Applied Research Results on Field Crop and Vegetable Disease Control

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The research described in this book was designed to evaluate strategies for improving disease control and the efficiency of crop production in Delaware and Maryland. Commercial products are named for informational purposes only. Delaware Cooperative Extension and University of Delaware, do not advocate or warrant products named nor do they intend or imply discrimination against those not named.

The primary purpose of this book is to provide cooperators and contributors a summary of the results of field research. Many data summaries and conclusions in chapters from this book have been submitted to the American Phytopathological Society for publication in *Plant Disease Management Reports* in 2017. Other work may be published in other peer reviewed scientific journals as appropriate. Reprints of these publications are available upon request.

The authors would like to thank the collaborators, farm crews at UD and UMD, funding groups, and industry for assistance with many aspects of these projects. Without your help, the applied plant pathology programs would not be possible.

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Small Grains

In Delaware and Maryland, **Wheat** yields averaged 67 and 64 bu/A, respectively on 70,000 (DE) and 360,000 A (MD). Planted and harvested acres continued to drop from 2013, mostly as a result of low commodity prices coupled with high input costs. The 2015 winter was mild, allowing aphid populations to persist well into January in many areas. Powdery mildew was present early in susceptible fields to varying degrees, and cool, moist conditions present through flag leaf resulted in the need for a fungicide application in some fields. The moderate winter and spring also resulted in movement of stripe rust into the Southern areas of both states at or slightly after flag emergence. Susceptible varieties planted in these areas experienced varying degrees of yield loss as a result of stripe rust. Cool wet conditions persisted through flowering, but pronounced Fusarium head blight and vomitoxin contamination were not widely observed. Leaf blotches were mild to moderate in severity. Viral diseases including soilborne mosaic and barley yellow dwarf were present to varying degrees, again likely as a result of the cool fall and spring conditions.

Barley yields averaged 76 and 72 bu/A for Delaware and Maryland, respectively, on 28,000 (DE) and 50,000 A (MD).on 22,000 harvested acres. Net and spot blotch were the dominant diseases occurring in barley this year, with minimal levels of scald. Rusts and powdery mildew were largely absent. Fusarium head blight was minimal. Barley yellow dwarf virus was present in some fields and had varying impacts on overall production.

Title: Examining the utility and economic returns of different fungicide application programs to manage foliar diseases of wheat.

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Overview

Fungal diseases of small grains can pose significant limitations to wheat production. These diseases can reduce green leaf tissue and impact both yield and grain quality. In the Mid-Atlantic, foliar diseases, particularly residue-borne fungal pathogens belonging to the Leaf blotch complex of diseases (LBC), are present in many fields to varying degrees each year. This is likely a result of increased conservation tillage in the region, resulting in higher levels of fungal inoculum. If foliar diseases reach the upper 3 leaves or glumes before grain fill is complete, yield losses may occur. Traditional fungicide programs to manage foliar disease of wheat call for a single fungicide spray at Feekes Growth Stage (FGS) 8/9 to protect the flag leaf from foliar disease. However, threats to wheat production by Fusarium head blight (FHB) have forced growers to reevaluate their chemical management programs. FHB is a disease of the head, and can only be suppressed when specific fungicides are applied at flowering (FGS 10.5.1), 1-2 weeks after traditional FGS 8 applications. The application of both an FGS 8 and FGS 10.5.1 fungicide application is not practical in Mid-Atlantic production systems due to applicator limitations and cost. Growers can also apply fungicides early when nitrogen is applied at greenup (FGS 5) which is advertised as a means to protect against early onset of foliar diseases. Fungicide applications at FGS 5 are often combined along with an application at FGS 8/9 or FGS 10.5.1. **These "new" FGS 5 and FGS 10.5.1 timings have not been adequately assessed for their efficacy and potential to promote yields compared to standard, FGS 8/9 applications.**

Fungicide application costs differ depending on product, rate, and number of applications. Most fungicide studies focus on the "best" fungicide in terms of ability to suppress disease and improve yield. Few unbiased, replicated studies examine fungicide programs for their potential to improve grower profits. For example, it is possible that a FGS 5 + 8 fungicide program may be the best in terms of disease suppression and yield protection. However, product and application cost relative to the yield improvement may not result in the greatest net profit. A single application or cheaper product may deliver similar benefit at reduced cost, therefore resulting in greater potential net returns. **Currently there is no information on the potential profitability of fungicides in Mid-Atlantic wheat production systems.**

To address these questions, a two year study was established in Delaware, Maryland, Virginia, and Pennsylvania. Thirteen fungicide application programs plus an untreated control at six locations were evaluated from 2015 through 2016. Five commonly used fungicides were applied at a variety of timings to represent programs currently being used by growers in Maryland and Delaware. Disease severity, test weight, and yield data were collected. In addition, local agriculture businesses were surveyed for fungicide and application costs. Data were analyzed statistically at the end of each season and used to determine the efficacy and profitability of programs relative to FGS 8/9 fungicide applications and untreated controls. At the end of two seasons data were combined and probability of profitability charts were produced for fungicide programs across a range of cost and commodity prices. These charts can be used by producers to assist in fungicide management decisions.

How objectives have been met

This study was replicated at four locations in 2015 (DE and MD) six locations across DE, VA, PA, and MD in 2016. The wheat variety FS 815 [Growmark FS] was planted at all locations. Plots were planted in rows spaced 7" or 7.5" apart into corn, soybean, or wheat residue. Target seeding rate was 1.8 million seeds/A. The experimental design at each site was a randomized complete block with four to six replications of each treatment. Spreader rows were utilized to facilitate even disease development and minimize plot to plot fungicide drift.

The fungicide application programs were evaluated using the fungicides Tilt® (Propiconazole), Quilt Xcel® (Azoxystrobin + Propiconazole), Priaxor® (Fluoxapyroxad + Pyraclostrobin), Stratego YLD® (Prothioconazole + Trifloxystrobin), and Prosaro® (Prothioconazole+Tebuconazole), applied according to **Table 1**. An untreated control was included for comparison. Tilt® was selected because propiconazole fungicides are cheap and often used at greenup (FGS 5) as part of a split-application fungicide program. Quilt Xcel®, Stratego

YLD®, and Priaxor® are dual mode of action fungicides that are commonly used in fungicide programs in the region and include strobilurin (Group 11) fungicides, which are touted to improve yields in the absence of significant disease pressure or under stressful conditions, such as drought. Prosaro is one of the industry standards for suppression of Fusarium head blight. All fungicides were applied with a CO_2 backpack sprayer equipped with Twinjet Flat Fan 8002 nozzles at a pressure of 34 psi in 20 gallons of water per acre. Yields, test weights, and foliar and head diseases were assessed. To determine the potential net returns of various fungicide programs, yields relative to untreated controls were compared across a range of grain prices and application costs typical for the region. Each year, five local agriculture businesses were surveyed for input costs, mainly fungicide costs and custom application costs during the growing season.

Table 1. The fungicide programs used, and abbreviated designations used in the following tables and charts.

