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Major virus and virus-like diseases of citrus in the Mediterranean

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SUMMARY – A description of major graft-transmissible diseases of citrus is given with particular reference to those which are spread in the Mediterranean countries (tristeza, psorosis complex, infectious variegation, satsuma dwarf, concave gum, cristacortis, impietratura, exocortis, cachexia-xyloporosis, stubborn) and those which may represent a serious threat for this area (tatterleaf, greening).

Key words: citrus, citrus viruses, citrus virus-like diseases, Mediterranean countries

RESUME *– Les principales maladies à virus des agrumes transmissibles par greffage sont passées en revue, en particulier, celles sévissant dans les Pays Méditerranéens (tristeza, complexe de la psorose, panachure infectieuse, nanisme du satsuma, concavité gommeuse, cristacortis, impietratura, exocortis, cachexie-xyloporose, stubborn) et celles qui représentent une grave menace pour cette région (tatterleaf, greening)*

Mots-clés: *agrumes, virus des agrumes, maladies virus-similaires des agrumes, Pays Méditerranéenes*

Introduction

A great number of viruses and of other graft-transmissible infectious agents are known to affect and endanger the citrus industry world-wide (Whiteside *et al.*, 1988; Roistacher, 1991). These pathogens are more devastating in citrus than in other fruit crops because of their severe effect on plant longevity, development and productivity. Fortunately some of them are not present yet (greening and blight) or limitedly distributed (tatterleaf and satsuma dwarf viruses) in the Mediterranean basin, although they represent a potential threat for the citrus groves in the area. It is known that they are primarily transmitted by infected propagating budwood and their control is only possible through the use of healthy material. The absence of plant quarantine and certification programmes in many countries deteriorated the situation to such an extent that sanitary improvement has now become mandatory.

In this paper a brief description of the major citrus graft-transmissible diseases is given with particular reference to the Mediterranean area. Most of the information provided comes from reviews by Roistacher (1991) and Bové (1995).

Citrus graft-transmissible diseases are subdivided into four groups based on their *aetiology:*

1) ***virus*** (tristeza, psorosis, infectious variegation, satsuma dwarf, tatterleaf*);*
2) ***virus-like*** (concave gum, cristacortis, impietratura);
3) ***viroid*** (exocortis, cachexia*);*
4) ***phloem-restricted prokaryotic agents*** (stubborn, witches'broom, greening).

Graft-transmissible diseases

1. Virus

Tristeza. Tristeza is the most destructive virus disease of citrus, which is induced by a phloem-limited virus. It is reported from many citrus-growing regions worldwide. In South America, California and Florida as well as in the Mediterranean area (Spain and Israel) million of plants were killed. It has been found in various Mediterranean countries (Cyprus, Turkey, Lebanon) and isolated foci in Morocco and Italy were probably originated by illegally imported plant material (Davino *et al.*, 1983).

The name tristeza indicates the syndrome which is responsible for the incompatibility of sweet orange and mandarin grafted onto sour orange. On this rootstock, largely utilized in all Mediterranean countries, a necrotic line is visible at the bud union, caused by the presence of inclusions in the phloem parenchyma cells and by the death of sieve tubes of sour orange; roots are damaged and the plant may collapse in the most severe cases. Some species (Satsuma, Kumquat etc.) are healthy carriers of the disease, being dangerous inoculum source for the spread of the virus. Inverse stem pitting in the bark of sour orange rootstock at the bud union area is highly diagnostic for tristeza.

The susceptibility to this disease depends on the environmental conditions, the species, the graft combination and the presence of different virus strains some of which are very virulent (seedling yellows and stem pitting).

Apart from infected propagating material, the disease is mainly vectored by aphids (*Toxoptera citricida, Aphis gossypii, A. citricola, T. aurantii, Myzus persicae*). *Aphis gossypii*, after *T. citricida*, is an efficient vector of the virus and its presence in the Mediterranean represents a serious threat for CTV spread.

