

Evaluation of Possible Recovery of Declinio-Affected Citrus Trees

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ABSTRACT. For one year beginning in December 1980, groups of the declinio-affected 12-yr-old Valencia sweet orange trees on Rangpur lime were scion-rooted and severely pruned every 2 months in an attempt to induce recovery. Sixty treated and ten untreated diseased trees were used. After 2 yr some of the first treated trees were well formed and fruiting abundantly, and showed no symptoms of declinio. In May 1986, 4.5 to 5.5 yr after treatment, the root systems of the 60 trees were uncovered by water jets for observation and evaluation. Ten of the 60 trees were affected by *Phytophthora* gummosis or sunburn and were not evaluated. Of the remaining 50 trees, 20% were not scion-rooted, 48% had an established scion-root system and 32% were partially scion-rooted. Canopy appearance and production for scion-rooted and nonscion-rooted trees were similar although there was no water uptake in any of the treated trees, with one exception. Water flow in secondary roots of sweet orange roots was higher than in Rangpur lime. Results indicated that severely pruned trees recovered even when they did not develop scion roots. Scion rooting does not seem to enhance recovery of declinio-affected trees. More observation will be needed to show whether severely pruned trees will remain free from declinio and if the scion-rooted trees will recover. Preventive scion rooting did not reduce the incidence of declinio.

Index words. Blight, scion rooting, root water flow, xylem plugging.

In previous papers, results of surveys in the State of São Paulo (4) showed that citrus trees grafted on sweet orange rootstock are not affected by declinio. Such observations were confirmed by experiments carried out in 1985 based on three main parameters for declinio diagnosis: visual symptoms, water absorption by syringe injection in the field, and percentage of amorphous plugs obstructing vessels. The experiments showed that trees on sweet orange and Sunki tangerine rootstocks are tolerant to declinio, those on Cleopatra mandarin have intermediate tolerance, and plants on rangpur lime are highly susceptible (1, 2, 3). Scion rooting, was tried successfully in some orchards in Argentina (J. Krausemann, personal communication) as both preventive and curative methods for declinamiento, a disease similar to declinio in Brazil, and to blight in Florida.

Because of this information, a series of experiments was started in

Brazil, including scion rooting as preventive and curative methods for declinio (5, 6, 7, 8).

The first experiments were carried out in the Barretos area, State of São Paulo, since 1979, by simply scion rooting 8-yr-old Valencia sweet orange trees on rangpur lime rootstock showing initial to intermediate symptoms of declinio. Roots were uncovered 30 months later for observation. Although the scion roots of treated trees showed reasonable development, the treatment was unsuccessful. The trees were badly affected, some died and the disease seems to have followed its normal course (7).

In 1980, three experiments were carried out to scion root apparently healthy trees in the Barretos region as a preventive method, as had been done in Argentina (5, 6). At the same time another experiment was carried out in Conchal, in which Valencia trees on rangpur lime rootstock showing early declinio symptoms were scion rooted and severely pruned to induce recovery (5, 7).

In this paper, evaluation of the preventive and curative effects of scion-rooting adult trees is presented.

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MATERIAL AND METHODS

Preventive scion rooting. The method, as described in a previous paper (5) consisted of scion rooting 42 6-yr-old healthy trees of Hamlin sweet orange on trifoliolate rootstock from an apparently healthy orchard in the Barretos area. Forty-two control trees were not scion rooted. Treated and control trees were in alternate rows of the same orchard. The same method was applied to 246 nine and 14-yr-old healthy Valencia on rangpur lime trees in two other orchards affected by declinio. These experiments were carried out in September-October 1980.

In April 1986 visual symptoms were observed. Some of the treated trees had their root systems uncovered for observation. Segments of Hamlin scion and trifoliolate orange roots in one experiment and of the Valencia scion and rangpur lime roots in the other experiments were collected for laboratory water-flow tests.

