Studies of "Declinamiento" in Citrus in the Northwest of Argentina

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ABSTRACT. In 1974, declining citrus plants were observed in the northern part of Salta province with symptoms similar to "blight" of Florida and to "fruta bolita" of Misiones. Due to the damage observed and the danger of spread in the region, INTA, EERA, Famailla started studies to determine the identity of the disease, its causes and possibilities of control. This paper reports information on distribution and spread of the disease, citrus combinations affected, relationships with soil and nutritional factors, nematode and fungus occurrence and transmission tests.

We have observed the decline and death of citrus plants in northwest Argentina since 1968.

The disease was detected first in Salta and Jujuy (26, 28) and later in Tucumán (17). Features in common with "fruta bolita" in Misiones (Argentina), "blight" in Florida (USA) (11) and "marchitamiento repentino" in Salto (Uruguay) have been observed. This paper summarizes the results of a plan started by EERA-INTA-Famailla in 1981 to study this problem and to find a solution.

MATERIALS AND METHODS

Disease identification. We tried to characterize the symptomatology and the association of the disease with citrus varieties and rootstocks. We also tried to study the relationship between declinamiento and nutritional, anatomical, pathological and climatic factors. To study nutritional and edaphic causes, we sampled soil, twigs and leaves of healthy and affected plants. The analyses were done in the INTA-Famailla Laboratory. Methods proposed by Chapman (8) and Wutscher (30, 31) were used. We analyzed nematode population (14, 29) after extraction by the Baermann funnel method (12).

Transmission. We studied possible means and vectors for the transmission of the disease. We tried transmission by grafting and sap to different citrus and herbaceous species. Planting of the above species in soils with nematodes taken from affected orchards was also done. We also studied behavior of scion-rootstock combinations, control and prevention of the disease.

RESULTS AND DISCUSSION

Symptomatology. The symptoms are similar to those in Florida (4, 5, 9, 32); Brazil (21, 23); Uruguay and in northeastern Argentina (3, 26). Affected plants lose vigor and productivity. Zinc, magnesium, manganese and iron pattern deficiency in leaves are common. When environmental conditions are not adequate, signs of stress, wilt, and defoliation also occur. Stem-pitting is not associated with affected plants, and this symptom can be found indistinctly in healthy or affected plants. Frequently, new and vigorous flushes grow from trunk and main branches, but they die in a short time. Fruits are smaller and paler than normal with a higher acid content (2).

The waterflow rates in affected plants are lower than in healthy ones (16).

Distribution of affected plants. According to our records, affected plants in the field are grouped. The problem starts from a locus and advances in concentric circles. We have not found differences between

TABLE 1
DEVELOPMENT OF "DECLINAMIENTO" IN DIFFERENT CITRUS COMBINATIONS IN ORÁN, SALTA, ARGENTINA

Variety/ rootstock	Year of planting	No. of trees	% plants affected at different ages							% affected in 1983
			12	13	14	18	19	22	23	
Valencia/ trifoliate orange	1958	2020	—	—	—	18.2	74.5	83.6	—	83.6
Valencia/ trifoliate orange	1959	2121	—	—	—	—	66.5	76.5	80.1	80.1
Valencia/ trifoliate orange	1969	2121	—	40.5	43.1	—	—	—	—	43.1
Valencia/ Cleopatra mandarin	1970	2121	1.9	18.4	—	—	—	—	—	18.4
Pineapple/ Cleopatra mandarin	1969	2142	1.8	4.3	8.0	—	—	—	—	8.0

soils in locations with healthy and diseased plants. We could not associate the occurrance of the problem with the texture, organic content or proximity to roads (7) nor with carbonate, and sodium excess or nutrient deficiencies.

The highest number of affected plants has been observed in Oran (Salta) and Chalican (Jujuy) which are suptropical areas. Lower numbers were found in Tucumán which has a milder climate.

Plant material and age. In a site where trifoliate orange and Cleopatra mandarin were used as rootstocks for Valencia orange, we observed that 84% were affected on the former, but only 43% were affected on the latter. In some areas with Valencia late on trifoliate orange, up to 80% of the plants have declined at 18-20 years of age. In young plantations originating from buds taken from apparently healthy plants in affected areas, similar rates of decline have been observed when plants were only 12 to 14 years old (table 1).

If we assume the disease is transmissible, we could suppose that those plants and budwood could have been carriers of the "disease" and, in other words, we could create a greater inoculum pressure in the area.