Treatment	Product	Program Code	Timing (Feekes Growth Stage)	Growth Stage
1	Untreated Control	CK	CK	Untreated
2	Tilt	TSOLO8	FGS 8	Flag leaf Only
3	Tilt	TSPLT5+8	FGS 5 & 8	Greenup and Flag Leaf
4	Tilt+Prosaro	TSPLT5+F	FGS 5 & 10.51	Greenup and Beginning Flower
5	Quilt Xcel	QSOLO8	FGS 8	Flag leaf Only
6	Quilt Xcel	QSPLT5+8	FGS 5 & 8	Greenup and Flag Leaf
7	Quilt Xcel+Prosaro	QSPLT5+F	FGS 5 & 10.51	Greenup and Beginning Flower
8	Priaxor	XSOLO8	FGS 8	Flag leaf Only
9	Priaxor	XSPLT5+8	FGS 5 & 8	Greenup and Flag Leaf
10	Priaxor+ Prosaro	XSPLT5+F	FGS 5 & 10.51	Greenup and Beginning Flower
11	Stratego YLD	SSOLO8	FGS 8	Flag leaf Only
12	Stratego YLD	SSPLT5+8	FGS 5 & 8	Greenup and Flag Leaf
13	Stratego YLD + Prosaro	SSPLT5+F	FGS 5 & 10.51	Greenup and Beginning Flower
14	Prosaro	PSOLOF	FGS 10.51	Beginning Flower Only

Data indicate that, regardless of program or product, fungicide use can increase yield compared to untreated controls, but the degree of yield increase differs significantly (Figure 1). Our data indicate that Quilt Xcel (FGS 5) followed by Prosaro (FGS 10.5.1) and Quilt Xcel (FGS 5 followed by FGS 8), Tilt (FGS 5) followed by Prosaro (FGS 10.5.1), and Priaxor (FGS 5) followed by Prosaro (FGS 10.5.1) resulted in the greatest yields across years (79-80 bu/A) (**Figure 1**). These programs increased yields over the untreated controls by roughly 8 bu/A. When assessing programs based only on timing programs using a 2 pass, flowering fungicide application system or a two pass flag leaf application system yielded 8 or 7 bu/A better than untreated controls, respectively (**Table 2**). Overall, fungicide programs increased yields over controls by 3-8.5 bu/A.

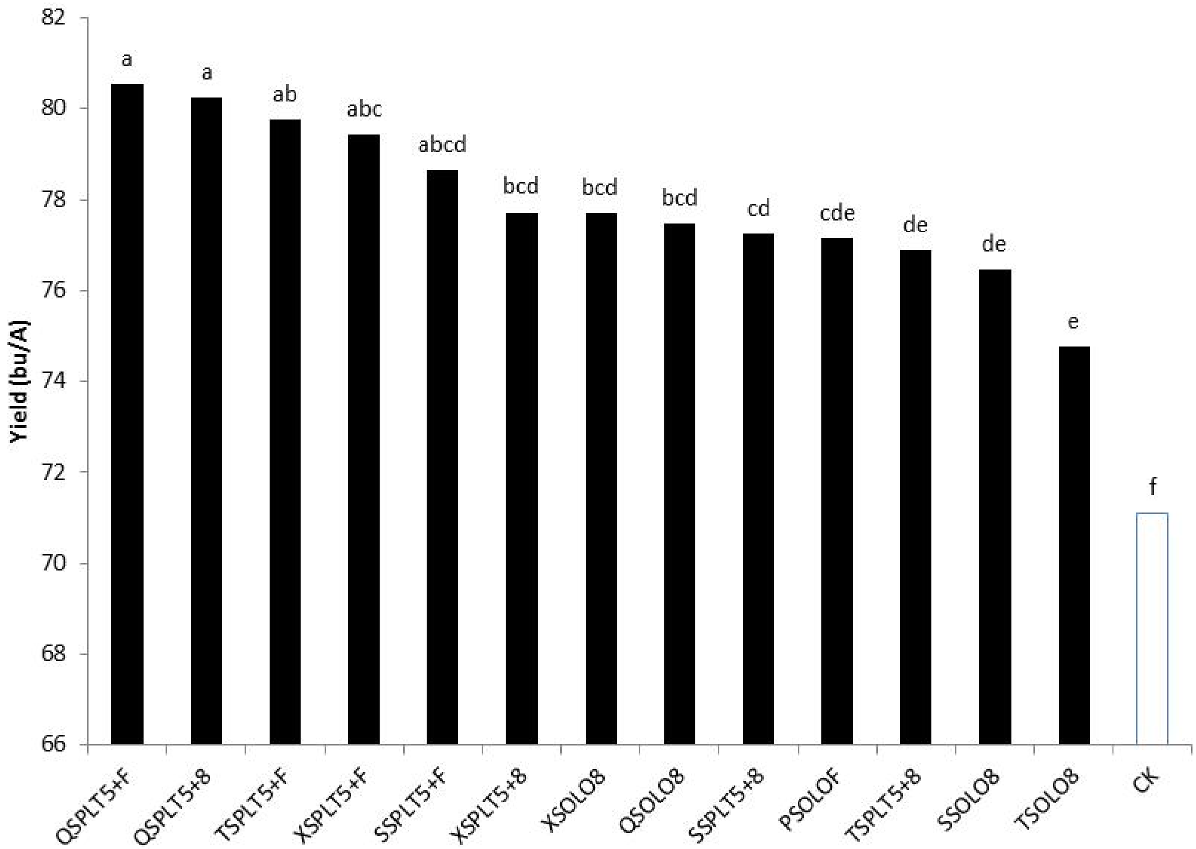

Figure 1. Effects of 13 fungicide programs and an untreated control on yields of soft red winter wheat grown in the mid-Atlantic from 2015 to 2016. Each bar is the average of 57 independent observations. Different letters indicate significant differences using Fisher's Protected LSD (α=0.05).

Table 2. Effects of fungicide timing on measured variables across all experimental sites and years. Different letters indicate significant differences using Fisher's protected LSD (α=0.05).

Timing	Foliar Disease	Glume Blotch	Yield	TWT
F5+F10.51	2.53 B	36.38 C	79.60 A	51.82 A
F5+F8	11.49 B	59.87 B	78.06 AB	50.84 B
F10.51	2.73 B	34.98 C	77.17 B	51.59 A
F8	12.14 B	60.42 B	76.59 B	50.84 B
Control	30.29 A	67.82 A	71.09 C	49.69 C

Test weight, a measure of wheat quality, was significantly impacted by fungicide program (**Figure 2**) with programs containing a FGS 10.5.1 fungicide application increasing approximately 3 lbs/bu more than untreated controls. Programs using an FGS 8 application increased test weight over controls as well, but only by approximately 1-1.5 lbs/bu (**Figure 2**). This was likely due to foliar disease pressure and pressure from Glume blotch, which is discussed in the next section. In addition, effects of variety, late season weather, and timely harvest all impact test weight. We were able to harvest all sites in a timely fashion; however, in cases where wheat is not harvested soon after ripening and rains occur, fungicides are not likely to provide a significant test weight benefit.

