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Attempts to Induce Recovery of Citrus Trees Affected by "Declinio"

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ABSTRACT. Diagnostic tests for "declinio" of citrus trees have been applied in the States of São Paulo, Sergipe and Bahia, in Brazil. The percentage of affected trees is increasing every year, and methods to induce recovery are needed to minimize the disease loss where "declinio" is severe. Three methods have been tried in two severely affected regions of São Paulo, as follows: 1. **Inarching.** Affected trees were inarched with Caipira sweet orange. Results are not yet available. 2. **Scion-rooting.** Since 1979 we have scion-rooted trees from 8 to 15 years old in the early or moderate stages of decline. No satisfactory recovery resulted after 2 and 3 years. Apparently healthy trees of Hamlin on trifoliolate orange and Valencia on Rangpur lime were also preventively scion-rooted in severely affected orchards. After 2 years, 1%-2% of the treated trees showed early "declinio" symptoms. 3. **Scion-rooting plus severe pruning:** Groups of 17 year-old trees of Valencia sweet orange on Rangpur lime in early or moderate decline were scion-rooted and severely pruned every 2 months from December 1980 to September 1981. Control diseased trees were left without treatment. The treated trees, after 19 to 28 months show good apparently healthy canopy and root system, and many of them are bearing normal fruit. This method will be promising if trees continue healthy.

Index words. Blight, water flow, Zn analysis.

Some characteristics of citrus trees affected by declinio in Brazil are well known (5, 8, 9). They include: visual symptoms such as leaf blight, lack of new shoot development in the spring, foliar symptoms of zinc deficiency, dull leaf colour, reduced fruit set, small or malformed fruits, no root-rot except in advanced stages; microscopic symptoms such as the occurrence of filamentous obstructions in the vessels of roots, trunks and branches; physiological abnormalities such as the lack of normal water uptake, accumulation of zinc compounds and water-soluble phenolics in the wood of the trunk above the bud-union, low water and air flow rates through secondary roots, low specific weight of secondary roots. These symptoms and abnormalities, based on comparison with neighbour apparently healthy trees, are very similar to those of citrus blight in Florida (9).

Because of these similarities, several diagnostic methods developed in Florida for blight-affected trees (1, 2, 10) have been used in surveys to determine the

occurrence of declinio in the States of São Paulo (8) Sergipe (6) and Bahia (4). These include: water injection in the trunk by gravity or by pressure, zinc analysis of the trunk wood, and water and air flow rates through secondary roots. These techniques have been applied to declining trees and apparently healthy trees in the same orchards.

Citrus growers in Brazil are most interested in the possibility of inducing recovery of declinio-affected trees in their orchards. For this reason, experiments were started in 1979 in the State of São Paulo to find methods that will help declinio trees to recover.

MATERIALS AND METHODS

The following methods have been tested:

Inarching. A survey in the State of São Paulo (3) showed that "declinio" affected trees budded on Rangpur lime, trifoliolate orange and other rootstocks, but never affected those on Caipira sweet orange. For this reason an experiment was set up in an orchard of 14 year-old trees of Valen-

cia sweet orange on Rangpur lime rootstock in the Conchal region, in which 20 apparently healthy and 20 declinio-affected trees showing moderate symptoms were inarched with 3 Caipira seedlings, which were planted on December 4, 1980 and inarched on February 26, 1981.

Preventive scion-rooting. In Argentina, scion-rooting of apparently healthy trees has been reported as a successful method to prevent "declinamiento" in severely affected orchards. For this reason, in 1980, several trials were carried out in the Barretos and Conchal regions of the State of São Paulo. In Barretos, 60 apparently six-year-old trees of Hamlin sweet orange on trifoliata orange rootstock and 60 apparently healthy nine-year-old trees of Valencia sweet orange on Rangpur lime rootstock were scion-rooted and treated with a commercial rooting compound. The treated Hamlin trees were in alternate rows. In Conchal the trial was carried out in two orchards of 14-year-old Valencia sweet orange on Rangpur lime rootstock, in apparently healthy trees in each orchard. Every two months a different group of 15 trees in each orchard was scion-rooted (December 1980, February, May, July, September and October 1981). Five treatments were applied in 3 replications each time in both orchards, as follows: A) no wound, no soil mound (control); B) no wound, with soil mound; C) no wound + rooting compound, with soil mound; D) wounded, with soil mound; and E) wounded + rooting compound, with soil mound. Observations on the presence of declinio symptoms in the experiments was made in April 1983.

