Reducing Soil Borne Disease with Cover Crops

Tianna DuPont, Penn State Extension; Harold Weaver, Meadow Gate Vista Farm

Soil-borne diseases can be devastating to crops. Unseen they may persist in the soil for years. Harold Weaver, from Meadow Gate Vista Farm in Bowers, Pennsylvania, tried a new strategy for combating soil-borne disease: cover crops. This update contains results from both 2011 and 2013 when we repeated the experiment.

The cover crop was ready for biofumigation when the plants were at full flower (above) but the seeds were still green in the pods (below).

Weaver has a few fields field with a history of verticillium wilt. Verticillium is a fungal disease that can attack over 200 plant species; especially tomatoes, potatoes, eggplant, strawberries and black raspberries. It is common in the cooler, wetter soils here in the Northeast. Infected tomatoes might not actually wilt, as the name implies. Instead they generally develop blotches on lower leaves that eventually turn into brown dead spots. If the plants are drought stressed, they wilt.

The affected field had been rotated out of tomatoes for a number of years. But, Weaver knew that other crops or weeds could have been hosting the disease and was interested in trying cover crops to reduce disease pressure further. Certain cover crops, including mustards, rapeseed and sudangrass contain a chemical and an enzyme in the plant tissue. When these cover crops are chopped into small pieces with a flail mower, the chemical and enzyme come into contact and create a chemical reaction. The chemical and the enzyme are not toxic by themselves, but when they react, they create a compound that is toxic to soil-borne pathogens and even weeds seeds.

First the mustard was flail mowed.

Harold decided to try using mustard and sudangrass cover crops to try to reduce the verticilliun in his field. He divided his field into three strips. On May 26 and June 16, 2010, he planted one strip to “Caliente 119” mustard at the normal rate of 16 pounds per acre, walking it on with a spinner spreader. He planted another strip to the “Caliente 119” mustard at twice the normal rate due to a problem with the spreader. He planted the third (middle) strip to buckwheat as a control. He fertilized (6-1 with sulfur) for a target rate of 120 N in a split application. There was rainfall of about an inch a week (or irrigation) and so the cover crops came up and grew well. Six weeks after planting, there was 1 to 1.2 tons per acre of mustard biomass (dry weight).

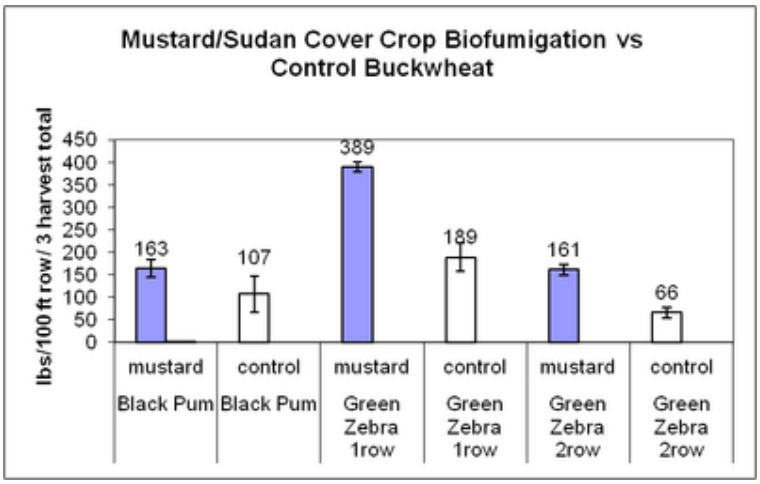
Then the chopped plant material was disked in.

By the first week in July, the mustard fields were in full flower and full of buzzing bees. The earlier planted section was starting to put on seed heads signaling that it was time to kill the cover crop. The trick is to wait as long as you can so that the plant has grown as much as possible, but not wait too long and have hard seed start to form. To incorporate the cover crop, first Harold did one pass with the flail mower. This chopped the mustard into nice small pieces, crushing the leaves to cause the chemical reaction. Then he quickly disked the field to incorporate the fresh plant material. It was incorporated within ten minutes of chopping to make sure that the volatiles were released into the soil instead of the air. Walking behind the tractor, the spicy mustard pricked my eyes and nose – the chemical reaction was

happening! The last step was to set up sprinklers so that the water sealed off the soil surface. He followed the mustards with sudangrass to give a double biofumigation to the plots. Sudangrass also has volatile compounds shown to kill soil-borne disease and weeds.

