Chemigation with metam at the end of strawberry season can help reduce infestations of nutsedge and soilborne pathogens

Oleg Daugovish, Mark Bolda, Anna Howell, Gina Ferrari (UC-ANR) and Peter Henry, UC-Davis

At the end of fall-planted strawberry season many problems surface, including pathogen related plant collapse and unrestricted weed growth. Soil-borne pathogens *Fusarium oxysporum* f. sp. *fragariae* (causing Fusarium wilt) and *Macrophomina phaseolina* (causing charcoal rot) like warm soil as much as yellow nutsedge (*Cyperus esculentus*). Strawberry plants stressed with heavy fruit loads try to cool off by transpiring water, but pathogens colonize and block their vascular systems and nutsedge competes for water and resources while producing new tubers for future.

It certainly would be nice to do a 'clean-up' instead of just burying these problems back in the ground and see them reappear during the next season.

MITC (methyl isothiocyanate) generating fumigants can be applied in many troubled fields via existing drip lines at the end of season accompanied by sprinkler irrigation to mitigate potential emissions. These fumigants are short lived, can be very effective and are considerably cheaper than chloropicrin.

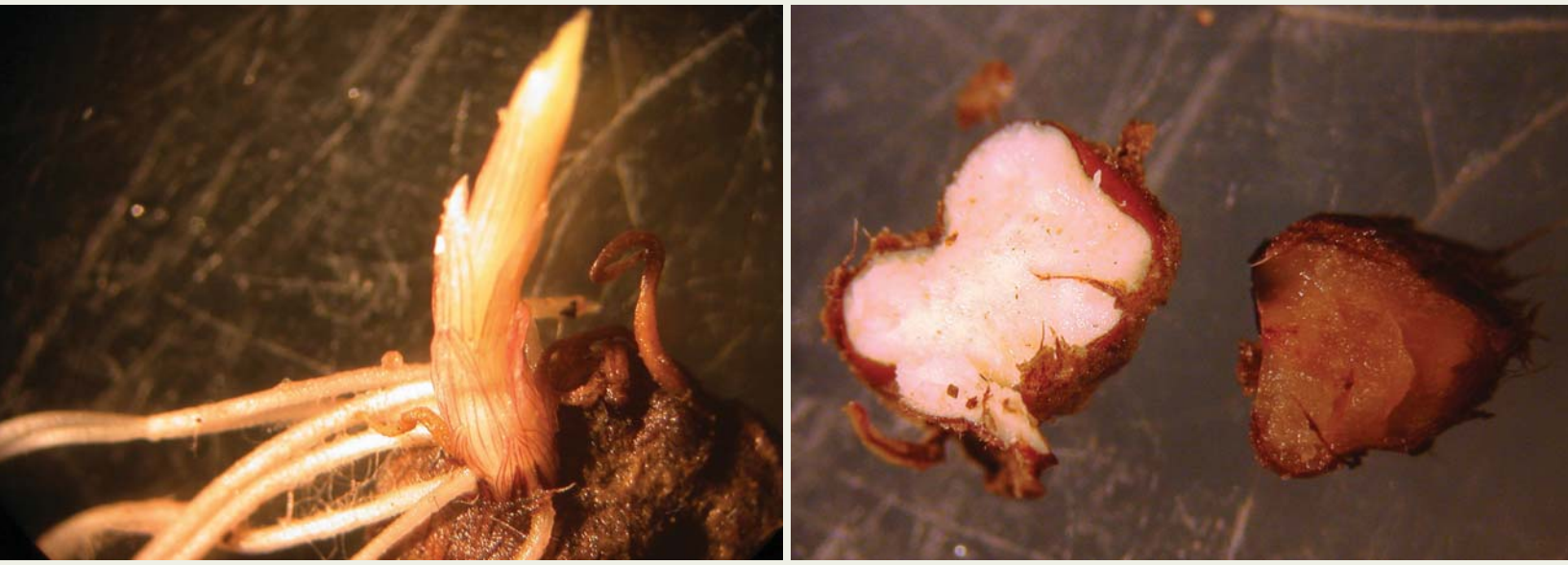
Ventura county projects:
We conducted two trials in 68-inch Oxnard beds with end-season injections via two drip lines per bed in 2015 (213 lbs/acre of metam sodium) and in 2018 (174 lbs/acre of metam potassium). The collaboration included Advisors and staff from UC ANR and California Strawberry Commission and help from Crop Production Services and cooperating growers.

At 2 depths (6 and 12 inches) and 2 locations in strawberry beds (under drip lines and between them) we buried permeable bags containing locally collected nutsedge tubers and sand-mixed Fusarium inoculum and pathogen-infested strawberry crowns with roots. The bags were excavated 12 days after metam fumigation and contents of bags analyzed for viability.