Scion-rooting declinio-affected trees to induce recovery. Several 8-year-old trees of Valencia sweet orange on Rangpur lime rootstock showing initial to intermediate

symptoms of declinio were scion-rooted in 1978 and 1979 in a badly affected orchard at Barretos. In 1981 the roots were uncovered for observation and photographed (7).

Scion rooting plus severe pruning. Previous experiments in which Valencia trees on Rangpur lime were scion-rooted as an attempted treatment to induce recovery of declinio-affected trees were unsuccessful although a fairly good root-system was formed (7). Severe pruning alone resulted in vigorous growth, but after 2 years the trees started to show declinio symptoms. To establish a better physiological equilibrium between a new root system that is induced by scion-rooting and the developing canopy, experiments were carried out in which trees showing early and moderate declinio symptoms were scion-rooted and severely pruned at the same time. In a severely affected orchard at the Conchal region, 60 trees of 14-year-old Valencia sweet orange on Rangpur lime rootstock were treated in groups of 10 trees each two months starting December 4, 1980. Ten trees in the same condition were marked and not treated as controls. All of the scion-rooted trees were treated with a commercial rooting compound that was applied to the wound. The trunk was whitewashed to avoid sunburning. When the shoots started growing they were thinned 3 times. The treated trees received only the same nutritional or phytosanitary sprays that were given to the orchards in general at the grower's judgment. Observations were made in October 1982 and April 1983 (fig. 1, 2).

RESULTS AND DISCUSSION

Inarching. The inarching was not successful in all of the diseased trees and had to be repeated in some cases. Observations made in April 1983 showed that the dis-

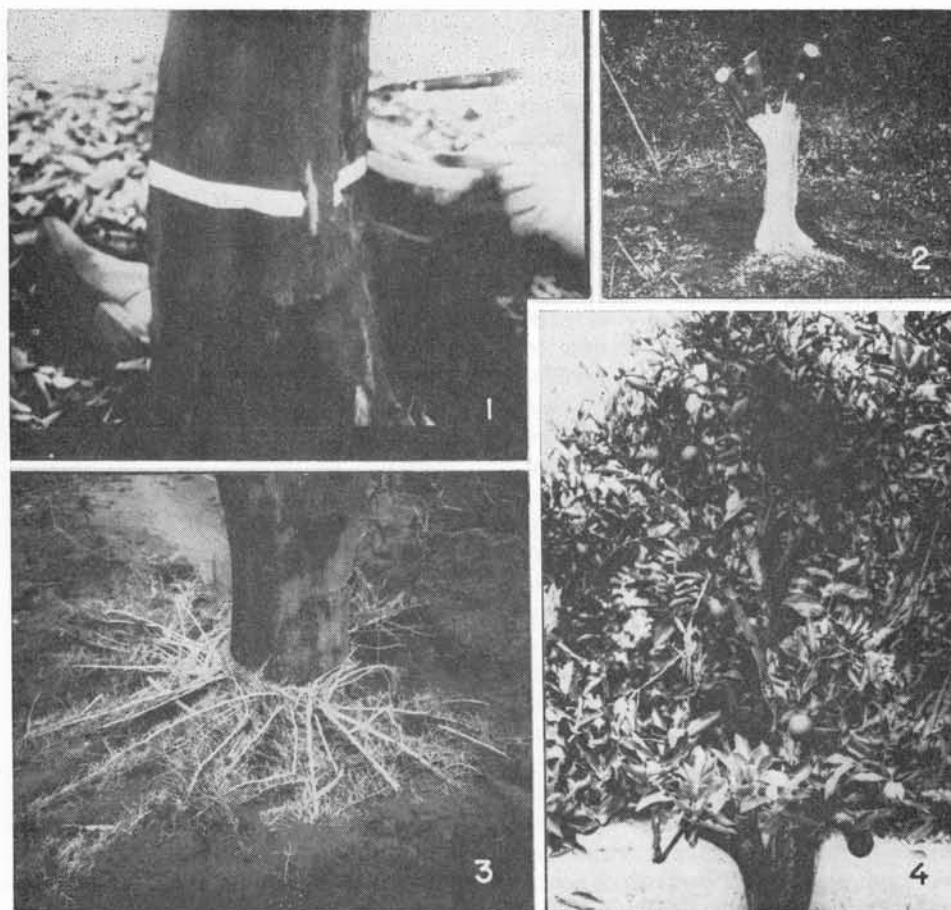


Fig. 1. Wounds in the trunk of declinio-affected Valencia trees on Rangpur lime rootstock to induce scion-rooting.

