STRAWBERRY PRODUCTION WITH ALTERNATIVES TO METHYL BROMIDE FUMIGATION

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Strawberries were transplanted in the fall of 1997 to polyethylene mulched beds in Gainesville on a Millhopper fine sand and in Quincy on an Orangeburg fine sandy loam to evaluate the effects of soil fumigants and solarization on fruit production and reported (Locascio, et al., 1999). Fumigant and solarization treatments were applied on Aug. 21 and 19, 1997, respectively. On selected plots, napropamide was applied at 4.8 kg/ha for weed control and fumigant metam-Na at 300 L/ha were rototilled into the bed. Soil fumigants were injected with two chisels per bed spaced 30 cm apart at a depth of 20 to 25 cm at 390 kg/ha 67 % MBr + 33 % Pic, 340 kg/ha Pic, 327 L/ha a C-17, and C-35, and 440 kg/ha dazomet. Drip tubing was placed on the beds before application of 38.1µm (1.5 mil) black polyethylene mulch or 102 µm (4 mil) clear thermal infrared-absorbing film (AT Plastics, Inc., Edmonton, Canada)**.** Soil temperature was measured at 0- to 25-cm depths in two plots mulched with black and in four plots mulched with the clear film (Chase et al., 1997). Some clear mulches (Table 1) were painted with black latex paint a week before transplanting. ‘Chandler’ was transplants on Oct.21 and Nov.7, respectively.

Transplants were sampled for fungal colonization of roots on 24 Oct. Fruits were harvested twice weekly, graded and weighed. Soil and plants were sampled for nematode and fungal populations at Gainesville at the end of the harvest season on May 18.

Fungi were isolated from the roots and crown tissue of every plant sampled before transplanting. VA mycorrhizal fungi were observed on 95% of the root samples. *Alternaria, Fusarium, Rhizoctonia, Trichoderma,* and an unknown pycnidial forming fungus were isolated from 5, 35, 25, 5, and 5% of the crown pieces, respectively. Although some species of *Alternaria, Fusarium,* and *Rhizoctonia* may cause root diseases, it was not possible to determine the source of pathogens isolated from roots during the growing season and at harvest.

Solar radiation and soil temperatures decreased over the measurement periods (60 days) from Aug. to Oct. Soil temperatures by late Sept. were insufficient to control nutsedge tubers or to kill emerged shoots trapped under the clear film. Maximum soil temperatures exceeding 45 C with the clear mulch at 10 cm occurred on less than 2 % of the days. By the sixth week of solarization at Gainesville, nutsedge density in the control treatment was 22 plants m^{-2} (Table 1). Metam-Na + napropamide was the only treatment that failed to reduce the number of nutsedge plants penetrating the mulches. All other treatments significantly reduced nutsedge densities to levels that were statistically similar to that with MBr-Pic. By Dec., it was apparent that painting the solarization film before transplanting was necessary. The clear film maintained soil temperatures that were sufficiently warm to promote the sprouting of tubers but not hot enough to cause foliar scorching of the shoots trapped under the film. The cooler temperatures apparently induced nutsedge dormancy since the nutsedge pressure was relatively low with all other treatments. By the end of the crop, nutsedge densities under the solarization films were greater than with the black films (Table 1).

At Gainesville, strawberry plant growth was slow, possibly due to the high occurrence of rainfall after transplanting. Rainfall exceeded average in each month from transplanting through Mar. Rainfall in Feb. was approximately three times the average. Plant vigor ratings were made on Jan. 29, 1998 (Table 1). Plant growth rating of plants with no treatment was only 2.5 on a rating of 1 (poor growth) to 10 (excellent growth) and was significantly greater with all treatments except that with the unpainted clear mulch solarization treatment. Marketable fruit yields were significantly higher with MBr-Pic than with no fumigant, metam-Na with and without Pic, and with the soil solarization treatment-mulch painted black before transplanting (Table1). Total fruit yields in flats/ha were highest with MBr-Pic (4,131), C-17 (3,620), C-35 (3,541), Pic (3,311), and soil solarization with metam-Na-mulch painted (3,002), and significantly lower with metam-Na (2,552), soil solarization-mulch painted (2,710), metam-Na + Pic (2,199) and the check (1,705). Fruit was not obtained with soil solarization-clear mulch not painted. Weed growth under the clear mulch was extensive and picked the mulch up 7.5 to 15 cm over the soil; thus, strawberry plants did not survive the weed competition.

At Quincy, strawberry plant growth was excellent and fruit yields are shown in Table 2. Total fruit yield (in flats/ha) was highest with Pic (4,040), MBr-Pic(3511), C-35 (3,553), C-17 (3,333), Metam-Na + Pic (3,279), Dazomet (3,620), and Dazomet + solarization-mulch painted (3,543). Lower yields were obtained with solarization-mulch painted (3,210) and with metam-Na + Pic (3,116) and with no fumigant (2,417). The lowest yield was obtained with solarization- mulch not painted (815). Fruit size response to fumigant treatment was similar to that obtained for total yield. Marketable fruit were larger with treatments that resulted in higher yield and smaller with treatments that resulted in lower yields. Nutsedge counts were made on Sept. 30 and data are shown in Table 2. Nutsedge control was excellent with MBr-Pic, and with all solarization treatments, intermediate with C-17 and C-35 + napropamide, and poorest with Pic, metam-Na-Pic and dazomet each + napropamide and with the untreated check.

