Chemical Control of Avocado Root Rot and Stem Canker

Continuing Project: Year 3 of 4

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Benefit to the Industry

Effective control and management of Phytophthora root rot and stem canker can only be achieved by planting certified disease-free nursery stock, integrating cultural methods, orchard sanitation, use of tolerant rootstocks and chemical control. The likelihood of developing a rootstock which will be immune to these diseases is very remote owing to the nature of the pathogens involved. Several promising tolerant rootstocks are being developed, but without the use of an integrated management system, relying on these rootstocks alone as a means of controlling these diseases, will be of no avail. Phytophthora stem canker, which was previously uncommon in the California avocado industry, has now become second to Phytophthora root rot in being a major limiting factor to avocado production. This disease is becoming more prevalent in the cooler coastal production areas, where entire orchards have been found to be affected. This disease is also the most difficult of the two diseases to control and the disease can go unobserved for several years, while the pathogen slowly girdles the tree below soil level, until it is too late to take any remedial steps. So far there are no definite chemical control measures to manage this disease and several of the clonal rootstocks which are tolerant to Phytophthora root rot have been found susceptible to stem canker. Conventional methods of application of chemicals used to control Phytophthora root rot have not been successful in controlling stem canker in California.

Objectives

1. To refine and standardize topical and injection treatments for the control of both avocado root rot and stem canker**,** which are cost effective, efficient and not injurious to the tree.
2. To screen the efficacy of new and currently used products derived from phosphorous acid and other compounds as they become available, for use against these diseases.

Summary

Orchard Selection

A survey was made of orchards in the avocado production areas from San Diego County in the south to San Luis Obispo in the north, Cambria being the northern most area. It was imperative to identify orchards in which both diseases were not prevalent in the same orchard, and orchards which had not been exposed to chemical treatment, as the presence of both diseases and previous use of phosphorous acid, would confound the results. In October 2000 an orchard was found in the Cayucos area in which stem canker appeared to be prevalent. Routine isolations from affected trees, and symptoms confirmed that the stem canker pathogen was the cause of the disorder observed. During March of 2001 another two experimental sites were found in Ventura County, one in Montecito and the other

in Santa Rosa Valley. The Montecito site exhibited severe root rot pressure in young (2-3 years old) and mature bearing trees (>20 years old) and was selected as it had no previous record of chemical control. The Santa Rosa site appeared to be exclusively affected by stem canker. This is a 10 ac block of trees which was planted on virgin land in the early 1980s, and was comprised of trees with ratings of 0-5 (0= healthy; 5=dead). The high incidence of stem canker at this site and the one in Cayucos was indicative of infection which originated in the nursery, as both these sites were originally virgin land.

In 2002 it was decided to discard the site at Montecito comprising the non-bearing replants following the discovery that the soil on this site had an impenetrable layer of clay at a depth of 12 inches, which resulted in a high rate of mortality in spite of the treatments applied. Two new sites comprising newly planted Hass on Duke 7 were found in Santa Rosa Valley, to replace this trial. One of these sites is on an old avocado soil and the other on an old citrus soil. Treatment on these sites commenced during May, 2002.

Control Of Avocado Stem Canker

Cayucos Experimental Site: The following treatments were applied at this site:

1. Trunk injection* with 40% neutralized phosphorous acid.
2. Trunk injection with a neutralized commercial product (0-28-25).
3. Trunk injection plus soil drench application of 40% neutralized phosphorous acid.
4. Soil drench with 40% neutralized phosphorous acid.
5. Topical trunk application.

The treatments commenced in the fall of 2000 and were repeated in the spring and fall of subsequent years.
(* Pressure injection using the Australian designed 'Sidewinder' knapsack injector)

Relatively mild winter temperatures and low rainfall at this site resulted in the lesions in the untreated controls to remain active in only 20% of the trees. Lesion severity has decreased in many of the treated trees with no significant differences being observed between methods of application**.** The mode of irrigation (drip) and the lack of leaf litter around the trunks appear to be non-conducive to disease development. The presence of the disease in this block appears to have had no detrimental effect on the condition of the canopies, irrespective of the treatments. Yield and fruit size will be measured during the fall of 2002 to evaluate the effect of the different treatments on these parameters.

Santa Rosa Site: The following treatments were applied at this site:

A. 'Sidewinder' Trunk Injection with:
1. Phitogard®
2. Phostrol®
3. ProPhyt®

B. Topical Trunk Application
1. Aliette®
2. Phitogard® (with and without exposure of lesions)*
3. Phostrol®
4. Ridomil® Gold EC (with and without exposure of lesions)

*(Lesions were exposed by removing all bark around the affected areas on the trunk using a hatchet)

Trunk injections were applied during the fall and spring of each year and topical trunk applications were applied during spring, summer and fall of each year, commencing in the fall of 2001.

