

## METHYL BROMIDE ALTERNATIVES TRIALS IN RASPBERRY NURSERIES

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### Introduction

Raspberry nurseries must produce disease-free plants to meet marketplace, certification and export requirements. Nursery phytosanitary requirements are high, because even minor disease infestations in nurseries can cause severe epidemics in production fields. Nurseries prevent disease infestations by fumigating soil with Methyl Bromide (MB), under a quarantine/preshipment exemption, but there is increasing pressure to find alternatives.

MB is valued by raspberry nurseries for its role in eliminating many pathogens and weeds. The most serious soil-borne diseases of raspberries in many growing regions are root rot caused by *Phytophthora rubi* (PR) and the root lesion nematode *Pratylenchus penetrans* (PP). Spread of PR was associated with infected nursery stock in Scotland [1] and growers rely upon nematode-free planting stock produced in fumigated soil for PP management [2]. Crown gall (*Agrobacterium tumefaciens*, AT) is a common problem in the coarse-textured soils favorable to raspberry nursery production. Soil fumigation with MB reduces but does not consistently eliminate AT. Improved AT control would be a very attractive feature of a MB alternative for raspberry nurseries. In 2007 and 2008, we identified several alternatives that effectively controlled soil-borne pathogens and weeds in trials at the WSU-Northwestern Washington Research and Extension Center. Our objective for 2009 was to evaluate these alternatives in commercial raspberry nurseries.

### Methods

Trials were established September 2009 in Burlington and Lynden WA, and in Macdoel CA within commercial raspberry nurseries (Table 1). At Burlington and Lynden WA, treatments were replicated in randomized complete blocks (three in Burlington and five in Lynden), with each plot 10 ft x 70 ft. Treatments in Macdoel were applied to large (0.5 acre) blocks and were not replicated.

Nylon mesh bags containing PR and AT inoculum were buried in Burlington and Lynden plots at depths of 6, 12 and 18 in prior to treatment. Bags containing quackgrass (*Elytrigia repens*) rhizomes and nutsedge (*Cyperus esculentus*) nutlets were also buried at this time, but only at 6 and 12 inches. Inoculum bags were removed Jan 2010. AT survival was evaluated by dilution plating on a selective medium. PR survival was evaluated by greenhouse bioassay. Weed propagules

were germinated in the greenhouse. Plant-parasitic nematode populations were determined from soil samples taken prior to and after treatment.

## Results

*Perennial and Annual Weeds.* All of the treatments eliminated quackgrass and nutsedge germination at both 6 and 12 inches in the Burlington and Lynden trials (Friedman's test,  $P < 0.05$ , data not shown). The major weed problem at Lynden was volunteer potato, which was controlled by all treatments, although the Pic Clor 60 and Telone C-35 (conventional tarp) treatments were not as effective as MB (Figure 1). All of the treatments enhanced white clover emergence at Burlington, but effectively controlled other weeds (Figure 2).

*Pratylenchus penetrans.* All of the treatments eliminated PP from plots at Burlington (Table 2). Telone C-35 and Pic-Clor 60 eliminated nematodes at Macdoel, but several nematodes were recovered from the MIDAS-treated plot at this location. No PP were detected in any of the Lynden plots.

*Agrobacterium tumefaciens.* Results at 6, 12 and 18 inches were similar, so the combined results are presented in Table 2. All of the treatments reduced AT viability by over 99% at Burlington and at Lynden. MB:pic-treated plots had significantly higher AT survival than other treatments at Lynden, with a similar but nonsignificant trend in Burlington.

*Phytophthora rubi.* Results were similar at 6, 12 and 18 inches, so results from the three depths were combined in Table 2. All of the treatments reduced PR viability in the bioassay, and were indistinguishable from MB:pic.

## Summary

- MIDAS 50:50 at 350 lb/A under HDPE film, MIDAS 50:50 at 225 lb/A under either HDPE or VIF film, Telone C-35 at 433 lb/A under HDPE or VIF, or Pic Clor 60 at 366 lb/A under VIF film were as effective as MB:pic in these trials. In fact, these provided better control of AT than MB:pic at the Lynden trial.
- These were our first evaluations of Pic Clor 60, but 350 lb/A MIDAS under HDPE and 433 lb/A Telone C-35 under VIF were similarly effective in our earlier trials.
- MIDAS registration is proposed in California, but the application for registration has been withdrawn in Washington. MIDAS is also quite expensive. Telone C-35 is available, but widespread implementation of this alternative in California may be limited by township caps.

