FIELD EVALUATIONS OF METHYL BROMIDE ALTERNATIVES FOR VINEYARD REPLANT

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Alternatives to methyl bromide for perennial crops must demonstrate efficacy not only for the first growing season, but throughout the early growth and fruiting years. This paper reports the on-going performance of field trials planted in 1999, 2000, 2001, and 2003. Complete details on experimental design and previous years' data were reported at the 2000, 2001, 2002, 2003, and 2004 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions.

Field Trial of Chemical, Genetic, and Cultural Alternatives for Vineyard Replant Disorder – Planted 1999. Treatments are described in Table 1. Drip applied treatments were applied in January, 1999 and shanked treatments in November, 1998 to a 65-year-old Thompson Seedless vineyard, following removal of the vines in fall, 1998. In June 1999, each plot was planted with three grape variety/rootstock combinations; own-rooted Thompson Seedless, Merlot on Harmony rootstock, and Merlot on Teleki 5C rootstock.

Soil samples were collected to a depth of 24 inches from each treatment/rootstock combination in October 2004 and processed by the sugar flotation-centrifugation method. Nematode populations are given in Table 2. After six growing seasons, the drip-applied Telone and shank-injected iodomethane continue to demonstrate control comparable to methyl bromide of both the rootknot (*Meloidogyne spp.*) and citrus (*Tylenchulus semipentrans*) nematode populations for most treatment/nematode/ rootstock combinations. Plots that were fallowed for a year prior to treatment with Telone, supported lower populations of both rootknot and citrus nematodes, in all but two instances, as compared to Telone applied without the fallow. All chemical treatments resulted in populations of rootknot nematode that remain low. Citrus nematode populations on Thompson Seedless and Teleki 5C rootstock in plots subjected to chemical treatments were higher than in past years, but remained lower than populations in non-chemical treatments. Large variability in populations resulted in some loss of statistical significance between citrus nematode populations on Thompson Seedless. The rootknot nematode populations on Harmony rootstock remained very low for all treatments, as would be expected for this rootknot-nematode-resistant rootstock, but the citrus nematode populations were highest on Harmony.

Berries were harvested in August 2004. Yield in the Thompson Seedless plots treated with iodomethane or Telone delivered in 4 inches of water was significantly greater than in plots treated with 1-year fallow alone or followed by a Telone treatment. All other treatments were intermediate. There was no significant difference in yield of Merlot on Teleki 5C or Merlot on Harmony across treatments.

Long-term Fallow for Vineyard Replant Disorder Field Trial – Planted 2000. Vines were removed from a 65-year-old Thompson Seedless vineyard in Fall, 1996, 1997, 1998, and 1999 (untreated control and methyl bromide plots). Plots were laid out in a randomized complete block design with 5 replications of each treatment, and planted in June of 2000 with own-rooted Thompson Seedless, Thompson Seedless on Harmony rootstock, and Thompson Seedless on Teleki 5C rootstock.

Soil samples were collected in October 2004 to a depth of 24" from each treatment/rootstock combination and processed with the sugar flotation/centrifugation method. After five growing seasons, there were no significant differences in rootknot or citrus nematode populations in one, two, or three-year fallow as compared to the untreated control. Rootknot populations on Thompson Seedless in methyl bromide treated plots were not significantly different from untreated plots, but citrus nematode populations in methyl bromide treated plots were significantly lower than untreated plots.

Berries were harvested in August 2004. There was no significant difference in yield between treatments in the own-rooted Thompson Seedless and the Thompson Seedless on Harmony. No data were available from the Thompson Seedless on Teleki 5C due to vine damage late in the 2003 season.

Field Trial of Chemical Alternatives for Vineyard Replant Disorder – Planted 2001. Vines were removed from an 85-year-old, plant-parasitic-nematode-infested Thompson Seedless vineyard located at the USDA Parlier, CA research station in fall, 2000. All treatments (Table 3) were applied in mid April 2001 and plots were planted in June 2001 to own-rooted Thompson Seedless, Thompson Seedless on Freedom, and Merlot on 1103P.

Soil samples were collected to a depth of 24 inches from each treatment/rootstock combination in October 2004 and processed by the sugar flotation-centrifugation method. Nematode populations after four growing seasons are given in Table 3. Rootknot nematode control comparable to methyl bromide was achieved on Thompson Seedless with InLine and propargyl bromide and for citrus nematode with iodomethane + chloropicrin, propargyl bromide, and InLine. On the more resistant Freedom rootstock, iodomethane + chloropicrin, propargyl bromide and InLine treatments controlled rootknot and citrus nematodes comparable to methyl bromide. Nematode control on the 1103P rootstock was comparable to methyl bromide for iodomethane + chloropicrin and propargyl bromide.