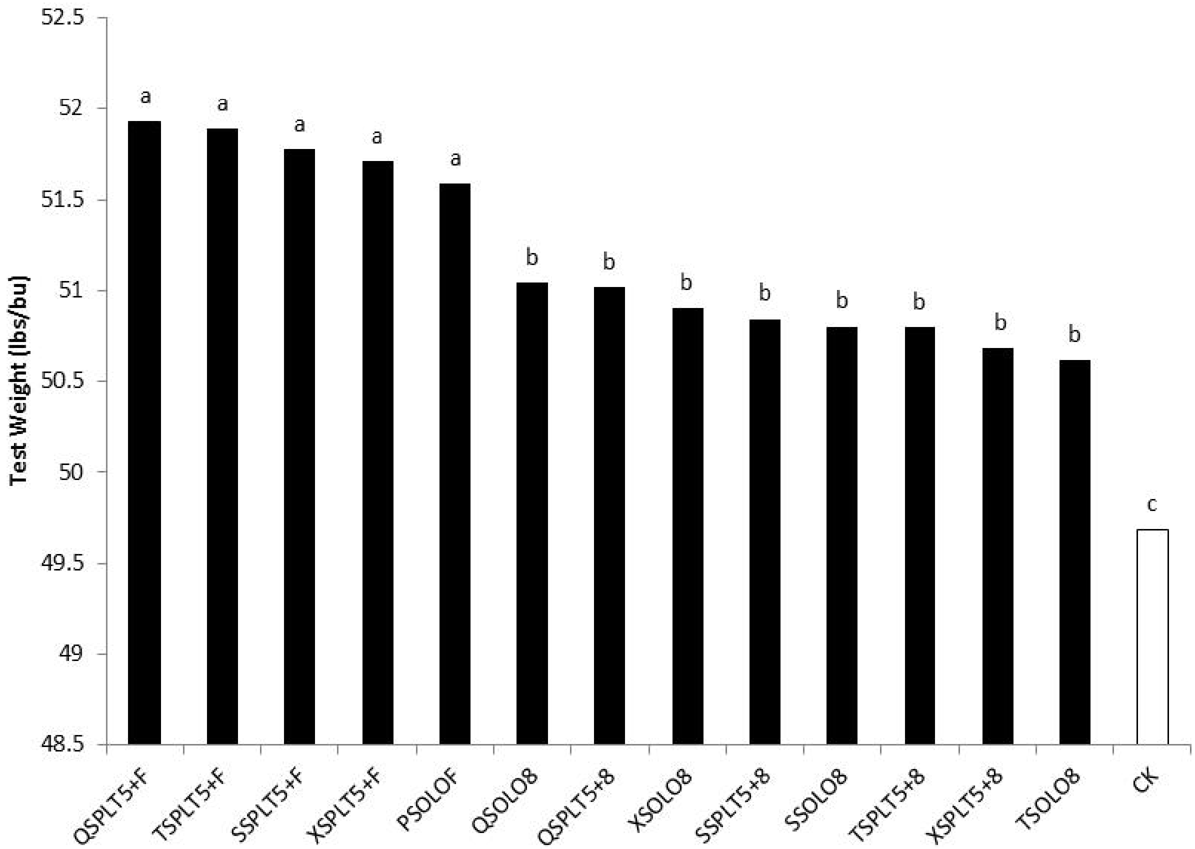

Figure 2. Effects of 13 fungicide programs and an untreated control on test weights of soft red winter wheat grown in the mid-Atlantic from 2015 to 2016. Each bar is the average of 57 independent observations. Different letters indicate significant differences using Fisher's Protected LSD (α=0.05).

Fungicides are marketed to improve yields; however, yield benefits are most likely to occur in situations where fungal disease pressure is high. This was true in this work, as we saw a significant negative association between yield and disease severity on the flag leaf at FGS 11.1 (kernels milky ripe), and Glume blotch on the heads (-0.46 and -0.53, respectively). Thus, the main reason these programs improved yield overall was through reduction of foliar and head diseases.

Data indicate that fungicide programs and timings impacted foliar and head diseases differently, with programs using a FGS 10.5.1 timing resulting in the greatest reduction of foliar and head diseases. In these studies, LBC was the most commonly encountered disease, although powdery mildew and leaf rust was detected at low levels at some locations. When flag leaves were rated, the total amount of disease from all sources was used to determine the percent of affected leaf tissue. Therefore, results encompass a wide range of diseases encountered in the region.

Our data indicate that programs using a FGS 10.5.1 fungicide application resulted in the greatest reduction of disease on flag leaves (**Figure 3**) and Glume blotch on heads (**Figure 4**). This supports the aforementioned statement pertaining to fungicide yield benefits being tied to protection of wheat from disease. When examining the data across fungicides, there was no advantage of a 2 pass program compared to single pass programs for control of foliar disease, but there was a slight advantage in reducing Glume blotch. This may be due to residual control early in the season that may have reduced initial development of Stagonospora. Consequently, this could have resulted in reduced local movement of Stagonospora up the canopy by the end of the season. Regardless, the increase in yield over single pass programs, although statistically significant, was relatively small (approximately 3 bu/A) and therefore, these programs may not ultimately be the most profitable to producers when economic factors are considered.

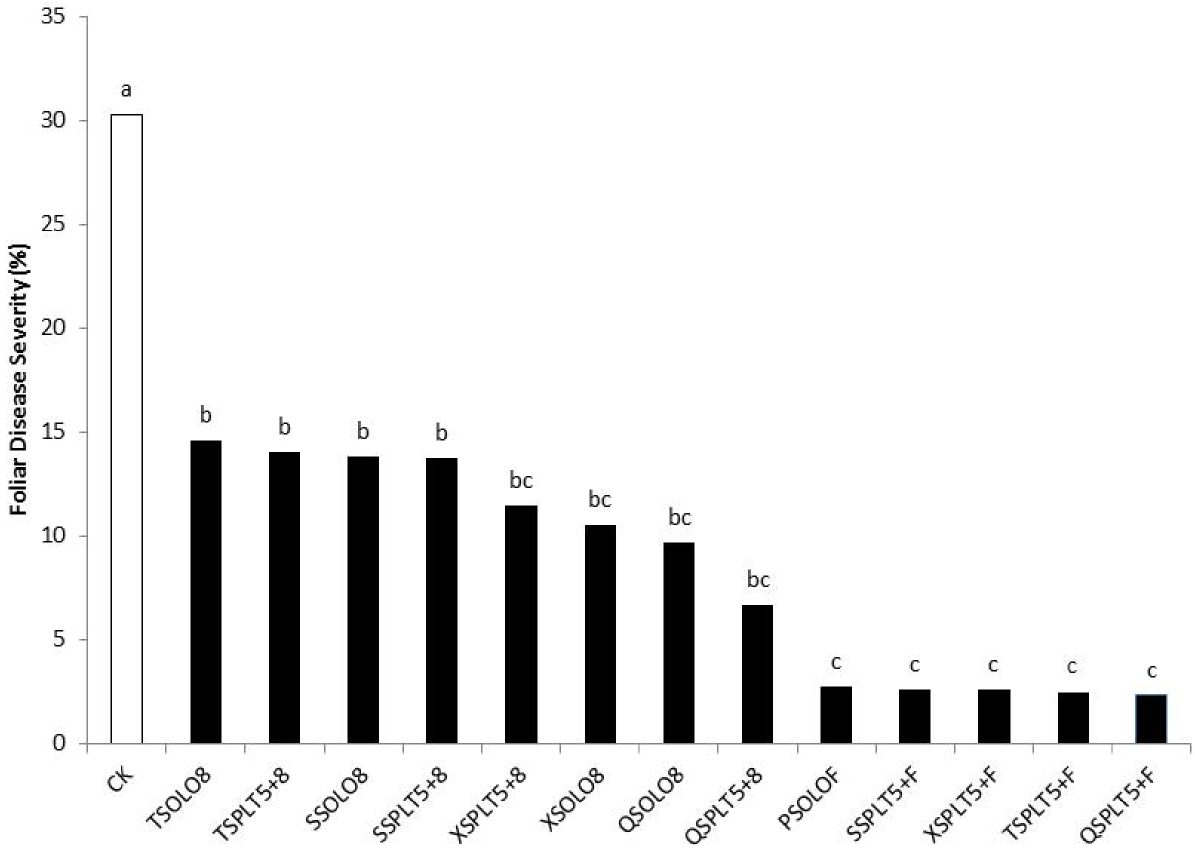

Figure 3. Effects of 13 fungicide programs and an untreated control on foliar disease of soft red winter wheat grown in the mid-Atlantic from 2015 to 2016. Disease was rated on the flag leaf at FGS 11.1. Stagonospora leaf blotch and tan spot were the most commonly encountered diseases, although some powdery mildew and leaf rust were present at some locations. Each bar is the average of 57 independent observations. Different letters indicate significant differences using Fisher's Protected LSD (α=0.05).

