FUSARIUM OXYSPORUM AND *MACROPHOMINA PHASEOLINA* PERSISTENCE IN FUMIGATED SOIL AND MANAGEMNT APPROACHES

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In spite of the effectiveness of fumigants against *Macrophomina phaseolina* and *Fusarium oxysporum* documented in previous studies, the number of strawberry fields with die-back associated with these two pathogens is increasing. In particular, we observed greater mortality of plants at the edge of the beds compared with inner rows in four-row beds with two drip lines.

Pathogen survival in soil during bed fumigation.

We evaluated pathogen survival at 6 and 12" depths under the drip tape supplying fumigant and in bed centers and edges/shoulders. After drip application of Pic Clor 60 (1,3D + chloropicrin, 37/56), buried inoculum was retrieved and assayed for survival. No survival occurred at either depth underneath the drip tape, (< 5%) survived at bed centers at both depths and at 6" on the bed shoulder. However, at 12" depth in the bed shoulder, pathogen survival was very high (Figure 1) and was no different from non-fumigated control (data not shown). This suggests poor distribution of fumigant into areas most distant from the drip tape and the need to evaluate increased number of tapes and their placement for improved bed fumigation efficacy (study in progress). Flat fumigation is considered more effective than drip fumigation of beds due to greater uniformity. However, soil sampling before and after flat fumigation with chloropicrin 300 lbs /a provided 90% reduction for *M. phaseolina* and 79% for *F. oxysporum* compared to untreated soil, suggesting good but incomplete control. Additionally, more than 50% plant collapse was observed in a methyl bromide-chloropicrin flat fumigated field with a history of *M. phaseolina*, suggesting that the pathogen can escape fumigation.

Pathogen survival in infested strawberry crowns during fumigation.

We evaluated pathogen survival in strawberry crowns infested with *M. phaseolina* at 6 and 12" depths under the drip tape and at bed shoulder and in-between tapes. High percentage of viable sclerotia was observed in all areas except directly under drip tape (Figure 2), and 96% of all crowns had sclerotia in tissue, thought it was not immediately confirmed as *M. phaseolina* with essays.. This shows that fumigants have difficulty penetrating crowns at lethal concentrations and that infested crowns can be an important source of inoculum in fumigated fields.

Root infection in soil at different depths

In a non-fumigated buffer zone with confirmed infestation of both pathogens, we excavated infested soil and replaced it with fumigated soil to the depths of 6, 12

and 16" in four replicated blocks. The sooner roots grew out of fumigated soil and into infested soil the greater was the percent mortality (Figure 3) and infection rate comparisons followed the same trend (data not shown). This showed the value of fumigation to depths greater than 12" and possibility of use of fumigated soil as the growing medium in an infested field.

In–progress work on integrated management of *M. phaseolina* and *F. oxysporum* is focused on following questions:

- How finely do the infested crowns have to be broken down to allow fumigants to kill pathogens inside the crowns during soil fumigation?
  To answer this we buried infested crowns either whole or cut to 1/2, 1/4, or 1/8 of original size and retrieved from a flat-fumigated field.

- What effect does crop rotation and management have on clamydospores of *Fusarium* and sclerotia of *Macrophomina*?
  To answer this we initiated a 3-year project using GPS-based soil sampling at 9 locations with confirmed pathogen presence

- What is the effect of increasing the number of drip tapes and their placement on fumigant distribution and pathogen control?
  We evaluate this in grower fields during 2013-2014 season.

Figure 1. *Fusarium oxysporum* survival at two depths in different sampling areas in drip-fumigated beds (Pic Clor60 at 300 lbs/a) at Ventura, CA.

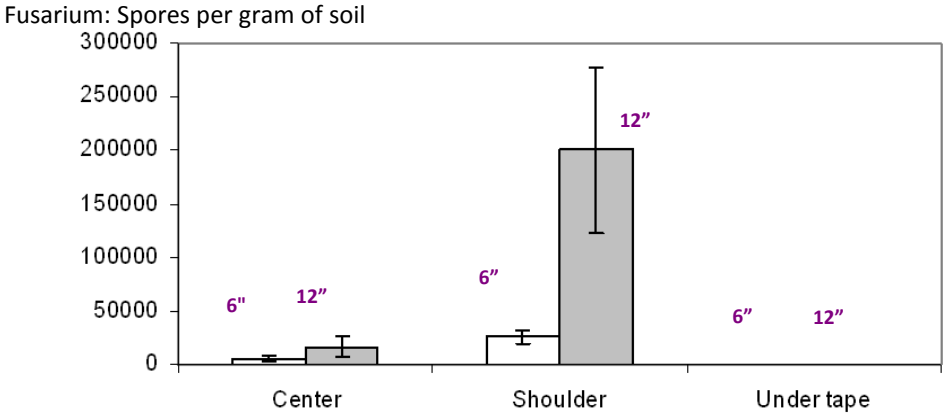

Figure 2. Percent of samples containing viable *M. phaseolina* in infested crowns after bed fumigation with three lines with chloropicrin at 200 lbs/a at Camarillo, CA.

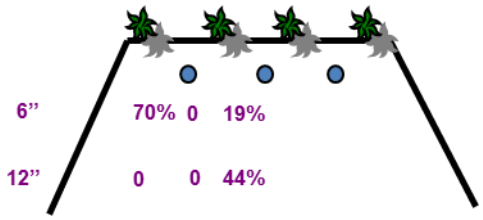

Figure 3. Mortality of San Andreas strawberry at the end of the season in infested soil replaced with fumigated soil at three depths at Ventura, CA.