SITE-SPECIFIC SOIL PEST MANAGEMENT IN THE STARWBERRY PRODUCTION SYSTEM

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Summary: The overall objective of this research program is to develop a system that will lead to a site specific application of fumigants within a field based on pathogen distribution maps that reflect the actual need for pest management rather than the current one size fits all fumigation with a single rate evenly applied. Our reasoning is that variable rate fumigant application will reduce total fumigant applied while allowing for a higher rate of application in areas of the field where disease pressure is high. In areas with little or no pathogen pressure low fumigant rates would be applied. Our hypothesis is that precision fumigation will reduce net fumigant pounds applied while disease management will be equal or better than traditional fumigation strategies.

There are a range of soilborne pathogens that impact strawberry productivity in California, and from a historical perspective, lethal pathogens such as *Verticillium dahliae* and *Phytophthora* spp. were one of the primary reasons for development of MB + Pic preplant fumigation in the first place. With the phase out of MB, use of alternative fumigants and application by bed fumigation has led to serious problems with emerging lethal pathogens like *Macrophomina phaseolina* and *Fusarium oxysporum* f. sp. *fragariae* in all California production areas. In addition to these lethal pathogens, there are also general root pathogens such as some binucleate *Rhizoctonia* and *Pythium* spp. that can significantly impact the level of productivity due to root pruning and stunting the growth of the plant.

Apart from direct production costs and effects on revenue due to changes in yield, growers face significant and growing costs of complying with federal, state, and local permit requirements regarding fumigant use. Application rates are limited to less than label rate recommendations in some areas, which can compromise pathogen and pest management. In addition, the concentration of strawberry production in a small number of coastal areas may cause some townships to reach limits, i.e., “township caps”, for the amounts of 1, 3-D available. If site specific applications reduce the amount of 1,3-D required to treat individual fields, then 1,3-D will be available to treat additional acreage within a township.

<u>Next generation approaches for site specific fumigation strategies</u>

Pathogen populations are typically uneven across the field, leading growers to fumigate the entire field in an effort to make sure to control all pathogens that

may be present. Some areas have little pathogen pressure and do not need to be fumigated, while infested areas do require fumigation. Without maps of where these infested - noninfested areas are, the whole field is treated and high fumigant are applied needlessly in the low disease pressure sections of the field. Pathogen maps would allow for precision fumigation as was done for preplant treatments with almond (Udompetaikul et al. 2013). If techniques were available to determine the density of a specific pathogen in a field it would enable applicators to use a more targeted approach for pest management, applying the required amount of fumigant exactly where needed to manage a particular pathogen, thereby reducing the average application rate and overall levels of fumigant use while improving pest management. The technologies that are required to develop a site specific fumigation strategy are available now, and with the appropriate effort the disparate technologies could be integrated into an improved strawberry crop management system.

- Dose response data is available for a range of fumigants identifying their efficacy in controlling a number of soilborne strawberry pathogens (Fennimore et al. 2008).
- Precision technology is well established in the equipment used for fumigant application with tractors equipped with GPS directed guidance systems that can regulate variable rate applicators to apply the appropriate dose based on the pathogen field map.
- High quality, high spatial resolution aerial remote sensing imagery is available from commercial companies using airplanes or drones that provide frequent image collection with overnight image processing at a reasonable cost. Some companies have websites to view the images and provide basic tools to allow end user directed analysis. This information is needed to develop accurate maps of disease response in rotational crops so that multi-year and multi-crop monitoring of the fields are feasible. For example, are high disease pressure patches stable across years?
- Prior research using remote sensing data to evaluate the efficacy of alternative fumigants on strawberry production in California has been conducted (Martin 2002, 2004, Martin and Anchieta, 2008). Tools developed for nondestructive analysis of plant growth parameters in the field and research correlating data from aerial imagery with plant characteristics on the ground provide a solid framework on which to build the use of this technology to support mapping of pathogen distribution within a field.
- Molecular tools for rapid onsite identification of pathogens and laboratory assays for quantification in the soil have been developed for many soilborne strawberry pathogens (Bilodeau et al. 2012, 2014, Miles et al. 2014; Suga et al. 2013, Miles and Martin, unpublished) with assays for *Macrophomina phaseolina* and *Fusarium oxysporum* f. sp. *fragariae* the remaining pathogens to be completed soon (Martin, unpublished).

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