Disorders of Trifoliate Orange Rootstock in Tucumán, Argentina

J. L. FOGUET and C. A. OSTE

BECAUSE of its tolerance to tristeza and resistance to foot rot, its adaptation to heavy soils, and the excellent quality fruit produced by trees grown on it, trifoliate orange [*Poncirus trifoliata* (L.) Raf.] is a promising rootstock in Tucumán. However, the unpredictable behavior of trifoliate orange in rootstock trials at the Agricultural Experiment Station of Tucumán has limited its use. As a result, a search for exocortis-free trees on trifoliata rootstock was started in 1958. In this search, certain other disorders of trifoliate rootstocks were observed. The purpose of this paper is to report the evidence of exocortis and certain other disorders and to describe the latter.

Materials and Methods

The trees examined at the Station are in a rootstock trial that was started in 1929 before virus diseases were known to be a problem in citrus. In general, no records were kept of the origin of the buds or of the seeds from which the rootstocks originated. Visual inspection was made of each tree, and bark pieces were removed at the bud-union and midway between the union and the soil line. Attempts were made to transmit exocortis and the other disorders to trifoliata seedlings.

Forty-nine sweet orange [*Citrus sinensis* (L.) Osb.] trees, ranging in age from 7 to 34 years, were examined. These comprise 12 varieties as follows: Adan, Mediterranean sweet, Jaffa, Joppa, Lue Gim Gong, Navelencia, Parramata, Robertson navel, Ruby Blood, Sanguinea de Sicilia, San Pablo, and Valencia. Five tangerine (*C. reticulata* Blanco) trees, 4 of Cape Naartje, 34 years of age and 1 Satsuma, 20 years old were examined. The 3 following varieties of grapefruit (*C. paradisi* Macf.) were examined: 4 of Duncan, 16 years old; 2 of Henningers pink Marsh, 5 years old; and 3 of McCarty, 22 years old. Nine lemon trees were examined as follows: 2 Lisboa [*C. limon* (L.) Burm. f.], 17 years old and 7 Meyer (*C. limon* hyb.), 14 years old. Seventeen kumquat trees were examined as follows: 6 Marumi [*Fortunella japonica* (Thunb.) Swing.], 13 to 29 years old and 11 Nagami [*F. margarita* (Lour.) Swing.], 16 to 29 years old. A total of 147 trees was examined.

Results

Although it is not specifically detailed in this report, one must remember that virtually all trees were infected with tristeza virus.

EXOCORTIS.—Symptoms of this disease were observed on 40 per cent of the trees examined. Occasional trees of sweet orange, tangerine, and grapefruit were free of symptoms and all the lemon and kumquat trees were symptomless. There was considerable variation in the degree of bark scaling and stunting on different trees, but in no case were stunted trees completely free of bark scaling.

BUD-UNION CREASE.—Symptoms of this disorder were observed on 51 per cent of the trees. There seemed to be no dwarfing associated with bud-union creasing. Trees in advanced stages were declining and some showed symptoms suggesting "blight." Ninety-five per cent of the Ruby

Blood trees exhibited bud-union creasing and except for this variety, 36 per cent of the remaining trees showed this symptom. Overgrowth of the trifoliata rootstock was much more severe on trees with this disorder than on the others. In transmission tests with trifoliata seedlings budded with Pera sweet orange, the characteristic ring appeared 6 years after grafting, whereas only 2 years were required in Brazil (8).

WOOD PITTING ON TRIFOLIATE ORANGE.—This disorder on trifoliata causes indentations in the wood (Fig. 1) similar to those caused by xyloporosis (cachexia) in Orlando tangelo. Gum accumulates in both the xylem and the bark at the site of the pit. DuCharme and Knorr (2)

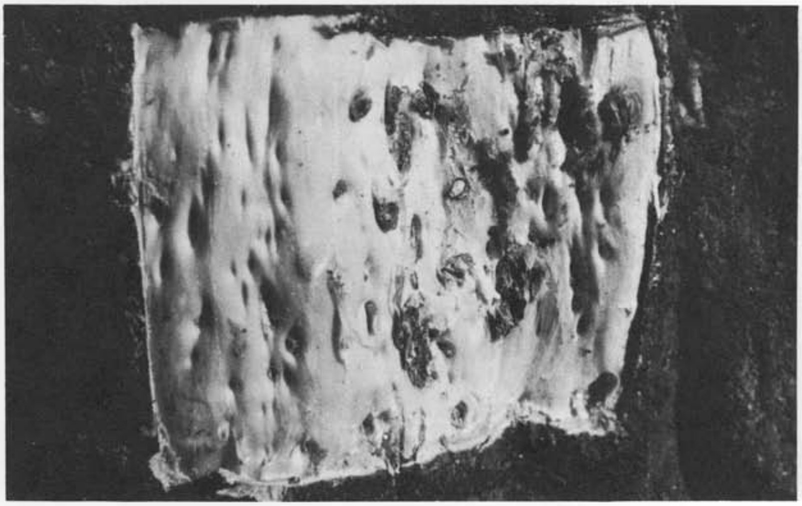

FIGURE 1. *Pitting on* Poncirus trifoliata.

