OTHER GRAFT-TRANSMISSIBLE AGENTS

Natural Spread of Psorosis in Sweet Orange Seedlings

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ABSTRACT. The work was carried out at the EEA Concordia in a plot of 504 plants. At every growth flush the plants were checked to detect the first foliar symptoms of psorosis. To determine the relationship between the different species of insects and the natural spread of the disease, the species found were cataloged and the plants where each species settled were tagged. The first foliar symptoms of psorosis were found three years after the seedlings were planted. The species of insects found on the plants were aphids, white flies, true bugs and leafhoppers.
Index words. aphids, foliar symptoms.

Psorosis or a psorosis-like disease is one of the principal citrus diseases that affect oranges and grapefruit in the citrus area of Concordia and causes serious tree losses.

Pujol and Beñatena (2) recognized the high incidence of psorosis in some commercial plantings and Pujol (3) concluded that psorosis in Concordia is spread by a vector, probably a sucking insect. Timmer and Beñatena (4) described some citrus virus diseases producing foliar symptoms in young leaves related to psorosis A and ringspot and psorosis bark lesions in seedlings and budded nucellar trees in Texas (USA) and Concordia (Argentina). Portillo and Beñatena (1) did not transmit psorosis by three species of aphids on sweet orange seedlings until September 1980. The observations made in the EEA Concordia from 1963 to 1983 in experimental plots provide other evidence of natural or insect spread of psorosis or psorosis-like diseases.

Trees budded on rough lemon rootstock showed a higher incidence of affected plants than those budded on trifoliate orange.

The bark lesions on affected trees are typical of psorosis but the foliar symptoms are not.

With the increasing evidence of a natural spread of psorosis a trial was begun in August 1978 at the EEA Concordia and this paper presents our results to date.

MATERIALS AND METHODS

Seedlings of Pineapple and Common sweet orange were grown in plastic pots in a screenhouse. When the seedlings reached a height of 30 cm they were planted in a plot of 504 plants (252 of each variety) on October 15, 1979. The plot had 18 rows and each row had 28 plants. (Fig. 1).

The distance between plants was 1.5 m with 2.0 m between rows. At the same time 5 plants of each variety were covered with a screen to protect them against insects as controls. Every growth flush was observed routinely for foliar symptoms in every plant in the plot.

As a source of infection next to the plot, 90 plants of Pira Lima sweet orange budded on trifoliate orange which were strongly affected by psorosis were planted beside the plot in September 1980. All the insects found on the sweet orange seedlings were recorded

