Conventional and organic alternatives to methyl bromide on California strawberries.

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This project was made possible through grants from the California Department Pesticide Regulation and USEPA.

These data present the fifth year of field tests of alternative chemical fumigation, greenhouse grown strawberry plug plants, and an organically acceptable production program with potential use to a wide variety of California growers. The 1999-2000 development program compared three production systems: **Conventional** – MBr/CP, **Alternative**- Telone/CP and Iodomethane/CP, and **Organic** - using CCOF/OMRI acceptable soil amendments and VAM inoculation, all planted to Camerosa cult.

Results

Crop development: Early season flower and leaf number were determined on February 24. Neither parameter consistently favored any one treatment or plant type. Plant growth was similar between transplant types, including leaf number and resulting plant diameters. Late season development however, revealed differences in crown development and runner production between plug and bare root plants. In this study, plug plants showed a 63% reduction in runner production in the organic production system, a 93% reduction in runner production in the Telone/cp production system, a 92% reduction in the iodomethane system, and a 58% reduction in the methyl bromide standard production system.

Weeding requirements: Weed populations were managed differently between the chemical and organic treatment plots. The opaque plastic allowed for good weed control between plants, however, the crop was delayed at least two to three weeks in harvest from the use of this technology. All soil treatments had statistically similar hand weeding requirements which ranged between $381 and $577 per acre per season. The predominant weed species among all plots were *Malva*, Filaree and various grasses.

Soil foodweb: Soil biomass data did not demonstrate trends in soil food web parameters among the various soil amendment programs. This included the Organic soil treatment, where large quantities of compost and Mycorrhizal inoculate were used. The VAM root colonization data were also unrevealing. Although increases in root colonization were expected from the early season application of VAM, roots did not show any corresponding increase in colonization by VAM at plant maturity late season.

Harvest: Table 1 presents the average production by fruit type for the season from each soil management program and plant type. Data are expressed in number of marketable flats per acre and total weight produced from both fresh market and processing harvests. Production data on and after May 27 was harvested for processing and includes bulk packed fruit of both quality types. At this period in the season, the Central Coast growers were harvesting exclusively for this market, and therefore the experimental harvest practices were changed to mimic commercial condition. Comparisons between treatments indicated significant differences among soil management programs. Compared to the methyl bromide/chloropicrin bare-root plant treatment (standard grower practice), all soil management systems were statistically similar among similar plant type. That is, all bare-root planted soil systems, and all plug-plant soil systems were not statistically differentiated from one another within plant type. Numerically however, the Telone/CP and Iodomethane/CP systems out-performed the Organic system by 8.9% and 12.9%

respectively for bare root plants, and 19.3% and 11.4% respectively for plug plants. The major differences in yields were between plant types. In all cases, plug-plant treatments out-performed bare-root treatments by a significant margin. Figure 1 illustrates the seasonal yields from the four soil management programs for each plant type through the season. The harvest differences were apparent initially, and into the mid-season pickings. However, plug plants did not terminate as quickly as bare root plants, and continued to produce through the later part of the season. Further, these plants had fruit and flowers still present when the study was terminated in late June.

TOTAL SEASON HARVESTS BY FRUIT TYPE AND WEIGHT

	Total fruit production by market		Total fruit wt	
Soil management program	Fresh K/ha	Processing K/ha	K/ha	% incr.
Organic Bare-root	3570a	11480 b	15050 c	
Organic Plug plant	8075 a	29435ab	37510 b	+149.2
Telone/CP Bare-root	3834 a	12514ab	16348 c	
Telone/CP Plug plant	10273 a	33033 ab	43306 a	+164.9
Iodomethane/CP Bare-root	4047 a	12921b	16968 c	
Iodomethane/CP Plug plant	10234 a	30205 a	40439 ab	+147.4
Methyl Br/CP Bare root	3712 a	11312 a	15024 c	
Methyl Br/CP Plug plant	7764 a	28527 ab	36291ab	+141.5

Means followed by same letter are not statistically different, Duncan's new multiple range test, P>0.05.

Summary and Conclusions

Field preparation and enhancement of planting material are the central aspects of this project. Among the soil conditioning systems, the organic system utilized the highest inputs for amendments. Here, the cost of compost and chicken pellets applied prior to listing beds was approximately $1000/acre at the rates used in this study. This was followed by weekly applications of fish emulsion that further added to the cost of plant nutrition. Also, while weeding requirements were similar to fumigated plots, this was the result of the black plastic mulch, which favored the organic system, but retarded growth and reduced overall yields across all soil management systems. In this respect, the fumigated plots could have used transparent plastic mulch, which would have resulted in earlier and significantly higher yields, compared to the Organic program.

Telone/chloropicrin and Iodomethane/chloropicrin performed very well with season yields overall. The cost of application of alternative fumigants was less than either methyl bromide/chloropicrin or the Organic program, as a result of the use of reduced rate drip application technology employed. In current dollars, at the rates used in this study, the cost of methyl bromide/chloropicrin broadcast fumigation is approximately $1400/ac, compared to $800/ac. for Telone/chloropicrin applied in this manner. The cost for Iodomethane at the rates used in this study is currently unknown.

Among all inputs tested, the use of plug plants had the greatest effect on yield. In each soil management system, the resulting fruit production was markedly higher than the bare-root transplants. The fruit was also of equal quality with respect to deformities and other defects. It should be noted, however, that the cost of this technology is much higher than bare root plants. At current prices, plug plants sell for more than three-fold that of bare roots of the same cultivar.

The true cost of the technology, however, is the benefit derived from the earlier and higher yields obtained, minus the difference in direct cost of the plug plants. These parameters would vary from year to year, and most certainly be driven by the market prices early season.