Scion rooting plus severe pruning for recovery from declinio. This experiment was carried out in the Conchal area to establish a better physiological equilibrium between the new root system induced by scion rooting and the newly-developing canopy (6). Sixty declinio-affected 14-yr-old Valencia orange trees on rangpur lime rootstock were treated in groups of 10 trees every 2 months from December 1980 to December 1981. The trunks were whitewashed to protect them against sunburn and new shoots were thinned three times. First observations were made in October 1982 and April 1983, and yearly thereafter for visual symptoms, fruit production, and occurrence of *Phytophthora* root rot. In 1985 and 1986, fruit production was determined for each treated tree.

In April 1986, root-systems of all treated trees were uncovered by water jets for careful observation. Segments of Valencia and rangpur lime roots were collected for labora-

tory water-flow tests. Water absorption by syringe injection in the field was measured for all the treated trees and for some control replant trees in the same orchard. Wood trunk samples were collected for evaluation of amorphous plugs in the vessels.

RESULTS AND DISCUSSION

Preventive scion rooting. A total of 246 scion-rooted Valencia on rangpur lime trees in two declinio-affected orchards of the Barretos area were carefully observed for visual symptoms.

In April 1986, visual canopy symptoms were recorded on a scale of 0=healthy, to 5=very severe symptoms or dead trees. The number of trees for each rating was 0—85; 2—13; 3—14; 4—11; 5—35; (33—dead). Declinio incidence in untreated trees in the same orchard was similar to that in scion-rooted trees. The treatment did not prevent declinio although the roots from the scion seemed fairly well developed.

In the other experiment, originally healthy Hamlin sweet orange on trifoliolate trees of a healthy orchard, which had been scion rooted in 1980 when they were 6 yr old, showed a high incidence of declinio in 1986. These trees were compared with the 42 nontreated trees of alternate rows in the same orchard.

Using the same rating method as described above, declinio was evaluated and showed that only 24 treated trees and 23 control trees remained healthy (table 1). Six treated and 15 control trees were killed by the disease.

Root segments collected in both experiments were subjected to laboratory water-flow tests. Results were erratic (table 2). Each data set is the mean of five readings. The only consistent results, comparable with similar tests applied in previous experiments, were obtained with root segments of rangpur lime roots, which showed much lower water-flow rate in diseased than in healthy trees.

TABLE 1
EVALUATION OF PREVENTIVE SCION
ROOTING OF 6-YR-OLD HAMLIN SWEET
ORANGE TREES ON TRIFOLIATE ROOT-
STOCK 6 YR AFTER TREATMENT^z

| Declinio rating ^y | No. of trees | |
|---------------------------------|--------------|---------|
| | Scion-rooted | Control |
| 0 | 24 | 23 |
| 1 | 3 | 1 |
| 2 | 2 | 2 |
| 3 | 3 | 1 |
| 4 | 2 | 0 |
| 5 | 2 | 0 |
| Dead | 6 | 15 |

^zDate of treatment—September 1980; date of rating—April 1986.

^yRated on a scale of 0 = healthy to 5 = severe.

Scion rooting plus severe pruning for recovery. Observation of visual symptoms did not reveal declinio occurrence in the treated trees, although some of them had better growth than others. Ten were affected by *Phytophthora* root rot and were disregarded. Only one of 60 trees showed some water absorption (8.5 ml in 30 sec) by the syringe water injection test. Controls consisting of apparently healthy 4-yr-old trees in the same orchard absorbed 8.0 to 10.0 ml in 30 sec. The 10 untreated control declinio-affected trees showed severe symptoms.

When the root systems were uncovered, some of the trees showed total development of Valencia roots

TABLE 2
EVALUATION OF PREVENTIVE SCION ROOTING ON 14-YR-OLD VALENCIA ORANGE ON RANGPUR LIME AND 6-YR-OLD HAMLIN SWEET ON TRIFOLIATE ORANGE ROOTSTOCKS BY WATER FLOW THROUGH ROOT SEGMENTS

| Tree | Water-flow rates (ml/cm ² /min) ^z | | | | | | | |
|--------|---|-------|---------|-------|----------------------------|-------|---------------------|-------|
| | Valencia/rangpur lime | | | | Hamlin/trifoliolate orange | | | |
| | Valencia | | rangpur | | Hamlin | | trifoliolate orange | |
| | H ^y | D | H | D | H | D | H | D |
| 1 | 15.10 | 57.37 | 28.89 | 15.55 | 16.19 | 20.83 | 9.18 | 3.47 |
| 2 | 43.50 | 9.11 | 43.22 | 7.70 | 30.42 | 20.02 | 23.31 | 20.48 |
| 3 | 30.14 | 3.33 | 44.78 | 1.33 | 45.45 | 31.54 | 35.42 | 13.77 |
| Means: | 29.58 | 23.27 | 38.96 | 8.19 | 30.69 | 24.13 | 22.64 | 12.57 |

