# COMPARISON OF APPLICATION TIMING ON THE EFFICACY OF METAM SODIUM AND CHLOROPICRIN AGAINST SOILBORNE FUNGI AND YELLOW NUTSEDGE

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The scheduled withdrawal of methyl bromide from use as an agricultural fumigant in 2005 has resulted in the identification of a number of alternative fumigants, including chloropicrin and metam sodium, that have been shown to be efficacious in reducing diseases of caused by soilborne plant-pathogenic fungi on several crops. Researchers have found that combination applications of metam sodium and chloropicrin or 1,3-dichloropropene plus chloropicrin (1,3-DC) provide good control of soilborne fungal pathogens, nematodes, and weeds in vegetables grown under plastic mulch on raised beds. Recommendations state that these materials be applied to raised beds 3-4 weeks prior to planting to avoid the risk of phytotoxicity; however, the optimum interval between treatment and planting for maximum suppression of fungal pathogens and weed propagules is not clear.

The purpose of this study was to evaluate the effects of metam sodium and 83% 1,3-dichloropropene plus 17% chloropicrin on the survival *Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp., and yellow nutsedge (*Cyperus esculentus*) when applied in combination to raised, plastic-mulched plant beds, and to determine the optimum interval between application and planting for maximum suppression of these organisms.

## MATERIALS AND METHODS

The experiment was conducted in March and April 2001 at the Coastal Plain Experiment Station in Tifton, GA on a Fuquay loamy sand (loamy, siliceous, thermic Arenic Plinthic Paleudults). Applications of 1,3-dichloropropene (83% v/v) plus chloropicrin (17% v/v) in combination with metam sodium (42%) were made at rates of 93 l/ha and 349 l/ha, respectively, to raised beds at intervals simulating 4 weeks, 3 weeks, 2 weeks, and 4 days prior to transplanting of yellow crookneck squash. The materials were applied with a chisel injection rig mounted behind a rototiller with toolbar-mounted spray nozzles. This permitted chisel injection of 1,3-DC at a depth of 20 cm and simultaneous application of metam sodium to soil, followed by incorporation of the metam sodium into the upper 10-15 cm of soil. An attached bed shaper formed a 20 cm high by 76 cm wide bed. Drip tape was laid and beds were covered with black polyethylene mulch immediately after treatment. Metam sodium in combination with chloropicrin (applied at 349 l/ha and 84 l/ha, respectively), and methyl bromide (224 kg/ha) were included as comparison treatments along with an untreated control.

Treatment effects on fungal pathogens and yellow nutsedge were evaluated by placing mesh bags measuring 7.5 X 7.5 cm and containing approximately 10 nutlets of *C. esculentus* or 10 oat grains colonized with *Fusarium solani*, *Pythium irregulare*, or *Rhizoctonia solani* AG-4 into plant beds at a depth of 10 cm immediately after treatment. Untreated beds and beds treated with methyl bromide or metam sodium plus chloropicrin received these packets at 4 weeks prior to transplanting. Bags were removed immediately before transplanting of squash. Survival of yellow nutsedge was determined by counting the number of germinated, living nutlets per mesh bag. Survival of fungi was evaluated by plating the contents of mesh bags on selective media and counting the number of colonies recovered. Soil samples were also taken for each treatment and assayed on selective media for total populations of *Fusarium* spp., *Pythium* spp., and *Rhizoctonia* spp.

## RESULTS AND DISCUSSION

In general, total populations of *Rhizoctonia* spp. and *Pythium* spp. were significantly reduced by applications of 1,3-DC plus metam sodium, metam sodium plus chloropicrin, and methyl bromide when compared to the untreated control. No differences in populations were found between application intervals of 1,3-DC plus metam sodium (Table 1). Total populations of *Fusarium* spp. were reduced by all treatments except 1,3-DC plus metam sodium applied 4 weeks prior to transplanting. Lowest *Fusarium* populations were found in plots treated with 1,3-DC plus metam sodium 4 days before transplanting, or those treated with metam sodium plus chloropicrin or methyl bromide. Populations of *Fusarium* tended to increase as the interval between treatment and sampling lengthened, and could be a result of recolonization by the fungus as levels of residue decreased in soil. *Fusarium* populations in plots treated with metam sodium plus chloropicrin were similar to those in methyl bromide-treated plots; however, the rate of chloropicrin was substantially higher for this treatment than in the 1,3-DC plus metam sodium combinations.