Psorosis *(psorosis A, psorosis B and ringspot).* This disease, originated in the Orient, is now reported from all the citrus-growing countries where it may induce very serious damages (i.e. Argentina, 1965).

Psorosis, whose causal agent is a virus, is the most widespread disease in the Mediterranean area. It is often latent in most citrus species and cultivars and its diagnosis is therefore difficult. Fawcett (1933) designated the disease as psorosis-A to distinguish it from a more virulent form called psorosis-B.

The psorosis-A form can occur in susceptible species such as sweet orange, mandarin and grapefruit, where it causes a distinct bark scaling of trunks and branches with gummy concavities and wood staining visible in the cross-section of branches.

It is not always possible to observe leaf symptoms in the field, which are characterized by mottling and interveinal flecking affecting the spring and end-summer flush of growth.

Psorosis B, the severe form of psorosis A, induces expanded and rampant bark lesions with gum-impregnation in the twigs. Ringspots and chlorotic patterns are visible in the leaves, which show brownish gum-impregnated eruptions in the lower surface. The agent can be mechanically transmissible.

Ringspot is another type of psorosis occurring on mature leaves and on fruits mostly of orange varieties. Its agent is also a mechanically transmissible.

Cross-protection of the milder forms of psorosis A against a challenge with the severe psorosis-B is diagnostic for classifying a disease as belonging to the psorosis complex.

The disease, primarily transmitted by propagative infected budwood, can be symptomless in some hosts and induce symptoms in progeny trees.

Infectious variegation. Present in some Mediterranean countries, the disease, whose agent is an ilarvirus, usually does not compromise the plant development and productivity both in quality and in quantity. It is the first citrus virus which has been mechanically transmitted from citrus to citrus and to herbaceous hosts. Its major symptom, crinkly leaf in association with chlorotic variegation, can be very severe in lemon, sweet orange and mandarin groves. These symptoms are very similar to those induced by Petri's variegation in sour orange, whose agent is not transmissible, and to leaf rugose, which is caused by a serologically different virus.

Satsuma Dwarf. Originated in Japan, where it is spread in an epidemic form, satsuma dwarf has been reported only from Turkey in the Mediterranean area. Caused by an isometric virus, the disease mainly affects Satsuma which shows a stunted development and boat-shaped leaves in spring flushes. Production is reduced by the presence of small fruits, with a thick rind.

Tatterleaf. Tatterleaf, whose agent is a filamentous elongated virus, has been found in Meyer lemon in different countries, but only in Morocco in the Mediterranean. It is probably present wherever Meyer lemon has been introduced from China.

It causes serious damages in plants grafted on trifoliate and its hybrids. It is symptomless in most citrus species. Small leaves, with irregular edges, yellow spots and ziz-zag branches are typical of this disease; the disease may also induce bud-union crease or fluting and reduction of the stock on susceptible rootstocks, which can cause the scion to break at the graft union under the thrust of strong winds.

This virus is dangerous because it is readily transmissible by pruning tools. It can be inactivated by dipping the tools in a 1% sodium hypochlorite solution.

2. Virus-like

Concave gum, cristacortis and impietratura. These virus-like diseases are often included in the same group. The affected plants show the typical oak-leaf pattern on the new spring vegetation.

They are mainly reported from the Mediterranean area and are rather widespread in old and topworked citrus groves.

Concave gum is characterized by deep concavities in the trunk and in the branches, wood swelling and gum exudation. The presence of concentric gum rings in the cross-section of the branch is highly symptomatic for this disease. Sweet oranges, in particular the Navel group, and mandarins are the most susceptible species, showing the disease mainly in old trees.

Impietratura mostly affects sweet orange, mandarin and, in a low incidence, lemon. Fruits are as hard as a stone with gumming in the albedo which corresponds to discoloured circular spots of the rind. If fruits are dissected at the level of these areas, hardened gum pockets are visible. Furthermore, fruits drop to the ground prematurely and are small-sized.

