ARNOLDO R. PUJOL and HORACIO N. BEÑATENA

Study of Psorosis in Concordia, Argentina

THIS PAPER summarizes the results of some studies carried out in Concordia to determine the present status of psorosis in this area.

Incidence of Psorosis in Various Citrus Varieties and Rootstocks

A survey was made of trees in 19 different plots to determine the incidence of young leaf-symptoms and of bark symptoms of psorosis in many varieties of citrus on several different kinds of rootstocks. The zone in which the survey was made comprises about 30,000 hectares in which there are 6 million trees. The results of the survey are summarized in Table 1.

Psorosis was generally present throughout the zone. As will be seen from the table, varieties of citrus grafted on trifoliate orange [*Poncirus trifoliata* (L.) Raf.] developed symptoms later than those grafted on sweet orange [*Citrus sinensis* (L.) Osbeck] or on rough lemon (*C. jambhiri* Lushington). The trifoliate orange when used as a rootstock apparently retards the development of the bark-scaling symptoms of psorosis. This conclusion has been confirmed by other observations made since 1961. The higher incidence of scaling in plot No. 9, which is on trifoliate orange, is explained by a greater susceptibility of the variety used as a top; this is borne out by the higher incidence of scaling in the same variety in plot No. 10.

The Común de Concordia variety of mandarin (*C. reticulata* Blanco), which comprises about 50 per cent of the trees of commercial plantations of the zone, is resistant to the bark-scaling form of psorosis. When the Común de Concordia variety is grafted on a susceptible rootstock,

TABLE 1. INCIDENCE OF PSOROSIS IN SOME COMMERCIAL PLANTINGS

Plot No.	Scion	Stock	No. of Plants	Age	Scaling	Foliar	% Scaling
1	Late[a]	*P. trifoliata*	336	20	20	—	6.0
2	Late	*P. trifoliata*	450	21	27	—	6.0
3	Late	*P. trifoliata*	400	20	32	—	8.0
4	Late	*P. trifoliata*	540	20	29	—	5.4
5	Late	*P. trifoliata*	118	20	0	—	0.0
6	Late	*P. trifoliata*	584	16	32	351	5.5
7	Late	*P. trifoliata*	100	18	1	41	1.0
8	Late	Sweet orange	159	11	30	—	18.8
9	Sweet or.	*P. trifoliata*	267	20	56	—	20.9
10	Sweet or.	Ungrafted	108	15	48	—	44.4
11	Common mandarin	Sweet orange	300	20	23	—	7.6
12	Hamlin	Sweet orange	130	9	36	130	27.6
13	Marsh	Rough lemon	120	32	1	—	0.8
14	Marsh	*P. trifoliata*	100	14	8	35	8.0
15	Marsh	*P. trifoliata*	156	17	6	—	3.8
16	Marsh	Sweet orange	555	14	247	—	44.5
17	Grapefruit	Several	180	13	25	—	13.0
18	Several	Several	522	Sev.	22	106	6.9
19	King of Siam	*P. trifoliata*	224	16	0	140	0.0

[a]Lue Gim Gong and Valencia.

such as sweet orange, scaling developed only on the rootstock (Fig. 1,A). When the variety is used as a rootstock under sweet orange, scaling appears only on the sweet orange above the bud-union (Fig. 1,B). The scaling reported in Table 1 for plot No. 11 was present only in the rootstock.

Although the incidence of foliar symptoms was high in the King mandarin (*C. nobilis* Loureiro), the trees were without scaling symptoms when 16 years old. The variety appears to be resistant. Other varieties that developed bark scaling were Real lime (*C. latifolia* Tanaka) and Grandiflora Plena Maxima shaddock (*C. grandis* Osbeck). Sour orange (*C. aurantium* L.) is resistant.

TYPES OF PSOROSIS OBSERVED IN THE ZONE.—The majority of trees with bark symptoms in the zone have lesions of Type A. In isolated cases, the tree has a more active type of lesion, which develops more rapidly and is often localized on one side of the trunk or a main branch; small leaves and fruit are produced and branches often die. The symptoms on such trees are similar to those described for psorosis B by Fawcett and Bitan-