The effects of treatment have been more dramatic at this site. Disease pressure appears to be considerably higher here and is influenced by the presence of high volumes of leaf litter around the trunks and use of sprinkler irrigation. A high percentage of the trees have been girdled by the disease at soil level to an extent of more than 50%. The

canopy ratings in all treatments have improved by approximately 1.0, with the ratings of the Ridomil treated trees being the lowest i.e the Ridomil treatments appear to be more effective. In spite of the improvement of the canopy condition in injection treatments, a high percentage of the lesions still showed activity. This also applied to topical trunk treatments in which the lesions were not exposed, with the exception of the Ridomil treatment. The most efficacious treatments appeared to be the Ridomil topical applications, with and without exposing the lesions, and the Phitogard applications with the lesions exposed. The dosage rate used for Ridomil was 10 ml per liter and that of the Phitogard a 1:1 dilution, to make up a 20% solution of phosphorous acid. It appears that Ridomil has the ability to penetrate the bark to a much higher degree than phosphorous acid, resulting in more effective control. Lesion activity was arrested in the Ridomil treated trees irrespective of whether the lesions were exposed or not. Prior to the initiation of this experiment the cooperator made use of passive gravity injection using unneutralized phosphorous acid. This treatment was unsuccessful, the trees continued to decline (many of which are dead) and severe damage was caused to the trees by chemical burn.

Table 1. Effect of trunk injection and topical trunk application of chemicals on the control of Avocado Stem Canker

	Canopy Rating (0-5; 5 = dead)*	
Treatment	05/16/01	09/05/02
Untreated control	2.5 a	2.4 a
Phitogard injection	2.4 a	1.6 b
Phostrol injection	2.4 a	1.3 b
Aliette topical	2.4 a	1.7 b
Phostrol topical	2.4 a	1.4 b
Phitogard topical	2.3 a	1.6 b
Phitogard topical (exposed)	2.5 a	1.6 b
Ridomil topical	2.7 a	1.0 b
Ridomil topical (exposed)	2.3 a	1.3 b

*****Mean values in each column followed by identical letters are not statistically different according to Duncan's Multiple Range Test (p = 0.05)

CONTROL OF AVOCADO ROOT ROT

Montecito site:

The trees selected for treatment at this site were 25 years of age and all had canopy ratings of 3-4 (0=healthy; 5=dead). The first treatment was applied in June, 2001, following this all trees were stumped to a height of 8 feet. Subsequent treatments were applied during the fall, spring and summer of each year. The following treatments were applied:

A. ' Sidewinder' Trunk Injection with:
   1. ProPhyt®
   2. Phitogard®
   3. Phostrol®
   4. 40% neutralized phosphorous acid

B. Macro injection using a 7/16" drill bit and squirting the chemical into 2" deep holes, using:
   1. Un-neutralized 0-60-0 phosphorous acid.
   2. Phitogard®.

C. Topical Trunk Application
   1. Phitogard®

The efficacy of the treatments was evaluated by counting the number and length of shoots which had developed subsequent to stumping and treatment, and rating the canopy vigor and density. The canopies of all treated trees exhibited enhanced vigor; the untreated controls were less vigorous exhibiting light green foliage color whereas the color of the foliage of the treated trees was dark green. The number and length and of shoots, and canopy density and vigor of the trees receiving pressure injection treatment was far superior to the trees which received the topical trunk sprays and passive, gravity (macro-injection) treatments. Mechanical damage to the bark of the trees which were treated with the un-neutralized source of phosphorous acid (0-60-0) was very severe compared with that of the trees treated with neutralized Phitogard. No damage was observed in the trees injected using the 'Sidewinder' injector. Phitogard and Phostrol injection appeared to stimulate more superior growth than ProPhyt and standard 40% neutralized phosphorous acid.