## References

1. Duncan, J.M. and L.E.M. Cooke, *Work on raspberry root rot at the Scottish Crop Research Institute*. Acta Horticulturae, 2002. **585**: p. 271-276.
2. McElroy, F.D., *Nematode parasites*, in *Compendium of raspberry and blackberry diseases and pests*, M.A. Ellis, et al., Editors. 1991, APS Press: St. Paul, MN. p. 59-62.

Table 1. Treatments, rates applied (lb/A) and films used in 2009 field trials

	Burlington, WA	Lynden, WA	Macdoel, CA
Non-fumigated	0	0	--
Telone C-35 (1,3-D:chloropicrin 63:35)	433 H	433 H, V	433 H
MIDAS 50:50 (MI:chloropicrin 50:50)	--	350 H	300 H
MIDAS 50:50 Reduced rate	225 V	225 H, V	--
Pic-Clor 60 (1,3-D:chloropicrin 38:60)	366 V	366 V	427 H
MB:chloropicrin, 67:33	350 H	350 H	400 H

<sup>z</sup> H=high density polyethylene film, V=virtually impermeable film (Pliant Blockade XL)

Table 2. Pathogen survival in plots at Burlington and Lynden, Washington

Treatment, rate/A and tarp type	<i>Phytophthora</i> <i>rubi</i> <sup>z</sup>	<i>Agrobacterium</i> <i>tumefaciens</i> <sup>y</sup>	<i>Pratylenchus</i> <i>penetrans</i> /100 g soil
<i>Burlington, WA</i>			
Non-treated, V <sup>x</sup>	6.1 a <sup>w</sup>	3,347,500 a	11 b
Telone C-35, V	1.2 bc	0 b	0 a
MIDAS 50:50 reduced rate, V	1.4 b	0 b	0 a
Pic-Clor 60, V	0.4 c	0 b	0 a
Methyl bromide:chloropicrin, 67:33, H	1.2 bc	5,500 b	0 a
<i>Lynden, WA</i>			
Non-treated, V	6.2 a	6,217,333 a	0
Telone C-35, H	1.2 bc	22 c	0
Telone C-35, V	1.9 b	67 c	0
MIDAS 50:50, full rate, H	1.6 bc	0 c	0
MIDAS 50:50, reduced rate, H	1.2 c	1,333 d	0
MIDAS 50:50, reduced rate, V	1.3 bc	1,133 c	0
Pic-Clor 60, V	1.3 bc	0 c	0
Methyl bromide:chloropicrin, 67:33, H	1.5 bc	4,405 b	0

<sup>z</sup> Proportion of roots affected by raspberry root rot in greenhouse bioassays of *P. rubi* inoculum bags buried in plots. Rated on a 1-7 scale, with 1= 0-12.5% roots affected, and 7=87.5-100% roots affected.

<sup>y</sup> *Agrobacterium tumefaciens* survival measured by dilution plating on selective medium as colony forming units/g soil.

<sup>x</sup> H=high density polyethylene film, V=virtually impermeable film (Pliant Blockade XL)

<sup>w</sup> Within a trial (Burlington or Lynden), means in a column followed by the same letter are not significantly different. Fisher's Protected LSD (P<0.05) was used for *P. rubi* and *P. penetrans* data, but Friedman's non-parametric test (P<0.05) was used for *A. tumefaciens* data, because variances were unequal.

