# Control of Citrus Greening and its Psylla Vector by Trunk Injections of Tetracyclines and Insecticides

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The incidence of citrus fruit greening (*5, 9*) was reduced considerably by trunk injections of tetracyclines into severely affected trees (*10*). Control of the causal organism must be combined with a simultaneous control of its psylla vector. Methods have been formulated (*1, 2*) for psylla control in South Africa by means of insecticide sprays. Insecticides may also be applied effectively to woody plants by trunk injections (*8*). Literature on controlling diseases and pests through plant injections is scant. Previous attempts at such disease control have been described by May (*6*), Dunegan and Wilson (*3*), Moll (*7*) and Dunegan *et al.* (*4*); and at insect control, by Morris (*8*). Although insecticide injections may not entirely replace spraying for the control of psylla, they might replace at least one spray when included with the antibiotic application.

We report on experiments to determine: (1) proper dosages and timing of tetracyclines for the control of greening; (2) the possibility of combatting psylla by trunk injections of insecticides; and (3) phytotoxicity associated with injections of insecticides and tetracyclines.

## EXPERIMENTS AND RESULTS

In all three experiments, substances were injected by means of a modified blowlamp (fig. 1) as described by Schwarz and van Vuuren (*10*).

**Fig. 1. Modified blowlamp injector.**

**Experiment 1.** Table 1 illustrates the effect of tetracycline injection treatments on the incidence of fruit greening in the two years following treatment in September. Data through 1971 were reported earlier (*10*). A comparison of the greening incidence during the first and second years after treatment shows that the effect persisted into the second year.

**Experiment 2.** Table 2 shows results of a small experiment carried out in September to determine the effectiveness of two additional mycoplasmastats, demethyl chlortetracycline HCl (DM-CTC) and Tylan. Results indicate that demethyl chlortetracycline HCl is effective against the causative organism of greening, whereas Tylan is ineffective.

**Experiment 3.** Table 3 gives the results of a large-scale trial involving a group of 446 Valencia sweet orange trees uniformly infected with greening. Incidence of fruit greening before treatment was between 25 and 30 per cent. Trees were injected with penicillin and

TABLE 1

PERCENTAGE OF SEVERE FRUIT GREENING IN SEVEN-YEAR-OLD VALENCIA ORANGE TREES BEFORE AND AFTER TREATMENT WITH VARIOUS TETRACYCLINES AND INSECTICIDES

| Treatment and amount* | Mean % fruit greening in five trees in: | | |
|---|---|---|---|
| | 1970 Before treat. | 1971 After treat. | 1972 After treat. |
| Tetracycline hydrochloride: | | | |
| 250 ppm | 60.3 | 22.5 | 19.7 |
| 500 ppm | 62.7 | 13.0 | 11.0 |
| 750 ppm | 63.2 | 15.3 | 21.2 |
| Oxytetracycline hydrochloride, animal formula: | | | |
| 250 ppm | 61.2 | 32.3 | 32.1 |
| 500 ppm | 62.7 | 42.8 | 43.8 |
| Chlortetracycline, 750 ppm | 61.6 | 46.7 | 39.6 |
| Tetracycline/chloramphenicol, 750 ppm/750 ppm | 61.7 | 40.4 | 47.2 |
| Cycocel (2-chloroethyl trimethyl-ammonium hydrochloride), 1,000 ppm | 63.6 | 66.3 | 54.2 |
| Control, water | 63.4 | 59.0 | 48.7 |

* All materials were injected in 1 liter aqueous solution.

three different tetracyclines—tetracycline hydrochloride (Cyanamid), oxytetracycline hydrochloride (Pfizer), and chlortetracycline hydrochloride (Cyanamid)—each at two dosage levels.

