even if they induce quite severe symptoms, they do not seem to be transmitted naturally. Examples are cherry twisted leaf (whose causal agent is identical to that of apricot ring pox), cherry rusty mottle, cherry little cherry, peach mosaic, phony peach, peach wart and peach blotch. For rapid description of these diseases, reference can be made to the European Handbook of Plant Diseases (Eds. Smith et al., 1988). As the causal agent has not been yet identified, they can only be detected by transmission onto indicator plants.

Phytosanitary Situation of Mediterranean Countries Visited. Presence of Virus and Virus-Like Diseases, Incidence and Risks.

From the above description of virus and virus-like diseases of stone fruit, it results that the most dangerous or potentially dangerous virus and virus-like diseases are those which are spread naturally. Natural transmission can occur via pollen, aphids, leafhoppers or nematodes.

It is clear that our picture of the different viruses present in the countries visited depends on the length of the visit, the size of the country and the organization of the visit itself. A limited number of orchards were visited and, in general,visits concentrated on collections, mother plants and nurseries.

Comments are based on the results of visual inspections of application of the ELISA test (in Bordeaux) to the collected samples and, for some of these samples, of peach seedling indexing. ELISA was applied to the following viruses: Prunus necrotic ring spot, prune dwarf, apple mosaic (Ilarvirus group); strawberry latent ring spot, tomato ring spot, tomato black ring (Nepovirus group); apple chlorotic leaf spot (closterovirus group); plum pox (potyvirus group). Peach seedling indexing was used to confirm some of the results of the ELISA tests and to provide information about non-transmissible diseases such as peach yellows, X disease and the other nepoviruses not investigated by ELISA. As the risks are very different, results will be discussed. Group by group, starting with the plum pox situation.

The situation of plum pox

Plum pox virus is known to have originated in Bulgaria in the 1930's. In fact, this only reflects the first description of the disease and it is possible to speculate about the real origin of the disease. It is clearly prevalent in all Eastern and Mediterranean Europe, and it has extended in the last 20 years to all countries of Europe including Western Europe, Scandinavia, Spain, Portugal and Italy. Many countries in the Mediterranean basin are highly infested.

Presence of PPV was confirmed in Turkey and the disease was identified for the first time in Syria, Cyprus and Egypt. Because visits were generally limited, it does not mean that PPV is definitely absent from the other countries: it means that special attention must be paid, to the disease at all levels, from the collections down to the orchards.

Many questions arose from these observations. First of all, in some countries the disease is well established, in others it seems to be restricted to a few areas and even to a few trees. The number of infected trees seems to be very limited in Turkey which is next to Greece where, in some areas, 100% of plants are infected. One possible explanation is that no susceptible fruit trees grow in the border region or even at a distance of hundreds of kilometers, and that exchange of plant material between these countries is limited. In addition, there are some good (even if very few) specialists of fruit tree viruses in Turkey and some good fruit tree culture stations. The disease has been detected in some collections of an experimental farm and in the field but eradication has been carried out immediately and followed by careful inspections.

It is clear that PPV was introduced into Syria through importations. The only places where the disease was identified were collections of experimental government farms. A fairly significant number of apricot trees were infected in these collections. The disease was not detected on peach and plum and no cases of infection were found in the field. At this stage, eradication, if carried out immediately, can allow the elimination of the disease provided that careful inspections follow this eradication. As it seemed that the disease was restricted to collections, it was of major importance to destroy the infected trees: in the interests of safety it would have been better to destroy all the susceptible plants growing in these collections. In any case, budwood should not be taken from these collections without previous careful and repeated indexing.

In Cyprus, PPV is present in collections and mother plants but has already been transmitted from these mother plants or from elsewhere to the orchard. In some localities, the level of infection is no longer compatible with eradication, if the eradicated orchards remain profitable.

In other places where, because of new facilities, fruit trees have been introduced recently and where PPV is present but still at a low level, eradication is still valuable provided that this operation is carried out rapidly and carefully. PPV is also present in a collection in the northern part of Cyprus but it was impossible to judge how well established the disease is in the orchards and nurseries.

