# Chemotherapy of Cherry Buckskin and Peach Yellow Leafroll Diseases: An Evaluation of Two Tetracycline Formulations and Methods of Application

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**ABSTRACT**

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Two formulations of tetracycline, *N*-pyrrolidinomethyl tetracycline and oxytetracycline hydrochloride, were tested for their efficacy by high-pressure or syringe injection on cherry trees affected with buckskin disease and by high-pressure, syringe injection or gravity bag infusion on peach trees affected with yellow leafroll (PYLR). The trees were treated in August 1983 and evaluated before harvest in 1984. The disease rating of cherry trees affected with buckskin disease was reduced from severe to mild by both antibiotic formulations when 4 g a.i. was injected per tree, providing economic control. When peach trees affected with PYLR were injected with 2 g a.i. of antibiotic per tree, the average disease rating of the trees was reduced from severe to moderate by high-pressure injection, syringe injection, and gravity bag infusion of both formulations. No significant differences in efficacy were found between the two tetracycline formulations or between the method of application in either cherry or peach. Three grams active ingredient of either formulation will provide economic control of PYLR disease in peach.

In California, two of the most destructive diseases of stone fruits are cherry buckskin (8) and peach yellow leafroll (PYLR) (6); both diseases are caused by strains of X-disease (3,5). Strains of the causal agents of these diseases also are found elsewhere (3). These diseases cause yield reduction, lower fruit quality, and tree death. Cherry buckskin has eliminated cherry growing in several areas of California and threatens to do so in additional areas (7).

The etiological agent of each disease is presumed to be a phloem-limited mycoplasmalike organism. Mycoplasma diseases are known to be ameliorated by tetracycline injections of affected trees, e.g., oxytetracycline hydrochloride (OTC) for control of pear decline (4; B. C. Raju and G. Nyland, *unpublished*) and peach X-disease (9,10; B. C. Raju and G. Nyland, *unpublished*). Control of pear decline in the United States by the use of OTC is approved. The use of OTC applied by high-pressure injection for control of mycoplasma diseases in cherry and peach has been done under temporary permits. Recently, in South Africa, another tetracycline in a soluble formulation, *N*-pyrrolidinomethyl tetracycline (PMT), was tested and is currently used for control of greening disease of citrus (2). Its high solubility and low phytotoxicity permit treatment of citrus trees with a syringe and low volumes of water to carry the antibiotic solution (2).

In August 1983, a series of experiments was initiated to compare the efficacy of the two soluble formulations of tetracycline, PMT and OTC, applied by different methods: high-pressure (9) and syringe injection (1) for cherry buckskin; and high-pressure, syringe injection and gravity bag infusion (4) for PYLR.

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## MATERIALS AND METHODS

**Tree selection.** Sweet cherry trees (*Prunus avium* L. cv. Bing) in San Joaquin County, California, chronically affected with buckskin with all parts of the trees showing fruit symptoms, and peach trees (*P. persica* (L.) Batsch cv. Tufts) in Sutter County, California, showing typical symptoms of PYLR in all parts of the trees, were selected for the injection experiments. Cherry trees were 20 yr old on Mazzard rootstocks and peach trees were 10 yr old on Lovell seedling rootstocks. Individual test trees of cherry were rated visually for symptoms on a scale of 0–3, where 0 = healthy, 1 = mild, 2 = moderate, and 3 = severe. Criteria used were canopy density, number of fruit showing symptoms, limb dieback, and proximity to death of a quadrant or entire tree. Each quadrant of each cherry tree was rated, and the ratings were totaled, then divided by four to give an average rating value for each tree. The peach trees were rated on the appearance of the whole tree, using the same numerical scale based on the same criteria. Test trees of both peach and cherry, including controls, were selected for use from trees rated 3 immediately before the trees were treated in August 1983 after the current-season's crop, if any, had been harvested. All trees were rated again in summer 1984 just before fruit harvest.