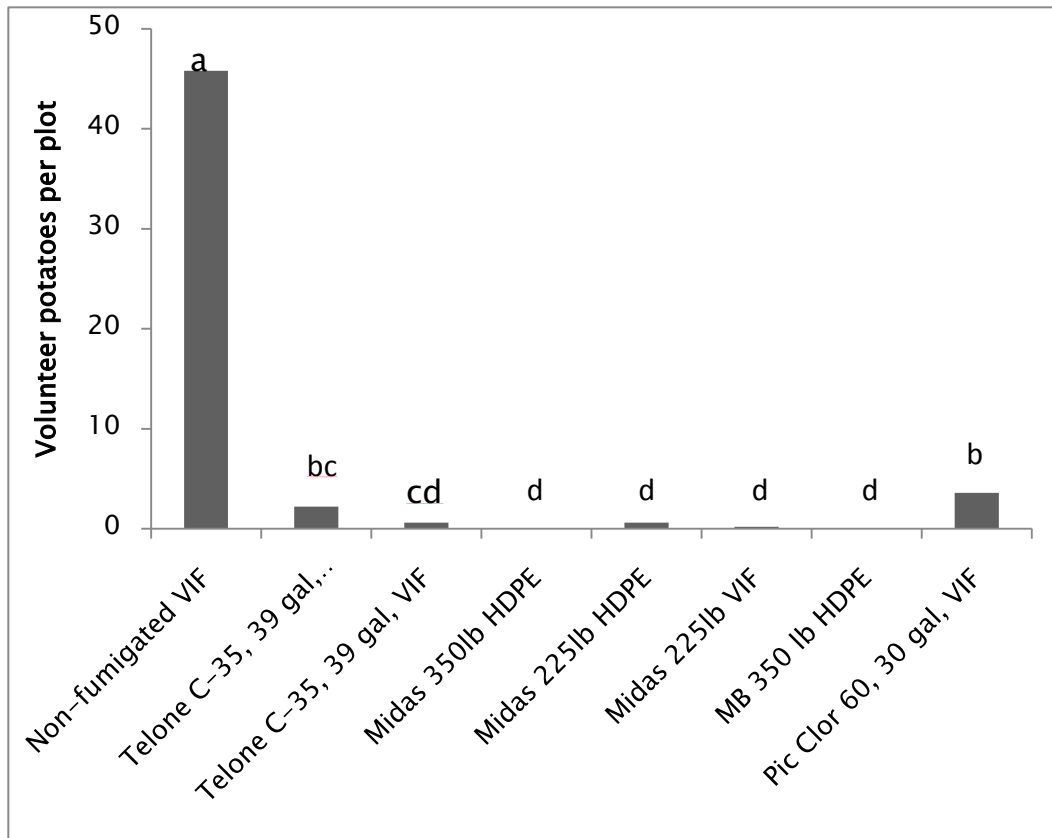


Figure 1. Volunteer potatoes per plot at Lynden, WA.

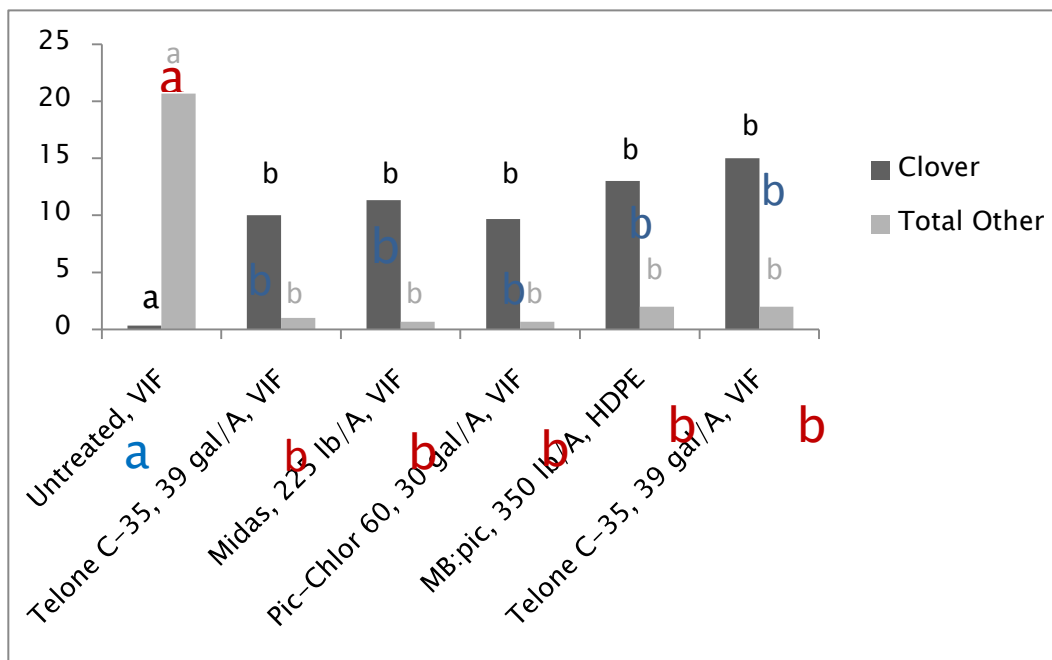


Figure 2. Volunteer weeds per plot at Burlington, WA