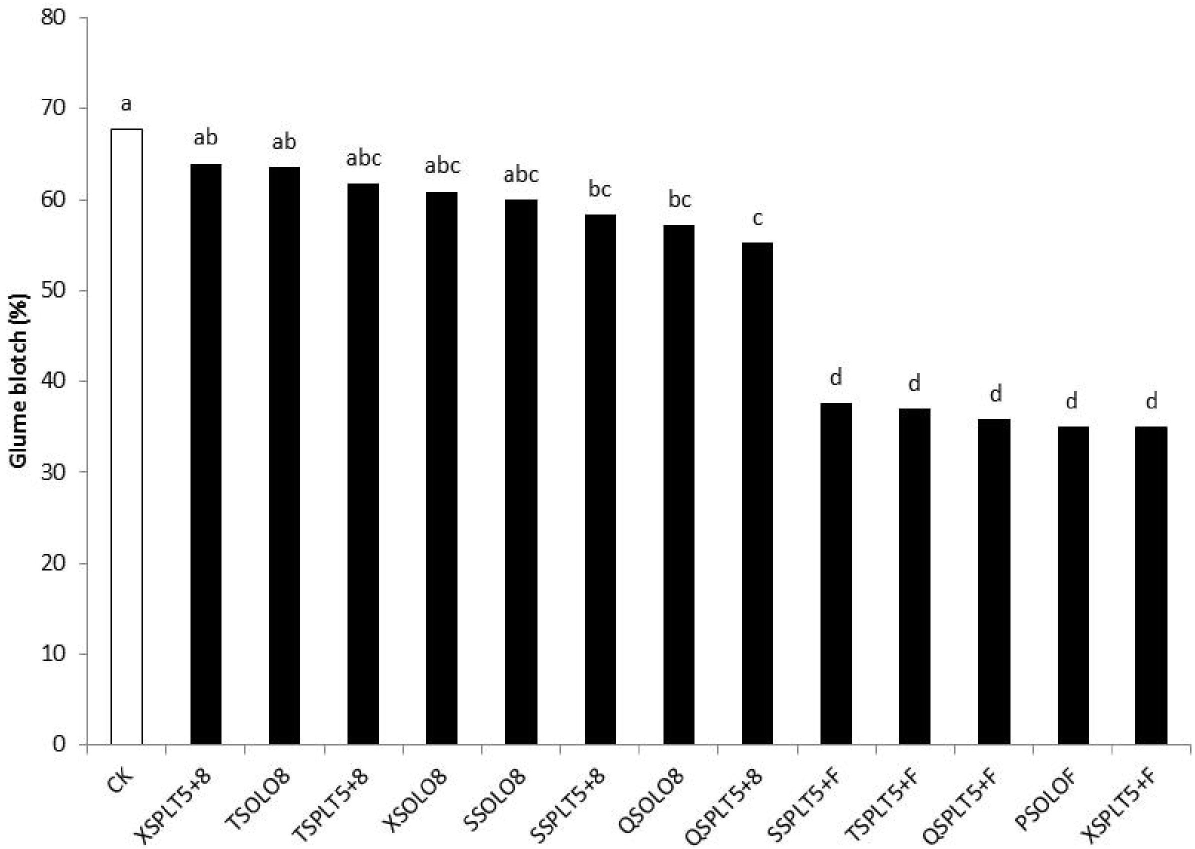

Figure 4. Effects of 13 fungicide programs and an untreated control on Glume blotch of soft red winter wheat grown in the mid-Atlantic from 2015 to 2016. Disease was rated on the flag leaf at FGS 11.1. Each bar is the average of 24 independent observations. Different letters indicate significant differences using Fisher's Protected LSD (α=0.05).

Preliminary economic analysis of the data indicates programs that result in the highest yields are not necessarily the most profitable, although most programs can be profitable as commodity prices exceed $4.00 per bu (**Table 3**). The most profitable programs overall were the Tilt (FGS 5) followed by Prosaro (FGS 10.5.1) and the Tilt (FGS 5) followed by Tilt (FGS 8). These programs resulted in an overall net return across all tested commodity process. When assessed at $5.00/bu, the Tilt/Prosaro program overcame the Tilt/Tilt program in terms of overall profitability, likely as a result of the overall net yield increase. At $5.00/bu, all programs except Priaxor (FGS 5 followed by FGS 8) and Stratego YLD (FGS 5 followed by FGS 8) returned a profit. However, there was a great range in overall profitability ($1.36-$18.82 per bu).

Table 3. Net returns of 13 fungicide programs tested in 2015 and 2016.

Program	Total Cost	Avg Yield	Avg. Increase in Yield	$ 3.00	$ 4.00	$ 5.00
UTC	$ -	71.1				
Tilt 8	$ 11.28	74.8	3.7	-0.31	3.34	7.00
Tilt 5+8	$ 13.02	76.9	5.8	4.39	10.19	16.00
Tilt 5 fb Prosaro 10.51	$ 24.56	79.8	8.7	1.47	10.14	18.82
Quilt X 8	$ 23.42	77.5	6.4	-4.32	2.05	8.41
Quilt X 5+8	$ 33.83	80.3	9.2	-6.35	2.80	11.96
Quilt X 5 fb Prosaro 10.51	$ 33.23	80.6	9.5	-4.87	4.58	14.04
Priaxor 8	$ 25.48	76.5	5.4	-9.38	-4.01	1.36
Priaxor 5+8	$ 34.33	77.7	6.6	-14.46	-7.83	-1.21
Priaxor 5 fb Prosaro 10.51	$ 31.66	79.4	8.3	-6.65	1.69	10.02
Stratego YLD 8	$ 23.96	76.5	5.4	-7.85	-2.49	2.88
Stratego YLD 5+8	$ 32.04	77.3	6.2	-13.55	-7.39	-1.23
Stratego YLD 5 fb Prosaro 10.51	$ 30.90	78.6	7.5	-8.26	-0.72	6.83
Prosaro 10.51	$ 22.82	77.2	6.1	-4.64	1.42	7.48

Data indicate that overall profitability varies greatly between programs, and that the most profitable programs never exceeded a net profitability success rate of more than 63% (**Table 4**). In many cases, fungicide use below $4.00/bu resulted in less than a 50% chance in resulting in a profit. In the two most profitable programs, successful returns were only realized in 54 and 49% of cases for the Tilt (FGS 5 followed by FGS 8) and Tilt (FGS 5) followed by Prosaro (FGS 10.5.1) programs, respectively (**Table 4**) when assessed at $3.00 per acre. These chances increased to 57 and 58% at $4.00/bu and 63% at $5.00/bu. The Quilt Xcel (FGS 5) followed by Prosaro (FGS 10.5.1) program, when assessed at $5.00/bu, resulted in the greatest overall success rate, at 68%. However, net profitability at this price was $14.04 when compared to the most profitable program, Tilt (FGS 5) followed by Prosaro (FGS 10.5.1) which returned $18.82/bu in 63% of cases.