Cristacortis is mainly found in sour orange and rarely in sweet orange and mandarin. Typical symptoms are prominent pegs on the cambial face of the bark and corresponding deep pits in the trunk, with gum deposits at the end. Pegs are more or less prominent and variable in number implying different forms and severity of the disease.

3. Viroid

Exocortis and cachexia-xyloporosis. These viroid diseases are widespread in all citrus groves. They are disseminated by infected propagative budwood and readily mechanically transmissible via working tools, which can be easily cleaned by the regular use of sodium hypochlorite solution. These viroids may induce severe damages if one of the two scions is susceptible.

Exocortis affects both old and young plantings especially topworked plants. Typical symptoms of bark cracking and scaling are exhibited only by susceptible rootstocks such as trifoliate orange and lime. - Since citrus are mainly grafted on sour orange, most of the cultivars are symptomless carriers. In this case a general stunting can be found causing a reduced production, which never drops by 40% as in the case of susceptible varieties.

Attention should be paid to the introduction of new rootstocks such as trifoliate and trifoliate hybrids which are highly susceptible to exocortis, that is present in most of the citrus as a dangerous inoculum source.

Cachexia, symptomless in most citrus cultivars, is frequently reported on susceptible species such as mandarin and *C. macrophylla*. Symptoms consisting of pits in the wood with corresponding pegs and

gumming in the bark are highly diagnostic. Affected plants are stunted and chlorotic. On tangelo in particular, numerous small pustules are observed on the lower leaf surface (Terranova *et al.*, 1991).

4. Phloem-restricted prokaryotic agents

Stubborn. This disease, whose causal agent is *Spiroplasma citri*, is present in most citrus-growing countries; it is very severe in arid and desert areas where it causes a production drop up to 50% in sweet orange. In the Mediterranean, besides Spain, Turkey, Greece and Cyprus, it has been reported in most North African countries, in the Near East and the Arabian peninsula. In Italy only a few cases of typical fruit symptoms have been reported but the agent was not isolated (Catara *et al.*, 1981). Although it is not destructive, stubborn strongly affects the fruit production. Fruits are green, especially at their stylar end, small, deformed, with asymmetric and curved columella; at times they are acorn-shaped and mummified. Infected plants show a dense vegetation, leaf chlorosis, thickening and cupping, with dry branches, appearing compressed and stunted. Grapefruit, sweet orange, tangelo, mandarin, lime and pummelo are very susceptible to this disease.

The spread of the disease is primarily mediated by leafhoppers, among which *Neoaliturus tenellus* and *N. haematoceps,* are the major vectors in the Mediterranean area.. *Salsola kali*, a chenopodiacea widely distributed in this area, is an alternative host of the agent and the vectors of stubborn and represents a dangerous inoculum for its spread.

Witches'broom. This disease, caused by a MLO, was firstly observed in Oman provoking severe disorders of small-fruited acid lime trees. Withces'brooms mainly develop on the top or sides of the trees but some occurr at the soil level, too. Shoots are consistently ramified, have short internodes and are thin and fragile. No flowers or fruits are produced on witches'brooms and leaves are very small. The disease is now reported in the United Arab Emirates.

Greening. Greening represents a threat to the Mediterranean region, which is still free from the disease and its vectors. A gram- negative bacterium is its agent, which can be found in most Citrus *spp.*, inducing severe symptoms on sweet orange, mandarin and tangelo. Two types of psyllid (*Trioza erytreae* and *Diaphorina citri*) are respectively vectoring the two forms of the disease, the African and the Asian type.

Affected trees show stunting, dieback, leaf mottling and zinc deficiency-like symptoms. Fruits are poorly coloured, they ripen only on the sun exposed side, with production losses from 30 to 100 percent, due to their small size and their severe drop.

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