6870 Licking Valley Road
Frazeysburg, Ohio 43822
Phone: 740-828-3400
ohiopgma@gmail.com; www.opgma.org/ovsfrdp

Final Report – December 19, 2019

Project: Using Mustard Cover Crops as a Biofumigant to Reduce Plectosporium (White Speck) in Pumpkin.

Principle Investigator(s): Jim Jasinski
Phone Number: 937-484-1526
Fax: 937-484-1540
E-mail: Jasinski.4@osu.edu
Cooperating Institution: Ohio State University Extension
Mailing Address: 1512 S US 68, Suite B100, Urbana, OH 43078
Other Key Personnel: Mac Riedel, retired Emeritus Plant Pathologist

Objectives(s) of research proposal:

1. Establish a study at the Western Ag Research Station (WARS) in South Charleston to evaluate the effect of mustard cover crops on disease incidence of Plectosporium blight.

2. Determine the efficacy of several mustard cover crop combinations on reducing Plectosporium blight compared to an untreated check and current fungicide treatment recommendations.

Introduction

Ohio growers produced 4,000 acres of pumpkins in 2018 with an estimated farm gate value of $10.6M. Pumpkins are seen by many growers as one of the last cash crops they can sell heading into the fall, so a good crop is important to the farm economically. While we have trained and educated growers over past years to scout and treat many recurring diseases like powdery mildew and downy mildew, there are several soil borne diseases like phytophthora, fusarium and plectosporium that are difficult to control using tolerant germplasm or fungicides so it's difficult to provide useful management recommendations. White speck, aka plectosporium, is a disease seen by many growers in their fields and is considered on the rise in Ohio. Instead of using a fungicide based program to control this disease, research has been undertaken in several other states to use mustard cover crops as a soil biofumigant to reduce the inoculum and therefore lower the impact of this disease.

Site Selection and Preparation

In 2018, a pumpkin research trial for powdery mildew was established at the Western Ag Research Station in South Charleston, OH. By the end of that trial it was apparent that plectosporium was present in large areas across the trial, causing significant scarring of foliage, fruit and plant loss. This area was seen as a great location to try the mustard cover crop biofumigation project in 2019.

In an effort to establish the initial research trial in the fall of 2018, the site was disked and culti-mulched on September 18 to create a seed bed for the mustard cover crop planting. The mustard cover crop treatments were broadcast seeded and then culti-mulched on September 21. The cover crop seed sprouted but did not grow more than a few inches tall before being killed by frost and cold temperatures, thus the effort to establish a fall cover crop failed due to the short growing season.

In the spring of 2019, the mustard cover crop biofumigation trial was repeated following the same treatments and plot design used in the fall 2018. Instead of broadcasting seeding, the mustard cover crops were drilled in a 10' wide band into the middle of each treated plot on April 10. Prior to drilling the cover crop, 100 pounds of urea and 17 pounds of ammonium sulfate were drop spread and disked into the trial area to provide fertility for vigorous growth of the mustard cover crop. Seeding rates for the mustard cover crops were based on suggested rates provided by the seed companies. Seed costs were approximately $6.70/lb for Pacific Gold (Johnny's Seed) and $6.50/lb of Caliente 199 (SeedWay).

Methods

The trial consisted of five treatments and four replications in a randomized block design. Each plot measured 13' x 45'. Mustard cover crops were seeded at two rates in three treatments (**Figure 1**) with the remaining two treatments left bare (unseeded). The mustard cover crops were grown to full bloom for peak glucosinolate production, and then mowed with a bush hog and incorporated 3-4" into the soil using a rototiller. Each plot was culti-mulched immediately after tilling to pack the soil and then watered with ca. 2,000 GPA to seal the soil and maximize the biofumigation process. The two mustard cover crop varieties did not bloom at the same time. The Pacific Gold treatment reached full bloom about two weeks earlier than Caliente 199 or the mixture treatment. This means the mowing and incorporating processes occurred on June 4 for Pacific Gold and June 12 for Caliente 199 and the mixture. All plots were sprayed with glyphosate 32 oz/A, Dual 1.3pts/A, and Strategy 4pts/A on June 26 for burndown and residual weed control. Solid Gold pumpkin seedlings (Rupp Seed) were transplanted into all plots on June 27 at first leaf stage. All plots were sidedressed with 75 pounds of nitrogen using 28-0-0 on June 28. The transplants were hand watered twice to overcome any transplant shock. At this point the biofumigation plots were deemed established, completing Objective 1.