Table 4. Chance of 13 tested fungicide programs resulting in a net profit.

Program	Price Received per bushel		
No Fungicide	$ 3.00	$ 4.00	$ 5.00
Tilt F8	51%	52%	58%
Tilt F5+F8	54%	57%	63%
Tilt F5 fb Prosaro F10.51	49%	58%	63%
Quilt Xcel F8	39%	51%	59%
Quilt Xcel F5+F8	32%	46%	56%
Quilt Xcel F5 fb Prosaro F10.51	55%	66%	68%
Priaxor F8	39%	55%	64%
Priaxor F5+F8	24%	39%	52%
Priaxor F5 fb Prosaro F10.51	40%	56%	67%
Stratego YLD F8	38%	49%	55%
Stratego YLD F5 + F8	27%	44%	53%
Stratego YLD F5 fb Prosaro F10.51	35%	48%	62%
Prosaro F10.51	47%	55%	58%

In summary, our data show that fungicide use can result in significant increases in yield and profitability in SRWW grown in the mid-Atlantic. Data indicate that programs including a treatment at FGS 10.5.1 may result in the greatest reduction in foliar and head diseases and protect yield in many case. Data indicate that fungicide use on a typical wheat variety grown in this region can be profitable at relatively low commodity prices, but their overall chances of success is less than 50% for many programs when commodity prices are less than $4.00. This, of course, does not include dockage for other factors that growers can encounter, including DON, test weight, and falling numbers, all of which may impact overall profitability. In addition, overall profitability may be increased when planting varieties with poor levels of resistance to common fungal diseases, and conversely, may be reduced in high yielding varieties with high levels of disease resistance, when compared to our tested variety. Inclusion of additional fungicides early slightly improved yields in some cases but more commonly resulted in reduced profitability. These data will provide growers with excellent unbiased data pertaining to fungicide efficacy and utility and will be used to begin to develop a regional fungicide profitability tool for use by growers in the region.

Preliminary data were shared as a poster at the NEAPS meeting held in Philadelphia, PA in 2016. Data were shared at the Delaware Ag Week Field Crop Disease Update in January 2016. MSGUB was noted in the acknowledgements and the logo used in both cases. The research is being prepared for professional publication and MSGUB will also be noted as a funding source.

Title: Examining the Utility and Economic Returns of Palisade growth regulator and fungicides in high input wheat production systems

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Introduction:
Growers in Maryland and Delaware strive to produce high-yielding, high quality wheat. Intensively managed wheat in our area has involved applying nitrogen at appropriate rates and timings and applying fungicides to control diseases, but plant growth regulators have not typically been included in these programs. Palisade is a fairly new plant growth regulator that may have a fit in intensively managed wheat in our area to increase productivity. This product offers a wide window of application for wheat producers as opposed to other growth regulators, which have narrow application windows and may injure plants if applied outside of this window. Palisade works by reducing plant height and claims to improve overall strength of the stem, thereby reducing lodging. Thus, the use of Palisade in intensively managed wheat may allow growers to further push yields by increasing nitrogen rates without a concern for lodging, particularly under irrigated conditions where water stress can be eliminated as a limiting factor to yield. However, increasing nitrogen rates could potentially increase plant disease issues, as this favors lush dense canopies early in plant development. Dense canopies trap moisture and provide an environment conducive to many plant diseases. Currently it is not known what impact Palisade and additional nitrogen may have on disease development in wheat.

The use of Palisade may also impact management of Fusarium head blight (FHB) and other wheat diseases. Concerns about vomitoxin contamination due to FHB have resulted in more growers applying fungicides prophylactically around flowering (Feekes' 10.5.1). There is concern that a single application of fungicide may not be sufficient in some high production fields where residue-borne diseases such as leaf blotch complex and powdery mildew may occur earlier in the season and potentially impact yield. Historically, fungicide programs in Delaware and Maryland were targeted at protecting the flag leaf and not the flowering head. These programs are unfortunately not efficacious for suppression of FHB. Palisade can be applied between FGS 4-7 (greenup - 2nd joint visible). Some growers and consultants are experimenting with a, "wait and see" Palisade and nitrogen application at FGS 7 (2nd joint visible) on fields that appear to have high yield potential. Including a fungicide with Palisade at this timing may provide foliar protection that could carry over until flowering (FGS 10.5.1). Thus, intensively managed wheat growers using Palisade may be able to address early season disease concerns and still use fungicides to suppress FHB at FGS 10.5.1 without sacrificing yield due to foliar diseases. The use of fungicides applied with Palisade at FGS 7 has not been evaluated. In addition, because growers are interested in Palisade use, unbiased research is needed to assess Palisade and its potential fit in Mid-Atlantic wheat production systems.

The **goals** of this project were: 1) to examine the utility of Palisade in intensively managed wheat production systems that include different fungicide programs and nitrogen rates 2) to examine the utility of early fungicide applications at FGS 7 for suppressing diseases compared to standard fungicide application timings (FGS 8-10.5.1), with and without Palisade, 3) to determine the effect of Palisade on wheat yield under different conditions.

Progress to date:
In 2015 and 2016 the study was conducted at the University of Delaware Warrington Irrigation Research farm located in Harbeson, DE. The variety SS8500 was planted in 7.5" rows on October 27, 2014 at 1.8 million seeds / A with a no-till Great Plains precision drill. The field was turbo-tilled two times before planting to provide a suitable seedbed and to size the residue from the previous corn crop. SS8500 was chosen because it has yielded well in state variety trials, has some moderate susceptibility to leaf blotch complex and powdery mildew, and is a tall variety. Nitrogen was applied in the spring as a 50:50lbs split application of N. High N treatments received an additional application of 20lbs N at FGS 7. Fungicides were applied alone or in combination with Palisade or N according to Table 1. Wheat was rated for chemical damage, foliar and head disease, height, test weight, and yield. Each treatment was randomized into a spatial block and each block replicated four times per study. The entire study was replicated three times, twice in 2015 and once in 2016. In 2015, one study site received 5.5 additional inches of

overhead irrigation from 4/20/2015 through 6/15/2015. A total of 11 irrigation events occurred over this period in time, with each event providing 0.5 inches of water.

Table 1. Overall treatment list for the studies conducted in 2015.

Treatment	Spring N	Product	Timing (Feekes)	rate (oz/A)
1	100	untreated control		
2	100	Palisade	6 to 7	10.5
3	100	Palisade + Quilt Xcel	6 to 7	10.5+10.5
4	100	Palisade FB Quilt Xcel	6 FB 8/9	10.5 FB 10.5
5	100	Palisade FB Prosaro	6 FB 10.5.1	10.5 FB 6.5
6	100	Palisade+ QXL FB Prosaro	6 FB 10.5.1	10.5+10.5 FB 6.5
7	120	untreated control		
8	120	Palisade	6 to 7	10.5
9	120	Palisade + Quilt Xcel	6 to 7	10.5+10.5
10	120	Palisade FB Quilt Xcel	6 FB 8/9	10.5 FB 10.5
11	120	Palisade FB Prosaro	6 FB 10.5.1	10.5 FB 6.5
12	120	Palisade+ QXL FB Prosaro	6 FB 10.5.1	10.5+10.5 FB 6.5

FB= Followed by. Experiment replicated under irrigated and dryland conditions.