The situation in Egypt is very particular. Firstly, Egypt could be the only country in North Africa infected by the disease. Secondly, horticulture in Egypt has special characteristics, one of these being that most trees are grown ungrafted from seedlings (this is the case for apricot and peach trees); the only grafted trees are plum trees. Thirdly, the virus was first detected by the ELISA test in a sample collected in an area where no symptoms were observable and where, from further tests, the level of infection appeared to be very low. Fourthly, highly infested plots (up to 60 - 100%) were recently detected in a traditional apricot growing area in a very isolated part of Egypt (Fayum). All these features pose the question of introduction and spread in the country.Egypt is located between the Sinai desert, Libya and other desert areas in the south where no stone fruits grow. It seems likely that the disease was transmitted by aphids from the neighbouring countries. It was certainly introduced through importation of infected plants, but there is no satisfactory answer as to where it originated. The only reported importation was from Syria 30 - 40 years ago. If the virus was present in Syria at that time, it is surprising that during the last 30 - 40 years it has not been transmitted from the mother plants to the orchards which today seem healthy. More inspections and tests need to be carried out in order to ascertain the origin of the virus in Egypt. It cannot be excluded that this disease, which Egyptian growers did not notice despite clear symptoms in the last years, has been present for a very long time in these traditional apricot growing areas, which could have been one of the original or historical sources of PPV. Besides these historical points, it is clear that the disease is unevenly distributed in Egypt but is well established in some areas and is present in some collections of experimental farms. One of the major priorities is to limit the spread of the disease within the country through strict control of propagation material and, especially, to prevent its introduction into the new fruit tree growing areas.

In conclusion, if some countries of the region seem to have escaped PPV infection so far, the presence of the virus, which is well established in some areas (Cyprus, Egypt) and in other developed countries of the Mediterranean area, presents a major threat to fruit tree production and exportation for all the countries of the region.

Other viruses and virus-like diseases

In most of the countries visited, the level of infection observed reflects the origin of the cultivated material (local or imported). Surveys were very often incomplete, because, except in the smaller countries visited, only a limited part of the fruit tree growing areas was visited. So, the results of observations and of the tests carried out on the collected samples must be interpreted carefully, especially when a virus has not been detected. As an example, PDV was not detected in Morocco but it would be very surprising if this very common and worldwide distributed virus were absent from the country.

It is clear that the effect of a virus varies according to the country, the climate and the varieties used. A susceptible variety can remain symptomless under special conditions. From visual inspections in Egypt, orchards exhibit very vigorous growth and look free of virus infection: from the ELISA test, 25% of peach samples and more than 80% of apricot samples were found to be infected by NRSV (which is fairly unusual in Apricot). The typical peach symptoms of NRSV (except if the local strain is very mild, which unlikely regarding symptom expression obtained by indexing on peach seedlings), consisting of leaf and tip necrosis and reduction of growth, do not develop in Egypt probably because of the agricultural and climatic conditions (irrigation and heat) and because of the type of trees growing as seedlings which seem to be extremely tolerant to infection. By contrast, it is clear that development of the fruit tree industry will necessitate the introduction of new, modern varieties (some are under experimentation) which will be more susceptible to infection.

NRSV and PDV are present in most countries of the region but, in general, are not well established. In contrast to situations observed elsewhere (including developed countries), mixed infections by NRSV, PDV and other viruses are fairly rare. Such mixed infections usually result in severe reduction of growth, stunting, etc. and can reduce production to zero with the death of the infected trees. NRSV or PDV infected trees were observed in several locations: some of them only showed leaf or fruit symptoms, others reduced growth or severe decline. Even when, from visual inspection, the trees do not seem to be infected, reduction or production could be in the range of 10 - 30% and much higher in cases of severe decline. Another effect of PDV or NRSV appears in the nursery. In many cases the rate of bud uptake in the nurseries is very low, in some cases as low as 10 - 15%. In most of these situations NRSV, PDV or sometimes CLSV were found and this could be the partial cause of this low bud uptake: a reasonable rate of bud uptake in the nursery for compatible species with apricot, peach or plum is in the range of 70 - 95%. Viruses can reduce these values to 40 - - 50%, i.e. if viruses are responsible in part for the low bud-uptake observed in many nurseries of the region, other factors of a horticultural origin are also involved.

