ADOPTION OF METHYL BROMIDE ALTERNATIVES BY CALIFORNIA STRAWBERRY GROWERS

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California strawberries is a billion dollar crop. Over 80% of U.S. commercial strawberries are grown along the central and southern CA coast on about 30,000 acres of land. Nearly all soil planted to strawberries in CA is fumigated before each crop. About 5 million pounds, or 1/3 of the MeBr use in CA in the 1990s, was applied to soils used to grow strawberries. As the phaseout progressed and the price of MeBr increased, many growers of tree, vine, and vegetable crops quit using MeBr, but because strawberry is a very high-valued crop, strawberry growers have been able to continue use. In 2002, over half of the total use in CA. was for this crop.

Total fumigated strawberry land has increased since before the phaseout, due both to increasing strawberry acreage and state regulatory changes that caused many growers to change from bed to broadcast fumigation (increasing "treated" area by about 50%). Thus, the fumigated area likely increased by over 20% from the late 1990s to 2002 and has increased an additional 15% since 2002. During this time, MeBr use decreased about 15% (to 2002). This reduction is the result of both reduced use rates and adoption of alternative fumigants. One of the main factors has been the adoption of MeBr:chloropicrin combinations that are higher in chloropicrin. As the price of MeBr increased from about $1 to $3 per pound, the average combination changed from 70:30 to 60:40.

Drip application technology was developed and demonstrated in the late 1990s and emulsified fumigants were registered for drip application in 2001 and 2002. The adoption of drip application of InLine (emulsified Telone:chloropicrin mixture) and emulsified chloropicrin has been growing rapidly since 2001. Approximately 10% of the strawberry fields were drip fumigated in 2002, and we estimate that portion increased to about 20% in 2003 and will increase further in 2004. Drip application to beds allow rates to be reduced about 35% because of reduced treated area.

Use of chloropicrin as a stand-alone fumigant has increased, with about 40% of this product being drip-applied in 2002. With both stand-alone and combination uses, about 80% as much chloropicrin was being used in 2001 and 2002 as MeBr. Chloropicrin rates are nearly always under 200 lb/ac, due to regulatory constraints. Metam sodium use has generally increased, although erratically, over the last few years. Rates are generally under 50 gal/ac, compared to a maximum label rate of 75 gal/ac. Metam sodium is recommended as a follow-on treatment behind other drip-applied alternatives (esp. chloropicrin) to improve weed control, although through 2002, most uses were not combination treatments. Very few,

except organic growers, grow strawberries without fumigation. Research data has shown yield declines of 10 to 50% without fumigation.

A CA. Strawberry Commission survey of growers in 2003 indicated that, MeBr alternatives were used on about 25% of the strawberry land. Informal discussions with growers indicate that the percentage will increase further in 2004. Adoption rate varies widely with growing region, with adoption rates much higher in the southern growing regions. Most growers do not believe that, in the near term with moderate pest pressures, yields with alternatives are less than those with MeBr:chloropicrin mixtures. Some growers are more concerned about loss of chloropicrin (currently under re-registration) than MeBr.

The alternative most often preferred is drip-applied InLine, although in 2004, the major strawberry township in Oxnard had already hit the CA Telone township cap (2X) before fall strawberry fumigation had begun, and the cap is expected to be hit in at least one other township. Where InLine is not available, growers will generally use drip or shank chloropicrin or revert to MeBr.

