Pest Management Grants Final Report

Contract #98-0281

EVALUATION OF ALTERNATIVES TO METHYL BROMIDE FOR SOIL FUMIGATION AT COMMERCIAL FRUIT AND NUT TREE NURSERIES

Principal Investigator:

Michael V. McKenry
University of California, Riverside
Located at UC Kearney Agricultural Center
9240 S. Riverbend Ave.
Parlier, CA 93648
Phone: (559) 646-6554
Fax: (559) 646-6593
E-mail: mckenry@uckac.edu

Contractor Organization:

California Association of Nurserymen

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ABSTRACT

An industry initiated effort to field evaluate methyl bromide alternatives in nursery settings is underway. As a result there are now two nursery trials with five and six replicated treatments each. The walnut nursery at Davis and peach nursery in Hickman now have enough funding to carry them to completion which is one full year at Hickman and two more years at Davis. At the time of this report we had collected nematode samples from each foot to five-foot depth from each replicate of each treatment. Data were also available from a Phytophthora bioassay at three soil depths as well as preliminary assessments of weed control. An attempt to expose wood pieces containing *Agrobacterium tumefaciens* was unsuccessful. The seeds planted into these sites are just beginning to sprout with no growth data available until harvest. The nematode sampling information already collected is adequate to identify successful treatments for the one-year nursery crops but these numbers will be verified with six-month soil sampling intervals until harvested. In the sandy loam soil having less than 12% soil moisture throughout the surface 5 ft there was success with: a) methyl bromide and chloropicrin (75/25) at 535 lb./acre, tarped; b) dual application of Telone C-35 at 500 lb./acre followed in 2 weeks with another150 lb./acre; c) 330 lb./acre 1,3-dichloropropene followed with a drench of 110 lb./acre metam sodium in 1.8 acre inches water; d) 330 lb./ acre 1,3-dichloropropene followed with application, incorporation, and intermittent delivery of 1.8 acre inches water onto 200 lb./acre Basamid. In the silty clay loam soil near Davis the soil was non-irrigated throughout the years of 1998 and 1999 but soil moisture levels in excess of 12% by weight remained present especially at the three to five foot depths. In these sites methyl bromide and the Telone/Basamid combination were the only treatments to provide adequate nematode control. As moisture levels exceeded 12% there were failures with the 350 lb./acre rate of 1,3-dichloropropene (35 gallons per acre Telone II). In sites having moisture levels below 12% all treatments are currently successful at Davis and Hickman. In general, Phytophthora control was inadequate across all treatments and completely ineffective at the four-foot depth.

EXECUTIVE SUMMARY

Our objective has been to evaluate the most promising methyl bromide alternatives for nurseries. In nursery settings the level of control must approximate 99.9% when sampled 30 to 60 days after treatment if we are to harvest nematode-free nursery stock more than 18-months later. Control of 98. % or less is generally proven inadequate by the end of one year. At the Hickman site all three treatments involving Telone II provided seemingly 100% control indicating there will be no detectable nematodes in nursery stock harvested over the next 14 months. Although the Davis site involves only two acres, half the site is a silty clay loam underlain by sand whereas the other half is underlain by clay loam. The finer-textured soils hold more moisture and that becomes an impediment to thorough distribution of a shank-applied fumigant, specifically when the Telone II rate is currently limited to 35 gallons per acre or 330 lb./acre. 1,3-dichloropropene. Across the soil moisture differences the level of nematode control from MB, dual application of Telone C-35, Telone II plus Vapam, and Telone II plus Basamid, is 99.2%, 97.4%, 93.7% and 99.1%, respectively. Prior to treatment we added only a small amount of irrigation water (0.2 acre-inches) to this site in our attempt to treat a dried soil (requiring a Research Authorization). Had we added the currently required moisture level our nematode control would have been reduced further. Based on prevailing soil moisture levels an application rate of 70 gallons per

acre (660 lb./acre 1,3-dichloropropene) would have been required for this 26-month nursery crop. We will verify these statements by collecting nematode samples at harvest while avoiding plot to plot contamination throughout the next two years.