Summary of Important Findings

Our data indicate that Palisade® applied at the rates and timings used in this study can significantly reduce plant heights compared to untreated controls. Across the three sites, Palisade reduced plant heights by approximately 8% (Figure 1). Inclusion of Quilt Xcel at FGS 8 resulted in increased plant height compared to other treatments containing Palisade; however, these plants were still shorter than controls by approximately 3%. It is possible that this increase in height was due to an effect of the fungicide on plant nutrient allocation and growth, as well as disease severity. Statistical analysis indicated that plant height was correlated with lower disease levels and higher yields (Table 2).

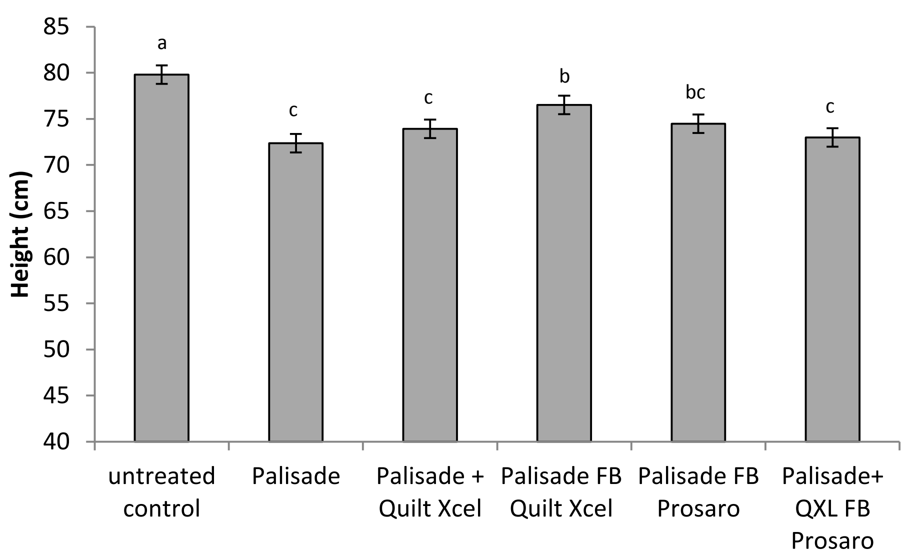

Figure 1. The effects of Palisade and fungicides, averaged across nitrogen treatments, on heights of soft red winter wheat variety SS8500. Different letters indicate statistically significant differences using Fisher's Protected LSD (α=0.05).

Table 2. Spearman's correlations, which show the relationship between pairs of variables. A positive relationship indicatses that one increases at the same time the other increases. Negative values indicate one increases while the other decreases. The closer to 1 or -1 the stronger the relationship.

Variable	by Variable	Spearman ρ	Prob>|ρ|
bu/A	Test Weight	0.7693	<.0001*
Height (cm)	Test Weight	0.1179	0.1731
Height (cm)	bu/A	0.3272	<.0001*
Disease sev	Test Weight	-0.5922	<.0001*
Disease sev	bu/A	-0.5480	<.0001*
Disease sev	Height (cm)	0.0877	0.3065

Data showed that Palisade, when used alone, may have yield and disease penalties under the conditions tested. All treatments receiving fungicide, regardless of product or timing, resulted in increased yields compared to controls and the Palisade only treatments (Figure 2). Similarly, disease was elevated in Palisade only treatments when compared to those containing a fungicide, particularly when additional nitrogen was added at FGS 7 (Figure 3). Palisade impacts gibberellin activity in the plant, which could have an impact on aspects of plant growth and defense. Consequently, if growers are currently investing in Palisade application, these data indicate the incorporation of a foliar fungicide application may be beneficial. FGS 7 fungicide applications had no significant stand alone benefit on yields. However, 2 pass systems using this timing plus a FGS 10.5.1 application resulted in greater yields than the FGS 10.5.1 application alone. Fungicides containing a QOI mode of action such as Quilt Xcel typically have better residual disease control than fungicides containing a DMI mode of action only (e.g. Tilt). In this study Leaf blotch complex (LBC), consisting of Stagonospora leaf blotch and tan spot, was the dominant disease. There was light powdery mildew in 2016, but this did not persist in the canopy after FGS 8 and therefore was not ratable. In addition, FGB and glume blotch were not present at ratable levels. LBC is residue borne and typically moves slowly from the base of the plant up the canopy over time. FGS 7 applications of Quilt Xcel appear to have offered some additional reduction in foliar disease potential, which may have contributed to cleaner overall canopies and improved yields in the 2 pass system (approximately 15 bu/A greater than untreated controls or Palisade only treatments). We did not detect any significant impact of FGS 8 vs FGS 10.5.1 applications on foliar disease control or yield, suggesting that either timing can be used for suppressing LBC under some conditions. These data also indicate that growers could see a dual benefit from a FGS 10.5.1 fungicide application without significant impact on foliar disease control and yield, while simultaneously suppressing FHB.

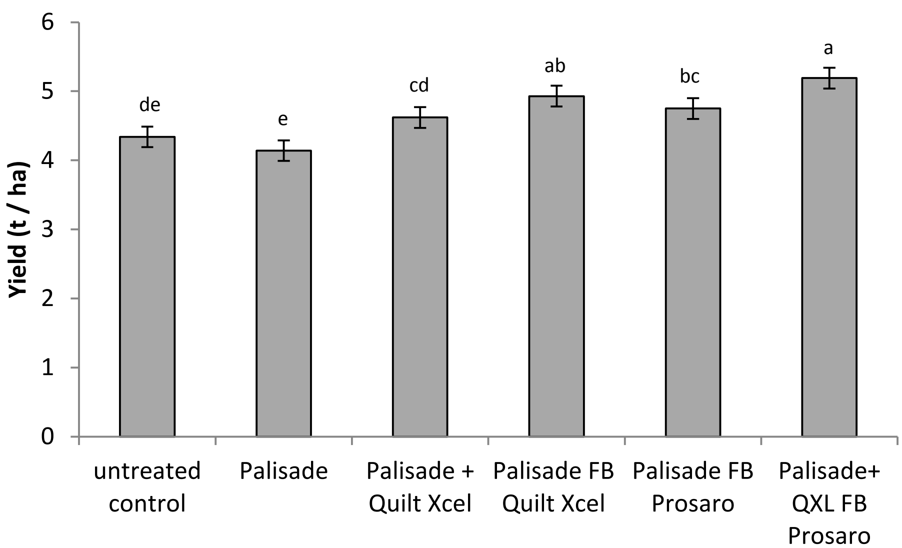

Figure 2. The effects of Palisade and fungicides averaged across treatments on yields of the soft red winter wheat variety SS8500. Different letters indicate statistically significant differences using Fisher's Protected LSD (α=0.05).

