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EFFECT OF METAM SODIUM AND METHYL BROMIDE ON ROOTKNOT NEMATODE, YELLOW NUTSEDGE, AND DAMP-OFF ON CUCUMBER CV. DASHER II

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Abstract. **A soil fumigation field trial with 'Dasher II' cucumber (*Cucumis sativus* L.) was conducted on Krome gravely loam in the spring of 1999. Methyl bromide plus chloropicrin (MC33) or metam sodium (MS) were applied to 10 acres each and subplots, four beds wide and 100 ft long, of control and fumigant, were randomized with four replications within each 10-acre unit. The fumigant MC33 was injected through three chisels spaced 9 to 10 in apart at 250 lb/acre and beds were covered with 1.5-mil polyethylene film and single bi-wall drip tube was laid at that time. The MS was injected at the irrigation pump at 6 gal/min for 40 min duration at 60 gal/treated acre, allowing 45 min to clear the MS from lines. The MS beds were covered with polyethylene film and drip tube, as in MC33 plots, was in place 12 h prior to fumigant injection. Fourteen d after treatment, cucumber was direct seeded at a spacing of 12 in within the row. Metam sodium applied through single drip irrigation tubing and MC33 increased yields over the nontreated control. Weed biomass from MS and MC33 treatments was significantly reduced at the end of season. The rootknot nematode root galling that occurred early in the development of the control cucumber plants adversely affected yields compared with MS and MC33 treatments.**

Fresh market cucumbers (*Cucumis sativus* L.) have been grown in Miami-Dade County, Florida for over 40 years (Agricultural Experiment Stations Annual Report, 1954). There has been no virgin agricultural soil in southern Florida for over 25 years, as most of the land has been used for bean (*Phaseolus vulgaris* L.), squash (*Cucurbita pepo* L.), sweet corn (*Zea mays* L. var. *rugosa* Bonaf.), cucumber, pepper (*Capsicum annuum* L.), and tomato (*Lycopersicon esculentum* Mill.) production, alternately or consecutively, for over 45 years. Vegetable production declines on these old soils mainly due to soilborne pathogens, nematodes, and competition from weeds (Volin and McMillan 1973). In spite of the fact that most of the tillable soil in Miami-Dade County is infested with soilborne plant pathogens, growers still plant cucumbers without fumigating the soil.

Soil fumigants were primarily designed for the control of plant pathogenic nematodes and insect pests in the soil. These chemicals were later found to be effective in the control of soilborne fungi and bacteria. Some of the early preplant fumigants were D-D, ethylene dibromide, ethylene dichloride, carbon disulfide, propolyene dichloride, hydrocyanie, sulfur dioxide, tetrachloroethane, ethide, and others (Averre et al., 1965; Geraldson et al., 1965; Jones et al., 1971; Stakman and Harrar, 1957; Volin and McMillan, 1973). More recent studies of methyl iodide have shown promise as a replacement for methyl bromide for the control of soilborne pathogens, nematodes, and weeds on tomato and peppers (McMillan et al., 1995, 1996). However, the most effective and universally used fumigant has been methyl bromide with its companion fumigant for fungi and bacteria, chloropicrin (Anonymous, 1993).

The proceedings of the Montreal Protocol of 1991 and its 1992 amendment categorized methyl bromide as an ozone-depleting chemical (Albritton and Watson, 1992). Having been designated as such, all production, importation, and use of the chemical in the United States was to be phased out by the year 2001 (Ohr et al., 1996) but recently was extended to 2005.

The Florida cucumber farmer's most serious production problems are nematodes, soilborne fungi, and nutsedge (*Cyperus* spp.). Many of the alternative fumigants, such as Telone and metam sodium, do not adequately and/or consistently control all of these pests. There are five soil fumigants, metam sodium (Vapam), chloropicrin, propargyl bromide, sodium and potassium azide, and methyl iodide, that have been tested on a limited basis and have been shown to have significant activity against nematodes, soilborne fungi, and weeds. However, metam sodium and chloropicrin are the only fumigants with labels for use on cucumber and would provide cucumber growers in southern Florida (Dade County) with an alternative to methyl bromide.

Chloropicrin alone will not provide adequate control of weeds or nematodes except at high rates, which would be neither economical nor environmentally friendly. Metam sodium when applied at the 60 gal per treated acre provides adequate control of soilborne pests and reduces weed populations. Continued studies from 1980 to 1999, in regards to the delivery systems for metam sodium, have shown that soil injections with plastic tarps and drenches are consistently more effective for the control of soilborne pests and weeds than injection through drip irrigation tube(s). The purpose of this field study was to evaluate consistency of metam sodium application and compare it with the standard methyl bromide soil fumigation.