Apple mosaic virus (APMV) was observed in several countries on apple and almond. Severe decline of almond trees is more likely to be due to NRSV than to APMV.

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CLSV seems to be quite rare. This can be explained by the absence of natural spread of the virus. Nevertheless, it is present on some species and, when present, was mainly identified in plum trees (both on *Prunus domestica* and *P. salicina:* Japanese plum). Its effect is difficult to estimate: the major risk is in the nurseries because of its ability to induce graft-incompatibility especially in apricot-apricot and apricot-peach combinations. On plum, it can induce bark splits affecting the vigour of the plant (such splits have been observed but can be of different origins) and the quality of the fruits of plum trees *(P. domestica),* but Japanese plum, which is frequent in the region, is known to be fairly tolerant to CLSV.

Viruses of the nepovirus group seem to be rare in this region, but they are sometimes difficult to detect because of the diversity of strains, absence of typical symptoms and their localization in the infected plant (Bitterlin and Gonsalves, 1936). Raspberry ring spot is seen only occasionally: it is well known in cherry and was described on peach in Turkey in 1971 (Demiroren et al.). SLRV, which is quite common in several countries of the Mediterranean area, has been detected in several places. SLRV by itself is not a major risk (except possible severe strains). The danger is known to come from eventual mixed infections with other viruses such as NRSV or PDV. Such mixed infections have not been detected: nevertheless, as NRSV and PDV are quite frequent, it is important to know more about the possible presence of SLRV or even other nepoviruses. Tomato ring spot has been suspected in some places especially in certain collections. Identification of the virus is often difficult and unreliable: so far, to our knowledge, the virus has not been clearly identified on woody plants in Europe, Near East or the Mediterranean basin. As it is known to be responsible for considerable losses in North America on Prunus species, its introduction would pose a major threat to fruit production.

This means that special attention must be paid to this virus.

Finally, no clear occurrence of MLO diseases was detected in stone fruit except on some declining cherry and peach trees.

Once again all the negative results have to be interpreted carefully for different reasons. In many countries (especially the larger ones) only a part of the fruit growing area was visited. Very often, the countries grow local varieties whose sensitivity to the different viruses and virus-like agents is unknown. In various countries or locations, the cultivated species or varieties are not adapted to the soil or climate (excessive heat in summer, lack of cold in winter, etc.). In addition, the sanitary situation is often very bad (lack of, or inappropriate application of pesticides). For these reasons, very often the usual symptoms do not develop or, if they do develop, are not diagnostic as they are in other more conventional situations.

Viruses are often present in collections and in mother plants used for propagation. For all these viruses (except PPV which was discussed in the previous section), control is possible as the natural spread is not very efficient. Distributing virus-free material entails the establishment and maintenance of virus-free stock. Should indexing be limited to a very small number of trees, first of all it should concern the stock and the mother plants, any plant being eliminated at once if recognized as infected. As several countries still use planting material imported as virus-free, the plants distributed are virus-free and, in fact, some viruses are still absent in some countries and some species: this is the case of CLSV or PDV. However, some limited reinfection has already occurred and the infected plants must be eliminated. CLSV, which does not seem to have any natural vector, can be definitely eradicated by distribution and plantation of virus-free material. PDV and NRSC are pollen-borne. Efficiency of transmission depends on the pressure of the infected pollen (infected pollen has a low level of competitiveness compared to healthy) and on the characteristics of pollination of the species. Virus-free plants located close to some infected trees will escape infection more readily if they belong to a self-pollinated (peach) rather than to a cross-pollinated species (cherry). Control of nematode-borne viruses depends, of course, on the presence of nematode vectors. Once established in a soil, nematodes are very difficult or even impossible to eliminate. If infection by a nematode-borne virus has occurred, elimination will require nematicide treatment followed, over a period of several years, by a culture which is not susceptible to this virus.

