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Citrus Virus and Virus-Like Diseases in Libya

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Citrus is one of the most important fruit tree in Libya. The cultivated area of citrus at present is more than 7,000 hectares mainly distributed in the western coast of the country. Commercial varieties include sweet orange, *Citrus sinensis* (Linn.) Osbeck., mandarin, *C. reticulata* Blanco, and grapefruit, *C. paradisi* Macf. Rootstock variety used is mainly sour orange, *C. aurantium* Linn.

An extensive survey for citrus virus diseases was conducted during the last six years. It showed that most of the sweet orange and mandarin trees budded on sour orange rootstock were affected with one disease or more.

This paper reports citrus virus diseases, and other virus-like disorders, including mycoplasmalike diseases which have been encountered during the survey. Control measures of these diseases are also discussed.

I. CITRUS VIRUS DISEASES

1. Psorosis

Among the various forms of psorosis that have been described (5), concave gum and blind pocket are very common in Libya; symptoms of psorosis 'A', crinckly leaf, and infectious variegation are very rare.

i. Psorosis 'A'

Bark lesions (4) appearing on the trunks of sweet orange trees (Fig. 1) were seldom seen in commercial orchards. On the other hand, young leaf symptoms (3) were noted on all old line sweet orange and mandarin trees. Flecking type and oak-leaf pattern symptoms (5,7) were exhibited pronouncedly on the young leaves of the spring flushes (Fig. 2, 3).

Grafting sweet orange seedlings with bark patches from lesions of psorosis 'A' induced the shock effect (6) within 2–4 months after inoculation. Leaves of the inoculated

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seedlings became necrotic and dropped prematurely. Red brownish lesions developed after 5–7 months from graft-inoculation.

No psorosis 'A' bark lesions were noted on the trunks of willow *leaf* mandarin trees.

ii. Concave gum.

Concave gum disease is the most frequently encountered form of psorosis in Libya. All of the commercial citrus species are affected with the disease. Young leaf symptoms (3,5,7) were always associated with infected trees. Typical concavities (Fig. 4) were noticed on the trunks and limbs of many sweet orange and mandarin trees. Concavities on 1–2 year old twigs were also present.

iii. Blind pocket

Trees affected with blind pocket (Fig. 5) were less abundant than those affected with concave gum in commercial orchards. Development of young leaf symptoms were always associated with this disease.

iv. Crinkly leaf

Crinkly leaf symptoms have been observed on few trees of lemon, *C. limon* (Linn.) Burm., and sweet orange (Fig. 6).

v. Infectious variegation

Symptoms of this disease were noticed on few lemon trees (Fig. 7).