**Application of materials.** The two tetracycline formulations tested were PMT (supplied by E. F. Schulze and produced by Hoechst South Africa LTD) and OTC (Terramycin; pear decline formulation supplied by V. Carroll of Pfizer, Inc.). Aqueous solutions of these antibiotics were introduced into the trunks of the trees.

High-pressure injection was performed with a hydraulic injector powered by compressed nitrogen gas as described by Reil and Beutel (9). Syringe injection was done as previously reported (1,2) and as follows: Holes about 2.5 cm deep were drilled with a 3.8-mm-diameter drill bit on a smooth section of the bark of the trunk or main scaffold limb. Plastic syringes, 30-ml capacity with a luer tip, were filled with the aqueous solution and hand pressure was applied to force the solution into the tree. Gravity bag infusion was carried out as previously described (4). All treatments were applied above the bud union.

Cherry trees affected by buckskin disease were injected with 2 L of either PMT or OTC solutions, each containing 2 g a.i./L, distributed equally through injection ports by high-pressure injection. Six to eight injection ports were used because of the number of branches and mature size of the trees. For applications with the syringe method, 4 g a.i. of PMT or OTC was dissolved in 60 ml of water, and 10 ml was injected through each of

six injection ports into each tree. The gravity bag method was not used in tests with cherry.

Peach trees affected by PYLR were injected with 2 g a.i., rather than the 3 g a.i. needed for optimum control, to facilitate detection of possible differences in efficacy of the two tetracycline formulations or methods of application. One liter of water containing 2 g a.i. of either PMT or OTC solution was injected through three or four injection ports into each peach tree by high-pressure injection. With the gravity bag infusion method, 1 L of PMT or OTC containing 2 g a.i. was infused into each tree, distributed equally through three holes 7 mm in diameter and 4–6 cm deep drilled into the trunk just below and in line with each main scaffold. For syringe injection, 2 g a.i. of PMT or OTC was dissolved in 60 ml of water; 10 ml was then injected through each of six injection sites into each tree. A summary of methods and dosage of chemicals used is presented in Table 1.

## RESULTS AND DISCUSSION

Both cherry and peach trees took up both formulations of tetracycline rapidly by high-pressure injection and syringe injection. Uptake of the dose by the tree was usually within 10 sec to 2 min. Applications by gravity bags in peach required one to several hours for uptake of the liter of solution. Diseased cherry and peach trees responded favorably to chemotherapy with both PMT and OTC. As a group, these trees showed restored overall vigor as evidenced by new growth on individual limbs. No phytotoxicity was observed on the foliage with either antibiotic. In most instances in cherry, all the fruit on the tree appeared normal in shape, size, and color; and in others, remission of fruit symptoms was clearly evident but not in all parts of the tree. We attribute the lack of uniform remission of symptoms in cherry to poor distribution of the chemicals in very large, many-branched trees.

The 4-g dosage applied to cherry trees affected by buckskin disease was expected to provide economic control of the disease (5; B. C. Raju and G. Nyland, *unpublished*). Economic control, as we use the term, is when $1–2 for the cost of treatment per tree results in the production of $100–200 of marketable fruit on a tree which, if not treated, would not produce any marketable fruit. All trees were rated 3 (severe) at the time of application of the antibiotics in 1983. The average rating of all trees in summer 1984 treated with PMT and for those treated with OTC was 1 (Table 1). Both antibiotics as well as both methods of application achieved economic control. There were no significant differences ($P = 0.05$) in disease ratings after treatment between antibiotics or among the methods of application. Growers and commercial applicators using OTC injected by high pressure achieved as good control as reported here if treatments were made according to our recommendations.