At the Davis sites the higher soil moisture will likely make it difficult to distinguish the two surface treatments of metam sodium because it was the initial 330 lb./acre 1,3-dichloropropene that failed to move uniformly and deep.

A sub plot applied to half the field surface at Davis involved application of ammonium thiosulfate as a method for reducing 1,3 dichloropropene volatilization. Nematode samples are currently being collected from this sub plot to determine if any nematode control was lost. The assessment of free-living nematodes was carried out at the Hickman site because they tend to be more resilient of most soil treatments compared to plant parasitic nematodes.

Although this trial will continue and more will be learned the prognosis is that combination treatments of Telone and metam sodium will perform adequately when applied to properly dried soils and exclusively those soils consisting of a coarser texture. For most Northern California soils or soils of finer texture the use of 1,3-dichloropropene at 330 lb./acre is inadequate. Because of the Telone II label requirement for surface soil moisture at the time of treatment we cannot recommend any Telone II treatments as an alternative to methyl bromide without soil moisture monitoring. These findings are in complete agreement with the current nursery certification requirements referred to as NIPM #12. The finding of moisture levels in excess of 12% on a dry weight basis within the surface 5 feet should exclude use of shanked Telone II for nursery sites. This decision will eventually rest in the hands of the Nematode Study Committee for implementation. We included no six-acre-inch drench applications of emulsified Telone or Vapam in these studies. We did learn while conducting the unsuccessful urea and lime urea treatment at Hickman and two other locations that some of these finer-textured nursery soils infiltrate the 6-acre-inches even faster than sands. The Davis soil, by contrast, barely infiltrated 2 acre-inches of water in eight hours.

REPORT

a. Introduction

Our search for methyl bromide alternatives for nurseries has been underway since 1990 when we began looking for alternatives to Telone II. Over the last 10 years we have identified several promising treatments. The most expensive but current task is to test these alternatives in commercial settings and on a larger scale. We do this keeping in mind that there must be proper delivery equipment available and that we must reduce volatilization of the fumigants. For this DPR, IAB, Walnut Board and EPA funded project we are evaluating industry-generated notions of how best to replace methyl bromide. These treatments are all dependent on a shank application of Telone II plus an additional treatment that serves to provide control at the soil surface. In November 1999 this author published a text entitled the Replant Problem and Its Management. Therein one chapter was devoted to treatments needed to maintain a nursery site free of nematodes for up to 26 months. In that work less attention was paid to the practicality of delivery systems, preferring to identify their performance when applied by the best known methods. The objective of this work is to field

evaluate the most promising methyl bromide alternatives for nursery conditions while insuring nematode-free nursery stock for California growers.

b. Results

The industry-preferred treatment choices involved shank applications of Telone or1,3-dichloropropene. Tarped methyl bromide became treatment A. Treatment B was Telone C-35 followed in two weeks with a flipping of the surface 12 inches soil and re-treatment. Treatment C involved the 35 gallons per acre Telone II followed by a drenching of 250 ppm metam sodium in 2 acre-inches of water. Treatment D involved Telone II coupled with surface incorporation of 200 lb./ acre Basamid which was incorporated and then irrigated with 1.8 acre-inches water. The initial 0.6 inches of water was applied 6 hr after incorporation, another 0.6 inches the next morning and the final 0.6 inches the evening of the second day after application. These methods and a non-treated check, treatment E, were applied to a coarser-textured soil near Hickman, CA and a silty clay loam soil near Davis, CA. At the Hickman site we also evaluated use of urea plus lime urea drenched in 6 acre-inches of water which did not perform in any of three sites where we evaluated it in 1999. At the Davis site ammonium thiosulfate at 80 gallons per acre was applied to half of each replicate involving Telone II. This inexpensive fertilizer placed on the field surface is reported to reduce the volatilized portion of Telone II. Properly timed, the drenching of Vapam and the wetting of Basamid granules also provide methods for reducing volatilization of 1,3 dichloropropene.