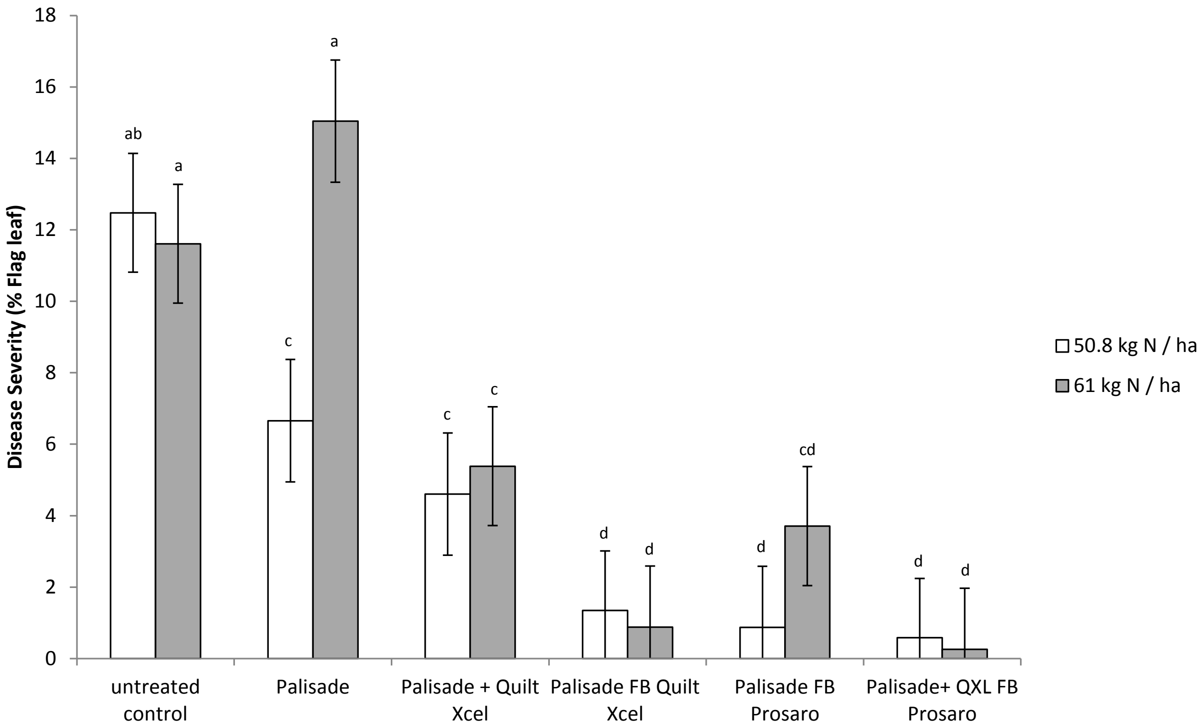

Figure 3. The effects of Palisade, nitrogen, and fungicides on foliar diseases of SS8500 . Different letters indicate statistically significant differences using Fisher's Protected LSD (α=0.05).

Lastly, test weights were influenced by treatment but not by the additional nitrogen application, and followed a similar trend to yield (Figure 4). The 2 pass fungicide program resulted in a 6% increase in test weight compared to untreated to controls. All other treatments containing fungicides, regardless of timing or application, increased test weights over untreated controls or Palisade only treatments. Figure 4.

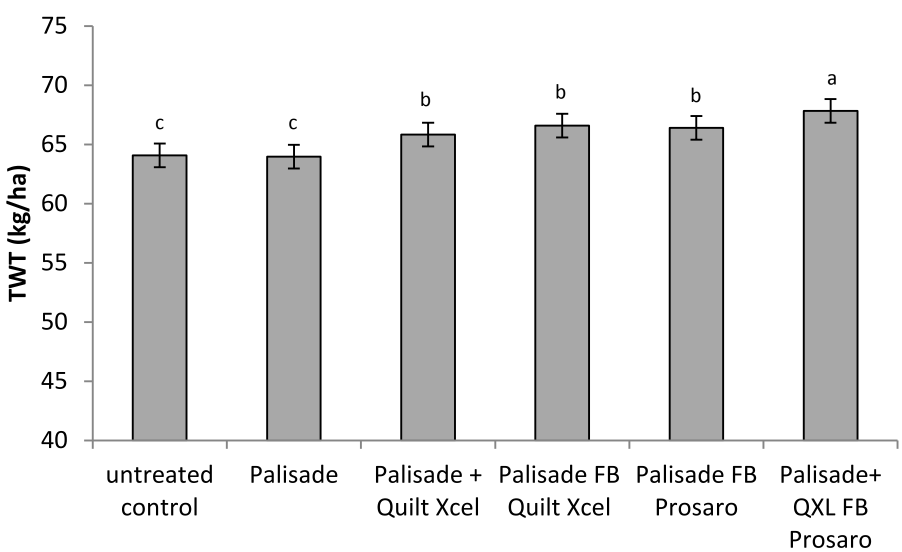

Figure 4. The effects of Palisade and fungicides on test weights of the soft red winter wheat variety SS8500 . Different letters indicate statistically significant differences using Fisher's Protected LSD (α=0.05).

We used our data set to estimate net returns of the various programs across nitrogen treatments (Table 3). Our data indicate that the use of fungicides in conjunction with Palisade can result in net losses at low commodity prices ($3.00 / bu). When prices exceed $4.00 / bu the 2 pass fungicide program and the standard FGS 8 fungicide program returned a profit. At $5.00 / bu the solo FGS 10.5.1 fungicide application returned a profit. The FGS 7 fungicide application alone did not return a profit at the prices assessed. These data demonstrate that Palisade use can be profitable in the absence of lodging when commodity prices increase over $.00 / bu. However, our net returns do not include potential losses from lodging, as none was observed in these studies. In cases where lodging occurs, Palisade use may provide additional yield benefits and therefore increase overall returns. Situations where this may occur include settings where poultry manure or other manure is spread heavily, tall varieties with susceptibility to LBC are used, and with fields or a history of lodging issues.

Table 3. Net returns for the various chemical programs used in this study

Treatment	timing	Application cost (total)	$3.00	$4.00	$5.00	$6.00
Palisade only	FGS 7*	$19.15	$2.69	$9.98	$17.26	$24.54
Quilt Excel	FGS 7	$29.00	-$19.08	-$15.77	-$12.46	-$9.15
Quilt Excel + Prosaro	FGS 7 + FGS 10.5.1	$50.70	-$3.34	$12.45	$28.23	$44.02
Prosaro	FGS 10.5.1	$40.85	-$13.11	-$3.86	$5.39	$14.64
Quilt Excel	FFGS 8/9	$37.50	-$1.52	$10.47	$22.46	$34.45

.

Wheat (*Triticum aestivum* Southern States ‘SS8500’)
Tan Spot; *Pyrenophora tritici-repentis*
Stagonospora leaf blotch; *Stagonospora nodorum*

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Effect of foliar fungicides and timings on leaf blotch complex on wheat in Delaware, 2016.

The trial was conducted at the Carvel Research and Education Center near Delaware, DE. The wheat variety SS8500 was planted at 1.8 x 10^6 seeds per acre on 6 Oct 16 in rows 7.5-in apart. The previous crop was corn, vertically tilled before planting. Experimental units were 5 x 23 ft. There were two untreated buffer rows between adjacent plots and 7-ft of untreated wheat at plot ends. Nitrogen (UAN) was applied at 40 lb/A on 11 Mar and 9 Apr. Standard weed and insect management procedures were followed. The experimental design was a spatially balanced randomized complete block with 4 replications. Fungicide applications were applied with a CO_2 pressurized backpack sprayer with four Teejet 8002 flat fan nozzles spaced 18-in apart on an offset handheld boom. Applications were made at 35 psi at a pace to deliver 20 gal/A of spray solution. Treatments were applied at 17 Mar, 18 Apr, and 14 May at Feekes’ growth stage (FGS) 5; FGS 8; and FGS 10.5.1. Disease evaluations were conducted on 6 Jun at FGS 11.2 on the flag leaf. All disease evaluations were made on 10 randomly selected leaves per plot by visually estimating the percent of diseased leaf area. Plots were harvested on 2 Jul. Data were analyzed by ANOVA, and Fisher’s LSD at $P \leq 0.05$ was calculated for mean comparisons. Yields were calculated based on a 60 lb bushel weight and adjusted to 13.5% moisture.