Survival of *F. solani* and *R. solani* in soil treated with 1,3-DC plus metam sodium was greatest when colonized oat grains were exposed to the materials for 2 weeks or less (Table 2). Exposures of 3-4 weeks to 1,3-DC plus metam sodium significantly reduced survival of these pathogens as compared to the untreated checks. Metam sodium plus chloropicrin reduced survival of *F. solani*, *P. irregulare*, *R. solani*, and yellow nutsedge to 18, 0, 0, and 0% respectively. Methyl bromide appeared to have no effect on *F. solani* in this test. A similar pattern was observed for yellow nutsedge, although methyl bromide reduced survival to 2%. *Pythium irregulare* was not recovered for any treatment except the untreated control. Thus, the optimal time of exposure to 1,3-DC plus metam sodium needed to suppress fungal pathogens varies with the species being evaluated; however, longer exposure times tend to be more effective against fungal pathogens and also yellow nutsedge. Both temperature and moisture may also influence the optimum time of exposure and should be studied further.

**Table 1**. Population densities of *Pythium* spp., *Rhizoctonia* spp., and *Fusarium* spp., in soil after treatment with alternatives to methyl bromide at various intervals prior to transplanting of squash.

| | Application | | Fungal populations[c] | | |
|---|---|---|---|---|---|
| **Treatment[a]** | **rate** | **timing[b]** | ***Fusarium*** | ***Pythium*** | ***Rhizoctonia*** |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 4 weeks | 528 ab | 4.0 b | 0.03 b |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 3 weeks | 112 cd | 0.8 b | 0.05 b |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 2 weeks | 320 bc | 0 b | 0 b |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 4 days | 32 d | 0 b | 0 b |
| Metam sodium 42% plus Chloropicrin | 349 l/ha 84 l/ha | 4 weeks | 16 d | 6.4 b | 0.05 b |
| Methyl bromide 98% | 224 kg/ha | 4 weeks | 16 d | 0 b | 0.08 b |
| Untreated check | -- | -- | 608 a | 140 a | 0.5 a |

Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).

[a]1,3-DC=1,3-dichloropropene (83%) plus chloropicrin (17%); methyl bromide 98% contained 2% chloropicrin by weight.

[b]Interval between application and planting.

[c]Total populations of *Fusarium* spp., *Pythium* spp., and *Rhizoctonia* spp. expressed as the number of colony forming units per gram of soil.

**Table 2**. Survival of *Fusarium solani*, *Pythium irregulare*, *Rhizoctonia solani*, and yellow nutsedge in soil after treatment with alternatives to methyl bromide at various intervals prior to transplanting of squash.

| | Application | | Pathogen and weed viability[c] | | | |
|---|---|---|---|---|---|---|
| **Treatment[a]** | **rate** | **timing[b]** | ***F. solani*** | ***P. irregulare*** | ***R. solani* AG4** | **Yellow Nutsedge** |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 4 weeks | 48 b | 0 b | 10 c | 0 c |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 3 weeks | 20 b | 0 b | 0 c | 0 c |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 2 weeks | 64 ab | 0 b | 52 ab | 10 c |
| 1,3-DC plus Metam sodium 42% | 93 l/ha 349 l/ha | 4 days | 64 ab | 0 b | 86 a | 68 b |
| Metam sodium 42% plus Chloropicrin | 349 l/ha 84 l/ha | 4 weeks | 18 b | 0 b | 0 c | 0 c |
| Methyl bromide 98% | 224 kg/ha | 4 weeks | 100 a | 0 b | 20 bc | 2 c |
| Untreated check | -- | -- | 100 a | 80 a | 74 a | 88 a |

Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test ($P \leq 0.05$).

[a]1,3-DC=1,3-dichloropropene (83%) plus chloropicrin (17%); methyl bromide 98% contained 2% chloropicrin by weight.

[b]Interval between application and planting.

[C]Percentage of pathogen-infested oat grains or yellow nutsedge nutlets that were viable after removal from treated soil prior to transplanting of peppers.