With respect to Organic production, the yields derived from plug plants may overcome differences caused from parasitism by soil borne pathogens in non-fumigated soil. This is the result of plug-plants exhibiting less wounding and transplant shock at planting, which translates to increased vigor and overall improved health of the planting early season. Rapid early season growth establishes extensive fruiting crowns and a rhyzosphere that is developed in and around a nutritional matrix of potting soil. This system is ideal for water retention and root development. Roots so developed tend to inhibit opportunistic pathogenic organisms and may out-grow localized infections. Plug plant technology can also provide an ideal delivery system for economical use of Mycorrhizae and other beneficial organisms. Incorporation of beneficial organisms in the planting plug at the greenhouse can uniformly distribute them across the field without the requirement for high rates to be soil applied. This could facilitate the use of these biocontrols in the future by reducing the rate per acre, and at the same time, improve their placement on the roots from the onset of the season

In conclusion, these results show that there are several existing alternatives to methyl bromide fumigation for California strawberries. The technology demonstrated here however, may require an increase in growing costs at the field level. In the case of alternative fumigants, the cost increases are relatively minor, and may be compensated for in other ways such as reduced rates and simplified drip chemigation methods. Plug plants can also provide high strawberry fruit production in non-fumigated soil, provided pathogen and weed loads are low. The limitations here are the direct cost of weeding if transparent plastic is used, and the high cost of the plants themselves. In any case, growers will ultimately determine which of these alternatives are feasible for their individual operations in each distinct strawberry growing area of California.

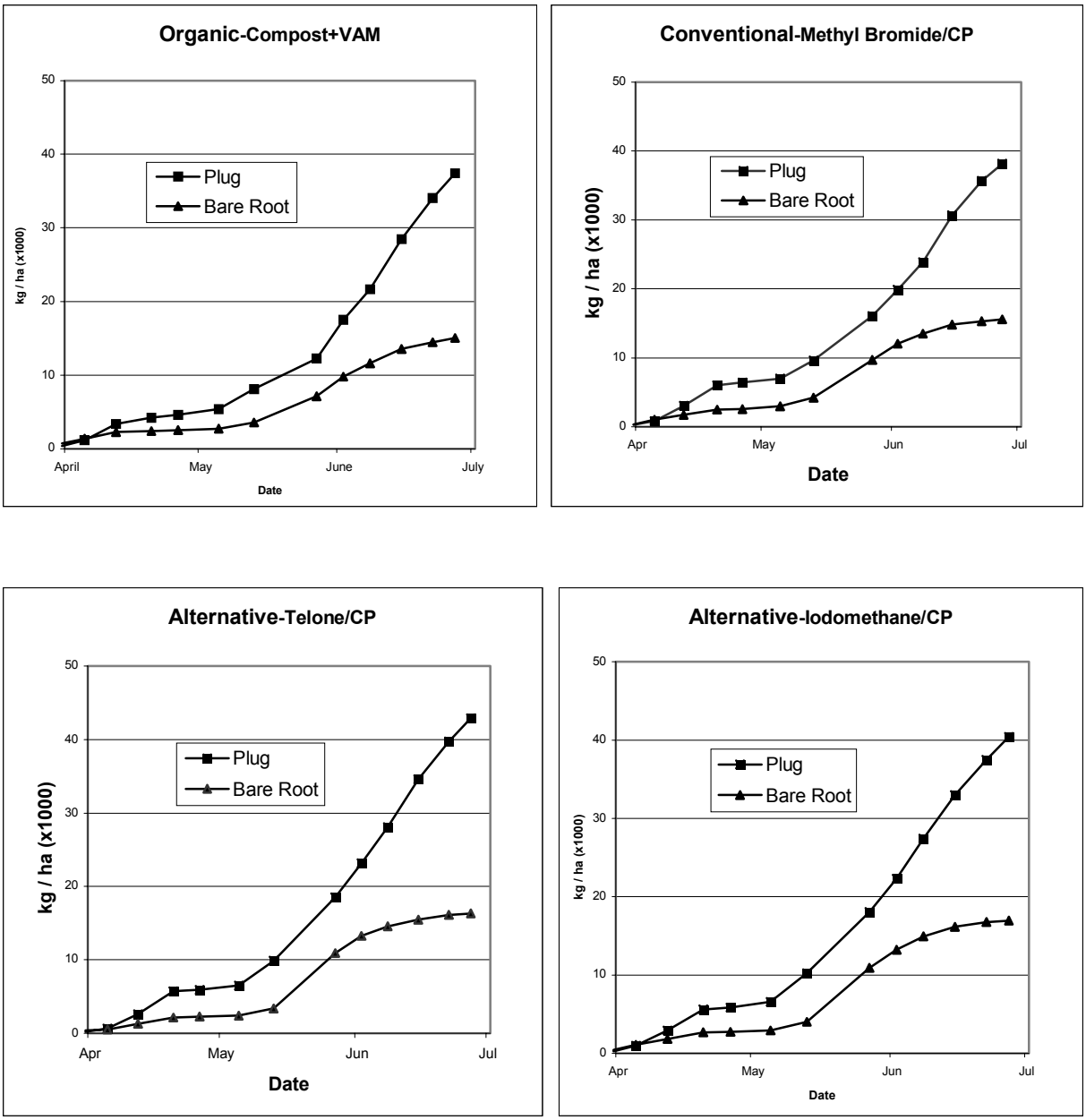

Figure 1. Cumulative yield for four soil management systems for conventional bare-root and alternative plug plants through the harvest period of the study. *San Luis Obispo,CA*