ON-FARM METHYL BROMIDE PREPLANT SOIL FUMIGATION ALTERNATIVES IN CALIFORNIA STRAWBERRY PRODUCTION

Christopher Winterbottom*[1], James Mueller[2], Thomas Trout[3], Frank Westerlund[1], Tri-Cal[4]

The strawberry industry in California could be characterized by innovation and explosive growth. In 1979 there were 11,500 acres devoted to strawberry production in California. Over the period 1979 to 1993 the strawberry acreage in California increased, on average, by 1,030 acres per year due to new areas coming into production, introduction of new varieties, improved cultural practices and better crop protection tools (Figure 1). Over the period 1994-1998 the California strawberry acreage has held steady at about 24,000 acres. *The result of the tremendous industry growth has been an increase in the amount of strawberries on the market and a large decrease in per unit return to the farm gate, thus making any significant detrimental change in production practices a threat to the viability of the industry in the short to midterm.*

Strawberry farmers were early adopters of preplant soil fumigation with methyl bromide due to the virtual elimination of soil-borne pathogens (notably *Verticillium* spp., *Phytophthora* spp.) and other pests (nematodes, weeds, arthropods, etc.) for a growing season, thus allowing farmers and researchers alike to focus on other factors that limited production. Nearly 100% of the California strawberry acreage is presently preplant fumigated with methyl bromide, and it is the fumigant of choice due to its efficacy across many different growing situations (soil types, temperatures, moisture, etc.).

Methyl bromide has been identified as a Class I ozone depleting substance, and on September 17, 1997 at the Ninth Meeting of the Parties to the Montreal Protocol an accelerated methyl bromide phase-out schedule was established.

Due to the important role methyl bromide plays in strawberry production in California, the California Strawberry Commission initiated research with the USDA-ARS, the University of California and allied industries to focus on projects designed to find economical methyl bromide alternatives for strawberry production. The research approach taken thus far has been two-pronged. The first prong consists of small plot research designed to identify economically viable alternatives to methyl bromide, their efficacy and use parameters. The second prong is designed to evaluate the best methyl bromide alternatives in large plots (≥ 0.5 acres) on-farm under actual farming situations. The following is a brief summary of on-farm methyl bromide alternative trials supported by the California Strawberry Commission and the USDA-ARS conducted in the 1996-1997 and 1997-1998 growing seasons.

[1]California Strawberry Commission, Watsonville, California
[2]Dow Agro Sciences, Brentwood, California
[3]USDA-ARS Water Management Research Laboratory, Fresno, California
[4]Tri-Cal, Hollister, Santa Maria, Oxnard and Corona, California

Methyl bromide alternatives tested include chloropicrin, Telone C35, Vapam and Basamid. The alternatives were compared to the growers' standard preplant fumigation practice, usually an annual application of methyl bromide/chloropicrin (commonly 57/33, 67/33 or 80/20) at a rate of between 225 lbs/acre to 375 lbs/acre. Crop production followed standard grower practices in terms of cultivar selection, planting dates, pest control, etc. Yield data was collected by the farming operation in appropriate units (trays per acre, grams per plot, etc.) according to available means of collecting yield data, and converted to trays per acre.

During the 1996-1997 growing season, five on-farm methyl bromide alternative trials were established in four of the five strawberry growing districts (Table 1). During the 1997-1998 growing season, nine on-farm methyl bromide alternative trials were established with at least one methyl bromide alternative trial in each of the growing districts (Table 1). The trial locations and farming conditions represent only a very small fraction of strawberry farming conditions in terms of soil, microclimate, pest and disease pressure, and farming ability.

Based on the data from the five on-farm methyl bromide alternatives trials from the 1996-1997 growing season, chloropicrin yielded 91.9% to 102.6%, and Telone C35 72.1% to 107.0% relative to the fresh market yield of strawberry plants grown in soil preplant fumigated with methyl bromide/chloropicrin (Table 2). The average fresh market yields across fumigant rates, application methods and locations for chloropicrin and Telone C35 relative to the methyl bromide/chloropicrin grower's standard were 97.1% and 94.7% respectively (Table 2). Vapam was not included in on-farm trials during the 1996-1997 growing season.

Nine on-farm methyl bromide alternative trials were established in the 1997-1998 growing season. Complete fresh market yield data for the 1997-1998 season is currently available only from four of the nine trials (the four data sets are from southern production districts; the northern districts are either still in production or are tabulating data). Available data indicated fresh market yield relative to methyl bromide/chloropicrin ranged from 77.4% to 93.1% for Basamid, 68.5% to 115.3% for chloropicrin, and 82.1% to 105.9% for Telone C35 (Table 2). The average fresh market yields across rates, application methods and locations for chloropicrin, Telone C35 and Basamid relative to methyl bromide/chloropicrin from the available 1997-1998 trial data are 93.6 %, 94.2% and 89.9% respectively (Table 2).