Roots and crowns of strawberry plants in all soil treatments at the end of the season were colonized by a wide array and diversity of fungi, and high incidences of colonization were attained by many of them. Fungi in 18 genera were isolated from roots. Incidences of infection of plants by potentially damaging pathogenic fungi included 29-59% with *Alternaria* spp., 13-42% with *Sclerotium rolfsii*, 50-83% with *Colletotrichum* spp., 13-59% with *Curvularia* spp., 75-96% with *Fusarium oxysporum*, 4-17% with *Macrophomina phaseolina*, 29-79% with *Phoma* spp., 17-42% with *Pythium aphanidermatum*, 4-17% with other *Pythium* spp., and 67-92% with *Rhizoctonia solani*.

In general, the high incidence of pathogenic fungi, especially *S. rolfsii*, *F. oxysporum*, *P. aphanidermatum*, and *R. solani*, and the severity of root disease caused by them undoubtably contributed to poor plant growth, early plant mortality, and low yields at Gainesville. Fumigation probably delay the time of infection by fungi dispersed into treated soil and allowed increased yields before pathogenic fungi reach high levels of colonization and cause severe disease.

The population densities of the highly pathogenic sting (*Belonolaimus longicaudatus*) nematode at the end of the season at Gainesville was low and not affected by treatment (data not shown).

In summary, early plant growth and yields at Gainesville were poorer than expected, probably due the high incidences of fungal root diseases and to excessive rainfall during Dec. to Mar. The yield with MBr-Pic was statistically similar to that with 1,3-dichloropropene + 17% Pic (C-17), C-35, Pic, and soil solarization + metam-Na-mulch painted black before transplanting. Yields were significantly lower with the check, metam Na, metam Na + Pic, and soil solarization-mulch painted before planting than with MBr-Pic. At Quincy, plant growth was excellent and yields were statistically similar with Pic, MBr-Pic (67:33), dazomet, solarization + dazomet-mulch painted black, C-17, C35, and metam-Na + Pic. Lowest yields were obtained with the untreated check and solarization-mulch not painted black before planting. Soil solarization with the mulch painted black suppressed nutsedge but regrowth occurred with the mulch left clear. At Gainesville, treatment had no effect on sting nematode (*Belonloaimus longicaudatus)* population densities extracted from soil samples or fungi populations on plant roots at the end of the season.

Literature Cited

Chase, C.A., T. R. Sinclair, S.J. Locascio, J.P. Gilreath, J.P. Jones, and D.W. Dickson. 1997. An evaluation of improved polyethylene films for cool-season soil solarization. Proc. Fla. State Hort. Soc. 110:326-329.

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Table 1. Effect of fumigant treatments on fruit yield, plant vigor, and nutsedge counts of ‘Chandler’ strawberries. Gainesville, FL. 1997-98

				Nutsedge (plants/m^2)		
Treatment	Rate/ha	Yield (flats/ha)	Plant vigor[v] (Jan 29)	Through film Oct 8	Through film May 18	Under film May 18
Untreated		1705 d[w]	2.5 d	21.5 a	8.5	16.1 bc
Methyl bromide /Pic (67/33)	390 kg	4131 a	10.0 a	0.0 b	0.0	0.9 c
Chloropicrin (Pic)[z]	340 kg	3311 abc	6.8 bc	5.0 b	4.5	1.3 c
1,3-D + 35 % Pic[z]	327 L	3541 ab	8.0 b	3.4 b	0.9	4.0 c
1,3-D + 17 % Pic[z]	327 L	3620 ab	6.8 bc	0.8 b	20.2	16.6 bc
Metam-Na[z]	300 L	2552 bcd	5.5 c	28.4 b	12.1	13.9 bc
Metam-Na + Pic[z]	300 L + 170 kg	2199 cd	4.8 c	5.0 b	1.3	6.3 c
Solarization[x]		----	1.0 d	0.0 b	0.0	45.7 ab
Solarization[y]		2710 bcd	5.5 c	0.4 b	0.0	49.3 a
Metam-Na + Pic + solarization[y]	300 L + 170 kg	3002 abcd	6.0 bc	0.0 b	0.5	44.8 ab

[z] Napropamide applied at 4.4 kg/ha.
[y] Mulch painted black before planting.
[x] Mulch left clear and due to excessive weed growth, fruit was not harvested.
[w] Mean separation Duncan’s Multiple Range Test, 5 % level.
[v]Plant vigor ratings with 10 = maximum growth and 1 = 10 % of maximum growth.

Table 2. Effect of fumigant treatments on yield, fruit weight, and nutsedge counts of 'Chandler' strawberries. NFREC, Quincy, FL. 1997-98

Treatment	Rate/ha	Yield (flats/ha)	Size (g/fruit)	Nutsedge (plants/m^2)[v]
Untreated		2417 c[w]	15.5 c	29.3 ab
Methyl bromide /Pic (67/33)	390 kg	3511 ab	17.0 ab	1.0 d
Chloropicrin (Pic)[z]	340 kg	4040 a	17.4 ab	20.2 abc
1,3-D + 35 % Pic[z]	327 L	3553 ab	17.1 ab	10.1 cd
1,3-D + 17 % Pic[z]	327 L	3333 ab	17.2 ab	13.2 bcd
Metam-Na + Pic[z]	300 L + 170 kg	3279 ab	16.9 abc	19.8 abc
Metam-Na[z]	300 L	2933 bc	16.1 bc	30.4 a
Dazomet[z]	440 kg	3620 ab	17.1 ab	33.7 a
Solarization[x]		815 d	13.4 d	0.1 d
Solarization[y]		3210 b	16.2 abc	0.2 d
Metam-Na + Pic + solarization[y]	300 L + 170 kg	3116 bc	16.1 bc	0.1 d
Dazomet +solarization[y]	440 kg	3543 ab	17.7 a	0.1 d

[z] Napropamide applied at 4.4 kg/ha.
[y] Mulch painted black before planting.
[x] Mulch left clear.
[w] Mean separation Duncan's Multiple Range Test, 5 % level.
[v]Nutsedge shoots penetrating mulch counted on Sept. 30.