Table 2. Effect of phosphorous acid treatment using different modes of application on growth and vigor of mature avocado trees affected by avocado root rot, subsequent to stumping

Treatment	Pre-stump canopy rating	Post-stump canopy rating	No. of shoots	Length of shoots (cm)
Untreated control	3.9 a	1.0 b	9.5 a	38.7 a
Phitogard injection	3.6 a	0.0 b	16.0 b	66.4 b
ProPhyt injection	3.3 a	0.0 b	17.3 b	55.9 b
Phostrol injection	3.1 a	0.0 b	18.5 b	69.8 b
Phosphorous acid (40%) injection	3.9 a	0.0 b	19.6 b	58.0 b
Phitogard topical	3.9 a	0.0 b	9.1 a	37.6 a
0-60-0 (gravity)	3.8 a	0.0 b	12.1 a	51.4 a
Phitogard (gravity)	3.5 a	0.0 b	13.0 a	41.4 a

Mean values in each column followed by identical letters are not statistically significant according to Duncan's Multiple Range Test ($p = 0.05$)

Santa Rosa Site

Two sites were selected on the same farm viz. a new orchard of Hass on Duke 7 on an old avocado soil and a new orchard of the same combination on an old citrus soil. These sites were selected during April 2002 and the trees planted in May 2002. The first treatments were applied in May 2002. The treatments are applied at 8 weekly intervals and are as follows:

Foliar applications of:
- Nutriphite®
- ProPhyt®
- Phostrol®
- Messenger®

The untreated control trees in the trial on the old avocado soil are already exhibiting signs of disease stress. Height and canopy measurements were recorded at the initiation of this trial; this will be followed up annually, including canopy ratings.

GREENHOUSE TRIALS

Three new bio-pesticides viz. Messenger®, ISR 2000® and Agromos® are being tested in the greenhouse for efficacy against avocado root rot and stem canker. This experiment is being conducted on two-year old Hass on Zutano trees. One of these products viz. Messenger ® has already been tested on Topa Topa seedlings against avocado root rot, with good effect. This product appears to act synergistically with Aliette® and appears to be comparable to other products derived from phosphorous acid. These bio-pesticides elicit broad defense effects

involving systemic acquired resistance and are applied as foliar sprays. The three products mentioned above have all proved to be effective against Phytophthora diseases of row crops. These products are most effective when applied prior to infection, and as foliar applications, as the sites of action are located on the leaf surfaces.

Table 3. Effect of Messenger® on avocado root rot in Topa Topa seedlings

Treatment	% Diseased Roots	Disease Rating (1-5; 5 = dead)	Height differential (cm)
Uninoculated controls	6.3 d *	0.3 c	11.5 abc
Untreated inoculated controls	96.5 a	4.5 a	6.2 c
Aliette	60.0 bc	0.9 b	5.5 c
Phostrol	30.0 cd	0.0 c	14.3 a
ProPhyt	45.8 c	0.6 c	7.8 bc
Messenger	38.3 c	0.3 c	10.5 abc
Aliette/Messenger	27.5 cd	1.3 cd	6.7 c
Phostrol/Messenger	50.8 bc	0.3 c	13.2 ab
ProPhyt/Messenger	45.0 c	0.8 b	7.2 bc
Messenger drench	80.0 ab	2.0 d	9.8 abc
Aliette/Messenger drench	33.7 cd	1.0 b	8.3 abc
Phostrol/Messenger drench	50.8 bc	0.8 b	9.2 abc
ProPhyt/Messenger drench	44.2 c	0.3 c	8.2 abc

- Mean values in each column followed by identical letters are not statistically significant according to Fisher's LSD Comparison (p = 0.05)

Conclusions

Compared to avocado root rot, stem canker appears to be more difficult to control. The extent of disease development is not obvious when it occurs under soil level without evidence of cankers and conspicuous foliar symptoms being observed. Trees can be girdled by as much as 60 % without above ground symptoms being observed,with the result that it is often too late for remedial measures to be implemented. It has become apparent that the type of irrigation used and the accumulation of leaf litter around the base of the trunks of trees are factors which benefit disease development and progression. Observations have revealed that passive, gravity application of products derived from phosphorous acid, are ineffectual against avocado stem canker. Pressure injection appears to be more effective but still does not appear to arrest the cankers totally. The most effective treatment at present appears to be topical applications of either Ridomil® Gold EC or neutralized phosphorous acid. Ridomil can be applied directly to the trunk and lesions whereas phosphorous acid should be applied to lesions which have been exposed by removing the bark with a hatchet. The soil around the base of the trunk should also be drenched with the chemicals.

Pressure injection of neutralized phosphorous acid appears to be far more superior in its effect than passive, gravity applications of un-neutralized phosphorous acid. The latter also causes severe chemical burning of the bark and cambial tissues, and leaves large holes and dead tissues exposed to infection by casual secondary pathogens. The preliminary results of this study indicate that mature trees that are in a severe state of decline (rating 3-4) as a result of avocado root rot , can be successfully rejuvenated by a process of pressure injection- stumping - pressure injection.