The average fresh market yields across the 1996-1997 and 1997-1998 growing seasons, fumigant rates, application methods and locations for chloropicrin, Telone C35 and Basamid relative to methyl bromide/chloropicrin are 95.4%, 94.5% and 89.9% respectively (Table 2).

Although the above data looks promising there are problems with the alternatives and considerable gaps in our knowledge of the alternatives to methyl bromide in California strawberry production. These include:

- Most data received from the methyl bromide alternative trials is marketable fresh fruit. Approximately 70% of the strawberry crop in California goes to the fresh fruit market and

Table 1 Number of on-farm methyl bromide alternative trials by year and growing district.

Growing season	District	Number of sites
1996-1997	Watsonville/Salinas	2
	Santa Maria	1
	Oxnard	1
	San Joaquin Valley	1
	Total	5
1997-1998	Watsonville/Salinas	3
	Santa Maria	1
	Oxnard	1
	Orange/San Diego	2
	San Joaquin Valley	2
	Total	9

- 30% to the processing market. As a result, accurate data on a large and important component of the economics of farming strawberries under methyl bromide alternatives is missing.

- A key role of preplant soil fumigation with methyl bromide in strawberry production is weed control. Weeding costs can play an important role in the economics of strawberry farming, especially if methyl bromide alternatives are less efficacious herbicides than methyl bromide, which appears to be the case for the most likely methyl bromide alternatives.

- Yield data is but one aspect of profitable strawberry farming. To determine whether an alternative to preplant soil fumigation with methyl bromide is an economically viable alternative, one needs revenue associated for each unit of production sold, costs associated with each unit of production produced, selling costs for each unit, and transportation costs associated with each unit.

- Usage issues on methyl bromide alternatives still require considerable work

  Chloropicrin - excellent disease control, limited nematode and weed control, additional 4 to 6-week plant back period.

  Telone/chloropicrin combinations - excellent nematode and disease control, limited weed control, additional 4 to 6-week plant back period.

  Vapam (metham sodium) - application technique critical for efficacy, additional 4 to 8-week plant back period.

  Basamid (dazomet) - not registered for strawberry fruit production, application technique critical for efficacy. BASF has no EUP available for 1998-1999 season.

Table 2. Average fresh market yield across seasons, rates, application methods and locations under methyl bromide alternatives as a percent of freshmarket yield from MBr/Pic preplant fumigated soil.

	Yield (%MBr/Pic yield)		
Fumigant	**1996-1997**	**1997-1998**	**Average**
MBr/Pic	**100.0%**	**100.0%**	**100.0%**
Chloropicrin	**97.1%**	**93.6%**	**95.4%**
Telone C35	**94.7%**	**94.2%**	**94.5%**
Basamid		**89.9%**	**89.9%**

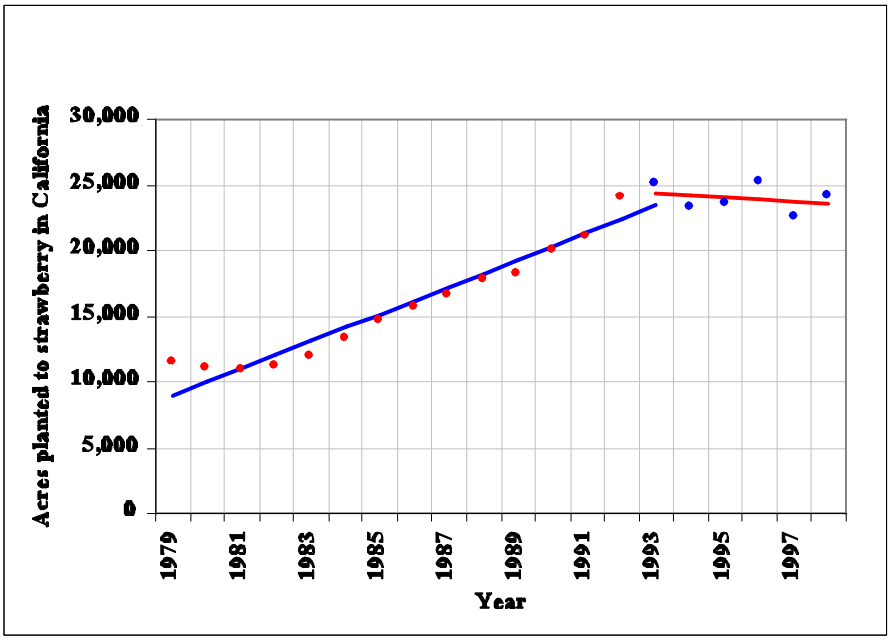

Figure 1. California strawberry acreage, 1979-1998.