2. Cachexia

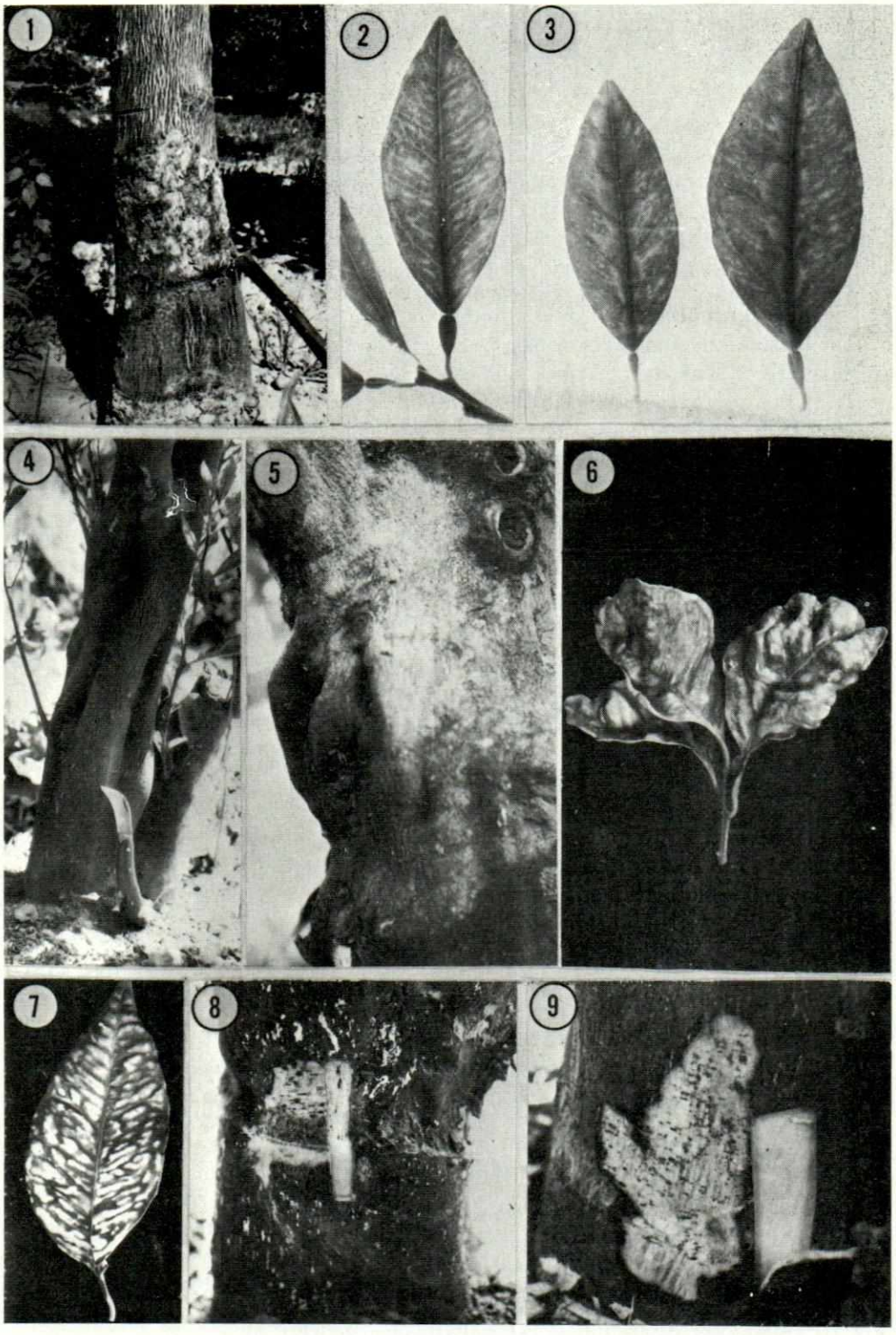
Characteristic symptoms of cachexia disease (2) were observed on more than 50% of the willow leaf mandarin trees that have been examined in this survey. By scraping the bark across the bud union, gum deposits were observed in the bark tissues of the mandarin trunk (Fig. 8). Conoid pits were also present in the cambial surface of the mandarin wood. These symptoms did not extend into the tissues of the sour orange rootstock.

In few cases, cachexia-diseased willow leaf mandarin trees exhibited shelling of the outer layers of the bark just above the bud union.

3. Gummy bark of sweet orange

It has been found that about 30% of the examined sweet orange trees were affected by this disease. Gum pockets can be detected by scraping the bark of the sweet orange scion just above the bud union (Fig. 9). Wood pitting usually accompanies the bark

Fig. 1. Psorosis 'A' bark lesion on baladi sweet orange trunk.
Fig. 2. Psorosis 'A' vein etching on young leaves of sweet orange seedlings.
Fig. 3. Oak-leaf pattern on sweet orange young leaves.
Fig. 4. Concave gum on navel sweet orange.
Fig. 5. Blind pocket on navel sweet orange.
Fig. 6. Crinkly leaf on lemon leaves.
Fig. 7. Infectious variegation on lemon leaves.
Fig. 8. Cachexia on willow leaf mandarin, bark gumming and wood pitting.
Fig. 9. Gummy bark of sweet orange.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discoloration (9). These symptoms did not extend into the tissues of the sour orange rootstock. The infected trees grew slowly and therefore were moderately stunted in comparison with normal trees.

4. Tristeza

About 30 sweet orange trees grafted on sour orange rootstock were suspected of being infected with tristeza virus. They were severely stunted (Fig. 10) and exhibited the characteristic bark pitting and honeycombing of the sour orange rootstock (Fig. 11, 12). Field observations of the presence of tristeza in different plantations were confirmed by bud transmission to Mexican lime, *C. aurantifolia* (Christm.) Swing., seedlings. All of the Mexican lime seedlings exhibited vein clearing (Fig. 13), however, they failed to show any stem pitting even after three years from infection.

The tristeza-affected sweet orange trees were found in the orchard of the Faculty of Agriculture, University of Tripoli and in another orchard at Ben Gashir.