Here is what we found out:

- Nutsedge tubers germinated 80-100% in untreated soil but after chemigation with metam sodium or metam potassium shoot number was significantly reduced in both years. Nutsedge shoot production was similar at 6 and 12-inch depths but varied among locations in bed. Fumigants reduced shoot production from tubers under drip lines to 0-5% in both years, but between drip lines only to 35% (2015) and 53% (2018). Reduction in efficacy with increased distance from drip emitters is something we observed in several studies with this and other fumigants. Lack of efficacy in bed centers (between drip lines) was also observed above ground in

Figure 1. Tubers of yellow nutsedge germinated readily in untreated soil (left) and failed to germinate near drip lines used for metam sodium application (right)



established nutsedge compared to nutsedge above drip lines used for fumigation (Figure 2).

- Fusarium microsclerotia in sand bags were an easy target and fumigants provided nearly compete (>99%) control compared to untreated soil. As with nutsedge, pathogen mortality was consistently lower in soil between drip lines compared to locations under drip lines. Fusarium-infested crowns and roots are known to harbor pathogens from fumigants and that was the case in these trials. Viable Fusarium recovery from infested plant material was 50-90% in fumigated soil generally not different from untreated soil.

Santa Cruz County Projects:
We conducted two trials, one in 2016 and the other in 2017 in a field heavily infested with Fusarium. Beds were 56" wide and metam potassium was injected through the drip irrigation system at 273 lbs/acre at the end of the season. The collaboration included the growers and personnel from AMVAC and SoilFume in Watsonville.

In 2016, following end-season fumigation of the beds, plants were mowed, plastic mulch and drip tape removed, bed tops chiseled to loosen soil and new drip tape and mulch installed in reshaped beds. Subsequently, six varieties: Cabrillo, Fronteras, Monterey, Petaluma and San Andreas were planted in fumigated and untreated beds in in a randomized complete block arrangement. Plant canopy growth and fruit yields were evaluated from December 2016 until the end of June of 2017.

In 2017, a 5-acre block heavily infested with Fusarium was treated with drip-applied metam potassium at 273 lbs/acre at the end of the season, and an untreated area was included in evaluation. After two weeks, once the re-entry interval was over, 20 plant crowns were collected for pathogen analyses from four locations in both treated and untreated beds. As in in 2016, plants were mowed, the bed tops chiseled and in renewed beds six strawberry varieties were planted: Portola, Sweet Ann, Monterey, San Andreas, Radiance and Fronteras.

Here is what we found out:
- Plant performance following the post crop application of metam potassium was remarkable. In the season following the 2016 application, all six tested varieties significantly outperformed the untreated check. Fruit yield increases in the treated plots over the untreated were as follows: 127% in Fronteras, 630% in Cabrillo, 52% in Monterey, 75% in Petaluma and 166% in San Andreas.

- In the 2017 metam potassium application for crop termination significantly improved fruit production of Monterey (26%) compared to untreated control. However, yield increases for Sweet Ann (13%), Portola were (17%), Fronteras (35%) and in San Andreas (44 %), were not sufficient to statistically separate (at P=0.05) fumigated plots from untreated control for these varieties. In the 2017 trial, Fusarium incidence was reduced in treated strawberry crowns by 75%. This finding is extremely important for our continuing approach to managing Fusarium in strawberry since the bulk of this disease is found in plant material and reductions of this magnitude will be very important in reducing disease.

Figure 2. Established yellow nutsedge turned yellow above drip lines used for metam potassium end-season injection and remained green in bed centers most distant from drip lines.

Figure 3. 'Sweet Ann' strawberry decline due to Fusarium wilt at Santa Cruz County project site.

Summary:
Metam sodium and metam potassium provided very good control of a troublesome soil pathogen and a perennial weed, however, distribution of fumigants in soil was likely insufficient to provide lethal concentrations in areas distant from drip lines. Survivorship in those areas may lead to future infestations. In previous years we evaluated fumigation via four lines instead of two and adding lines improved lateral distribution across bed (and pest control and strawberry performance) but we did not see differences below 12-inch depth.

Additionally, lignified plant materials such as crowns and thick roots containing Fusarium can remain a source of pathogen inoculum since fumigation did not provide adequate control. Higher rate of metam used at Santa Cruz County site, compared to Ventura was likely a lot more effective in reducing Fusarium survivorship in crowns and should be considered in infested fields. Flat fumigation via shanks, especially with destruction of infested crowns showed great improvements in fumigant efficiency in previous studies but is an expensive investment.

There are a couple very important points coming out of this work. First, it only underlines the utility of the crop termination approach in strawberry for managing the tremendous production reducing potential of Fusarium and nutsedge. Secondly, it also demonstrates the folly of thinking that varieties such as San Andreas and Fronteras, which are both ostensibly highly tolerant to Fusarium, are immune to its effects. They are clearly not and serve as hosts for the pathogen. The long-term soil-borne pest management should integrate variety resistance, production strategies and fumigation, including the end-season fumigation with MITC generator products. ■