Berries were harvested in August 2004. There was no significant difference in yield between treatments in Merlot on 1103P, own-rooted Thompson Seedless, and Thompson Seedless on Freedom.

Field Trial of Chemical Alternatives for Vineyard Replant Disorder – Planted 2003. Vines were removed from a 70-year-old, plant-parasitic-nematode-infested Thompson Seedless vineyard of located at the USDA Parlier, CA research station in Fall, 2002. Methyl bromide was applied in October, 2002 and drip treatments in November, 2002 (Table 4). In April, 2003 own-rooted Thompson Seedless, Autumn

Royal on Harmony, and Merlot on 1103P were planted. Nematode populations at planting were report in the 2004 MBAO Proceedings. Soil samples were collected to a depth of 24 inches from each treatment/rootstock combination in November 2003 and October 2004 and processed by the sugar flotation-centrifugation method. At the end of the first growing season, both root-knot and citrus nematode were found in the untreated plots (data not shown). The standard application of sodium azide gave better control of root-knot nematode than did the shallow application, but neither gave control comparable to methyl bromide except in plots planted with the Harmony rootstock. Methyl bromide, both rates of iodomethane + chloropicrin and InLine™ resulted in populations of both root-knot and citrus nematode not significantly different from zero for all variety/rootstock combinations. At the end of the second growing season (Table 4), nematode populations on all variety/rootstock combinations grown in plots treated with iodomethane + chloropicrin or InLine were comparable to methyl bromide. Rootknot nematode populations in azide treated plots were comparable to populations in the untreated control.

In January 2004, vines were pruned to two nodes above the graft union. Prunings were dried and weighed. Significant differences in pruning weights between plants grown in methyl bromide treated plots and those grown in untreated plots were documented for all variety/rootstock combinations (Table 4). The largest vines were grown in plots treated with methyl bromide for all variety/rootstock combinations. The smallest vines were grown in either the untreated plots or plots treated with sodium azide. In all cases, the pruning weights of vines grown in plots treated with azide were not significantly different from the pruning weights of vines grown in the untreated plots. Vines grown in plots treated with iodomethane + chloropicrin or InLine™ were intermediate in size, with the exception of Merlot on 1103P grown in plots treated with the higher rate of iodomethane + chloropicrin which were not significantly different in size from vines grown in methyl bromide treated plots. These results demonstrate that although iodomethane + chloropicrin and InLine controlled the nematode populations comparable to methyl bromide, other factors – that were not adequately controlled – were negatively impacting plant growth.

Conclusions

- Iodomethane, drip-applied Telone, and InLine appear to be good alternatives to methyl bromide for vineyard replant when both rootknot and citrus nematode are present. Iodomethane is not yet registered and use of 1,3-dichloropropene (in Telone and InLine) is restricted in California by township caps.
- Rootknot nematode populations on Harmony rootstock remain very low after 6 growing seasons, but populations of the citrus nematode are higher on Harmony than on either Thompson Seedless or Teleki 5C.
- Significant benefit in rootknot and citrus nematode population reduction from long-term fallow treatments for vineyard replant was no longer observed after five growing seasons.
- Nematode control alone is not sufficient to prevent negative growth impacts on young vines under vineyard replant conditions.

Table 1. Treatments applied in a 1999 vineyard replant trial.

Untreated control
Methyl bromide, 400 lbs/acre, shanked, tarped (the treated control)
One-year fallow
One-year fallow plus a sorghum-sudangrass hybrid cover crop
Iodomethane, 400 lbs/acre, shanked, tarped
Telone EC (35 gal/acre or 310 lbs/acre of 1,3-D) in 2.5 inches of water through a buried drip tape plus Vapam (26 gal/acre of 42% metam sodium) through microsprinklers
Telone EC (35 gal/acre) in 4 inches of water through a buried drip tape plus Vapam (26 gal/acre of 42% metam sodium) through microsprinklers
One-year fallow followed by Telone EC (35 gal/acre) in 2.5 inches of water through a buried drip tape plus Vapam (26 gal/acre of 42% metam sodium) through microsprinklers
One-year fallow followed by Telone EC (35 gal/acre) in 4 inches of water through a buried drip tape plus Vapam (26 gal/acre of 42% metam sodium) through microsprinklers

Table 2. Nematode populations per 100cc soil sampled October 2004, mean of 5 replications, in a vineyard replant trial planted in 1999. Statistical analyses conducted on log transformed (log10(n+1)) data. Data presented are the antilogs of the means. Means for each nematode genus/rootstock combination followed by the same letter are not significantly different at the *P* = .05 level