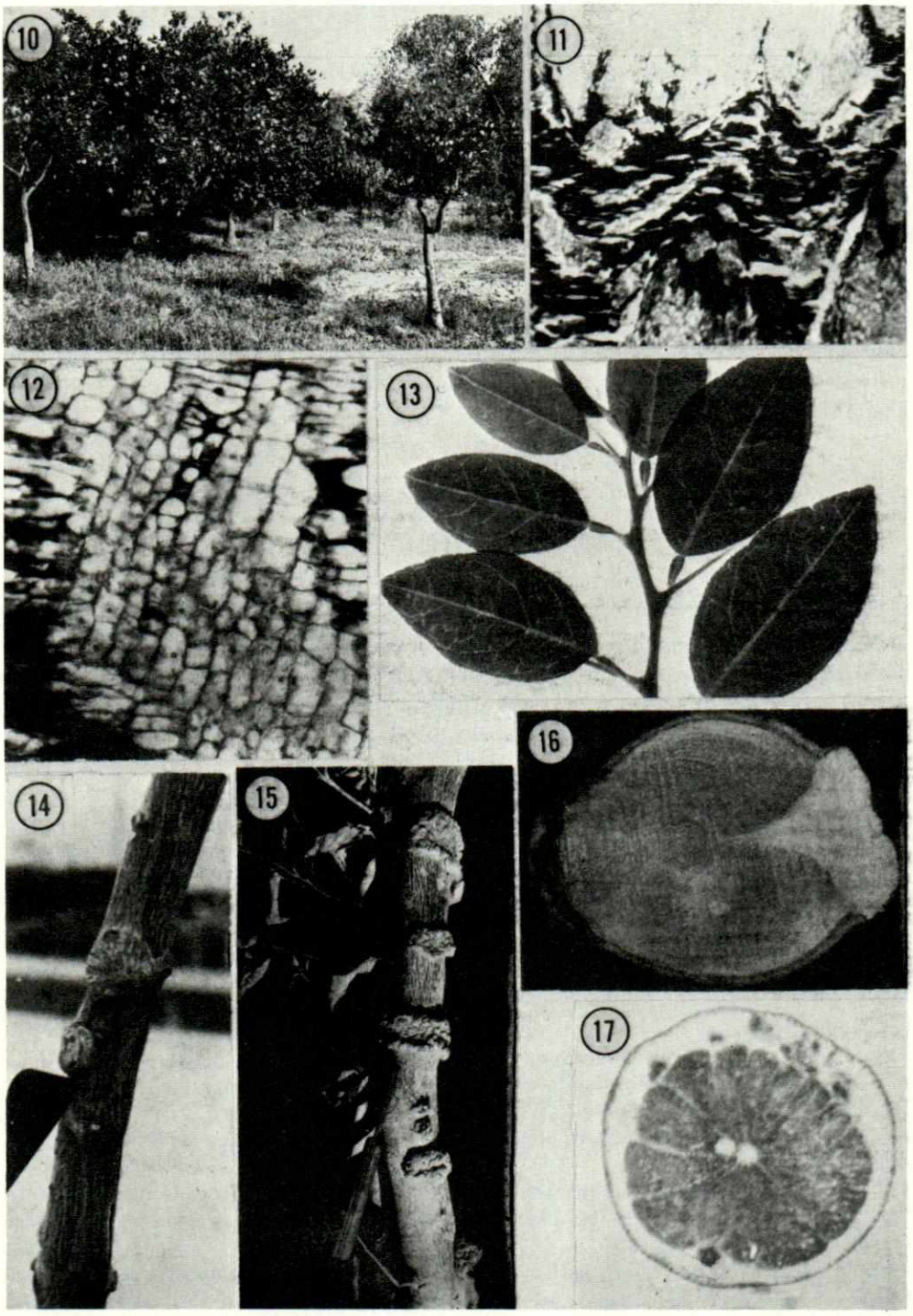
5. Woody gall of sweet orange

Woody gall disease of sweet orange was found in Libya (10) to be confined to a local blood orange variety, demi sweet orange.

The first sign of the disease is the development of rounded galls on the trunk of the infected sweet orange scion close to the bud union (Fig. 14, 15). New galls will develop later on the trunk, main limbs, and branches of not less than 3 years of age. As the gall gets older, it enlarges and flattens and its surface takes the shape of a volcano crater (Fig. 15). Galls were found to be formed from the stimulation of the wood cylinder tissues, and ensheated with a very thin bark (Fig. 16). These galls were not noticed on the sour orange rootstock. When young trees of a new line of demi sweet orange, grafted on sour orange rootstock, were bud-inoculated from gall-affected sweet orange trees, rounded galls started to develop only on the sweet orange scion three years after inoculation.

