FUMIGATION AND FALLOWING EFFECTS ON REPLANT PROBLEMS IN CALIFORNIA PEACH

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When peach and several other types of fruit and nut trees are replanted after a previous orchard is removed, the trees often grow slowly. Growers have learned that fumigation with methyl bromide reduces this "replant disorder" and the new trees are more vigorous and grow more uniformly. The causes of replant disorder have not been identified but are believed to result from a complex of major and minor soil-borne plant pests whose populations evolved with the previous orchard.

We are pursuing chemical and non-chemical strategies that reduce the replant problem in peach and plum. In another paper in these proceedings (Schneider, et al.) describes similar work in grapes. In this report, we describe the effects of fallowing and drip-applied fumigants on nematode populations and early tree growth. These field plot studies are being carried out at the USDA-ARS San Joaquin Valley Agricultural Sciences Center near Parlier, CA in field's with sandy-loam soils and long histories of orchards but no identified acute pathogen problems.

Methods - Fallow Studies. In many crops, fallow periods or crop rotations reduce populations of soil pests for the target crop. Studies were initiated in 1996 to quantify the benefits of fallow in a replant situation. Three row by 3 tree plots (60' x 50') were laid out in a randomized complete block design (4 replications). In studies 2a and 2b, trees were removed annually over 3 years in the fall. In studies 1 and 2, only zero (4 mo) and one-year (16 mo) fallow were compared. The fallow plots were ripped to 30" and maintained with winter cover (Merced rye, mowed in the spring) and left dry fallow in the summer. The trees in the remaining plots were maintained and harvested normally. All plots in a study were replanted simultaneously in February. The trees were replanted double density in both dimensions (5 rows x 5 trees plus borders). In study 3, in conjunction with Mike McKenry, UC-Riverside, the trees on a portion of the one-year fallow plots were cut down in September, the stumps immediately treated with 50 mL of Roundup® to accelerate root death, and the stumps removed in December.

Methods - Drip-Applied Fumigants. In some plots with zero or one-year fallow, 1,3-D (Telone®) and/or chloropicrin were applied in the fall through subsurface drip irrigation systems. This process, in which emulsified fumigants are applied with water through subsurface drip tape after a shallow surface water seal is sprinkled on, was described in detail in last year's Proceedings (Trout and Ajwa, 1999). The rates and treatments are given in the results tables.

All treatments were compared with standard methyl bromide shank fumigation under plastic mulch. Nematodes were sampled to 5 ft at planting and in the surface 2 ft annually thereafter. Plant growth was measured by trunk diameter 30 cm from the soil

surface, by pruning weights each fall, and by the weight of whole tops of removed trees. In study 1, we measured first year harvest weights of market-size fruit.

Results

Tables 1 - 5 show the initial results of the 4 studies in terms of nematode counts and tree growth. Pin nematodes were predominate with very few other species found. Although they are not commonly considered plant parasitic, the counts are used as indicators of effectiveness of the treatments. In all cases, methyl bromide and 1,3-D products eliminated the nematodes. In study 2a, the pin nematodes found in the chloropicrin plot may not have been viable. The herbicide root kill and lime urea treatments did not reduce nematode counts. Increasing fallow periods, especially 2 and 3 year, dramatically reduced counts. All nematodes found after 3 years of fallow were below 3 ft depth.

One year of fallow increased tree growth in all four studies, although the differences in individual studies were not statistically significant. Each additional fallow year in study 2a (plums) resulted in improved growth in the first year. Tree growth after 3 yrs fallow was nearly as good as with MeBr fumigation (with no fallow). In study 2b (peaches) the only trend was slightly increased growth with 2 and 3 yrs fallow, and MeBr gave much better growth than all fallow treatments.

The drip-applied Telone and Telone C-35 products always gave better growth than the no-fallow checks, and growth was not different than with MeBr in most cases. In study 1a where the Telone treatments were significantly smaller than MeBr, there may have been slight phytotoxicity in the initial months. By the third year, the differences are small. Also, this is the only treatment that used Telone without chloropicrin.

A interesting result in study 2a is that the best first-year growth was in soil drip fumigated with chloropicrin. This is the second time we have seen this result (McKenry, et al, 1998). Chloropicrin is not a good nematicide and has not been used for orchard replant. This may indicate that there are important aspects of the replant problem that are fungal based. Note that the Inline treatment in study 2a also contained chloropicrin.

In the oldest study (1a), although many of the differences are still significant, the relative differences in the treatments have gradually decreased over 3 years. This may indicate that the long-term effects of the replant problem are overestimated with measurements of pre-production trees. These studies will be continued through at least 4 years to quantify the effects on tree productivity.

Conclusions

These preliminary results indicate that increasing fallow periods reduce the replant disorder in most cases. One year gives some benefits, but even three years may not be sufficient to eliminate the problem. In conjunction with Greg Browne, we are seeking cover crops that may enhance the benefits of fallowing. Fallowing will be an expensive option for orchard crop growers, especially for crops like peaches that are replanted an average of every 7 years in California. Telone appears to be effective against the replant problem. It is known to be a good nematicide. The dramatic response with chlorpicrin fumigation is interesting and merits further study.

