# METHYL BROMIDE ALTERNATIVES FOR FIELD-GROWN NURSERY STOCK

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## INTRODUCTION

It is through the purchase of contaminated nursery stock that new and different soil pests, diseases, nematodes, and viruses are most readily and widely distributed to farmers' lands. For California growers the nurseries have provided nematode-free field-grown nursery stock through the combination treatments of fallowing/soil fumigation. Today, California farmlands remain free of reniform nematode and burrowing nematode. The same cannot be said for growers in Florida, Texas or northern Mexico. Of the 300,000 ha of California stone fruits and almonds, some of which have now been replanted three or four times, only 33% are infested with *Pratylenchus vulnus*, the root lesion nematode. As new biotypes of root knot nematodes have broken the resistance mechanisms in Harmony and Freedom grape rootstocks that problem is clearly an in-field occurrence rather than a problem being transported along with nursery stock. The same can be said about biotypes of phylloxera on A.xR.#1 (syn. *Vitis* Ganzin Number One) rootstock. Additionally, the fallowing/soil fumigation treatment has by its existence reduced the spread of soil pathogens other than nematodes.

The soil fumigants that formed the backbone of the nursery treatment have been methyl bromide and Telone, and alternatives to these two are currently the subject of much investigation. This paper provides an overview of our effort to evaluate potential alternatives and lists the four most practical alternatives which are now ready for fine tuning under field conditions. One should be careful to note that there are soil pests other than nematodes which influence the eventual worth of nursery stock.

## FIVE POTENTIAL ALTERNATIVES

The first potential alternative to the current treatment of fallowing/soil fumigation would be to double or triple the length of the fallowing period, thus increasing the land needed by the nurseryman. Certain advocates suggest that a rotation might help to shorten the fallowing period. For example, if one nursery crop has resistance to root lesion while another has resistance to root knot nematode one could still take advantage of the resistance they do have by rotating their planting through the nursery lands. Of course, nursery crops are grown for their demand by farmers, not for their utility as a rotation crop, but a bigger shortcoming is that no nursery crops are resistant to all nematodes and there are more than a dozen nematode species that can occur in California crops. Additionally, acceptance by nurseries of a lengthy clean fallow treatment, which can generate dust, may become a problem as the California $PM_{10}$ requirements evolve. Also, tree and vine roots remaining in soil can survive at least a year after undercutting for harvest and the nematodes without available food should be expected to persist a year and a half beyond as an egg stage. This lengthy fallow approach will have potential until the land once becomes contaminated with endoparasitic nematodes. We recently learned that peach and plum roots that had been dead for 2 full years remain a protective refuge for root lesion eggs within.

A second potential alternative involves the increased use of container-grown plants using steam-treated soils or soil mixes that are nematode-free. This approach has been taken in other areas of the world as well as in California. Factors to consider include the farmer's expectations for a large root system, the need for recycling of potting containers and many additional benefits or constraints associated with container-grown stock.

A third potential alternative involves the use of biocides or nematicides other than methyl bromide (MB). On the top of the list is a shanked Telone application. After 6 years without Telone the current California requirement is that no more than 65 ha/9400 ha of land can receive a Telone treatment each year. Given the size of California nurseries they would need to have a priority for the use of Telone within their township. For a better perspective, California's irrigated farmland is only about 350 townships in size. This California EPA requirement is based on the need for public protection from a Type B carcinogen as it is volatilized above the surface of a treated field.

It is clear that any new technologies which reduce Telone volatilization would be helpful for increasing the total hectares treated with Telone each year. In this regard, we now have data to show that Telone applied as a drench within 15 cm water is just as efficacious against nematodes as the same amount of Telone shank applied (McKenry, 1995). Telone drenches will probably never be applied by sprinkler or as a basin application. A portable drenching device like the one we have built would be necessary but it would also need to be covered by a plastic tarpaulin capable of moving across the field with the dripper lines (McKenry et al., 1994). Water is a very useful tool for reducing biocide volatilization once the biocide is beneath the soil surface.