The plots were sprayed with fungicide according to their treatment programs (**Figure 1**) on July 26, August 2, August 12, August 21, August 30, and September 5. Treatment 1 was the untreated check and did not receive any fungicide applications. Fungicide applications to treatments 2, 3, and 4 were only intended to control powdery mildew. The fungicides used in treatment 5 were intended to control both powdery mildew and plectosporium.

Scouting for plectosporium began July 23 where five petioles per plot were examined for signs of plectosporium. On August 7, August 20, September 4 and September 13; 10 petioles and leaves were examined per plot for signs of plectosporium.

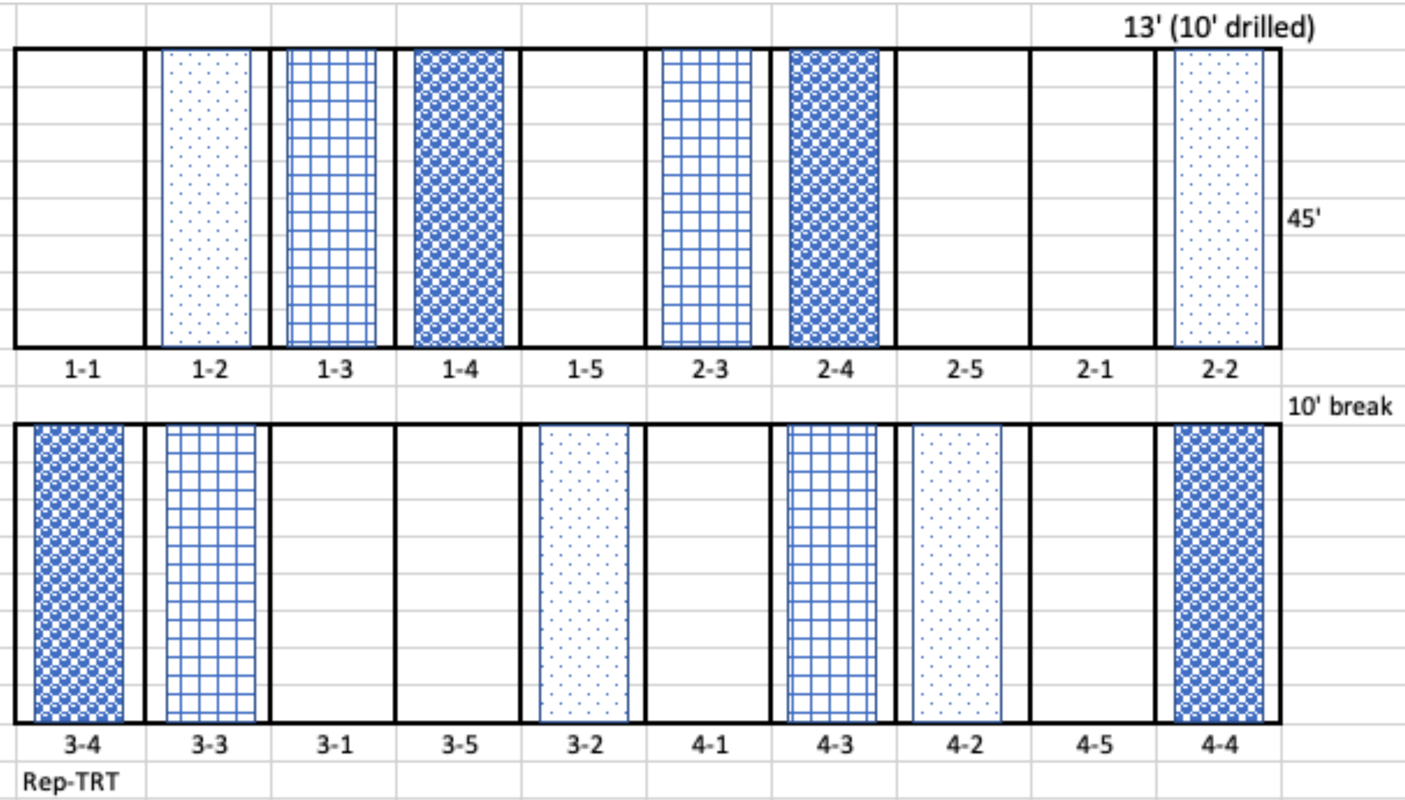
Yield data was taken from all plots on September 20. All marketable fruit from each plot were counted, weighed and graded for plectosporium on the rind and handle.

