CHEMICAL AND BIOLOGICAL ALTERNATIVES TO METHYL BROMIDE FOR STRAWBERRY IN THE SOUTHEASTERN US

L. M. Ferguson[1], F. J. Louws[1*], G. E. Fernandez[2], P. M. Brannen[4], E. B. Poling[2], O. B. Sydorovych[3], C. D. Safley[3], D. W. Monks[2], Z. Pesic-Van Esbroeck[1], D. C. Sanders[2], and J. P. Smith[5]. Departments of Plant Pathology[1], Horticulture[2] and Agricultural and Resource Economics[3] at North Carolina State University, Raleigh, NC, Plant Pathology[4] at University of Georgia, Athens, GA, and Clemson Extension Service[5], Lexington, SC.

Pre-plant soil treatments were evaluated in replicated research station trials during the 2001-2002 growing season in Clayton, NC, Plymouth, NC and Vidalia, GA. Fruit yield and quality data were collected for comparison among soil treatments. To complement this research, soilborne fungi that colonized symptomatic infected roots were routinely isolated pre-plant and at regular intervals during the growing season for identification and later pathogenicity testing. The effectiveness of control of weed growth through plant holes in the plastic mulch was also evaluated in these studies. Predominant soilborne fungal pathogen species associated with black root rot of strawberry were *Rhizoctonia fragariae*, *Phytophthora cactorum*, as well as several other *Phytophthora*, *Pythium*, and *Fusarium* spp. Standard annual strawberry production and pest management practices recommended for the southeastern US were followed. Fruit were harvested at least weekly for 8-10 wks according to conventional grower's practices.

In research trials conducted during the 2001-2002 strawberry production season, a variety of soil treatments, both shank- and drip-applied were studied. At the Vernon James Research and Extension Center in Plymouth, NC, soil treatments applied in 2000-01 season were repeated, plots maintained in the same positions in the field to examine the cumulative effects of treatments over time. The following treatments were tested at Plymouth in 2000-01 and 2001-02 after growing a mixed grass/legume cover crop (flail-mowed and tilled in) and prior to planting 'Camarosa': Chloropicrin (6 gal/A in-row), compost (30 yd^3/A), non-fumigated control, methyl bromide:chloropicrin (MB) 67:33 (200 lbs/A in-row), Telone-C35 (17.5 gal/A in-row), InLine T-C35 (drip applied at 17.5 gal/A in-row, 1 tape), Telone II (11 gal/A in-row), metam sodium (4 shanks at 37.5 gal/A in-row), metam sodium (drip applied at 37.5 gal/A in-row, 1 tape). The fumigant treatments at the Central Crops Research Station in Clayton, NC were implemented prior to planting Chandler in 2000-01 and 2001-02 and were maintained in the same plot position. Clayton soil

treatments consisted of: MB 67:33 (125 lbs/A in-row), Iodomethane (IM) 100% (125 lbs/A in-row), IM:chloropicrin 60:40 (150 lbs/A in-row), Telone-C35 (14 gal/A) and InLine T-C35 (drip applied at 14 gal/A) in the 2000-01 season with a minor change to IM:chloropicrin 75:25 (150 lbs/A) replacing 60:40 mixture in 2001-02 season. In 2000-01 trials, marketable yields comparable to MB (not statistically significantly different) were obtained in Telone-C35, InLine, metam sodium (drip and shank), chloropicrin, IM 100% and IM:chloropicrin 60:40 –treated plots. Only non-fumigated control plots produced significantly lower yields than MB in 2000-01 at Clayton, NC and in 2001-02 all treatments were equivalent to MB-treated plots (**Table 1**). At Plymouth in 2000-01, the non-fumigated control, compost and Telone II-treated plots produced lower yields than MB, all others being statistically equivalent and in 2001-02 only the non-fumigated control plots and the InLine treated plots produced significantly lower yields than MB (**Table 2**).

In Vidalia, GA combinations of the leading alternative chemicals were studied in 2001-02. The eight treatments studied included: **1.** non-fumigated control, **2.** methyl bromide:chloropicrin 67:33 (175 lbs/A in-row), **3.** InLine (17.5 gal/A, 2 drip tubes) + metam sodium (37.5 gal/A, 2 drip tubes), **4.** Telone-C35 (17.5 gal/A, shank) + metam sodium (18.75 gal/A, 4 shanks), **5.** T-C35 (17.5 gal/A) + metam sodium (37.5 gal/A, 4 shanks), **6.** T-C35 (17.5 gal/A) + chloropicrin (65 lbs/A), **7.** InLine (17.5 gal/A, 2 drip tubes), **8.** T-C35 (17.5 gal/A). At this test site, root disease severity, foliar dry weights, root dry weights, plant survival and yield were evaluated. No substantial differences were observed in nematode populations, weed control or phytotoxicity related to the treatments applied. Plant growth parameters were similar to MB for most combinations of 1,3-dichloropropene, metam sodium and chloropicrin. T-C35 and metam sodium applied together significantly reduced root disease symptoms at Feb assessment. Several of the treatments tested provided total season yields equivalent to MB (**Table 3**). T-C35 combined with metam sodium at the high rate was effective at reducing root disease and increased yield. Drip-applied fumigants did not improve yield or disease control above the same products shank-applied.

