STRAWBERRY RESPONSE TO FUMIGANTS APPLIED BY DRIP IRRIGATION SYSTEMS

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Soil fumigants 1,3-dichloropropene (1,3-D) in combination with chloropicrin (Telone C35[7]) and chloropicrin alone are potential alternatives to MeBr for strawberry production in California. These fumigants, when injected through shanks into flat fields or preformed beds and immediately covered with polyethylene films (as methyl bromide is applied), result in adequate control of most pathogens and strawberry yields 85 to 100% of those achieved with methyl bromide. Metham Sodium (Vapam[7]) which gives off the fumigant MITC, has also been tested for efficacy on strawberries. Mixed results are generally attributed to the difficulty of evenly distributing the material throughout the soil. Vapam may be beneficial in combination with other fumigants (esp. chloropicrin).

Emulsified formulations of Telone C35 (Inline[7]) and chloropicrin can be applied with irrigation water through the drip irrigation systems that are used to irrigate strawberries. This would reduce application costs and may reduce hazards associated with emissions. Metham sodium is soluble and can also be applied through the drip system. The USDA-ARS Water Management Research Laboratory, in collaboration with the California Strawberry Commission, is carrying out field studies to determine application procedures that maximize efficacy and minimize human and environmental risk associated with drip application of these materials. This report will describe the efficacy in terms of strawberry yields based on two years of trials on two fields in the coastal central California area.

Methods

The fumigants were applied in October to field plots located near Salinas (USDA-ARS Spence Farm) and Watsonville (Monterey Bay Academy), California, through 2 drip lines in the 32" wide beds. The Salinas site had not been fumigated or planted to strawberries previous to 1997 and similar treatments have been applied each year since 1997 to the same 3 bed x 100 ft long plots. The Watsonville site had been planted to strawberries for 3 previous years, but half the plot area had not been fumigated. Fumigant treatments were repeated on the same beds. Variables included fumigant (Telone C35, vapam, chloropicrin, and combinations), application method (bed shank and drip), application rates (full and 60%), and the amount of water applied as carrier for the fumigant (15, 25, or 35 mm). The treatments were compared to standard bed-shanked MeBr/Cloropicrin (65/35) applications, and non-fumigated plots. At both sites, opaque mulch and hand weeding were used to control weeds. These were the 2nd and 3rd years of testing most of these treatments at these sites. The first year (presented at last year=s conference) gave variable results due to less consistent application rates and methods.

Results

The accompanying table shows consistency in the results at each site, but variation between the two sites, indicative of differences in climate and pest pressures. At the Watsonville site, fresh market yield with no fumigation was low, due to high pathogen pressures. Verticillium was a major problem in 1998, resulting in substantial plant damage and yield loss for less efficacious treatments. The cause of early stunted growth in the weaker treatments in 1999 may have been Phytophthora or Pythium, but was not conclusively identified. Generally, shank-applied MeBr and Telone C-35 gave the best yields, followed closely by the full rate drip-applied Telone + Chloropicrin (Inline) treatments. Reduced rate Inline, even in combination with Vapam, gave inconsistent results at this site. Chloropicrin at the low rates used (160 lb/ac) and Vapam were also unable to control the pest pressures, although even the reduced yields of these fumigated treatments were 60% - 100% greater than those from the non-fumigated plots. Vapam injected simultaneously with Telone or chloropicrin did not show the expected synergism. Metham Sodium and chloropicrin and/or 1,3-D may have reacted in the aqueous solution resulting in rapid degradation/hydrolysis of the metham sodium. Beginning this year, we inject the vapam 5 days after the Telone or chlorpicrin fumigation.

At Salinas in 1998, all treatments, including the non-treated control, showed little soil-borne pest pressure and yields were relatively uniform for all treatments. In 1999, the non-treated plants showed moderate stunting that resulted in reduced yields. At this site, nearly all drip-applied treatments tended to out-produce the shank-applied fumigants. Drip-applied Inline, at full rates, gave a 10% - 20% yield boost compared to the MeBr standard. Note that standard fresh market yields at the Salinas site are below industry averages, due to the soil and climate. Total yield (including processed berries) from this site is more than double these fresh market values, and show the same relative trends.

These studies will be continued for the fourth year at these sites. A third research site was added this year in which particular pest pressures are being monitored and additional fumigants are being studied. A primary concern, especially with chloropicrin, is inadequate weed control. Both shank-applied and drip-applied fumigants are being tested in grower fields on large plots. Work will continue through laboratory tests and soil gas monitoring, to determine means to maximize efficacy (soil condition, water carrier amount, impermeable mulch films) and minimize emissions (impermeable mulch films, organic amendments). We are also working with product manufacturers to develop application equipment and procedures to minimize worker and environmental risks.

Strawberry Fresh Market Yield relative to Yield with Standard MeBr/C Shank Injection (%)[1]. (All are drip-applied unless noted.)

Trmt No.	Fumigant	Rate[2]	Water	Watsonville		Salinas	
				1998	1999	1998	1999
1	none			50	35	98	80
2	MeBr/C (65/35) shank	H		100	100	100	100
3	Telone C35 (65/35) shank	H		100	100	98	107
4	Telone C35	H	L	97	95	110	116
5	Telone C35	H	M	92	92	110	113
6	Telone C35	H	H	110	93	112	123
7	Telone C35	L	M	95	69	115	114
16	Telone C35	L	H			113	106
17	Telone C35	L	M+			114	120
15	Telone C35 + Vapam	H	H			109	89
11	Telone C35 + Vapam	L	M	73[3]	68	103	112
8	Vapam	H	M	70	70	110	117
9	Vapam	H	H	79[3]	80	98	105
10	Vapam	L	M	67	72	103	97
13	Vapam	H	L			99	102
12	Chloropicrin + Vapam	L	M	51[3]	76	106	105
14	Chloropicrin	L	M		69	102	100
18	Chloropicrin shank	L					100

[1] Average of 3 (Salinas) or 4 (Watsonville) replications. Standard MeBr/C (tmnt 2) yields (trays/ac) were: Watsonville 1998: 4600, Watsonville 1999: 4200, Salinas 1998: 1800, and Salinas 1999: 1200.

[2] High (H) rates = 425 lb/ac MeBr/C, 425 lb/ac Telone C35 (250 lb/ac 1,3-D (eq to 24 gal/ac Telone II) + 160 lb/ac chloropicrin), and 75 gal/ac Vapam (42% Metham Sodium). Low (L) rates = 255 lb/ac Telone C35, 50 gal/ac Vapam, and 160 lb/ac Chloropicrin. All rates are on a bed area basis; for application rates on a gross field area basis, (comparable to flat fumigation) multiply by 0.6.

[3] Application rate was inadvertently reduced by 30%