The peach trees affected with PYLR were treated with a dosage (2 g a.i.) below that needed to provide economic control (3 g a.i.) (5) to facilitate detection of differences in efficacy of the chemicals and methods. There were no significant differences ($P = 0.05$) in efficacy of either PMT or OTC or among the three methods of application (Table 1). Control trees rated 3 (severe) at time of application in 1983 were still rated 3 when evaluations were made in 1984. Trees in the surrounding area that were treated with 3 g a.i. OTC by a commercial high-pressure injector apparatus were rated 1 (mild) at the time of evaluation, thus demonstrating that 3 g a.i. OTC did indeed provide economic control.

Sometimes trees respond to wounding by oozing gum, and chemicals injected into the tree can cause necrosis of phloem and xylem tissues. In peach trees, there was no difference in amount of phloem and xylem necrosis occurring with any of the three methods of application. There was little or no gumming or necrosis in all instances. However, in cherry, more necrosis of xylem and phloem tissue occurred at the injection sites with the syringe method than with the high-pressure method. With the syringe method, a seal is made in the bark, allowing contact between chemical and phloem in the injection port. With the high-pressure method, a hollow lag screw (1 cm in diameter) is turned into the wood, thus preventing contact of the chemical with the bark. However, even with the high-pressure method, sometimes copious quantities of gum exude from the injured bark a few weeks after injection, especially if treatments are made before the middle of September. Treatments by high-pressure injection made between then and leaf fall cause little gumming in both peach and cherry. We have observed in previous studies that most injection ports from high-pressure injection seal over within 1 or 2 yr. Injection ports from the syringe method heal quicker, presumably because of their smaller size.

Syringe injection of antibiotics and other chemicals into trees is not now being used commercially in the United States. Syringe injection may merit consideration because of the advantages the method offers: low cost of equipment, rapidity of application, small injection ports that heal quickly, and the easy use of portable electric drills.

**Table 1.** Methods of application, dosage of *N*-pyrrolidinomethyl tetracycline (PMT) and oxytetracycline hydrochloride (OTC), and results of treatment for control of cherry buckskin and peach yellow leafroll (PYLR)

| Formulation | Number of trees[x] | Method of application[y] | | | Disease rating after treatment[z] |
|---|---|---|---|---|---|
| | | Pressure | Syringe (g/60 ml) | Gravity bag (g/L) | |
| Cherry buckskin | | | | | |
| PMT | 8 | 4 g/2 L | ... | ... | 0.9 ± 0.6 a |
| PMT | 7 | ... | 4 | ... | 1.0 ± 0.7 a |
| OTC | 2 | 4 g/2 L | ... | ... | 1.1 ± 0.7 a |
| OTC | 2 | ... | 4 | ... | 0.8 ± 0.7 a |
| No treatment | 6 | ... | ... | ... | 3.0 ± 0.0 b |
| PYLR | | | | | |
| PMT | 5 | 2 g/L | ... | ... | 1.6 ± 0.9 a |
| PMT | 5 | ... | 2 | ... | 1.6 ± 0.5 a |
| PMT | 3 | ... | ... | 2 | 1.7 ± 0.6 a |
| OTC | 5 | 2 g/L | ... | ... | 1.6 ± 0.5 a |
| OTC | 4 | ... | 2 | ... | 1.5 ± 0.6 a |
| OTC | 5 | ... | ... | 2 | 2.0 ± 0.7 a |
| No treatment | 5 | ... | ... | ... | 3.0 ± 0.0 b |

[x] Selected trees had an average disease rating of 3 (0 = healthy, 1 = mild, 2 = moderate, and 3 = severe symptoms) before treatment in August 1983.

[y] Dosage (a.i.) of tetracycline formulation per volume used per tree.

[z] Each tree was rated by quadrants using the scale of 0–3. The average of these four ratings was used as the rating for each tree. The mean disease rating ± the standard deviation for each treatment is given. All trees were rated 3 in 1983 before treatment. Control trees not treated in 1983 were all rated 3 when trees were evaluated in 1984. Mean separation within columns is by Duncan's multiple range test ($P = 0.05$).


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