That was a lot of work and Weaver had to wait a whole year in order to see if it was worth the effort. In the spring he transplanted tomatoes into the entire field, some of which had been treated with cover crop "biofumigation" and some of which had just had regular cover crops. We decided to monitor Green Zebra and Black Plum varieties which tend to be very susceptible to verticillium. Once a week, during the first three weeks of August (August 6th, 15th and 24th) we harvested from plants that had received the mustard biofumigation and those that had not for both Green Zebra (one row and two rows per bed) and Black Plum. To make sure we were getting a good representation of what was going on, we randomly chose three sets of three plants in each variety to monitor.

T**he result: the yield in areas that had the mustard and sudangrass cover crop treatment were twice as high as those that did not for Green Zebra.** Interestingly, the per plant yield was also almost twice as high where there was only one row of plants per bed versus two.



Year 2: Did we get repeated good results? Science always tells us it is not enough to do a trial only one time. In 2012 Weaver and I repeated the experiment to see if the results were solid.

Since sudangrass was easier to grow compared to the mustards and fits better in rotation we used sudangrass as the suppressive cover crop in 2012. On July 7th Harold planted four strips of sudangrass at 45 lb per acre. It rained 6/10th of an inch the next day. On July 13th he planted two strips of buckwheat at 50 lb per acre. Before planting he fertilized the field with 50 units of nitrogen and on July 13th with 60 additional units. The sudan planting was a little patchy but on July 15th it rained an additional inch.

By the end of August the sudangrass cover crop had been mowed once and the regrowth was more than 18" tall. Eight weeks after planting there was 6,090 lb per acre of biomass in the field. On August 30th Weaver rolled down two strips of sudangrass and flail chopped and integrated two strips. Buckwheat cover crop was also flail chopped and disked in. Even where the plots were disked there was still significant residue to slow any possible soil erosion over the winter.

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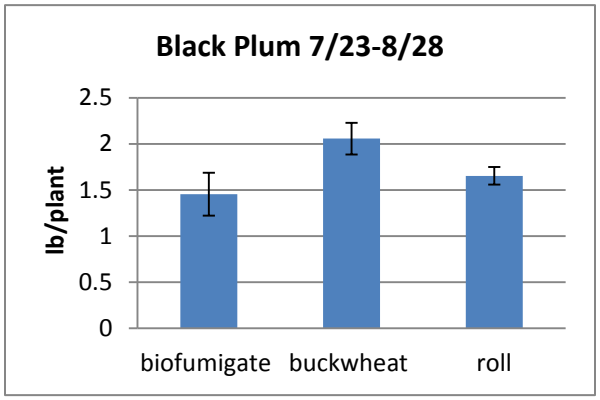
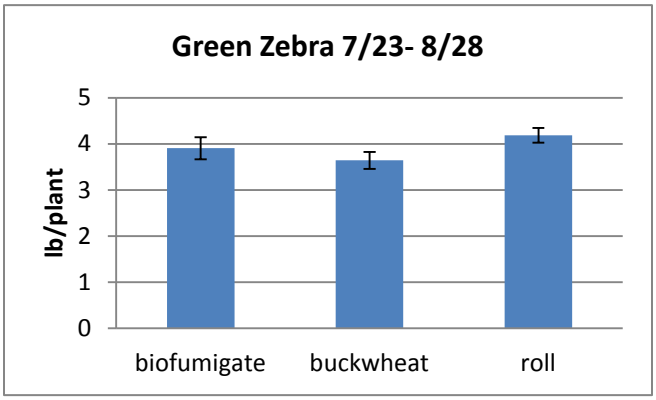
Mid May 2013 Weaver transplanted tomatoes into raised beds (plastic). We harvested subplots of black plum and green zebra (verticilium susceptible) weekly for six weeks from July 23 to August 28.

The result. In 2013 there was no significant difference in yield between plots where we had chopped and incorporated "biofumigated" with sudangrass cover crop compared to buckwheat or rolled down sudangrass. This may be because the plants were not very stressed by the verticillium for most of the season due to weekly rains. It is also possible that we were not as particular this year in terms of timely incorporation and sealing off the soil with water to keep in volatiles.