It seems that this disease is quite different from vein enation or woody gall virus reported from California (11,12), because the latter does not induce galls on sweet orange. Moreover, indexing budwood from the woody gall-diseased sweet orange trees understudy to Mexican lime seedling did not induce any vein enation on the lime leaves

Fig. 10. Tristeza-affected demi sweet orange trees on sour orange rootstock.
Fig. 11. Ploem necrosis of sour orange rootstock. Note the bark pitting.
Fig. 12. Phloem necrosis of sour orange rootstock infected with tristeza virus.
Fig. 13. Leaf symptoms of tristeza on baladi (Mexican lime).
Fig. 14. Inoculated demi sweet orange tree with infected bud from woody gall-diseased tree. Note the development of tumors at the edges of the bud-inoculum.
Fig. 15. Woody gall of sweet orange on demi variety. Note the development of crater-like tumors.
Fig. 16. Cross section through a gall. Note that it is formed from the stimulation of the wood cylinder tissues, and ensheated with a very thin bark.
Fig. 17. Symptoms of impietratura in the albedo of an orange fruit.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even after one year from inoculation. Further studies to establish the etiology of the disease have been undertaken.

6. Impietratura

A few cases of impietratura have been noticed on fruits of blood and navel orange varieties. By cutting across the diseased fruits, some hard, brown, and gum pockets were present in the albedo (Fig. 17).

7. Exocortis

Several sweet orange trees were indexed for exocortis virus by using USDCS 60–13 'Etrog' citron, *C. Medica* L., as test plants (1). Citron shoots, that became infected with exocortis virus, showed various degrees of leaf epinasty, browning, and cracking on the lower surface of the midveins (8). Yellow blotches and cracking on citron shoots were also observed (Fig. 18, 19).

II. CITRUS MYCOPLASMALIKE DISEASES

1. Stubborn.

Considerable numbers of stubborn sweet orange trees have been observed in many orchards. All important commercial varieties of citrus in Libya are susceptible to stubborn disease, e.g. naval, Tarocco, demi, Sanguin, baladi (local), and sukkary.

The leaves of stubborn affected trees are stiff and smaller in size than normal leaves and may be cup-shaped. Leaves are usually mottled exhibiting mineral deficiency-like symptoms (Fig. 20). Infected trees tend to develop upright and shortened internodes.

Blooming period of stubborn trees is longer than usual and in some cases off-season blooming is very apparent. Ovaries of the diseased flowers that develop out of season are often smaller than normal, resulting in a severe flower drop. Usually high percentages of the young fruits drop during May and June. Moreover, many fruits drop during September, mainly due to the cracking of the stylar end and the subsequent rot-

Fig. 18. Leaf epinasty and cracking on the lower surface of midveins of 'Etrog' citron infected with exocortis virus.
Fig. 19. Cracking and yellow blotch on shoots of 'Etrog' citron infected with exocortis virus.
Fig. 20. Foliage symptoms of stubborn disease on leaves of sweet orange.
Fig. 21. Stylar-end greening of fruits from stubborn affected sweet orange tree.
Fig. 22. Normal (A) and stubborn affected (B) sweet orange fruits and seeds. Note aborted seeds in the diseased fruit.
Fig. 23. Early symptoms of autumn leaf drop disease on the foliage of sweet orange.
Fig. 24. Necrosis of affected leaf tissues with autumn leaf drop disease on a young sweet orange tree.
Fig. 25. Leaf drop on an orange tree affected with autumn leaf drop disease. Note that petioles are attached to the twig.
Fig. 26. Severe die-back of sweet orange twigs affected with autumn leaf drop disease.


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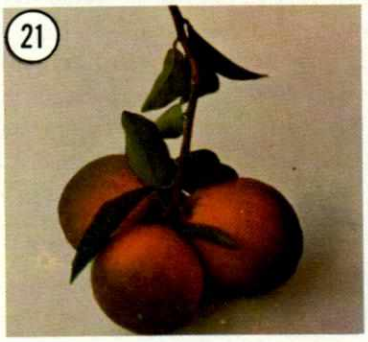
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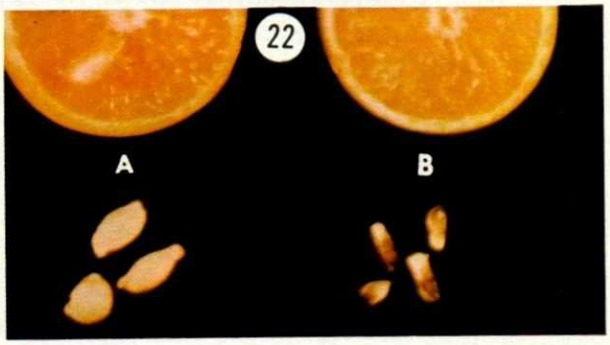
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ting of the fruits. Stylar-end greening (Fig. 21) is usually apparent in some years and not in others. Imperfect development and abortion of seeds (Fig. 22b) were associated with stubborn affected fruits. Lopsided or cylinderical fruits were also observed on the diseased trees.