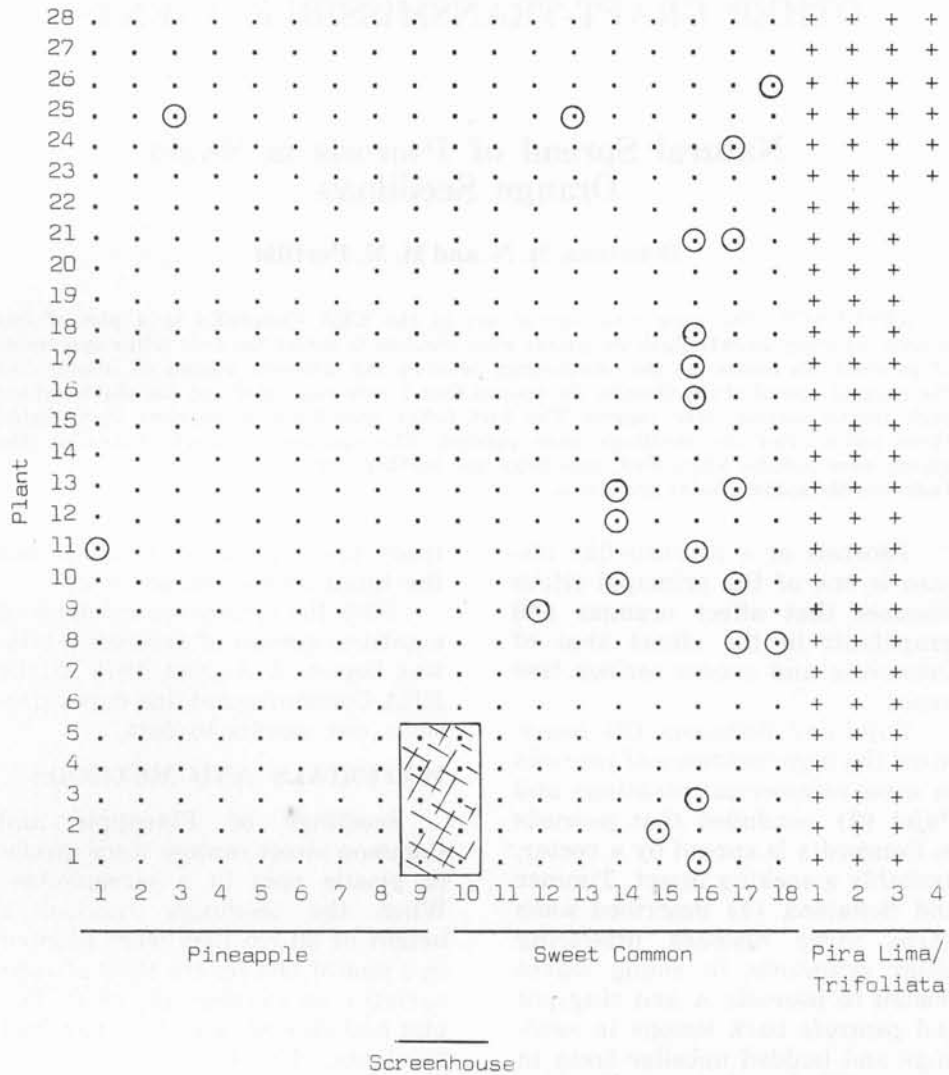

Fig. 1. Natural infection of psorosis as of Sept., 1982 in a plot of 504 sweet orange seedlings planted October 15, 1979 next to 90 psorosis-infected plants of Pira Lima sweet orange grafted on trifoliate orange and planted September 1980.
. Plants without symptoms; ⊙ Plants with foliar symptoms of psorosis from natural infection; + Plants infected with psorosis as inoculum source. Box indicates screenhouse surrounding 10 trees.

for each plant in the plot to determine the relationship between the insects found and the appearance of foliar symptoms of psorosis. In this way it was possible to identify the insect species found on the plants which later were affected by psorosis.

From October 1979 to September 1982, 56 records of species found on each plant of the plot were made. Observations were carried out weekly from April 1981 until January 1982, then biweekly until September 1982 and monthly thereafter because of the big size of the trees.

RESULTS

By September 1982, the first plants showing foliar symptoms in the plot of 504 sweet orange seed-

lings were observed. It was three years from the time of transplanting and the appearance of the first foliar symptoms. Foliar symptoms appeared at the same time in all the affected plants in the spring growth flush of September, 1982. Before this date no foliar symptoms were observed. In the sweet orange seedling trees of this plot, the foliar symptoms were similar to those previously mentioned, but stronger.

Once the young sprouts reached a certain size, they began to decline, lost their leaves, and the upper end curved and began to die from the terminals. In most cases the abscission point of the leaves was between the petiole and the stem and less commonly between the leaflet and the petiole. The typical flecking of psorosis was observed in few cases (elongate and clear small spot parallel to the secondary veins). The large round spots, ringspots and irregular spots with a diffuse edge were more common. The spots were only in a part of the leaf blade or throughout the blade and, in some cases, the leaves were crinkled. Sometimes the affected leaves lost their natural brightness and became opaque. Foliar symptoms occurred in a part of the canopy or in the entire canopy. Oak leaf symptoms were not observed in affected trees. Foliar symptoms were not observed in the controls.

By September 1982, the number of trees showing foliar symptoms was 22, (20 of Common sweet orange and 2 of Pineapple). Figure 1 shows the distribution of sweet orange seedlings with foliar symptoms in the plot.

The species of insects that were recorded on each of these 22 plants are indicated in table 2.

Of the 494 plants in the plot, except the 10 controls, 480 were

TABLE 1
NUMBER OF TREES WITH FOLIAR SYMPTOMS AND BARK LESIONS IN DIFFERENT PLOTS OF THE EEA CONCORDIA AS OF JANUARY 1983

Scion	Stock	Bark lesions/ Foliar symptoms	Total trees	Planting date
Buckeye navel orange	Trifoliate	5/58	120	1968
Baianinha navel orange	Trifoliate	9/45	120	1968
Alargada navel orange	Trifoliate	10/27	120	1968
Parent navel orange	Trifoliate	1/10	120	1968
Hamlin nucellar orange	Trifoliate	6/20	120	1968
Parson nucellar orange	Trifoliate	16/28	120	1969
Common sweet orange	Trifoliate	11/16	120	1968
Valencia LC orange	Trifoliate	8/26	120	1968
Valencia LC orange	Rough lemon	38/27	147	1964
Valencia LP orange	Trifoliate	5/32	120	1963
Marsh grapefruit	Trifoliate	17/12	120	1963
Marsh grapefruit	Rough lemon	65/46	140	1964
Foundation block				
grapefruit	Rough lemon	74/14	131	1962
sweet orange	Rough lemon	59/67	262	1962
Seed source block				
sweet orange	Seedlings	11/-*	48	1963
Variety block				
sweet orange	Seedlings	62/-	640	1967
grapefruit	Seedlings	4/-	95	1967
pummelo	Seedlings	7/-	65	1967

* In the blocks of seedlings trees, only the plants with bark lesions were recorded.