A major concern is the sanitary conditions of seeds. Most viruses are seed-borne to some extent: NRSV and PDV from a few percent in peach to more than 50% in cherry (especially sour cherry); CLSV is seed-borne in apricot seeds (G. Tavert, pers. comm.); nematode-borne viruses are also frequently seed-borne. Although the situation is still controversial, PPV does not seem to be seed-transmitted. The theory that viruses are not seed-transmitted and that using seedlings as rootstocks is a guarantee of non-infection should be opposed and great attention should be paid to the origin of the seeds used for the production of rootstocks.

Finally, two general comments can be made. The level of infection, except in a few countries and some areas, is still acceptable: the major risk comes from the fact that viruses exist in most collections used as stock or in mother plants and that distribution of grafting material from this stock will spread these viruses. If no rapid measures are taken, viruses which are still limited to a few trees of the collections will extend further. Secondly, plum pox exists in the region and is well established in some countries. To date, this disease has been reported in all countries of the Mediterranean basin except Morocco, Algeria and Tunisia. No information exists on the situation in Libya, Lebanon and Palestine. Undoubtedly PPV is a major threat to the arboriculture of the region.

Conclusions

As was reported at the beginning of this report, except for a few countries, especially Turkey, stone fruits are still of limited economic importance and, apart from almond, cover a fairly limited area. They are very often produced for domestic consumption and the consumers usually accept both fruit and planting material of low quality. On the other hand, as this crop is becoming highly profitable and could sometimes be a source of exportation, growers are prepared to make some efforts to improve the quality. Finally, as most countries of this region are in a situation of underproduction, the increase of production coming from the culture of virus-free plants is desirable. All the countries using virus-free material are now convinced of the advantages that stem from the elimination of viruses. Expected results are: fruit of better quality, larger size, with more regular ripening, increased yield (10 – 30% at least), increased life of the trees, more homogenous propagation material and increased bud uptake in the nursery. However, this cannot be achieved without the careful training of nurserymen and growers. In many countries, the major problems and mistakes come from ignorance of insufficient knowledge required to handle nurseries and orchards. Except for plum pox which is a major threat in the region, the general level of virus infection in the Mediterranean area is no greater than that which existed in fruit growing areas of more developed countries 25 years ago, prior to the initiation of certification schemes. The presence in many countries of isolated areas still free from viruses (in the new growing areas), and the limited number of plants to be released currently for most countries increases the chances of success of a programme of production of virus-free material, provided that required facilities are made available, well-trained and dedicated personnel collaborate and that good coordination and collaboration exist between the organizations and the people involved and between countries of the region.

الملخص

دونيز، ج. 1989. وضع الأمراض الفيروسية والشبيهة بها التي تعتري أشجار اللوزيات في دول حوض البحر الأبيض المتوسط ودول الشرق الأدنى. مجلة وقاية النبات العربية 7: 209 - 201.

تحدث الأمراض الفيروسية التي تعتري أشجار اللوزيات خسائر هامة، لا يمكن تجنبها بالطرائق التقليدية لمكافحة أمراض النبات. ويعتبر إنتاج وتبادل مواد الاكثار السليمة الطريقة الفضلى لدرء خطر هذه الأمراض التي قد تهدد زراعة أشجار اللوزيات في المنطقة. تتناول المقالة تعريفاً بأهم الأمراض الفيروسية التي تصيب أشجار اللوزيات بشكل عام، ثم تنتقل لمعالجة الوضع الصحي لهذه الأشجار بناء على نتائج حصل عليها الكاتب من خلال جولاته العلمية في دول المنطقة، وتناقش الأسباب المحتملة التي أدت إلى دخولها واستقرار بعض الأمراض الخطرة، والمخاطر المحدقة بزراعة اللوزيات إن لم تتخد إجراءات جذرية في منع انتشارها. ويركز الباحث على ضرورة تطوير كادر فني متمرّس قادر على كشف الاصابة بهذه الأمراض، وعلى أهمية الاختبارات المصلية واستعمال النباتات الدالّة في هذا المجال، ويحفّز على ضرورة البدء ببرامج وطنية لإنتاج مواد إكثار سليمة وعلى تبادل الخبرة بين المنظمات الوطنية والاقليمية في هذا المجال.

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