Table 1. Clayton MB alternatives fumigant trial results for strawberry production during the 2001-02 season. Values listed in the table followed by the same letter are not significantly different from one another and NS indicates non-significant differences by column.

Treatments and rate/A	Marketable yield (lbs/A)	Cull yield (lbs/A loss)	Fruit weight (g)	Crown number / plant	Yield / plant (g/plant)
Non-fumigated control	33006	2587 b	15.5	6.9	927 bc
MB standard (200 lbs/A)	33750	3485 ab	15.7	6.8	970 b
Telone-C35 shank (14 gal/A)	37010	4370 a	14.9	7.3	1078 a
InLine drip (14 gal/A)	30392	2552 b	15.3	5.9	858 c
Iodomethane 100% (100 lbs/A)	33525	3783 a	15.0	6.7	927 b
Iodomethane:chloropicrin 75:25 (138 lbs/A)	34362	3674 a	15.1	6.3	991 ab
	NS		NS	NS	

Table 2. Plymouth MB alternatives fumigant trial results for strawberry production during the 2001-02 season. Values listed in the table followed by the same letter within a column are not significantly different from one another.

Treatments and rate/A	Marketable yield/ plant (g/plant)	Fruit weight (g)
non-fumigated control	413.5 a	17.9 abc
InLine (drip 17.5 gal/A in-row, 1 tape)	420.1 a	16.9 a
Metam sodium (4 shanks at 37.5 gal/A in-row)	452.7 ab	19.1 c
Metam sodium (drip at 37.5 gal/A in-row, 1 tape)	474.7 ab	17.5 ab
Telone II (11 gal/A in-row)	475.1 ab	18.1 abc
Compost (30 yd^3/A)	490.1 abc	18.3 abc
Methyl bromide:chloropicrin (MB) 67:33 (200 lbs/A in-row)	528.5 bc	19.5 c
Chloropicrin (6 gal/A in-row),	534.7 bc	18.6 bc
Telone-C35 (17.5 gal/A in-row)	579.4 c	18.8 bc

Table 3. Vidalia, GA MB alternatives fumigant trial results for strawberry production during the 2001-02 season. Values in the table followed by the same letter are not significantly different from one another.

Treatments and rate/A	Root disease severity* (Feb 14)	Foliage dry weight (g/ 5 plants) (Feb 14)	Root dry Weight (g/ 5 plants) (Feb 14)	Plant survival (plants in 40 ft)	Foliage dry weight (g/ 5 plants (April 17)	Root dry weight (g/ 5 plants) (April 17)	Total yield (kg/ha)
Non-fumigated control	3.8 a **	48.5 d	28.3 b	75.0 ab	104.8 cd	13.9 a	9,417 d
Methyl bromide: chloropicrin 67:33 (175 lbs/A in-row)	3.4 ab	93.5 abc	44.7 a	72.7 b	195.1 a	19.5 a	16,652 ab
InLine (17.5 gal/A, 2 tapes) + metam sodium (37.5 gal/A, 2 drip tubes)	3.3 ab	79.3 c	37.9 ab	76.7 a	107.8 cd	17.5 a	13,821 bc
Telone-C35 (17.5 gal/A) + metam sodium (18.75 gal/A, 4 shanks)	3.4 ab	90.8 abc	37.1 ab	72.8 b	171.6 ab	16.0 a	15,892 abc
T-C35 (17.5 gal/A) + metam sodium (37.5 gal/A, 4 shanks)	3.1 b	109.0 a	41.7 a	74.5 ab	168.5 ab	17.2 a	18,840 a
T-C35 (17.5 gal/A) + chloropicrin (65 lbs/A)	3.3 ab	104.7 ab	41.7 a	73.8 ab	162.8 ab	13.7 a	14,750 bc
InLine (17.5 gal/A, 2 tapes)	3.6 ab	83.7 bc	45.7 a	76.2 ab	97.6 d	16.4 a	12,478 cd
T-C35 (17.5 gal/A)	3.5 ab	99.4 abc	31.4 b	74.5 ab	148.1 bc	17.3 a	16,018 abc
LSD (P=0.05)	0.5	24.2	9.7	3.5	45.9	6.8	3,691

* Root disease severity was determined using the following visual rating scale: 0 = not discolored root tissure, 1 = mild discoloration of older root tissue, otherwise healthy root system, 2 = moderate discoloration of older root tissues, otherwise healthy root system, 3 = older roots black, but otherwise healthy root system, 4 = older roots black, younger roots poorly developed or brown, 5 = older and younger roots black and root system overall poorly developed, root hairs sparse.

** Means followed by the same letters are not significantly different according to Fisher's protected LSD test of significance.