

WOODY GALL, A SUSPECTED VIRUS DISEASE OF ROUGH LEMON AND OTHER CITRUS VARIETIES.

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(Plate xvii.)

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Synopsis.

A disease is described which causes the development of woody galls on the trunk and branches of some citrus species. The outgrowth arises as an outward growing cone of woody tissue originating at cambial level. In older limbs it ultimately becomes a large compound structure with numerous blunt bark-covered growing points. The variety most commonly affected is the rough lemon, but infected trees of Eureka lemon and sour orange have been found. The disease is transmissible by budding and is presumed to be a virus. The name woody gall virus is proposed.

During 1953 a survey of citrus trees for infestation by the gall wasp (*Eurytoma fellis* (Gir.)) was commenced by field officers and entomologists of the New South Wales Department of Agriculture. In the course of this survey a type of gall development was found which was not caused by wasp attack (Pl. xvii, fig. 1). This disease was extremely prevalent on seedling trees of the rough lemon variety in the coastal strip north of Sydney, from Dee Why to Avalon. This district is not near any commercial citrus growing centre, but oranges, lemons, mandarins and occasionally grapefruit are grown in home gardens and the rough lemon is popular with some householders because of its hardiness and all year round cropping habit.

VARIETIES AFFECTED.

During the past three years the same disease has been found in a number of localities in addition to that in which it was first observed. In most cases the affected trees are rough lemon seedlings, but three orchards have been found in which the rough lemon stocks of a number of budded trees are galled (Pl. xvii, fig. 2). In addition, two trees of sour orange and one of Eureka lemon have been found which show symptoms of the disease. There is, however, no evidence to suggest that the disease is spreading or likely to spread in the areas where citrus is grown commercially.

The occurrences so far known are listed in the appendix.

SYMPTOMS.

Outgrowths develop on all above ground parts of the rough lemon trees, except the current season's growth. Occasional galls have been seen on crown roots. They vary in size from simple rounded swellings on the younger wood (Pl. xvii, fig. 3) to large complex knobbed growths on the larger branches and main trunk (Pl. xvii, fig. 4). The gall tissue is woody, but not so dense and hard as normal citrus wood, and small pockets and thin arcs of gum are present in the tissue. The outgrowths are covered with unbroken bark. Anatomical examination of swellings indicates that most appear to be initiated at an early stage of growth. They originate at cambial level, with the formation of a section of radially oriented xylem elements. As secondary growth continues this gall initial takes the form of a cone which gradually increases in size and grows outwards. After one or two seasons' growth this structure has developed a broad diffuse growing point and it extends outward at a much greater rate than the normal stem tissue. As the gall enlarges secondary and tertiary growing points appear, and the large compound galls seen on trunks and main limbs are condensed, profusely and irregularly branched structures with a large number of growing points.

The intensity of gall development varies considerably. Some trees show very numerous galls, others only a few. The size of galls also varies from small to large and the shape varies from rather effuse to protuberant.

There is no apparent detrimental effect on size and vigour of orange or mandarin trees growing as scions on galled rough lemon stocks. Adjacent trees of the same planting, on ungalled stocks, are not larger or in better condition. It is difficult to judge the effect of galls on the vigour of seedling rough lemon trees, but very heavily galled trees appear to be slightly reduced in vigour as compared with unaffected trees.

No trace of any pathogenic organism has been found in the tissue of galls.

TRANSMISSION OF GALL DISEASE.

1. *By Bud Insertion.*—Two sources of inoculum were used: (a) a mature heavily galled rough lemon seedling tree from Dee Why and (b) a mature heavily galled rough lemon seedling tree from the McDonald River district. Ten seedlings each of rough lemon and sweet orange were inoculated by budding from each source on the 11th December, 1955. An equal number of unbudded seedlings of the same source was retained as controls. The seedlings were in the 5-leaf stage when budded. The inoculating buds were not permitted to grow.

No gall production occurred in the first season following inoculation. By July, 1957, eighteen months after inoculation, swellings were present on the main stem of all inoculated rough lemon seedlings (Pl. xvii, fig. 5), and occasionally on the larger roots. No similar growths were produced on the uninoculated rough lemon and sweet orange seedlings, or on the inoculated sweet orange seedlings. Further work is in progress to determine the reaction of a range of citrus species and varieties to infection.

