Sustainable strawberry production (5.4.10)

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The methyl bromide (MB) phaseout and increasing restrictions on all fumigants requires significant changes for the California strawberry industry. From about 1960 until the present, MB and chloropicrin (Pic) have formed the basis for control of soil pests in strawberry. Following the introduction of MB and Pic, the only additional fumigant registered in California during in the past 50 years has been 1,3-dichloropropene (1,3-D, Telone, Inline, PicClor 60) which is highly restricted as it is classified as a class B carcinogen. Furthermore, air quality issues (volatile organic compounds or VOC's) in Ventura County- the major strawberry production region for Southern California have resulted in seasonal fumigant emission limits. Methyl iodide will probably soon be registered in California but at this time it is unclear how much impact this product will have. With the likelihood of a diminished future role for fumigants in California, what are the best options available for strawberry growers?

There is ongoing research by several researchers to develop nonfumigant methods of strawberry production such as soilless production systems, anaerobic soil disinfestation (ASD), steam for soil disinfestation, soil solarization, biofumigation, IPM and the breeding of strawberry varieties with greater disease resistance. Strawberry fields in need of non-fumigant production systems can be grouped in to three categories: a) organic fields, b) fields or parts of fields that fall into fumigant buffer zones and c) fields that lie in townships with unmet fumigant needs due to township caps on fumigant use. There is a need for predictability in terms of the year to year of the locations where nonfumigant systems are needed. Predictability of location where nonfumigants are needed is important because some of the nonfumigant systems such as substrate systems require infrastructure for irrigation over and above what is needed for a typical strawberry field. Consistency of nonfumigant field location is necessary to justify investment in infrastructure.

<u>Organic fields</u> do not use synthetic pesticides of any form including fumigants. Organic strawberry producers currently rely on cultural practices such as crop rotations to hold down pest populations. Any of the nonfumigant methods developed such as substrate production, ASD or steam for soil disinfestation should be considered for use in organic strawberry production. The locations of organic fields are predictable from year to year.

<u>Buffer zones.</u> Many strawberry production fields have acreage that cannot be fumigated due to the proximity of sensitive sites such as houses or schools. Chloropicrin and 1,3-D have buffer zones and rate caps in "sensitive" field sites near homes, schools, day care centers, nursing homes and other facilities. Portions of field sites impacted by buffer zones either cannot be cropped to strawberry, or instead must produce

strawberry without fumigants. The predictability of the size of buffer zones is moderate and depends upon the choice of fumigant and associated regulations.

Township caps. Fields that are in townships where there are unmet needs for soil fumigants either need a means to stretch current fumigant allocations over more acres, and to try nonfumigant options when all fumigant options are exhausted. These are areas where the need for 1,3-D exceeds township cap limits, and MBPic currently is used to meet this demand. As MB supplies decline further, the situation in these areas will be critically short. If the current Pic risk assessment by the California Dept. of Pesticide Regulation reduces the permissible exposure thresholds due to potential cancer risk, then we anticipate new regulations with strict chloropicrin township caps that would limit the fumigated area or force growers to used low application rates that might not be sufficient to control major soil pests. The locations where townships that have consistently reached the 1,3-D township cap are predictable. Within these high fumigant demand townships the size of the acreage in need of nonfumigant treatments is less predictable as it depends upon the cropping and fumigant use decisions of all growers in that township.

A description of the potential nonfumigant methods of soil disinfestation and pest exclusion (substrates):

1. Substrate production systems use clean growth media that is contained in a physical barrier to protect it from contact with potentially pest infested soil. The strawberry plants are grown in this clean growth media either bags or troughs. This is a common production system for strawberry in Europe. Substrate production requires high initial infrastructure investment beyond what is needed for conventional strawberry production as the plants require more frequent irrigation than plants grown in the soil. It is not clear how more than a fraction of the 37,900 acres of California strawberry can be produced on substrates because of: a) finite quantities of substrate material is available such as peat, b) establishment of the irrigation system, soil moisture sensors and associated infrastructure requires multi-year control of the production site property 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, say buffer zones that cannot be fumigated, how will it be possible to manage the intensive demands of 5 acres of substrate production within an 80 acre block managed by conventional strawberry production methods? d) Is it possible to design a profitable substrate production system for California?

2. Anaerobic soil disinfestation (ASD) utilizes a temporary anaerobic condition to kill soil pathogens using water, impermeable film, and a carbon source such as molasses. This method of soil disinfestation has been used in Japan and

appears to work. It is unclear how well or consistent its performance will be in water-limited California. It is further unclear how well ASD works on hillsides where it will not be possible to get even water distribution. Even water distribution has been a limitation in the use of drip fumigant chemigation on hilly ground and ASD is subject to the same issues. It is not clear how consistent will be the performance of ASD over time in California field conditions. The advantage of ASD is that after the soil disinfestation, the field is turned back over to conventional strawberry production practices and does not require special infrastructure as does substrate production. A large volume of water is required for ASD in California because the majority of California strawberry soils are well drained sandy loam soils. Also nitrous oxide, an ozone depletor, is produced by the ASD process. This is a flexible system that can be used in all nonfumigant areas.

3. Steam for soil disinfestation. 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 better methods of steam application available today. For example European manufactures, Moschle and Ferrari, 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, soil/steam agitation, more fuel efficient steam boilers, 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. This is a flexible system that can be used in all nonfumigant areas.

4. Active soil solarization. This method uses a solar heat as a source of energy as in traditional passive solarization, but uses water to actively distribute the heat more evenly than conventional solarization. Traditional soil solarization generally treats only a shallow layer of soil, in coastal strawberry production areas. Active soil solarization forces heat deeper in the soil. This system requires an infrastructure or device that can easily be installed and removed from the field to avoid high labor costs, i.e., rolled out for use and rolled up when finished. This

method will require quite a bit of research to engineer the infrastructure necessary to perform the thermal pest control on a consistent basis. This method was demonstrated to work in Jordan in the 1980s, but that method required much labor to set up. This is an interesting idea that is worthy of more research.

5. Biofumigation – the addition of mustard seed meal or mustard green manure crops to suppress or kill soil pathogens has been evaluated for many years. Natural products in mustards, such as allyl isothiocyanates are thought to be responsible for this activity. So far biofumigation does not appear to be dependable or potent enough to rely upon for strawberry production. There may be some merit in combining biofumigants with solarization or steam to enhance the effects of the biofumigant. This is a flexible system that can be used in all nonfumigant areas.

6. IPM – management of the soil to favor the strawberry and inhibit the soil pest. This is a long-term approach and does not solve any immediate problems. Also, most strawberry land is leased and growers tend to rotate between farms, which makes hard to maintain a consistent IPM program.

7. Disease resistance breeding – that is breeding for strawberry varieties with sufficient resistance to devastating soilborne pests such as Verticillium and Macrophomina. This is a long-term approach and does not solve any immediate problems. This is a flexible system that can be used in all nonfumigant areas.

How does current research on nonfumigant production systems for strawberry meet the needs for these areas identified above that cannot be fumigated? We are not aware of any research to explore the advantages and disadvantages of integrating these nonfumigant production systems into strawberry fields on a commercial scale. The objective of this research will be to evaluate the integration of one or more of these nonfumigant production systems into commercial fields. What are the logistical, pest management and economic advantages and disadvantages of these systems?