Evaluation of Reduced Methyl Bromide Rates and Alternative Fumigants in a Stonefruit Nursery

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California currently has over 1.2 million acres of bearing fruit and nut crops and, in any given year, significant portions are replanted due to declining productivity or changing market preferences. Establishment of productive orchards begins with vigorous, high-quality nursery stock. The perennial crop nursery industry, a $165 million annual contributor to California's economy, usually produces nursery stock in a 3-5 year cropping cycle that may include one or two years of cover crops between nursery crops. The nursery cycle usually begins with preplant soil fumigation in the summer prior to planting the nursery rootstock. Seed or cuttings of the desired rootstock are planted in the fall or winter after fumigation, and the trees are budded or grafted to a preferred scion variety in the spring or summer of the next year. Stonefruit tree stock usually reaches marketable size after only one growing season and is harvested as a bare-root plant the winter after the rootstock is planted. Plants are sized, graded, bundled, and held in cold storage until brought to production fields for dormant transplanting.

One of the keys to production of vigorous open-field nursery stock is the control of soil borne pests including parasitic nematodes, disease pathogens, and weeds. For more than 50 years, methyl bromide (MB) was widely used for soil fumigation in high value vegetable, fruit, and nursery crops but was phased out in 2005 due to concerns over stratospheric ozone depletion except for Critical Use Exemptions (CUE) and Quarentine/Preshipment (QPS) uses. The continued use of MB is under intense international scrutiny and the Methyl Bromide Technical Options Committee (MBTOC) recommends that reduced rates of MB can effectively control pests where no other feasible options exist. However, little research on the MBTOC-recommended rates has been conducted under California nursery conditions. A tree nursery field trial was conducted in 2006-2007 to determine the effects of low rates of MB with or without chloropicrin applied under standard tarps and virtually impermeable film (VIF).

Materials and Methods:
A trial was conducted at L.E. Cooke Nursery near Visalia, CA in a new nursery field. The field site had a silage corn crop in 2006 following removal of a 40 year old walnut orchard the previous fall. Corn was harvested in late summer 2007 and the field was prepared for fumigation by the nursery. Twelve fumigation treatments (Table) were shank-applied on October 16, 2007 by a commercial fumigant applicator (TriCal Inc., Hollister, CA). Specific reduced MB rates included in the experiment were intended to test MBTOC suggestions for use of MB with or without chloropicrin and with standard or low permeability film. Where chloropicrin (Pic) is not registered, MBTOC suggests that MB applications of 35 g/m^2 in warm, coarse soils, or 45 g/m^2 in cold (310 and 400 lb/A, respectively), fine soils can provide sufficient pest control. Where chloropicrin is registered, a combination of MB/Pic is used at 26 or 20 g/m^2 under standard tarps and at 17.5 or 15 g/m^2 under low permeability films for nutsedge and other weeds and pathogens, respectively. Two alternative fumigants, 1,3-dichloropropene (1,3-D) or 1,3-D plus chloropicrin, were also included in the trial. The nursery planted 100 ft rows of two rootstocks ('Nemaguard'

peach seed and 'Marianna 2624' plum cuttings) in each plot in November 2006. Crop emergence and vigor and weed control were monitored throughout the 2007 growing season. The nursery harvested and graded each row of trees in November 2007. Data collected in the trial included nematode control (citrus nematode bioassay), weed seed survival (bagged weed seed bioassay), resident weed establishment, initial handweeding time, and tree diameter and quality at harvest.

Table. Fumigation treatments in a field nursery trial near Visalia, CA in 2006-07.

	Treatment (%)	rate	MB equivalent (g/m^2)	Tarp
1	Untreated	--	--	None
2	MB (98:2)	350 lb/A	39	HDPE
3	MB:Pic (67:33)	350 lb/A	26	HDPE
4	MB (98:2)	237 lb/A	26	HDPE
5	MB (98:2)	237 lb/A	26	VIF
6	MB:Pic (67:33)	266 lb/A	20	VIF
7	MB:Pic (67:33)	233 lb/A	17.5	VIF
8	MB:Pic (67:33)	200 lb/A	15	VIF
9	MB:Pic (67:33)	166 lb/A	12.5	VIF
10	MB:Pic (67:33)	133 lb/A	10	VIF
11	Telone II	33.7 gal/A	--	HDPE
12	Telone C35	48.5 gal/A	--	HDPE

Results and Discussion

All fumigation treatments effectively controlled citrus nematode buried at 12, 24, and 36 inch depths. Unfortunately, there was not a sufficient natural nematode population to provide a better evaluation of nematode control. Viability of weed seed buried three inches deep in each plot was assessed using either germination tests or tetrazolium staining techniques. Yellow nutsedge tubers, annual ryegrass seed, common chickweed seed, and redroot pigweed seed viability was lower in all treated plots compared to the control. No treatment reduced the viability of common mallow. Evaluation of resident weeds on March 21, 2007 indicated that all treatments had fewer winter annual grass and broadleaf weeds compared to the unfumigated control (Figure 1). There were no statistical differences between fumigation treatments due to fairly large plot-to-plot variability; however the lowest MB rate and both 1,3-D treatments tended to have slightly higher (numerically and visually) weed populations. A timed handweeding operation was conducted on each plot on March 22, 2007. Similar to the weed population counts, there were no differences among treated plots and all treatments required less time to weed compared to the unfumigated plots (Figure 2). Once again, the 1,3-D treatments tended to take slightly more time to hand weed although the time was not statistically different. In November 2007, the cooperating nursery harvested each row of trees using a single-row tree digger. Nursery personnel sized and graded each tree according to commercial standards. No statistical differences due to fumigation treatment were noted in cull trees or in percent of saleable trees (Figure 3).