Results

Petiole, leaf, and yield data were analyzed using SAS software (Version 9.4). On July 23, the first foliage scouting date, one small plectosporium lesion was found on a single petiole. On August 7, several small lesions were found on a single petiole. Both of these sampling dates revealed extremely low levels of disease development on all treatments.

On August 20, September 4 and September 13, disease pressure on the petioles and leaves increased but there were no significant differences among the treatments on any date (**Table 1**). Percent plectosporium infection never exceeded 2.7% for the petioles and 3.2% for the leaves. Numerically most damage was observed on the untreated check and the least damage on the strobiluron treatment (treatment 5). The mustard cover crop treatments (treatments 2, 3, 4) appeared to suppress plectosporium development compared to the untreated check.

All marketable pumpkins were harvested and graded for disease on September 20 (**Table 2**). There were no significant differences between the treatments for fruit number however the untreated check produced the fewest fruit while the mixed mustard cover crop treatment produced the most fruit. The average weight per fruit in the Caliente 199 treatment was significantly heavier than the untreated check, Pacific Gold, and strobiluron treatments. The average treatment weight was nearly significant (P-value = 0.07) with the untreated check containing the lowest weight followed by the strobiluron, Pacific Gold, Caliente 199, and mixed mustard treatments. These results satisfy Objective 2 of the proposal.



Treatment	Mustard Cover Crop	Fungicide Program
1	None - Untreated Check	None
2	Pacific Gold (6lb / A)	Procure 8oz alt. with Quintec 6oz
3	Caliente 199 (11 lb / A)	Procure 8oz alt. with Quintec 6oz
4	PG + Cal 199 (1/2 rate each mixed)	Procure 8oz alt. with Quintec 6oz
5	None - Strobiluron control	Flint 2oz alt w Cabrio 16oz

Figure 1. Plot plan and treatment list of the mustard cover crop biofumigation trial. The first plot number refers to the replication, the second number is the treatment.

Table 1. Percent disease for plectorsporium found on petioles and leaves by treatment. Scouting on July 23 and August 7 revealed 99% of petioles and leaves had zero lesions and thus are not reported here.

	August 20		September 4		September 13	
Treatment	Petiole Avg. (%)	Leaf Avg. (%)	Petiole Avg. (%)	Leaf Avg. (%)	Petiole Avg. (%)	Leaf Avg. (%)
(1) Untreated check	0.7	0.8	1.7	3.1	2.7	1.2
(2) Pacific Gold	0.4	0.4	1.0	3.2	2.2	1.8
(3) Caliente 199	0.1	0.1	0.7	0.6	1.7	1.0
(4) PG + Cal 199	0.5	0.1	1.6	1.1	1.3	0.7
(5) Strobiluron control	0.1	0.1	0.7	0.5	0.6	0.3
P-value (0.05)	NS	NS	NS	NS	NS	NS

Table 2. Number and average fruit weight harvested September 20 per treatment.