Factors likely to influence a grower's decision whether to adopt alternative fumigants include:

- Length of growing season: Growers in the south that harvest for only about 5 months are more confident alternatives will "last" through the growing season. Growers in the north that generate income over a long season are concerned that alternatives will lose effectiveness before the end of the season, and that the plastic mulch required with drip fumigation will reduce plant winter hardening and vigor.
- Market window: Growers in the south that target early production feel that Telone and chloropicrin increases early growth and yields.
- Target yield and economics: Growers that tend to favor cost reduction over yield maximization tend to favor alternatives. Drip InLine or chloropicrin costs less than 50% as much as broadcast MeBr:chloropicrin mixtures ($750 vs $1700 per ac). Low prices or cash flow likewise induces use of low-cost alternatives. Increased demand for InLine in Oxnard in 2004 is partially due to poor economic returns in 2003.
- Cultural practices: Growers that previously used MeBr bed fumigation tend to favor land preparation scheduling used for drip fumigation.
- Neighbor concerns: Growers with neighbors that are concerned by fumigation activities favor drip fumigation because there is little field equipment or activity during fumigation.
- Land/pest history: Growers with land ownership (rare) or long leases where they know the fumigation and pest history of the land are more willing to adopt alternatives. Most growers that are developing new land for strawberries prefer to use MeBr at least the first year. Most growers are concerned that repeated use of an alternative might reduce efficacy (through evolution of degraders) or allow pest pressures to build up. They

want the option of having MeBr available, if necessary, to use about every 3 years.

- Crop rotation: Most alternatives require more time to dissipate from the soil which delays planting. Those that do not rotate crops and have short harvest seasons (south coast) have more time to prepare for planting. Those that rotate alternate years with vegetable growers (predominately Watsonville/Salinas) lose land rent when alternatives reduce rotation time from 3 to 2 vegetable crops. Those that do not rotate and have long seasons (central coast) may lose one or two weeks of late (and often high-valued) harvest.
- Philosophy: Some growers are early adopters of alternatives because "it's the right thing to do". Others adopt to keep options open or gain a competitive advantage in case MeBr use is abruptly eliminated. Some have tested alternatives and believe they can use them, but continue to use MeBr as long as they can under the assumption that is will not be available in the future. Some growers are late adopters and will not change until forced to do so.

Table 1. Fumigant use for California Strawberries[1]

Year	MeBr		Chloropicrin[2]		1,3-D (Telone)		Metam Sodium		Total[3]		Planted[4]
	Lbs	*Acres*	*Lbs*	*Acres*	*Lbs*	*Acres*	*Lbs*	*Acres*	*Lbs*	*Acres*	*Acres*
1996	4,139,602	19,564	1,870,360	631	165	1	14,732	80	6,024,859	20,275	24,245
1997	4,025,350	18,920	1,868,039	48	13,698	91	12,031	102	5,919,118	19,161	21,508
1998	4,301,804	19,989	2,027,084	96	3,096	17	141,504	679	6,473,488	20,780	23,164
1999	5,350,947	25,694	2,631,801	36	529	2	145,790	1,059	8,129,067	26,791	23,603
2000	4,285,599	22,131	2,388,863	196	16,715	104	62,981	313	6,754,158	22,743	25,339
2001	3,764,931	21,596	3,000,460	1,433	150,040	1,019	88,182	432	7,003,613	24,480	24,143
2002	3,635,090	19,959	2,869,986	1,458	444,016	2,308	238,030	1,367	7,187,122	25,092	26,178
2003					950,000[5]	5,378[5]					27,230
2004											30,639

[1] Developed from the CA Dept. of Pesticide Regulation Pesticide Use Reports database, as modified by the first author (corrections for unassigned crops and out of range rates). Strawberry fumigations in the high elevation counties were deducted on the assumption that they were nurseries rather than fruiting fields. 2002 is the last year data has been released thus far.

[2] Lbs chloropicrin are total use including as stand alone and combinations. Acres are only those acres on which chloropicrin was used as a stand alone fumigant (not in combination with MeBr or 1,3-D).

[3] Although Metam Sodium can be used as a separate application following other fumigants (primarily drip applications), data indicated that most fumigations through 2002 were on fields that had not received other fumigants.

[4] Based on harvested acres compiled by the CA Strawberry Commission, adjusted downward by 1000 acres to allow for harvesting of second year crop.

[5] Estimated