Treatment	***Meloidogyne sp.***			***Tylenchulus semipenetrans.***		
	Thompson Seedless	**Teleki 5C**	**Harmony**	**Thompson Seedless**	**Teleki 5C**	**Harmony**
Untreated Control	63 a	10 ab	3.8 a	564 ab	230 ab	995 a
1-year Fallow	126 a	60 a	0.4 b	1119 a	606 a	1351 a
1-year Fallow plus cover crop	59 a	46 a	0.2 b	448 ab	58 abcd	637 ab
Methyl Bromide (400lbs/acre)	5 b	0 c	0.0 b	71 abc	6 cde	83 c
Iodomethane (400lbs/acre)	3 bc	1 bc	0.0 b	9 cd	15 bcde	133 bc
Telone II EC (60mm H_20)	3 bc	3 bc	0.5 ab	70 abc	42 abcde	626 ab
Telone II EC (60mm H_20)+Fallow	0 c	3 bc	0.0 b	4 cd	3 de	85 c
Telone II EC (100mm H_20)	5 b	2 bc	0.3 b	61 bcd	74 abc	170 bc
Telone II EC (100mm H_20)+Fallow	0 c	1 bc	0.0 b	3 d	2 e	360 ab

Table 3. Nematode populations per 100cc soil sampled October 2004, mean of 5 replications, in a vineyard replant trial planted in 2001. Statistical analyses conducted on log transformed (log10(n+1)) data. Data presented are the antilogs of the means. Means for each nematode genus/rootstock combination followed by the same letter are not significantly different at the *P* = .05 level.

Treatment	***Meloidogyne sp.***			***Tylenchulus semipenetrans.***		
	Thompson Seedless	**TS/ Freedom**	**Merlot/ 1103P**	**Thompson Seedless**	**TS/ Freedom**	**Merlot/ 1103P**
Untreated Control	141 a	10 b	131 a	128 a	4 a	7 b
Methyl Bromide, 400 lb/acre, shank, tarped	0 d	0 d	0 c	0 c	0 a	0 c
Iodomethane, 240 lb/acre + chloropicrin, 240 lb/acre, shank, tarped	4 c	0 d	1 c	0 c	0 a	0 c
Propargyl Bromide, 200 lb/acre, shank, tarped	171 a	0 d	11 b	2 c	2 a	0 c
Herbicide cap (metam sodium) Vapam 26 gal/acre, microspray	118 a	12 b	182 a	318 a	22 a	153 a
InLine, 50 gal/acre, drip, + Vapam 26 gal/acre microspray	0 d	0 d	156 a	0 c	0 a	0 c
Chloropicrin, 400 lb/acre, drip, Vapam 26 gal/acre microspray	268 a	0 d	212 a	22 b	1 a	0 c
Iodomethane, 240 lb/acre + chloropicrin, 240 lb/acre, drip, water microspray	30 b	1 c	1 c	2 c	2 a	0 c
Propargyl bromide, 180 lb/acre, drip, water microspray	1 cd	0 d	1 c	0 c	0 a	0 c
Sodium azide, 300 lb/acre, drip, water microspray	184 a	29 a	27 b	72 ab	2 a	18 b
Sodium azide, 300 lb/acre, drip, tarped	117 a	2 c	29 b	126 a	8 a	40 ab

Table 4. Nematode populations per 100cc soil sampled October 2004, mean of 6 replications, in a vineyard replant trial planted in 2003. Statistical analyses conducted on log transformed (log10(n+1)) data. Nematode populations presented are the antilogs of the means. Pruning collected, dried and weighed January 2004. Means in each column followed by the same letter are not significantly different at the P = .05 level.

	Meloidogyne sp.			*Tylenchulus semipenetrans.*			**Pruning Dry Wt. (g)**		
Treatment	**Thompson Seedless**	**Merlot/ 1103P**	**Autumn Royal/ Harmony**	**Thompson Seedless**	**Merlot/ 1103P**	**Autumn Royal/ Harmony**	**Thompson Seedless**	**Autumn Royal/ Harmony**	**Merlot/ 1103P**
Untreated Control	242 a	2 a	136 a	149 a	142 a	5 a	48 d	54 d	69 e
Methyl Bromide, 400 lb/acre	4 b	0 a	0 c	0 c	2 b	1 bc	279 a	226 a	256 a
Iodomethane:chloropicrin (50:50), 240 lb/acre	35 ab	1 a	0 c	0 c	4 b	1 c	156 bc	80 bcd	148 cd
Iodomethane:chloropicrin (50:50), 300 lb/acre	9 b	0 a	1 bc	0 c	3 b	1 c	181 b	97 bc	223 ab
InLine™, 50 gal/acre	5 b	2 a	0 c	0 c	4 b	0 c	144 c	107. b	180 bc
Sodium azide, 300 lb/acre, standard depth drip tape	183 a	2 a	13 a	15 b	48 a	28 b	44 d	61 cd	80 de
Sodium azide, 300 lb/acre, shallow depth drip tape	232 a	6 a	4 abc	1 c	65 a	20 b	51 d	47 d	104 de