reported this pitting on trifoliata in Concordia, and Valiela (3) observed it in the Delta. It is always accompanied by laminate shelling of the bark (Fig. 2), but is not associated with exocortis, bud-union crease, or dwarfing. When buds of Mediterranean sweet oranges, free of xyloporosis, were worked on trifoliata rootstocks, pitting was present. This confirms the opinion of Calavan *et al.* (1) that pitting alone does not always indicate that xyloporosis virus is present. On the other hand, a xyloporosis-infected Ruby Blood orange clone caused pitting symptoms to develop in both Rangpur lime and trifoliata rootstocks. Trials designed to determine the nature of wood pitting on trifoliata proved that it is perpetuated through grafting.

LAMINATE SHELLING OF TRIFOLIATE ORANGE.—This disorder begins as small eruptions in the bark which enlarge and multiply until they reach the proportions shown in Figure 2. It was found on trees free of exocortis virus and bud-union crease, but seems to be related to wood pitting of trifoliata. In fact, laminate shelling and wood pitting always appear together. A similar disorder was described by Knorr and Reitz (5) who suggested a genetic origin. However, their name for the disorder was

FIGURE 2. *Laminate shelling on* Poncirus trifoliata. *Note longitudinal fissure beginning.*

adopted since it seems indentical with the disorder reported here.

FLATTENING AND LONGITUDINAL FISSURES.—These two abnormalities may be different symptoms of the same disorder. They always appear together. Flattening starts as a longitudinal fissure on the side of the stock facing west (Fig. 3). Necrosis destroys the tissues, giving the trunk an "eaten" aspect (Fig. 4). In advanced cases, necrosis reaches the medula and the other side of the rootstock. Flattening and fissuring always follow wood pitting, but are not necessarily associated with exocortis or bud-union crease. Valiela (3) observed flattening on trifoliata rootstocks in the Delta, but reported neither longitudinal fissures nor necrosis.

Discussion and Conclusions

Approximately 40 per cent of the 147 trees studied, comprising 21 varieties, have shown exocortis symptoms. Dwarfing or stunting in the absence of bark scaling has been reported (3, 4, 7) several times, but was not observed here.

Bud-union crease was observed on 51 per cent of the trees, but almost half (48 per cent) of that number were Ruby Blood trees. Only three of the Ruby Blood trees showed exocortis symptoms, which indicates that the two diseases are not related. Moreira (6) reported that bud-union crease is not related to xyloporosis.

Wood pitting on trifoliate orange is obviously not caused by tristeza

FIGURE 3. Poncirus trifoliata *rootstock of a 24-year-old Valencia orange with exocortis, pitting, flattening, and longitudinal fissure.*

virus or all the trees in the experiment would have exhibited this symptom. Nor is it related to xyloporosis because when Mediterranean sweet oranges, free of xyloporosis virus, were worked on trifoliata severe pitting developed. However, wood pitting on trifoliata seems closely related to the symptom we have called laminated shelling since they always appeared together on five varieties of citrus. Knorr and Reitz (5) considered laminate shelling to be of genetic origin, but its association with wood pitting suggests otherwise.

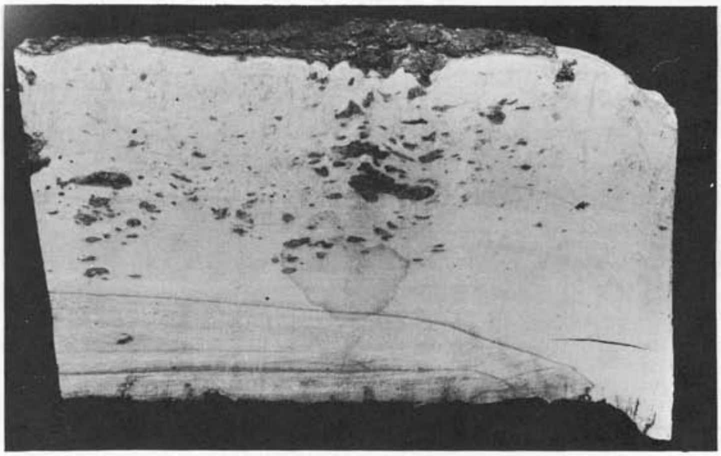

FIGURE 4. Poncirus trifoliata *rootstock of a 24-year-old Mediterranean sweet orange with exocortis; radial section showing bud-union crease, pitting, flattening, necrosis, and gum accumulations in the wood radii cells.*

Flattening and longitudinal fissure conditions also appear to be related to pitting. In fact, they seem to be the terminal stages of that disorder. Obviously, trifoliate orange can not be used successfully as a rootstock, even if exocortis is absent, until budwood free of the agents causing these disorders is available.

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