DEEP DRIP FUMIGATION IN TOTALLY IMPERMEABLE FILM TARPED RAISED-BEDS PRODUCTION SYSTEMS

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Soil fumigation is an important tool for controlling soilborne pests and sustaining strawberry production in California. Since methyl bromide was phased out due to its effects on stratospheric ozone, 1,3-dichloropropene (1,3-D) and chloropicrin (CP) have been used as the major alternatives for broad spectrum control of soil pests. However, high fumigant emissions have led to increasingly stringent environmental regulations on the use or the availability of the existing fumigants. Therefore, growers are facing challenges on how to effectively control pathogen and emissions. Strategies that can achieve both goals will significantly improve sustainable use of fumigants for the strawberry industry.

California strawberries are grown mainly in raised-bed systems covered with standard polyethylene (PE) film. Over 55% of strawberry fields are treated with fumigants applied directly through drip irrigation lines that are buried near the surface of the beds. Previous field trials have shown that the fumigant concentration under tarp is very high, which contributes to higher emissions under PE film. Applying fumigant near soil surface may result in insufficient pest control at greater soil depth. With deeper application, the fumigant concentration under tarp may be reduced because fumigants need travel longer distance to reach soil surface, which may lead to lower emission loss. The deeper fumigation also has a great potential to improve fumigant distribution and fumigation efficacy in the zone where strawberry roots will be developing during production season.

Previous field trials showed that totally impermeable film (TIF) can reduce emissions by >90% compared to PE film in fields with shank applied fumigant. In addition, fumigant distribution uniformity was improved, which suggests that a reduced application rate still results in acceptable pest control efficacy. Similar outcomes are expected in drip fumigated raised beds but field demonstrations are needed to ensure the safe adoption of TIF. The combination of TIF and deeper fumigant application may further improve fumigant distribution and increase pest control efficacy, but no data are available so far.

Objective: The goal of the project is to develop effective field fumigation strategies including optimizing application depths and rates under the low permeability film for increased fumigation efficiency, improved pest control, high strawberry yield, reduced fumigant input, and lower emission losses.

Field trial: A field trial was conducted in August 2013 in grower's strawberry field, Camarillo, CA. The tested field has confirmed high levels of critical

pathogens and resident weeds. The dimension of the raised bed was 120 cm wide and 35 cm high. Due to the proximity to the residential area, only TIF was used in the trial. Fumigants were applied via either two drip lines placed at 5 cm or four drip lines placed at 5 and 18 cm with either full rate or half-rate. At each depth, two drip tapes were installed spaced 60 cm in apart. Pic-Clor 60 EC (a mixture of 56.7% CP, 37.1% 1,3-D, and 6.2% inert ingredients) was used for fumigation and applied through the drip lines. The full rate is 25 gallon/ac. Treatments included:

1. Control: 0 rate, drip lines at 5 cm.
2. Pic-Clor 60 EC: Full rate (25 gallon/ac), drip lines at 5 cm.
3. Pic-Clor 60 EC: Full rate (25 gallon/ac), drip lines at 5 and 18 cm.
4. Pic-Clor 60 EC: 1/2 rate (12.5 gallon/ac), drip lines at 5 cm.
5. Pic-Clor 60 EC: 1/2 rate (12.5 gallon/ac), drip lines at 5 and 18 cm.

All treatment combinations were replicated four times in randomized complete block design.

Field monitoring: Fumigant emission was sampled by using passive chambers installed in the beds and furrows of full rate fumigant treatments. Fumigant emission flux was calculated based on the fumigant concentration within the chamber, capture time, chamber volume and surface area. Fumigant distribution in the soil gas phase was sampled using probes installed in the four fumigated treatments. Each sampling location included three sampling depths (10, 20, 30 cm) at the center of beds, five sampling depths (10, 20, 30, 40, 50 cm) at 15 cm from the edge of the bed, and two depths (10, 20 cm) in furrow near the bed bottom.

Air under tarp (above soil surface) was collected with four sampling positions including the center and the edge of bed-top, the middle of bed-side, and the bottom of the bed-side. Field monitoring lasted for two weeks. At the end of the trial, soil samples for residual fumigant determination were collected at depths corresponding to the soil gas sampling.

Pest control efficacy is being determined by evaluating the survival of the pre-buried pathogen samples in two bed locations in different treatments. After soil fumigation, the field will be planted with bare-root high elevation strawberry transplants. Plant growth, pathogen-related decline, and strawberry yield will be monitored for the full growing season.

By collecting all of these data, the most effective treatments for pest control and crop yield will be determined and the results will be presented to growers and stakeholders via various extension and outreach efforts.

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