Treatment	Total Fruit (#)	Avg fruit wt (lb)[a]	Avg treatment wt (lb)	Fruit infection (%)	Handles infected (<5%)
(1) UTC	42	18.0 bc	189.1	0	0
(2) Pacific Gold	54	17.2 bc	230.8	0	2
(3) Caliente 199	50	20.1 a	250.0	0	0
(4) PG + Cal 199	55	18.8 ab	256.9	0	1
(5) Strobilurons	50	16.8 c	210.8	0	0
P-value (0.05)	NS	0.01	0.07 (NS)	NS	NS

[a] Data in columns that share a letter indicate no statistical significance.

Conclusions

The trial was located in a specific field at the research station due to a significant amount of plectosporium foliar and fruit disease present in 2018. This fungus favors development under warm and wet conditions but after the wet spring, conditions at the research station turned quite dry. The research station received 1.24″ of precipitation between transplant (June 27) and fruit harvest (September 20) which translated into nearly drought like conditions during most of the season. Comparing this with 3.6″ of precipitation in 2015, 8.2″ in 2016, 4.6″ in 2017, and 9.0″ in 2018, it is easy to see that conditions favoring disease development were not present, and despite several artificial waterings with a boom sprayer, there was not enough moisture to boost disease levels to epidemic or even economically significant proportions. These drought-like conditions in the middle and later half of the season most certainly decreased the impact of this disease in this trial.

In terms of foliage damage due to plectosporium infections, the overall petiole and leaf injury ratings were at or below three percent at the time of last scouting which is extremely low pressure. Even at these low levels of infection, it appeared the strobiluron treatment did reduce the amount of disease, if only by a small amount. Coincidentally, it was observed that the strobiluron treatment did not control powdery mildew very effectively, which led to significant canopy loss, almost mirroring the untreated check plots. Seeing this first hand will allow for changes in the fungicide rotation if this experiment is repeated. After the trial was terminated, plectosporium continued to develop on the foliage to the point where vine and foliage symptoms were readily visible, but this was long after the fruit had been harvested and removed.

Plectosporium infestation of the fruit rind was not observed in this trial and only a few lesions were seen on the pumpkin handles. There were no significant treatment differences for the number of fruit or the treatment weight of fruit, only for the higher average fruit weight of the Caliente 199 treatment. The interaction of mustard cover crops with fruit size and yield will be followed up if future studies are conducted.

The process of using mustard cover crops involves significant management resources and equipment to prepare the field for eventual direct seeding or transplanting, thus it is important to understand the value this approach can return to the farm operation. While dry conditions may have prevented dramatic disease observations between treatments, there seems to be a trend that using either a mustard cover crop or specific fungicide regime can help reduce plectosporium. This research will likely need to be followed up for several years before efficacy conclusions are drawn.

Biofumigation may have the potential to allow other crops, not just cucurbits, to be grown in fields where known soil borne pathogens exist. Other benefits of this process include increased organic matter in the soil and a boon for all kinds of pollinators in the area while flowering. Future research may look at the effectiveness of following a short season soybean crop or wheat crop with a summer mustard cover crop in preparation for the next season's pumpkin crop. It would also be relevant to see the effects of a summer mustard cover crop followed by a spring planting for a double dose of biofumigation ahead of a mid to late June transplanting of pumpkin or other crops. There will be an active effort in the winter of 2020 to recruit several growers to try this technique on their farm. Hopefully these trials will demonstrate a pattern of efficacy against plectorsporium or other soil borne diseases like fusarium or phytophthora.

The process of converting mustard cover crops into a biofumigation bed has been detailed in a video on OSU's IPM YouTube site (https://youtu.be/Taz-PhDphhA) for both growers and other educators to watch and learn from. This video has been viewed 413 times since being posted in late June.