TABLE 2
SPECIES OF INSECTS RECORDED ON EACH OF THE PLANTS SHOWING THE FIRST FOLIAR SYMPTOMS OF PSOROSIS IN SEPTEMBER 1982. PLOT OF 504 SWEET ORANGE TREES. PERIOD: OCTOBER 1979 TO AUGUST 1982

		Species of insects											
		Aphids						White flies	True bugs		Leafhoppers		
Row	Plant	A.c.	A.g.	T.c.	T.spp.	T.a.	M.p.	Aley.	A.h.	T.p.	B.x.	G.s.	C.c.
1	11	x	x	x	x	x		x	x				
3	25	x	x										
12	9	x	x	x				x	x				
13	25	x	x										
14	10	x	x		x								
14	12	x	x	x				x			x		
14	13	x	x	x				x					
15	2	x											x
16	1	x	x		x			x					
16	3	x	x	x					x				
16	11	x	x			x	x	x		x			
16	16	x	x	x	x			x			x		
16	17	x	x	x				x					
16	18	x	x	x						x			
16	21	x	x	x	x								
17	8	x	x										
17	10	x	x	x	x			x					
17	13	x	x	x	x							x	
17	21	x	x		x			x					
17	24	x	x	x				x					
18	8	x	x										
18	26	x	x		x								
Total		22	21	12	9	2	1	11	3	2	2	1	1

x Presence of the species.
APHIDIDAE
A.c. *Aphis citricola* van der Goot
A.g. *Aphis gossypii* Glover
T.c. *Toxoptera citricida* (Kirk.)
T.spp. *Toxoptera* species
T.a. *Toxoptera aurantii* (Boyer)
M.p. *Myzus persicae* Sulzer
White flies
Aley. ALEYRODIDAE
True bugs
COREIDAE
A.h. *Athaumastus haematicus* (Stäl)
MIRIDAE
T.p. *Taylorilygus pallidulus* (Blanchard)
Leafhoppers
CICADELLIDAE
B.x. *Bucefalogonia xantophis* (Berg)
GYPONIDAE
G.s. *Gypona stalina* De L. et Frey
MEMBRACIDAE
C.c. *Cyphonia clavigera* (Fabr.)

infected by aphids: 456 by *Aphis citricola* van der Goot; 433 by *Aphis gossypii* Glover; 262 by *Toxoptera citricida* (Kirk.); 185 by *Toxoptera* spp.; 21 by *Myzus persicae* Sulzer and 19 by *Toxoptera aurantii* (Boyer).

Table 3 indicates the date of the first infestation by aphids and the time between this infestation until the appearance of foliar symptoms of psorosis in each of the 22 plants.

DISCUSSION

From the results of field observations for 20 years in the plots of the EEA Concordia, in relation to the appearance of the foliar symptoms and bark lesions with psorosis, transmission of the disease by insects is possible. The presence of foliar symptoms in seedlings or in plants budded with buds of nucellar origin (virus-free) indicated a possible spread

TABLE 3
DATE OF THE FIRST INFESTATION BY APHIDS IN EACH OF THE SWEET ORANGE PLANTS SHOWING SYMPTOMS

Row	Plant	Species of aphid	Date of the first infestation	Interval from infestation to appearance of symptoms (months)
1	11	A.c., A.g.*	Feb. 1981†	19
3	25	A.g.	Dec. 1980	21
12	9	A.c.	Dec. 1980	21
13	25	A.c.	Mar. 1981	18
14	10	A.c.	Dec. 1980	21
14	12	A.c.	Apr. 1980	29
14	13	T.c.	Sep. 1981	12
15	2	A.c.	Dec. 1980	21
16	1	A.c.	Dec. 1980	21
16	3	A.c.	Dec. 1980	21
16	11	A.c.	Dec. 1980	21
16	16	A.c.	Dec. 1980	21
16	17	A.c.	Dec. 1980	21
16	18	A.c.	Apr. 1980	29
16	21	T. spp.	Apr. 1981	17
17	8	A.c.	Feb. 1981	19
17	10	A.c.	Dec. 1980	21
17	13	A.c.	Apr. 1980	29
17	21	A.c.	Dec. 1980	21
17	24	A.c.	Dec. 1980	21
18	8	A.c.	Apr. 1981	17
18	26	A.c.	Mar. 1981	18

* See table 2 for names of aphids.
† Period of observation was October 1979 to August, 1982.

of the disease by insects. The appearance of foliar symptoms preceded by five to six years the appearance of bark lesions which causes the real damage to the citrus plants. Although the foliar symptoms are not the typical of psorosis (flecking), the final result is lesions on the trunk and decline of the tree which are characteristic of this disease. The insects that were found feeding on the seedlings of sweet oranges are all sucking insects. Some of them are recognized virus-vectors.

There is a close relationship between the appearance of foliar symptoms in 3-year-old seedlings of sweet orange and their colonization by aphids. Of the five species of aphids that were found in relation with appearance of foliar symptoms and necrosis of the sprouts, 100% were colonized by *Aphis citricola.*

The time between the first colonization of the plants by aphids and the appearance of symptoms varied between 12 to 29 months. Aphids were found most frequently and *Aphis citricola* maintains a close relationship with the late appearance of foliar symptoms and necrosis of the sprout of the affected plants. The plants that showed foliar symptoms of psorosis were near the edge of the plot and most were near the infected source plants. We think that the spread of the disease is from affected plants growing outside the experimental plot.

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