Compared with experiments 1 and 2, the treatments appear rather ineffective, probably because dosages were too low for the greater volume of trees in experiment 3. Data indicate that the greatest decrease in incidence of fruit greening was obtained with an application of 1 liter of a 1,000-ppm tetracycline HCl solution per tree during the September flush. The treatments carried out in July and November were less effective. Oxytetracycline also was effective, whereas chlortetracycline and

TABLE 2

PERCENTAGE OF SEVERE GREENING IN FIVE-YEAR-OLD VALENCIA ORANGE TREES BEFORE AND AFTER TREATMENT WITH VARIOUS TETRACYCLINES AND INSECTICIDES

| Treatment and amount* | Mean % of fruit greening in five trees in: | |
|---|---|---|
| | 1971 Before treatment | 1972 After treatment |
| Tetracycline hydrochloride, 250 ppm | 60.0 | 20.0 |
| Demethyl chlortetracycline, 250 ppm | 49.5 | 23.3 |
| Tylan (87% tylosin tartrate), 250 ppm | 33.8 | 46.9 |
| Control, water | 55.4 | 67.4 |

* All materials were injected in 1 liter aqueous solution. Lannate, 0.1 gm, was added to the injected solution in all treatments.

TABLE 3

PERCENTAGE OF SEVERE FRUIT GREENING IN 45-YEAR-OLD VALENCIA ORANGE TREES BEFORE AND AFTER TREATMENT WITH VARIOUS TETRACYCLINES AND INSECTICIDES

| Treatment and amount* | No. of trees | Month of application | Mean % fruit greening in: | | Difference |
|---|---|---|---|---|---|
| | | | 1971 Before treat. | 1972 After treat. | |
| Tetracycline hydrochloride: | | | | | |
| 1,000 ppm | 40 | July | 27.2 | 24.3 | – 2.9 |
| 1,000 ppm | 51 | Sept. | 29.5 | 19.3 | –10.2 |
| 1,000 ppm | 40 | Nov. | 26.5 | 25.5 | – 1.0 |
| 750 ppm | 51 | Sept. | 29.2 | 22.7 | – 6.5 |
| Chlortetracycline hydrochloride: | | | | | |
| 1,000 ppm | 51 | Sept. | 27.1 | 29.9 | + 2.8 |
| 750 ppm | 50 | Sept. | 25.0 | 27.3 | + 2.3 |
| Oxytetracycline hydrochloride, | | | | | |
| 1,000 ppm | 51 | Sept. | 27.6 | 20.6 | – 7.0 |
| 750 ppm | 51 | Sept. | 22.3 | 20.6 | – 1.7 |
| Penicillin, 1,000 IU | 11 | Sept. | 30.5 | 34.5 | + 4.1 |
| Control, water | 50 | Sept. | 26.6 | 29.8 | + 3.2 |

* All materials were injected in 1 liter aqueous solution.

penicillin had no effect on the incidence of fruit greening. This experiment should be repeated with higher levels of tetracyclines.

The uptake of antibiotic solutions varied from tree to tree depending on the time of application. For instance, 1 liter of a 1,000-ppm tetracycline HCl solution could be injected in a period of about 2 hours in September, whereas it took from 6 to 8 hours in July. This indicates that the injected solutions are taken up better and probably translocated better during periods of high metabolic activity. An advantage of injecting during the September flush period is that young fruits are developing, and the tetracyclines inhibit the growth of the causative organism during this decisive stage in greening development.

**Experiment 4.** A preliminary trial was designed to assess phytotoxicity of tetracyclines and insecticides as well as the efficacy of injecting insecticides. Injections were made by gravity-feeding the solutions through a section of polythene tubing into a hole drilled in the trunk of the tree. After treatment, the hole was closed with a tree-sealing compound. Tetracyclines listed in table 3 were injected in quantities of 1.0 and 0.1 gm. Insecticides used were: dimethoate (27.0 and 2.7 gm); methomyl (5.9 and 0.59 gm); Du Pont 1410 (4.4 and 0.44 gm); Azodrin (9.7 and 0.97 gm); Foremetomate (10.7 and 1.07 gm); Chlorphenamidone (6.7 and 0.67 gm); and Phorate (10.7 and 1.07 gm).

No phytotoxicity was observed with any of the materials. Insecticides, at both dosages, reduced psylla and aphid populations for 3 to 4 weeks, after which a rapid buildup of these insects occurred. Azodrin was most promising even though assessment was only semiquantitative.

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