Fig. 2. Declinio-affected tree treated for scion-rooting plus severe pruning as an attempt to induce recovering of diseased trees.

Fig. 3. Roots developed in 30 months on 10-year-old declinio-affected trees treated by scion-rooting alone. Roots were uncovered for observation.

Fig. 4. Appearance of a declinio-affected tree 28 months after treatment by scion-rooting plus severe pruning, bearing normal fruit.

eased trees in which the inarching was successful had improved appearance on the side where the Caipira inarch had developed well. It is too soon to draw any conclusions. If the method induces satisfactory recovery of declinio-affected trees, it will still require more study and modifications for more rapid results.

Preventive scion-rooting. Observations made in April 1983 showed that about 1-2% of the treated trees as well as the control trees showed early visual symp-

toms of declinio in all trials. This method, which seems to be satisfactory for declinamiento in Argentina was unsuccessful in preventing declinio under our experimental conditions in Barretos and Conchal.

Scion-rooting declinio-affected trees to induce recovery. The scion roots of the treated trees showed reasonable development when they were uncovered for observation in 1981, two years after treatment. Nevertheless, they showed the same or worse declinio symptoms than they did when they were

treated. Under the experimental conditions, in no case has any recovery been observed (fig. 3).

Scion-rooting plus severe pruning. Table 1 shows the growth and the amount of fruiting of the trees that were treated by scion-rooting plus severe pruning at six different times of the year.

Of 60 treated trees, six were judged to have had poor growth, 52 had good normal growth and two had excellent growth. Only the trees that were treated in December 1980 and February 1981 were bearing normal fruit on six and ten trees, respectively. The other trees, that were treated later, were not yet bearing fruit, but had good growth. All the trees treated in February 1981 showed the best performance. Two of the 10 trees of that group showed excellent growth and were bearing 111 and 96 normal, good-sized fruit respectively. Many of the treated trees as well as the untreated ones showed zinc deficiency leaf symptoms. (fig. 4).

The trees in the trial did not receive any special sprays, except those normally applied in the whole orchard. Zinc, manganese, boron were added as minor elements in the normal pesticide sprays.

The fact that the treatment made in February, gave better results than that applied in Decem-

ber cannot be explained by rainfall, since the experimental area has been irrigated at the grower's discretion by an overhead irrigation system since 1974. In 1980, it was irrigated once in July, twice in August, once in September and twice in November; in 1981, once in July, twice in August, twice in September; in 1982, once in July, once in August, twice in September. In each application the equivalent of 55 mm of rain was delivered. The natural rainfall distribution was as follows: June to December 1980—769.3 mm; January to June 1981—576.5 mm; July to December 1981—723.5 mm; January to June 1982—786.5 mm.

The cost of formation of a scion-rooted and pruned tree is about 35% less than that of a replant. The treated trees produced 2½ years earlier than the replants.

Of all the methods tested in this series of trials, only inarching with sweet orange seedlings and scion-rooting plus severe pruning of diseased trees seem promising. The inarching method used here takes too long time to show satisfactory results. Although the results of combining scion-rooting and pruning seem more promising, 28 months after treatment, it is too soon to recommend this method to the growers. If after further evaluation, the method still proves satisfactory, it might be a valu-

TABLE 1
GROWTH AND FRUITING OF TREES TREATED BY SCION-ROOTING AND SEVERE PRUNING, AS OBSERVED IN APRIL 1983, IN 10 TREES FOR EACH GROUP

Treatment dates	Growth			No. of fruiting plants	Total no. of fruits
	poor	good	excellent		
Dec. 4, 1980	2	8	0	6	54
Feb. 26, 1981	0	8	2	10	317
May 7, 1981	2	8	0	0	0
Jun. 29, 1981	1	9	0	0	0
Sep. 1, 1981	0	10	0	0	0
Dec. 10, 1981	1	9	0	0	0

able procedure for orchards in regions where decline is causing high economic losses.

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