^zData collected 6 yr after treatment. Means of replications for each tree.

^yH = roots from healthy trees; D = roots from declinio-affected trees.

TABLE 3
EVALUATION OF RECOVERY OF 14-YR-OLD DECLINIO-AFFECTED VALENCIA ORANGE ON RANGPUR LIME TREES AFTER SCION ROOTING PLUS SEVERE PRUNING

| Treatment date ^z | Tree condition | No. of scion-rooted trees ^z | | | No. of fruit per tree | |
|--------------------------------|-------------------|--|---------|------|-----------------------|-------|
| | | Total | Partial | None | 1985 | 1986 |
| Dec. 4, 1980 | 0.8 | 6 | 2 | 0 | 124.9 | 107.8 |
| Feb. 16, 1981 | 0.5 | 2 | 2 | 5 | 115.6 | 110.2 |
| May 7, 1981 | 0.5 | 0 | 3 | 5 | 91.5 | 91.4 |
| June 6, 1981 | 0.0 | 5 | 2 | 0 | 72.3 | 132.0 |
| Sept. 1, 1981 | 0.0 | 6 | 3 | 0 | 141.1 | 129.9 |
| Dec. 10, 1981 | 0.5 | 5 | 4 | 0 | 83.9 | 136.4 |
| | | 24 | 16 | 10 | | |

^zTen trees treated on each date. The missing trees were affected by *Phytophthora* root rot and were discarded. Rating was made in April 1986.

^yMean rating from 0 = excellent aspect to 5 = severe decline.

all around the trunk, others showed only partial development in one to two-thirds of the trunk periphery, and others, surprisingly, showed no scion-root formation. Table 3 shows data of the evaluation of the following parameters: general aspect of the trees rated from 1 (excellent aspect) to 5 (almost dead); numbers of trees with total, partial, or no scion rooting, and mean number of fruit per tree produced in 1985 and 1986. Table 4 shows the number of trees per scion-rooting group and their 1980 production, evaluated in April 1986.

The trees of this experiment will continue to be observed for visual symptoms of declinio. Results so far obtained lead to the following conclusions:

- 1) Since 16.0% of the treated trees did not develop scion roots, but showed apparently good recovery, scion rooting seems unnecessary and only drastic pruning and thinning favored a fair recovery at least for the first 5 yr.
- 2) Trees pruned in September 1981 showed higher production.

TABLE 4
RECOVERY OF DECLINIO-AFFECTED 14-YR-OLD VALENCIA ORANGE TREES ON RANGPUR LIME AFTER SCION ROOTING PLUS SEVERE PRUNING: COMPARISON OF DEGREE OF SCION ROOTING AND FRUIT PRODUCTION

| Scion Rooting ^y | No. of trees ^z | No. of fruit | |
|----------------------------|---------------------------|--------------|-------|
| | | Total | Avg. |
| Total | 24 | 2725.0 | 113.5 |
| Partial | 16 | 1561.0 | 97.6 |
| None | 10 | 998.0 | 99.8 |
| Root-rot | 10 | — | — |

^yTen trees treated every 2 months from December 1980 to December 1981. Total no. of trees = 60. Rating made in April 1986.

^zTotal = scion-rooted all around the trunk; Partial = scion-rooted only on part of the trunk; None = no scion-rooting.

- 3) The presence of amorphous plugs does not indicate continued good tree health.
- 4) If recovery is confirmed in some of the totally scion-rooted trees in the future, Valencia trees grafted on Valencia sweet orange rootstocks should remain free of declinio symptoms, as suggested (1).

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