Materials and Methods

The commercial field trial was conducted on Krome gravely loam in the spring of 1999. Prior to fumigation, soil beds were formed 42 in wide and 6 in high on 6-ft centers. Fertilizer at 30% of IFAS recommendations for N and K and 100% of the P recommendation was banded and rototilled into the bed. Each treatment plot of methyl bromide or metam sodium was 10 acres. Within the 10-acre plots, subplots, four beds wide and 100 ft long, of control and fumigant, were selected at random and replicated four times. Two soil fumigants, metam sodium and methyl bromide plus chloropicrin (MC33), were applied. Methyl bromide plus chloropicrin was injected at 250 lb/acre through three chisels, spaced at 9 to 10 in apart. Metam sodium was injected at the irrigation pump at 6 gal/

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min for a 40-min duration and lines were flushed for 45 min to clear the metam sodium from the lines. The metam sodium beds were covered with 1.5-mil polyethylene film and the single bi-wall drip tube was in place 12 h prior to the fumigant injection. After 72 h, the plastic was perforated in both the methyl bromide (MC33) and the metam sodium blocks to allow venting, and 14 d later 'Dasher II' cucumber was direct seeded at a spacing of 12 in within the rows. Supplemental fertilizer applications of 70% of the IFAS recommendation for N and K were fertigated through the drip irrigation tubing.

Weed counts (yellow nutsedge, *Cyperus esculentus* L.) were determined at the termination of the field trial. Cucumber roots were evaluated for root galls on a rating of 1 to 9 with1 = 0 galls to 9 = 80 to 100% galling at 4 weeks. Yields of marketable, fancy, large, and medium cucumber fruit were evaluated.

Results and Conclusions

Early picking packout of 'Dasher II' from the methyl bromide 10-acre plot, packed out 33 bu/acre fancy fruit. The early packout of marketable (U.S. Fancy, No. 1, and No.2) fruit from the methyl bromide plots was 98 bu/acre. The metam sodium 10-acre plot packed out 40 bu/acre fancy fruit. The early harvest of the marketable cucumber fruit from the metam sodium plots was 95 bu/acre. The early harvest packout for the controls was 2 bu/acre fancy and 3 bu/acre marketable. The total yield after 9 harvests from the plots of methyl bromide was 125 bu/acre of fancy and 415 bu/acre of marketable fruit compared to the control plots with 9 bu/acre of fancy and 18 bu/acre of marketable fruit. The metam sodium total harvest after 9 harvests was 119 bu/acre of fancy and 422 bu/acre of marketable fruit (Table 1).

The mean weed count in the methyl bromide plots was 12 yellow nutsedge per 100 ft of row. The mean weed count in the metam sodium plots was 20 yellow nutsedge per 100 ft of row compared with the untreated control with 2,052 yellow nutsedge per 100 ft of row (Table 2).

The percent rootknot galls after 4 weeks in the methyl bromide plots was 0.3 compared with 0.9% in the metam sodium plots. The mean percent rootknot galls in the control was 98 (Table 2). The percent dampoff (*Rhizoctonia solani*) from the methyl bromide plots was significant at 0.1 and 0.8 from the metam sodium compared with the untreated control at 72% dampoff.

In conclusion, the metam sodium application of 60 gal per treated acre through a single drip irrigation tube increased yields over the control. The standard methyl bromide (MC33) increased yields over the control. The weed counts from the metam sodium and the methyl bromide treatments were significantly reduced at the end of the harvest season. The nematode root galling occurred early in the development of the cucumber plants and thus the yields were adversely affected in the control compared with the fumigant treatments.

Metam sodium is still the only fumigant that can provide cucumber growers with some degree of control for the soilborne problems that were easily taken care of by the application of methyl bromide (MC33).

Table 1. Effect of methyl bromide and Vapam on marketable yield and size from early harvest and total after 9 harvests of 'Dasher II' cucumber in 1999.

	Total Yield (bu/acre)		Total Yield (bu/acre)	
Treatment	Marketable[x]	Fancy[x]	Marketable[x]	Fancy[x]
Nontreated Control	3 a	2 a	18 a	9 a
Vapam	95 b	40 b	422 b	119 b
MC33	98 b	33 b	415 b	125 b

[x]Means followed by the same letter are not significantly different as determined by Duncan's multiple range test at the 0.05 level.

Table 2. Fumigant effect on rootknot nematodes, seedling dampoff, and yellow nutsedge in 'Dasher II' cucumber in 1999.

Treatment	Rate (BC/A[w])	Root-gall (%)[xv]	Seedling dampoff (%)[xv]	Nutsedge (no.)[v]
Control	0.00	98.0 a	72.0 a	2,052 a
Vapam	60.00 gal	0.9 b	0.8 b	20 b
MC33	250.00 lb	0.3 c	0.1 c	12 c

[w]BC/A is broadcast per acre.
[x]Means followed by the same letter are not significantly different as determined by Duncan's multiple range test at the 0.05 level.
[v]Root gall index: 1 = no galls; 2 = 1%-25%; 3 = 26%-50%; 4 = 51%-75%; and 5 = 76%-100%, from 20 plants per treatment.
[r]Dampoff: Horsfall-Barratt disease index 1 = no dampoff and 10 = 100% from 100 ft of row per treatment.
[v]Total number of yellow nutsedge plants per 100 ft of row.

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