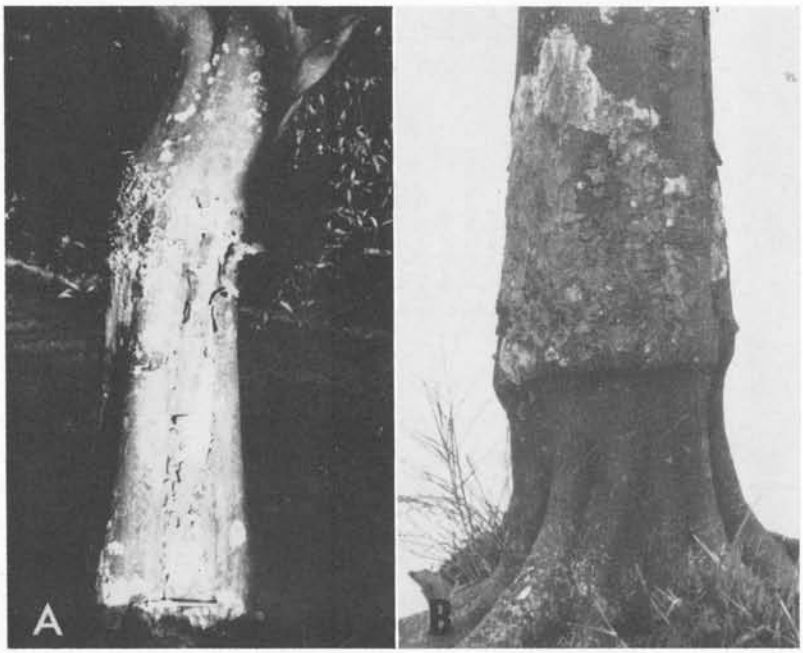

FIGURE 1. *A. Common mandarin on sweet orange; the scaling is limited by the bud-union line. B. Valencia orange on common mandarin; the latter is resistant to bark scaling.*

court (1). Symptoms on fruit or mature leaves, however, have never been found.

Some trees whose leaves develop oak-leaf patterns or flecking have depressions in the trunk similar to those described for blind pocket psorosis. In general, however, oak-leaf patterns on trees in the zone were not associated with a particular type of bark symptom as has been suggested by Fawcett and Bitancourt (1) and by Wallace (2).

In varieties of sweet orange, grapefruit (*C. paradisi* Macf.), and lemon [*C. limon* (L.) Burm. f.], leaves with distortion are frequently found, as well as leaves with more typical patterns. The distortion, which resembles that of crinkly leaf, is brought about by retardation in development of veinlets, which are strongly cleared. This symptom was not, however, transmitted by inoculation from such trees to sweet orange, sour orange, or Eureka lemon.

Other symptoms less frequently found, sometimes in nearly mature leaves, are clear circular spots 1-2 mm in diameter and chlorotic rings 2-4 mm in diameter. In seedlings of rough lemon, these rings may become necrotic.

PSOROSIS IN SEEDLINGS AND IN NON-GRAFTED SWEET ORANGE TREES. —The sweet orange plantings in an area between a point 40 km north of Concordia to Monte Caseros in Corrientes province, about 150 km from Concordia, are made up principally of non-grafted trees. In Colonia Argentina, 35 km northwest, where there are more than 50,000 trees between 12 and 25 years old, citrus had been reproduced exclusively by seed until just a few years ago. Psorosis is widespread in these plantings; bark lesions as well as foliar symptoms can be found. When the possibility that psorosis had been disseminated in the area by grafting was eliminated, there remained the possibility of a vector and the possibility of seed transmission. The possibility of seed transmission was eliminated for the following reasons: (a) Not one seedling with foliar symptoms was obtained from seed taken from a diseased non-grafted tree. (b) The parent trees that produced seed from which the trees of plot No. 10 were grown are still healthy although more than 50 years old. (c) The number of seedlings with foliar symptoms of psorosis increases from year to year at the Experiment Station. (d) Psorosis bark lesions are present in 4.5 per cent of the trees in a block of 817 8-year-old hybrid trees at the Experiment Station, the trees and the rootstocks (trifoliate orange) were grown from seed. For the above-mentioned reasons, we conclude that psorosis in Concordia is spread by a vector, probably a sucking insect.

EXPERIMENTAL WORK ON PSOROSIS IN CONCORDIA.—The foliar symptoms of psorosis, first observed in 1957, have been transmitted to young seedlings by grafting them with either leaf tissues or bark from diseased trees. Bark lesions have been transmitted likewise by grafting with bark-lesion inoculum; symptoms reproduced have included bark lesions in the trunk, necrotic areas in green twigs, secretion of gum, and general chlorosis and death of 2-year-old seedlings.

Attempts have been made to use the cross-protection reaction to detect the presence of psorosis virus in trees with foliar symptoms, since some workers have expressed doubt about the relationship of foliar symptoms to psorosis. Seedlings that showed foliar symptoms and others that did not were inoculated with bark-lesion inoculum. Four months later there was no difference in the two sets of seedlings except more secretion of gum in some of the controls at the point of inoculation.

Three series of inoculations were made as follows:

1. (a) Ten sweet orange seedlings were inoculated with bark tissue from a twig with foliar symptoms. (b) Ten seedlings were inoculated with bark tissue from a symptomless twig on the same tree. 2. Four groups of ten seedlings were inoculated with bark from twigs of different sectors of the same tree; only one twig on this tree had foliar symptoms. 3. Five seedlings were inoculated as in 1 (a) and five as in 1 (b) with inoculum taken from a tree that was scaling. All seedlings were cut back twice to force growth of new flushes. None of the seedlings inoculated with tissue from symptomless twigs have shown psorosis leaf symptoms; those inoculated with twigs having foliar symptoms developed young-leaf symptoms. From these results, it would seem that a tree showing symptoms of psorosis contains tissue that is free of virus.

Literature Cited

1. FAWCETT, H. S., and BITANCOURT, A. A. 1943. Comparative symptomatology of psorosis varieties on citrus in California. Phytopathology 33: 837-864.
2. WALLACE, J. M. 1957. Virus-strain interference in relation to symptoms of psorosis disease of citrus. Hilgardia 27: 223-246.