Between 30 and 90 days after treatment we collect soil samples at each one-foot increment down to 5 ft. depth and from each replicate. These soil samples are extracted for nematodes and counted. Results are recorded in Table 1. Table 1 only shows the summary data from all samples but the depth analysis depicted in Table 2 clearly shows that Telone II did not travel deep enough in soil horizons that exceeded 12% moisture on a dry weight basis. In one replicate of the Telone/Vapam treatment there appeared to be poor 1,3-dichloropropene movement even at shallower soil depths.

Data from beneath the ammonium thiosulfate treatment are not yet available. Data from the Phytophthora samples are available in Table 3. Some control of Phytophthora was attainable in the surface 2-ft of soil regardless of biocide used. As has been known for forty years, Phytophthora is more difficult to control than nematodes.

The Agrobacterium bioassay added to the soil was ineffective as a method of assessing crown gall control. Eleven different weed species were identified in the field prior to treatments and these will be re-assayed as the soils warm in summer 2000.

Clearly, PCAs and growers cannot be permitted to certify their nursery crops as nematode-free where the Telone application is made to moist soil. The practical problem entails the label requirement for addition of soil moisture to a deep-shanked soil profile prior to application of Telone II. Carefully controlled this pre-irrigation could reduce volatilization in coarse-textured soils without detracting from Telone performance. However, additions of moisture to a deep-ripped soil prior to fumigation will likely detract from performance in the finer-textured soils. In essence this trial will show the impact of moisture related problems as

nematode samples are collected over the next two years. Applicators, regulators and chemical manufacturers need to recognize the value of dry soils as a necessity for reducing the treatment rates of Telone or methyl bromide.

c. Discussion

These trials and the nematode collection data will be available for 2000 through 2001 for viewing by growers, PCAs and more importantly those involved with the nematode-free Nursery Certification process. Instead of 350 to 400 lb./acre methyl bromide and a tarp (sometimes chloropicrin is not added) the Telone based treatments will require a higher pesticide usage in finer-textured soils. Although only in California, the use rate of 1,3-dichloropropene is essentially limited to 330 lb./acre and this limitation is regardless of soil moisture content. Reality is that except for Vapam the active ingredients that replace methyl bromide will have to be applied at higher rates than methyl bromide. However, the ammonium thiosulfate may reduce the volatilized portion of Telone as might the applications of surface water when timed to 1½ days after Telone application.

d. Summary and Conclusions

Township caps are not the only limitation of Telone II. In settings involving soils that hold relatively high amounts of moisture the 35 gallon/acre rate (330 lb./acre 1,3-dichloropropene) is inadequate. The requirement for application of Telone to a deep ripped, pre-moistened soil profile presents practical problems relative to eventual performance. In dry soil a shallow drench of Vapam or its application in front of a rotavator will provide adequate control at the field surface. Dissolution rates of Basamid are not known so we are applying it inefficiently (200 lb./acre MS in Basamid compared to 110 lb./acre MS in Vapam HL). We will be looking for Basamid phytotoxicity this spring. If none occurs the Basamid treated plants can grow very well. The dual application of Telone C-35 is a good performer but will reduce the number of treatable acres per township from roughly 300 acres to 200 acres per township per year. For those soils having more than 12% soil moisture anywhere in the surface five feet, methods other than shanked Telone are needed. Vapam uniformly drenched at 330 lb. MS per acre is a good consistent performer in sandy loam soils as long as reduced volatilization equipment is available. This treatment will be tried in finer-textured soils in 2000. We already know that the Vapam must be delivered in 6 acre-inches of water to a moistened soil within an 8-hour period. Emulsified Telone also performs well as a drench but is not currently labeled above 250 lb. of ai and a portion of that active ingredient is chloropicrin which is a poor nematicide. Without labeling changes, Telone as an alternative to methyl bromide could meet approximately one-third of nursery industry needs.

APPENDICES

Table 1.