2. *Failure of Seed Transmission.*—Seed was collected from the heavily galled tree which had served as the source of budwood (a), and 100 seedlings were grown. None of these has developed any swellings during a period of 3½ years.

DISCUSSION.

As a result of its successful transfer by budding it is presumed that woody gall disease is caused by a virus, and the name Woody Gall virus is proposed. The galls produced are structurally distinct from the sphaeroblasts which are not uncommon in the bark of many citrus species and varieties. These bodies are spheroidal and originate and for the most part remain outside the vascular cylinder. Several types of out-growth have been briefly described by Fawcett and Bitancourt (1943), but none of these resembles the woody gall condition closely enough to suggest identity. The most similar, referred to by them as knobby bark, occurs on sweet orange as well as lemon, and appears to be related to the sphaeroblast type of growth rather than to woody gall.

Field observations indicate that Valencia and Washington Navel oranges and Emperor mandarins are either resistant to infection or are symptomless carriers of the disease. The presence of woody gall disease in seedling rough lemon trees, and the high percentage of infection in several localized areas, suggest that there is an active vector. If this is so, it is somewhat difficult to explain why the disease is not more common and widespread than it appears to be at present.

The distribution of the disease in a number of localities remote from commercial citrus growing districts and in several cases remote from citrus of any kind suggests the possibility that it has been introduced into rough lemon from a non-citrus source.

Literature Cited.

FAWCETT, H. S., and BITANCOURT, A. A., 1943.—Comparative Symptomatology of Psorosis Varieties on Citrus in California. *Phytopath.*, 33: 837-864.

APPENDIX.

KNOWN OCCURRENCES OF WOODY GALL DISEASE IN NEW SOUTH WALES.

Rough lemon seedling trees of various ages, in home gardens in the Dee Why to Avalon area, near Sydney.

A small community of seedling lemon trees up to about twenty years old, naturalized in bushland on the McDonald River, near Wiseman's Ferry. Citrus has

been grown for many years along the Hawkesbury and McDonald Rivers in discontinuous areas of suitable soil. This community was several miles from any commercial orchard.

A single rough lemon seedling tree of indefinite age growing in natural bushland at Minnemurra, isolated by at least fifty miles from the nearest commercial citrus area.

A single mature rough lemon seedling tree at Gresford (Pl. xvii, fig. 3), in open farming country well isolated from commercial citrus.

Rough lemon stocks of forty-year old Valencia orange trees in a block of about ten acres at Cornwallis, Windsor district. Many of the trees carried one to several galls of long standing on the butts below the bud union and in a few cases also on the crown roots. Some of the galls had started to decay. No galls were present on the Valencia orange scions.

Rough lemon rootstocks of ten-year old Washington Navel orange trees in a block of about two acres at Castle Hill (Pl. xvii, fig. 2). Almost all the trees were affected with large multiple galls, but no outgrowths were present on the Washington Navel orange scions. No galls could be found on trees of Eureka lemon on rough lemon stock in an adjoining block.

A mature Eureka lemon on rough lemon at Kenthurst. This tree showed a single large gall of structure identical with those on rough lemon.

Slight to moderate gall development on rough lemon stocks of Emperor mandarins about fourteen years old at Monak, Murray River.

Slight to moderate gall development on single trees of seedling rough lemon in orchards at Grose Vale, Wright's Creek, Narara, Wyong, home gardens at Coogee and Gordon and in the Sydney Botanic Gardens.

Slight gall development on two six-year old seedling sour orange trees at the Citrus Experiment Station, Narara. These trees are growing adjacent to natural bushland.

EXPLANATION OF PLATE XVII.

- 1.—Branch of mature rough lemon tree, showing typical growth of woody galls. $\times \frac{1}{2}$
- 2.—Base of trunk of ten-year old tree of Washington navel orange on rough lemon rootstock, showing multiple galls on rootstock below bud union. $\times \frac{1}{4}$.
- 3.—Early development of galls on young branch of a rough lemon tree. $\times 1$.
- 4.—Large old galls on main branch of a mature rough lemon tree. $\times \frac{1}{3}$.
- 5.—Galls developing on rough lemon seedling tree, eighteen months after inoculation by budding. $\times 1$.



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