

STRATEGIES TO SUSTAINABLY PRODUCE STRAWBERRY WITHOUT FUMIGANTS

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Summary. Fumigants cannot be used in buffer zones, near sensitive sites or organic fields. Most farms that overlap with buffer zones have some field blocks that lie in restricted areas and other field blocks that can be fumigated. Possible strategies for buffer zones include: 1) leave them fallow; 2) crop the buffer zones without soil disinfestation of any kind taking a chance on soilborne pests; 3) treat the buffer zones using non-fumigant strategies such as steam, anaerobic soil disinfestation, enhanced solarization or substrate production to aid in cropping the field block. All of these methods have limitations to some degree. This presentation will compare the potentials and limitations of a strawberry production system based on substrates or steam disinfestation of field soil.

Sustainable strawberry production. The assumption is that some fraction of the potential California strawberry farms cannot be fumigated due to regulatory limits. Within these impacted farms exist field blocks that can be fumigated and those that cannot be fumigated (Figure 1). With increasing urban pressures, and increasing regulation of fumigants, there is need for a hybrid system that uses fumigants in those areas of the field that can be fumigated, and nonfumigant production methods in areas that cannot be fumigated. The goal of the hybrid system is to make it possible for a grower to farm all of the land they want to use for strawberry. Here we focus on two potential methods: substrate production and steam for soil disinfestation.

1. Substrate production. These production systems use clean growth media contained in a physical barrier such as landscape fabric, to protect strawberry roots from contact with potentially pest infested field soil. The strawberry plants are rooted in clean growth media such as coir (coconut fiber) or peat moss contained in either bags or troughs. This is a common production system for strawberry in Europe. Substrate production requires a high initial infrastructure investment beyond what is needed for conventional strawberry production as the plants require more frequent irrigation and attention than plants grown in the soil due to the limited root zone and limited water holding capacity of the substrates. Advantages of the system are that it is not dependent on soil fumigants, and high yields can be attained regardless of the soil quality at the site. Limitations of the substrate system are: a) finite quantities of substrate materials are available such as coir or peat, b) establishment of the irrigation system, soil moisture sensors and associated infrastructure requires multi-year control of the production site which makes it more difficult to rotate strawberry with vegetable crops as is common in all production areas, c) if portions of

the field are committed to substrate production, there will be two distinct management systems in the field, substrate and conventional management. For example, management of 7 acres of strawberry substrate production and 70 acres of conventional production will require very different irrigation and fertility management.

2. Steam for soil disinfection. Steam has been used for over 100 years to kill soil pathogens primarily in greenhouse soils. Steam application for greenhouses, while effective, utilizes antiquated methods that consume large amounts of fuel, are very labor intensive and as a result traditional steam application methods are expensive and slow. There are more efficient methods of steam application available today. For example European manufactures, Celli, Ferrari, and Moschle, have developed automatic superheated steam applicators which are used for field steam application in Europe and can be adapted for use in California. We have measured fuel, machine and labor costs for the Ferrari and estimate them to be \$3848 per acre. Disadvantages to this system are the consumption of fuel, carbon emissions, the need for large numbers of applicators to treat a field area in a short time, and generally treatment for hard water is needed. There is the potential to increase fuel efficiency by directed steam application, mechanical mixing of soil and steam, high fuel efficiency steam generators, use of solar steam production technologies, soil additives such as quicklime to reduce steam application dwell time and other ideas. The chief advantage of steam is that it is flexible and does not require installation of a dedicated infrastructure beyond what strawberry growers currently use in fumigated soil. Steam is a flexible system that can be used in most nonfumigant areas.

Summary. Substrate production and soil disinfection with steam have the potential to be used in areas where fields cannot be fumigated. Both have the potential to meet or exceed the strawberry yields produced on soil previously fumigated with methyl bromide + chloropicrin. These methods are worthy of further evaluation to increase the efficiency and sustainability of the system. There are serious questions about the costs of either system and future work must focus on accurate crop budgets for both systems.



Figure 1. A hypothetical 80 acre strawberry farm with 10 blocks. Blocks 9 and 10 are impacted by a $\frac{1}{4}$ mile buffer zone from a school, and the edge of blocks 6, 7 and 8 lie in a buffer zone from a nearby house. Buffer zones are indicated by the circles. Blocks 1-5 and most of blocks 6-8 can be fumigated. Areas in the buffer zone cannot be fumigated.