Table 1. Study 1a: Peach; Fall 1997 Fumigation with Spring 1998 Replant

Treatment	*Non-Fumigated*	*1-Yr. Fallow Non-Fum*	*Telone EC + Vapam*[1]	*MeBr Shank*[2]
Pin Nematodes *(per 100cc)* May 98 *(to 0.5 m depth)*	229	44	0	0
Pin Nematodes *(per 100cc)* June 99 *(to 1.5 m depth)*	160	400	0	0
Trunk Diameter *(mm)* Nov 98 *(% of MeBr)*	21.7 c[3] (58%)	26.8 bc (72%)	29.3 b (78%)	37.4 a
Trunk Diameter *(mm)* Dec 99 *(% of MeBr)*	39.8 c (63%)	50.0 b (80%)	53.5 b (85%)	62.8 a
Pruning Weight *(kg/tree)* Dec 99 *(% of MeBr)*	1.9 c (30%)	3.1 bc (49%)	3.9 b (62%)	6.3 a
Tree Weight *(kg/tree)*[4] Dec 99 *(% of MeBr)*	3.1 c (29%)	5.2 bc (49%)	7.1 b (67%)	10.6 a
Trunk Diameter *(mm)* Aug 00 *(% of MeBr)*	55.4 c (69%)	66.2 bc (83%)	73.4 ab (92%)	80.1 a
Market Yield *(kg/tree)* Aug 00 *(% of MeBr)*	6.7 b (68%)	7.2 b (73%)	9.1 a (92%)	9.9 a

[1] 35 gal/ac Telone II EC *(310 lb/ac 1,3-D)* drip-applied in 4" of water with 26 gal/ac Vapam microsprayed on the surface.
[2] 350 lb/ac deep shanked and covered with HDPE plastic
[3] like letters within a row indicate no significant differences at P<0.05.
[4] alternate rows of trees were removed and weighed.

Table 2. Study 2b: Peach; Fall 1998 Fumigation with Spring 1999 Replant

Treatment	*Non-Fumigated*	*1-Yr Fallow Non-Fum*	*Inline + Vapam*[1]	*MeBr Shank*
Pin Nematodes *(per 100cc)* June 99 *(to 1.5 m depth)*	479	89	0	0
Trunk Diameter *(mm)* Dec 99 *(% of MeBr)*	17.5 c (75%)	19.1 b (82%)	22.2 a (96%)	23.2 a
Pruning Weight *(kg/tree)* Dec 99 *(% of MeBr)*	0.09 b (30%)	0.13 b (43%)	0.24 a (80%)	0.30 a
Trunk Diameter *(mm)* Aug 00 *(% of MeBr)*	34.0 c (70%)	39.8 b (82%)	47.8 a (98%)	48.7 a

[1] 35 gal/ac Inline® (Telone C-35 EC) *(230 lb/ac 1,3-D + 130 lb/ac chloropicrin)* drip-applied in 3" of water with 13 gal/ac Vapam microsprayed on the surface.

Table 3. Study 2a: Plum; Long Term Fallow; Feb 2000 replant

Fallow Period (yr)	*0*	*1*	*1*	*2*	*3*	*0*
Additional Treatment			*Herbic*[2]			*MeBr*
Pin Nematode counts[1]	783	572	729	94	90	0
Trunk Diameter (8/00)	19.5 d[3]	21.7 cd	21.1 cd	22.4 bc	24.6 ab	25.9 a

[1] per 100cc; sampled 2/00 to 1.5 m
[2] herbicide treatment to stumps *(50 ml Roundup)* Sept 1, 1998, to accelerate root kill
[3] like letters within a row indicate no significant differences at $P < 0.05$

Table 4. Study 2b: Peach; Long Term Fallow; Feb 2000 replant

Fallow Period (yr)	*0*	*1*	*2*	*3*	*0*
Additional Treatment					*MeBr*
Pin Nematode counts[1]	114	132	43	5	0
Trunk Diameter (8/00)	19.5 b[2]	19.3 b	20.7 b	20.6 b	24.4 a

[1] per 100cc; sampled 2/00 to 1.5 m
[2] like letters within a row indicate no significant differences at $P < 0.05$

Table 5. Study 2a: Plum; Alternative Chemicals; Oct 1999 fumigation; Feb 2000 replant

Chemical Treatment	*None*	*None*	*None*	*Lime-Urea*[1]	*Chloro-picrin*[2]	*Inline*[3]	*MeBr shank*
Fallow Period (yr)	*0*	*1*	*1*	*1*	*1*	*0*	*0*
Additional Treatment			*----Herbicide root kill---* [4]				
Pin Nematode counts[5]	783	572	729	729	(180) [6]	0	0
Trunk Diameter (8/00)	19.5 e[7]	21.7 de	21.1 de	23.7 cd	29.5 a	27.5 ab	25.9 bc

[1] 500 lb/ac Urea + 20 lb/ac lime urea *(240 lb N/ac)* microsprayed onto the soil surface
[2] 300 lb/ac Chloropicrin EC subsurface drip-applied with 6" of water with 20 gal/ac Vapam microsprayed on the surface.
[3] 60 gal/ac Inline *(390 lb/ac 1,3-D + 225 lb/ac Pic)* subsurface drip-applied in 6" of water with 20 gal/ac Vapam microsprayed on the surface
[4] herbicide treatment to stumps *(50 mL Roundup + 100 mL MorAct)* Sept 1, 1998, to accelerate root kill
[5] per 100cc; collected 2/00, to 1.5 m
[6] all were tightly coiled and/or immobile
[7] like letters within a row indicate no significant differences at $P < 0.05$

References:

McKenry, M.V., B. Hutmacher, and T. Trout. 1998. Nematicidal value of eighteen preplant treatments one year after replanting susceptible and resistant peach rootstocks. Proc. Ann. Intern'l Research Conf on MeBr Alt and Emissions Reductions. pp 34.

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