Under the conditions of this trial, pest control and tree productivity did not differ among reduced rate MB treatments and the industry standard treatment. VIF tarps are not currently allowed for use with MB in California but, if these regulations change, these treatments should be considered for use in perennial crop nurseries. Although the results of this trial were favorable, it is

important to note that the experiment was conducted in a first-year nursery site with low nematode and weed populations. In particular, the citrus nematode bioassay is a better indication of treatment failure than success due to the artificial conditions imposed with burying and recovering the sample bags. The issue of nematode control is of critical importance in the nursery industry because of certification requirements of "non-detectable" levels of parasitic nematodes. It is possible, if not probable, that long-term repeated use of low rates of MB or alternative fumigants could reveal weaknesses in pest control not evident in single-cycle field trials.

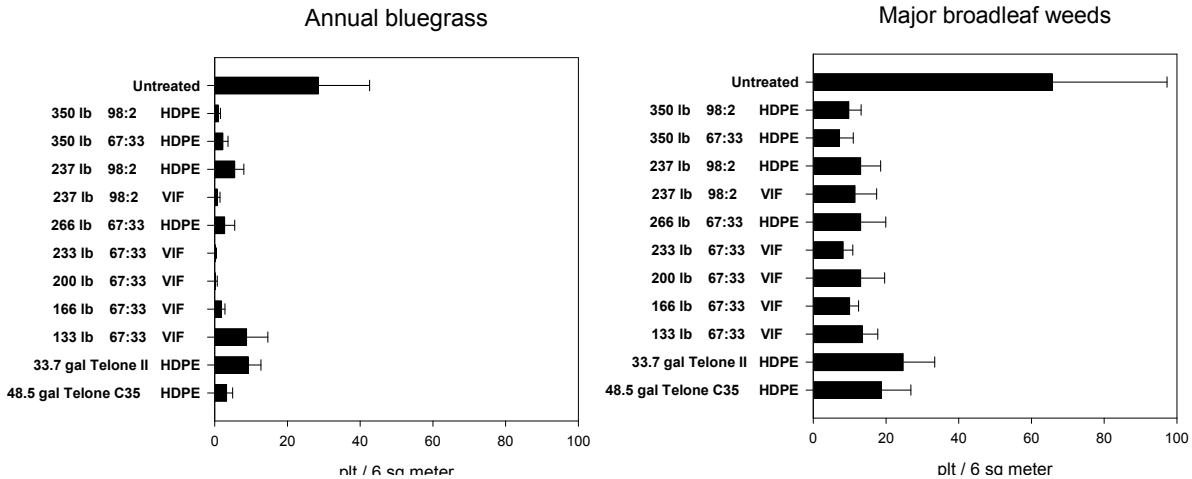

Figure 1. Annual bluegrass and broadleaf weed populations on March 21, 2007 in a stonefruit field nursery trial fumigated in October 2006. Weeds were counted in a 6 m^2 area between two rows of Prunus rootstock. Broadleaf weeds were primarily clover, horseweed, fiddleneck, filaree, and redmaids.

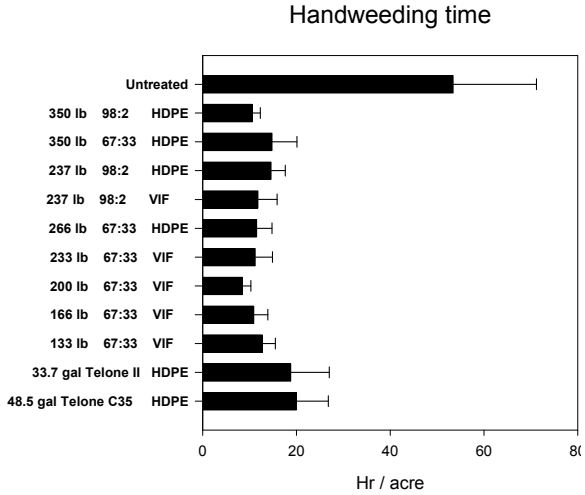

Figure 2. Initial handweeding time (hr/A) in a stonefruit nursery trial near Visalia, CA on March 22, 2007.

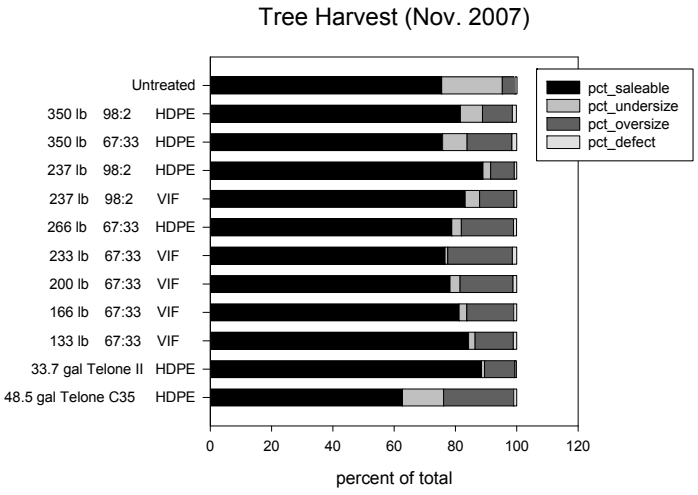

Figure 3. Nursery tree (peach and plum rootstock) grade at harvest in November 2007. Trees were commercially sorted into saleable, under-size, over-size, and cull classes.