A fourth potential alternative involves methyl-isothiocyanate (MIT)-liberating compounds such as Vapam or Soil Prep and others. For nursery settings requiring 1 and 2 years of nematode protection (tree or vine crops) MIT-liberating compounds can become an alternative, but we have identified serious shortcomings to the use of the product. First, MIT delivery can be effective when uniformly mixed into a solution of 10 to 15 cm of water, but it will not be effective when applied via shank where 99.9% nematode control is a requirement. The reason is that MIT is a poor fumigant even when delivery nozzles along each shank are spaced only 12 cm apart. A second problem is that there are many soils which cannot be effectively drenched. Soils having good internal drainage and usually classified as a sand, loamy sand, or coarse sandy loam are suitable for drenching if the 15 cm of water can be delivered with no puddles remaining after 8 h. A third shortcoming of MIT is that MIT delivered at 500 ppm (200 gal per acre in 15 cm water) can reduce growth of trees or vines planted within 6 months after a treatment. This problem disappears after a full year of clean fallowing. A fourth problem is that MIT is a poor penetrant. Roots that are pencil-sized and larger, tubers, corms, or even the nutlets of nutgrass need to be penetrated. A dosage of 250 ppm is adequate only if these plant tissues are all located within the surface 60 cm of soil. There must be no surviving pest-infected roots in the top 120 cm of soil to be planted to tree or vine nurseries. A fifth shortcoming with MIT is the need for a well-mixed addition of the MIT into the water so that in theory, every drop of water has some MIT within. On a positive note, MIT deliveries by sprinkler or basin can be effective if they meet the requirement of infiltration of 15 cm water within 8 h.

A fifth potential alternative to the fallowing/soil fumigation treatment involves the use of reduced rates of fumigants applied deeply followed within days by 4 to 5 cm of 250 ppm MIT solution. For example, 224 kg $ha^{-1}$ MB applied at 60 cm soil depth followed by a ring roller and then 24 h after treatment apply 1.2 cm of 250 ppm MIT each day for the next 4 days. This would mean the addition of approximately 120 kg $ha^{-1}$ of MIT as a sprinkler application. If 325 to 400 kg $ha^{-1}$ Telone is the shanked biocide at 45 cm soil depth; follow at 48 h, 72 h, 96 h, and 120 h with 1.2 cm of 250 ppm MIT solution. Treatments such as these will greatly reduce volatilization by plugging air pore spaces while delivering biocide to the surface 30 cm of soil where it is needed most.

## POTENTIAL ALTERNATIVES THAT HAVE SERIOUS LIMITATIONS

Other suggested alternatives specifically including hot water, steam, solarization, or antagonistic rotation crops have serious limitations where endoparasitic nematodes are the pests of concern. Biocides incapable of penetrating roots such as Enzone, Clorox, urea, and plant extracts also have major limitations where endoparasitic nematodes are present.

## FOUR ALTERNATIVES HAVING THE GREATEST CHANCE FOR FIELD SUCCESS

Based on the previously listed information, there are four alternatives worthy of field evaluation. Two are for situations where endoparasitic nematodes along with other soil pests (except oak root fungus, *Armillaria mellea*) are known to be present:

**Alternative #1.** Shank 390 kg $ha^{-1}$ Telone at a 45 cm depth. Connect manifold lines to existing sprinkler pipe and then 48 hours after treatment deliver 3 to 5 cm water containing 250 ppm MIT over a protracted period of up to 4 days.

**Alternative #2.** Drench 500 ppm MIT (200 gal per acre) in 15 cm water. Drenching may be by sprinkler or portable soil drenching device (McKenry, 1994) but the soil must take all the 15 cm water in 8 h or less. Then, clean fallow for one full year before planting.

For situations with ectoparasitic nematodes as the only pests present or where remnant roots are fully decayed, two additional alternatives are worthy of field testing.

**Alternative #3.** Drench 250 ppm MIT by some type of portable drenching device in 10 to 15 cm water that infiltrates in 5 to 8 h, respectively. Water may also be delivered by sprinkler if the application is uniform. A basin irrigation may have value in soils that infiltrate the water in 3 h or less.

**Alternative #4.** Drench 1000 ppm Enzone in 10 to 15 cm water. Water may be delivered by various means that provide uniformity of treatment.

This is not a final report but actually the first of a 3-year study now underway as we evaluate these four alternatives and many others.

## LITERATURE CITED

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