III. CITRUS DISEASES OF UNKNOWN CAUSE

1. Autumn leaf drop of sweet orange

This is one of the most important diseases in Libya. It causes severe damage to the sweet orange trees whether they were old or new lines. The first symptoms of the disease appears, during October or November, as mesophyll collapse in some areas of the lamina of the leaves (Fig. 23) particularly those that developed during the summer. The affected leaf tissues soon dry out (Fig. 24) causing upward leaf roll. These leaves will wilt and drop leaving the petioles attached to the twig for sometime (Fig. 25). The petioles soon drop with gum oozing out from the leaf trace. Later, severe die-back (Fig. 26) of the twigs takes place. In some cases the die-back might extend to the older branches. This will result in a severe pruning of the infected trees which in turn will seriously affect the blooming of the following season.

No pathogenic fungi or bacteria have been isolated from the affected leaves or twigs. This disease was observed on navel, Valencia, demi, sukkary, and Tarocco sweet orange varieties.

Natural spread of the causal agent of this disease is suspected because some trees of new lines of the previously mentioned sweet orange varieties started to show symptoms of the disease within 4 years from propagation.

This disease was first reported from Egypt by F. Nour-Eldin (unpublished report, 1957). It was found that baladi, Valencia, and navel sweet orange trees grafted on more than 20 different rootstocks have suffered from this condition regardless of the used rootstock.

VI. PRODUCTION OF NEW LINES OF CITRUS VARIETIES

From the surveys that have been conducted so far, it is concluded that most of old line citrus trees were found to be affected with more than one virus or virus-like disease. This situation called for the production of healthy and clean budwood. Two approaches were undertaken to establish virus-free mother trees.

The first approach was to import certified budwood from reliable sources. The second approach was to propagate from seedling trees of desirable varieties by grafting on different rootstocks, and placing the progeny trees under observation and inspection until they prove to be true to type and healthy. This will also enable us to select tristeza-tolerant rootstocks that will do best under the Libyan environmental conditions.

New lines of shamouti, Valencia, demi, sukkary demi, Tarocco, and Sanguin sweet orange varieties are now established. All are grafted on Cleopatra mandarin, sour orange, rough lemon, *C. jambhiri* Lushington, and Rangpur lime, *C. limonia* Osbeck, rootstocks. These trees have been planted in the field since four years ago, and non have developed any stubborn disease symptoms. However, some Tarocco trees had started to show symptoms of the autumn leaf drop disease.

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أمراض الحمضيات الفيرسية والشبيهة بها في ليبيا

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المستخلص

عمل حصر لأمراض الحمضيات الفيرسية والشبيهة بها ووجد أن معظم أشجار الحمضيات بالجمهورية العربية الليبية مصابة بمرض أو أكثر من تلك الأمراض وقـــد وجد أن الأمراض الفيرسية الموجودة هى القوباء «أ» على أشجار البرتقال والجيب المقعر والجيب شديد الانخفاض على البرتقال واليوسفي وتجعـــد الأوراق والتبرقش المعدي على الليمون ومرض تلون قلف البرتقال ومرض تلون قلف وتنقر خشب اليوسفى وتشقق قلف الترايفولياتا كما وجدت بعض أشجار البرتقال مصابة بمرض التدهور السريع كما وجدت بعض أشجار البرتقال مصابة بمرض الحجر .

كما وجدت نسبة اصابةعالية بمرضقلة نمو واثمار اشجار البرتقال المتسبب عن ميكوبلازما.

وقد لوحظ مرض شديد الخطورة اطلق عليه اسم التساقط الخريفي لاوراق البرتقال ولم يحدد حتي الان المسبب الذى يسببه .

وقد بدأت تجارب لانتاج سلالات حمضيات خالية من الأمراض الفيرسية جميعها مطعومة على عدة أصول مقاومة لمرض التدهور السريع بالمقارنة بأصل النارنج وجميع هذه السلالات موضوعة تحت الملاحظة والفحص المرضي والبستاني لانتخاب الصالح منها مستقبلا.