Field Evaluations of MB Alternatives for Nursery Settings
Nematode Control 45 Days after Treatment
(average nematodes/250 cm^3 soil from each foot to 5 ft depth)

Hickman Trial

	Helicotylenchus	Tylenchorhynchus	Tylenchus	Free-Living
MB+CP, tarped	0	0	0	0
Telone C-35 dual application	0	0	0	1
Telone II + Vapam drench	0	0	0	2.9
Telone II + 200 lb Basamid	0	0	0	15.3
Urea + lime urea drench	12.6	6.9	1.95	241.3
Untreated check	45.7	38.75	6.6	236.3

Davis Trial

	Soil Moisture	Helicotylenchus	Pratylenchus	*X. americanum*	Meloidogyne
MB+CP, tarped	< 12%	0	0	0	0
	> 12%	0	1.6	0	0
Telone C-35 dual application	< 12%	0	0.3	0	0
	> 12%	0.3	0	1.3	0
Telone II + Basamid	< 12%	0	0	0	0
	> 12%	6.5	2.0	0.6	0
Telone II + Vapam	< 12%	0	0	0	0
	> 12%	0	13.0	1.9	0
Untreated check	< 12%	0	64.5	8.0	91.3
	> 12%	6.7	25.5	4.7	0

Table 2. Total plant parasitic nematodes including Spiral, Root Lesion, Dagger, and Root Knot Nematodes at each soil depth across each replicate of five treatments.

Treatment A. MB+CP (75/25) at 535 lb./acre, tarped = 99.2% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0-1 ft.	0	0	0	0
1-2 ft	0	0	0	0
2-3 ft	0	0	0	0
3-4 ft	0	2	0	0
4-5 ft	0	15	0	0

Treatment B. Dual application Telone C-35 @65 gpa or ~650 lb./acre = 97.4% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0-1 ft.	0	0	2	0
1-2 ft	0	0	1	0
2-3 ft	0	0	0	0
3-4 ft	2	0	0	0
4-5 ft	14	33	0	0

Treatment C. 330 lb./acre 1,3-dichloropropene then 110 lb./acre MS drench = 93.7% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0-1 ft.	0	5	0	0
1-2 ft	0	0	0	0
2-3 ft	0	1	0	0
3-4 ft	2	38	0	0
4-5 ft	0	103	0	0

Treatment D. 330 lb./acre 1,3-dichloropropene then 200 lb./acre Basamid, drench = 99.1% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0-1 ft.	0	0	0	0
1-2 ft	0	0	0	0
2-3 ft	0	0	0	0
3-4 ft	0	2	0	0
4-5 ft	0	16	0	0

Treatment E. Non-treated check = 0% control or 2021 parasitic nematodes/20 samples

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0-1 ft.	43	6	29	20
1-2 ft	55	46	222	132
2-3 ft	26	135	193	62
3-4 ft	4	31	706	95
4-5 ft	1	34	40	141
	2 reps moist soil		2 reps dried soil	

Table 3. Number of *Phytophthora citricola* colonies formed out of 10 inoculum pieces plated at three soil depths across each replicate of five treatments at the Davis site.

Treatment A. MB+CP (75/25) at 535 lb./acre, tarped = 58.3% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0.5 ft.	0	0	0	0
2.0 ft	0	10	0	0
4.0 ft	10	10	10	10

Treatment B. Dual application Telone C-35 @65 gpa or ~650 lb./acre = 83.3% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0.5 ft.	–	0	0	0
2.0 ft	0	0	0	0
4.0 ft	10	10	0	0

Treatment C. 330 lb./acre 1,3-dichloropropene then 110 lb./acre MS drench = 51.7% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0.5 ft.	0	5	0	0
2.0 ft	10	1	9	0
4.0 ft	10	9	10	9

Treatment D. 330 lb./acre 1,3-dichloropropene then 200 lb./acre Basamid, drench = 66.7% control

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0.5 ft.	0	0	0	0
2.0 ft	0	0	0	0
4.0 ft	10	10	10	10

Treatment E. Non-treated check = 19% control or 97/120 inoculum pieces sampled produced fungal colonies.

Depth	Rep. 1	Rep. 2	Rep. 3	Rep 4
0.5 ft.	9	9	9	10
2.0 ft	10	10	0	10
4.0 ft	10	10	0	10