Paul C. and Edna H. Warner Grants for Sustainable Agriculture 2016 Progress Report

Anaerobic Soil Disinfestation to Improve Soilborne Disease Management for Ohio Vegetable Growers

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Trials were established in fall 2016 to develop and evaluate anaerobic soil disinfestation (ASD) as a tool for managing soilborne diseases in high value vegetable production systems in Ohio. Anaerobic soil disinfestation is a method in which soil is first amended with a carbon source, such as wheat bran or molasses, then the soil is irrigated to saturation and tarped with plastic for four to six weeks. The objectives of this project were to:

1) To determine the efficacy of an early fall application of ASD for managing soilborne diseases in greenhouse and field vegetable production systems
2) To compare different ASD carbon sources and identify those most effective in reducing disease

Field Trial

A field trial was established in collaboration with The Chef's Garden, located in Huron, OH in September 2016. The trial was set in a greenhouse with a natural soil infestation of *Verticillium dahliae* (Verticillium wilt), *Pyrenochaeta lycopersici* (corky root rot), *Colletotrichum coccodes* (brown root rot), and *Meloidogyne hapla* (root knot nematode). The trial was laid as a randomized complete block design with four replications of plots 6 ft by 60 ft and was conducted in one bay (Bay 22) of the greenhouse. Two ASD treatments (wheat bran 9 t/acre and wheat bran 9 t/acre plus molasses 4.5 t/acre) were compared to a non-amended, non-covered control. Wheat bran was incorporated to a depth of 8 inches using a rototiller, molasses was applied using watering cans, then soil was irrigated to saturation, and covered with a black plastic mulch, with the exclusion of the control. Soils remained covered for 5 weeks.

In anaerobic soils, reducing conditions develop due to a lack of oxygen. Under reducing conditions, microbes cannot use oxygen to generate energy and must switch to alternative compounds, such as iron, to generate energy. To measure these reducing conditions in our treatments, we used IRIS ("indicating reduction in soils") tubes. IRIS tubes are PVC pipes painted with an iron oxide ("rust") paint. Microbes use the iron in iron oxide paint to generate energy under anaerobic conditions, so anaerobic conditions are indicated by paint removal (less paint equals more reduction). The amount of paint missing can be quantified, and we evaluated the amount of paint missing from the upper and lower six inches of the tubes.

Plastic was removed from the soil after 5 weeks and soils were collected from each plot. A post-ASD bioassay was established at OARDC to determine if the ASD treatments impacted soil pathogens and plant growth. In each study, five pots were filled with soil from one of the two treatments and the non-treated control. Tomato 'Bonny Best' was planted in the soils and tomato plants will be harvested in early January to determine the impacts of ASD on soilborne diseases and yield.

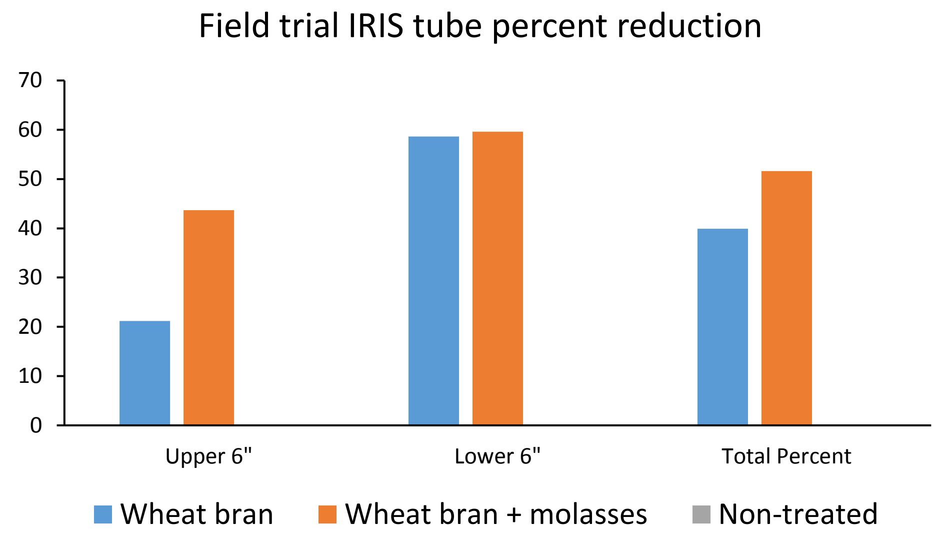
Carbon Source Trial

We had originally proposed to conduct an open field trial to assess various carbon sources, but we decided to conduct this trial under controlled conditions in the greenhouse to allow for better control of the environment and to use a soil that we knew to be infested with pathogens.

