

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), Dune-

gan and Wilson (3), Moll (7) and Dune-gan *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).

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



Fig. 1. Modified blowlamp injector.

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 applica- tion	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 semi-quantitative.

LITERATURE CITED

1. BUITENDAG, C. H.
1970. Bestryding van die lemoen bladvlooi *Trioza erytreae* (Del G.) (Control of citrus psylla *Trioza erytreae*). S. African Citrus Jour. **437**: 9, 11.
2. CATLING, H. D.
1969. The control of citrus psylla, *Trioza erytreae* (Del Guercio) Homoptera: Psyllidae. S. African Citrus Jour. **426**: 9, 11, 13, 15, 16.
3. DUNEGAN, J. C., AND R. A. WILSON
1953. Some effects resulting from the introduction of antibiotics into fruit trees. Phytopathology **43**: 405.
4. DUNEGAN, J. C., R. A. WILSON, AND W. T. MORRIS
1953. Effects of terramycin on peach trees affected with bacterial spot. Plant Dis. Repr. **37**: 604-05.
5. LAFLÈCHE, D., AND J. M. BOVÉ
1970. Structures de type mycoplasma dans les feuilles d'oranges atteints de la maladie du "greening." Compt. rend. Acad. Sci., Ser. D., **270**: 1915-17.
6. MAY, C.
1941. Methods of tree injection. Trees **4**: 7, 10-12, 14, 16.
7. MOLL, J. N.
1974. Fluorimetric determination of antibiotic residues in citrus trees injected with tetracycline hydrochloride, pp. 198-201, this volume.
8. NORRIS, D. M.
1967. Systemic insecticides in trees. Ann. Rev. Ent. **12**: 127-48.
9. SCHWARZ, R. E.
1970. Comparative indexing of the annual and seasonal incidence of greening in sweet orange fruit by external symptoms and by the albedo fluorescence test. S. African Jour. Agr. Sci., Phytophylactica **2**: 1-16.
10. SCHWARZ, R. E., AND S. P. VAN VUUREN
1971. Decrease in fruit greening of sweet orange by trunk injection of tetracyclines. Plant Dis. Repr. **55**: 747-50.