In 1980, Pineapple orange on Cleopatra mandarin also started to show declinamiento but with less intensity (8-10%). Other affected combinations are Thompson and Marsh grapefruit on rough lemon, Marrs Early orange on Troyer citrange, and Calderon orange on Cleopatra mandarin.

As in other places, decline is associated with the rootstock (3, 9, 10, 15, 20, 22, 30), but in no case was budunion crease observed (24, 25).

Nutritional factors. Foliar content of nutrients (table 2) showed differences only for potassium and magnesium. Potassium in affected plants was found at a concentration considered optimum by Chapman (8). The content of magnesium was higher in affected plants. The content of magnesium in the trunks of affected plants was higher than in healthy ones, which coincides with previous observations in this locale (17, 26, 30) (table 3).

Nitrogen content was low in all the plants. Our results did not show a clear correlation in the content of other nutrients in leaves and blight and young tree decline (1).

Although the zinc values are high for affected and healthy plants, perhaps because of a sample contamination, the affected plants have higher contents as observed in other areas for blight (6, 27, 31,

TABLE 2
FOLIAR MINERAL CONTENT IN APPARENTLY HEALTHY AND DECLINAMIENTO AFFECTED PLANTS IN ORÁN, SALTA, ARGENTINA

Nutrient	Healthy plants	Affected plants	"t"*
Fe (ppm)	128.33 (=)†	143.33 (=)	n.s.
Zn (ppm)	46.66 (=)	45.0 (=)	n.s.
N (%)	1.751 (—)	1.790 (—)	n.s.
P (%)	0.811 (+)	0.478 (+)	n.s.
K (%)	0.625 (=)	1.01 (=)	(*)
Ca (%)	3.751 (=)	3.576 (=)	n.s.
Mg (%)	Trace (—)	0.33 (=)	(**)
Cu (ppm)	30.0 (+)	43.33 (+)	n.s.

*n.s. = not significant; (*) = significant at 5%; (**) = significant at 1%.
†(—) = deficient; (+) = excess; (=) = optimum [according to Chapman (6)].

TABLE 3
WOOD MINERAL CONTENT IN APPARENTLY HEALTHY AND DECLINAMIENTO-AFFECTED TREES IN ORÁN, SALTA, ARGENTINA

Nutrient	Healthy plant	Affected plant	"t"*
Fe (ppm)	133.33	132.5	n.s.
Mg (ppm)	798.33	956.66	(**)
Cu (ppm)	10.83	12.5	n.s.
Zn (ppm)	18.33	21.66	n.s.†
Ca (%)	15.4	21.53	(*)
P (%)	0.100	0.108	n.s.
K (%)	0.106	0.310	(**)
N (%)	0.45	0.51	n.s.

*n.s. = not significant; (*) significant at 5%; (**) = significant at 1%.
† = high values by contamination.

32). Calcium content followed the same pattern (17, 27).

No differences have been observed between nutrient content of soil from healthy and affected plants (table 4).

Nematodes. Decline has been associated with nematode attack. In our study we found *Xiphinema americanum*, vector of many viruses related to tobacco ringspot, and *Pratylenchus* sp., an endoparasite that causes damage to citrus roots. Other nematodes present were: *Helicotylenchus* sp., *Criconemoides* sp., *Aphelenchus* sp., *Trichodorus* sp., and *Ditilenchus* sp.

Fungi. *Fusarium* sp., *Pythium* sp., and *Rhyzoctonia* sp. were isolated from damaged roots of affected plants. *F. solani* has been reported responsible for toxin synthesis and plug formation.

Viruses. Tristeza virus was present in affected and healthy plants, but we could not associate the decline with this pathogen as reported elsewhere (19). We found psorosis in a very low percentage of the trees.

Plants of *Phaseolus vulgaris* cv. Alubia showed an overgrowth of nodes and yellow stria in the stalks after juice inoculation from diseased plants. Xylem-limited bacteria were not detected in our study (13, 18). It was not possible to transmit "declinamiento" with aphids (*Toxoptera citricida*) taken from affected plants.

TABLE 4
pH, ORGANIC AND MINERAL CONTENT IN SOIL FROM DECLINE-AFFECTED AND APPARENTLY NONAFFECTED TREES IN ORÁN, SALTA, ARGENTINA

	Healthy	Affected	"t"*
pH	6.76	6.84	—
Organic matter (%)	3.16	3.85	n.s.
N (%)	0.23	0.25	n.s.
P (%)	48.75	57.25	n.s.
K (%)	0.160	0.190	n.s.
Na (%)	2.445	2.568	n.s.

*n.s. = not significant.

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