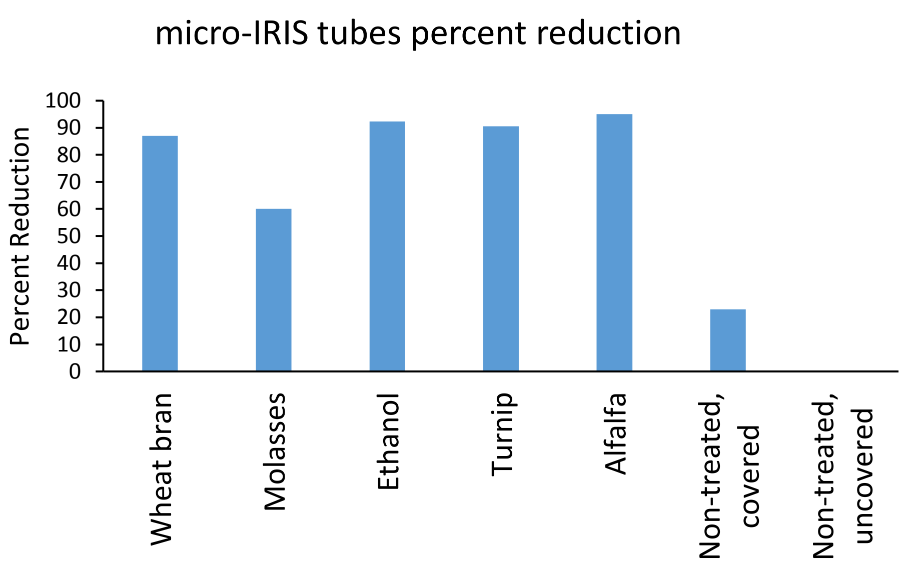
A carbon source trial was conducted to determine the efficacy of various carbon sources against the soilborne disease complex described above. Soil samples (no treatment) were collected from the tomato greenhouse at the Chef's Garden. ASD treatments were made at a rate of 9 t/acre, with the exception of ethanol, which was added with the irrigation water. The following ASD treatments were made: wheat bran, molasses, ethanol (2% solution in 150 mL total volume), a Brassicaceous crop (turnip, 'Hinona Kabu') and a leguminous crop (alfalfa). Solid carbon sources were evenly incorporated into soil prior to addition to pots, and fresh plant tissue inputs were coarsely chopped in a blender prior to soil incorporation. Soils were placed in pots and flooded with 150 mL of sterilized, distilled water following carbon source amendment. Controls were also flooded and both non-amended, covered and non-covered controls were included in the experiments. Pots were sealed with black plastic mulch at both the top and bottom of the pot. Micro-IRIS tubes (0.25" PVC rods painted with iron oxide paint) were used to measure soil reduction. Plastic mulch was adhered to the pot using rubber bands and electrical tape on the top of the pot only. Pots were incubated in a growth chamber (30° C for 16 hrs and 26° C for 8 hrs) for three weeks. Following removal of the mulch, soils were aired in a greenhouse for 5 days. Soils were homogenized and aerated using a 1.25 inch drill bit attached to a power drill. Four week old tomato 'Moneymaker' seedlings were transplanted into soils one day following aeration. The experiment was laid as a randomized complete block design with 5 reps, and the experiment was repeated once. Plants will be harvested seven weeks after transplanting and evaluated for soilborne diseases and yield.

Preliminary Results

Plants for both the post-ASD bioassay and the carbon source trial will be harvested in early January. We have preliminary data on soil reduction as indicated by IRIS tubes and micro-IRIS tubes during the trials. In the field trial, soil reduction was significantly higher in both the wheat bran and wheat bran plus molasses-amended treatments compared to the non-amended control.



Soil reduction was significantly higher in all ASD treatments compared to the two controls in the <u>carbon source trial</u>. Levels of soil reduction were significantly higher in soils treated with ASD utolizing wheat bran, ethanol, turnip, and alfalfa amendments compared to the molasses-amended soils. There were significantly higher levels of soil reduction in the non-treated, covered control compared to the non-covered control.



Soil reduction levels indicate that ASD treatments induced anaerobic conditions in soils, which are necessary for reductions in soil pathogen populations. These reductions in soil pathogen populations will be evaluated once plants are harvested.