So was it worth it? To answer that question we would have had to track the time and money spent on growing and managing the cover crops. We have learned a lot from this and other experimentation with growing mustard cover crops.

Mustard cover crops are picky – they need enough moisture, enough nitrogen, sulfur to create the chemical compounds, and have to be managed in a timely manner. Also, this was a field demonstration, without multiple reps, so we cannot say for sure that the cover crop biofumigation is what caused the larger yield in year one. Though, based on other research, it seems likely. I think that mustards and sudangrass are another tool in the tool box for combating soil-borne disease. But it is a tool that has to be wielded precisely. And it might not always work depending on the season. These are living plants which react to growing conditions. Since you need large plants to have enough of the compound in the plant to kill the pathogens, you have to grow them well for it to work.

You also have to have the time to manage them correctly. For example, if you just grow the cover crop and don't mow it or otherwise chop it into small pieces the chemical reaction will not happen sufficiently. Or if you don't work the cover crop in right away (they say within 15 minutes) a lot of the compound will have escaped, volatizing into the air instead of the soil where the problem is.

For more information contact tdupont@psu.edu

Sunn Hemp

- 30-40 lb/A drilled
- Prefers hot and dry
- Best to inocúlate
- $6.39/ lb (groworganic.com) ($281/A @ 44 lb/A)

Advantages

- Fast growing tropical legume
- Substantial biomass and N fixation when grown as a summer cover crop
- Potential to kill soil borne diseases and nematodes

Disadvantages

- A light frost kills sunn hemp
- Not a good fall cover crop
- Seed is expensive

Pearl Millet

- Warm season grass (needs 65-70 F for germination)
- 10 lb/A drilled ½" deep
- Fertilize at 70% rate of corn
- Mow when 2.5' tall
- Available from Adams Briscoe Seed Co. $5.25/ lb ($58/ A @11 lb/A)

Advantages

- Potential to suppress soil born diseases and nematodes
- High organic matter input (can reach 12' if not mowed)
- Drought resistant
- Winter kills

Disadvantages

- Seed can be expensive
- Can be difficult to incorporate

Sudangrass

- 30-50- lb/ acre drilled
- Mow at 18-30" tall (6-8 weeks)
- Tolerates heat
- Needs warm soil to germinate (Jun-Aug)
- $0.72/ lb ($33/ A @ 46 lb/A)

Advantages

- Varieties shown to suppress root-knot nematodes (*Meloidogyne spp*.): Trudan 8 sudangrass,and Sordan 79, SS-222, and SS-333 sorghum sudangrass hybrids.
- Suppress weeds
- Organic Matter (8-10,000 lb/A dry matter)

Disadvantages

- Large amount of residue can be difficult to integrate
- Can produce toxic levels of hydrogen cyanide and nitrate while young or just after a frost, and so should not be grazed at these times.
- Can harbor high levels of lesion nematodes

Mustards

- Drill 8-10 lb/ A
- ¼" to 1" depth
- Mid August planting is recommended.
- July plantings will mature quickly due to heat stress.
- Mustards are sensitive to glyphosate as well as to 2,4-D and various other broadleaf herbicides.
- Mow using a flail mower and incorporate residue immediately.

Advantages

- Suppress soil born diseases
- Suppress weeds

Disadvantages

- Are sensitive to drought stress
- Needs a fine seedbed.

Rapeseed

- Plant in mid to late September.
- Use only winter rapeseed varieties. A recommended variety is 'Dwarf Essex'.
- Rapeseed requires a firm, smooth seedbed that is free of weeds, heavy residue, and large clods.
- Seed may be drilled or broadcast. Avoid planting too deep! A seeding depth of 3/8 inch is good or if broadcast, a culti-packer may be used.
- Use a seeding rate of 7-8 lbs/acre.
- Alfalfa calibration settings usually apply if rapeseed settings are not provided.
- Rapeseed is sensitive to herbicide carry-over.
- Fall planted rapeseed should have 8-10 true leaves and a 5-6 inch tap root with a 3/8-inch diameter root neck before the ground freezes.
- For optimum nematode control green manure should be incorporated when there is adequate

  soil moisture and a soil temperature above 50 degrees.
- Mow rapeseed using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours.

Advantages

- Taproot breaks up compacted plow pans
- Can be used to reduce incidence of root knot nematode.
- Can reduce incidence of take all disease.