Leaf blotch complex (LBC) was not detected on flag leaves until FGS 11. Light, unratable stripe rust was also detected at this time. All treatments except Aproach Prima (FGS 8) and Stratego YLD (FGS 8) significantly reduced LBC relative to controls. All Prosaro treatments reduced LBC to the greatest degree, likely due to LBC not reaching the flag leaf until after flowering. Test weights were improved when compared to controls in all treatments; however, test weights were the greatest in all Prosaro treatments as well as Aproach Prima and Trivapro treatments. Yields were increased with all fungicide treatments relative to controls. No phytotoxicity was observed.

Treatment[z], Formulation,	Rate (oz/A)	Application stage (FGS)[w]	LBC[v] (%)	Test Weight (lb/bu)	Yield (bu/A)
Untreated control	--	--	7.0 a[x]	45.5 d	60.8 b
Aproach Prima	3.4	8	5.9 ab	52.1 ab	68.7 a
Trivapro	10.5	8	4.0 c	52.3 ab	72.5 a
Tilt FB[y] Trivapro	4 FB 10.5	5 FB8	4.9 bc	51.8 bc	71.1 a
Stratego YLD	4	8	5.7 abc	51.2 c	68.3 a
Prosaro421 SC	6.5	10.5.1	0.8 d	52.7 a	68.8 a
Quilt Excel FB Prosaro	7 FB 6.5	5 FB 10.5.1	0.4 d	52.8 a	71.9 a
Tilt FB Prosaro	3 FB 6.5	5 FB 10.5.1	0.7 d	52.8 a	71.0 a
Stratego YLD FB Prosaro	4 FB 6.5	5 FB 10.5.1	0.6 d	52.6 a	69.7 a
		P(F)	<0.0001	<0.0001	<0.001

[z] All products applied with NIS 0.125% (v/v)
[y] FB = followed by
[x] Column numbers followed by the same letter are not significantly different at *P*=0.05 as determined by Fisher’s LSD.
[W] FGS = Feekes’ Growth Stage
[V] LBC = Leaf Blotch Complex – Stagonospora leaf blotch and Tan Spot

Wheat (*Triticum aestivum* Southern States 'SS8500')
Tan Spot; *Pyrenophora tritici-repentis*
Stagonospora leaf blotch; *Stagonospora nodorum*

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Effect of foliar fungicides and timings on leaf blotch complex on wheat in Maryland, 2016.

The trial was conducted at the Wye Research and Education Center near Queenstown, MD. The wheat variety SS8500 was planted at 1.8 x 10^6 seeds per acre on 6 Oct 16 in rows 7.5-in apart. The previous crop was corn, vertically tilled before planting. Experimental units were 5 x 23 ft. There were two untreated buffer rows between adjacent plots and 7-ft of untreated wheat at plot ends. Nitrogen (UAN) was applied at 40 lb/A on 12 Mar and 11 Apr. Standard weed and insect management procedures were followed. The experimental design was a spatially balanced randomized complete block with 4 replications. Fungicide applications were applied with a CO_2 pressurized backpack sprayer with three Teejet 8002 flat fan nozzles spaced 20-in apart on an offset handheld boom. Applications were made at 35 psi at a pace to deliver 20 gal/A of spray solution. Treatments were applied at 23 Mar, 18 Apr, and 17 May at Feekes' growth stage (FGS) 5; FGS 8; and FGS 10.5.1. Disease evaluations were conducted on 6 Jun at FGS 11.2 on the flag leaf. All disease evaluations were made on 10 randomly selected leaves per plot by visually estimating the percent of diseased leaf area. Plots were harvested on 2 Jul. Data were analyzed by ANOVA, and Fisher's LSD at $P \leq 0.05$ was calculated for mean comparisons. Yields were calculated based on a 60 lb bushel weight and adjusted to 13.5% moisture.

Low levels of powdery mildew and tan spot were detected in control plots on 17 Apr, but this did not persist through FGS 8. All treatments except Tilt (FGS 5) and Twinline (FGS 8) significantly reduced LBC on flag leaves relative to controls. Overall, treatments applied at FGS 10.5.1 reduced LBC to the greatest degree. Test weights were improved compared to controls for all treatments applied at FGS 8 or FGS 10.5.1. FGS 10.5.1 treatments resulted in the greatest test weights. Yields were significantly greater in all treatments with a fungicide applied at FGS 10.5.1 compared to controls. No phytotoxicity or formulation issues were detected in this study.

Treatment[z], Formulation,	Rate (oz/A)	Application stage (FGS)[w]	LBC[v] (%)		Test Weight (lb/bu)		Yield (bu/A)	
Untreated control	--	--	7.3	a[x]	45.9	c	56.4	de
Tilt 3.6 EC	4	5	6.9	a	47.2	bc	58.8	cd
Quilt Xcel 2.2 SE	7	5	3.9	bc	45.9	c	59.8	bcd
Twinline 210 EC	6	8	5.9	ab	48.1	b	58.7	cd
Quilt Xcel 2.2 SE	10.5	8	3.0	bcd	46.7	bc	61.1	bcd
Quilt Xcel FB[y] Quilt Xcel	7 FB 10.5	5 FB 8	2.4	cd	47.2	bc	59.9	bcd
Tilt	4	8	3.1	bcd	48.0	bc	54.6	e
Prosaro 421 SC	6.5	10.5.1	0.3	d	51.8	a	63.4	ab
Caramba 90 EC	13.5	10.5.1	1.4	cd	51.3	a	65.1	a
Quilt Xcel FB Prosaro	10.5 FB 6.5	5 FB 10.5.1	0.3	d	51.3	a	63.4	ab
		P(F)	<0.0001		<0.0001		0.003	

[z] All products applied with NIS 0.125% (v/v)
[y] FB = followed by
[x] Column numbers followed by the same letter are not significantly different at *P*=0.05 as determined by Fisher's LSD.
[W] FGS = Feekes' Growth Stage
[V] LBC = Leaf Blotch Complex – Stagonospora leaf blotch and Tan Spot

Wheat (*Triticum aestivum* Dynagro'Shirley')
Stripe Rust: *Puccinia striiformis*

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Effect of foliar fungicides and timings on stripe rust in Delaware, 2016

The trial was conducted at the Carvel Research and Education Center near Georgetown, DE. . The wheat variety SS8500 was planted at 1.8 x 10^6 seeds per acre on 6 Oct 16 in rows 7.5-in apart. The previous crop was corn, vertically tilled before planting. Experimental units were 5 x 23 ft. There were two untreated buffer rows between adjacent plots and 7-ft of untreated wheat at plot ends. Nitrogen (UAN) was applied at 40 lb/A on 12 Mar and 11 Apr. Standard weed and insect management procedures were followed. The experimental design was a spatially balanced randomized complete block with 4 replications. Fungicide applications were applied with a CO_2 pressurized backpack sprayer with three Teejet 8002 flat fan nozzles spaced 20-in apart on an offset handheld boom. Applications were made at 35 psi at a pace to deliver 20 gal/A of spray solution. Treatments were applied at 23 Mar, 18 Apr, and 17 May at Feekes' growth stage (FGS) 5; FGS 8; and FGS 10.5.1. Disease evaluations were conducted on 6 Jun at FGS 11.2 on the flag leaf. All disease evaluations were made on 10 randomly selected leaves per plot by visually estimating the percent of diseased leaf area. Plots were harvested on 2 Jul. Data were analyzed by ANOVA, and Fisher's LSD at $P \leq 0.05$ was calculated for mean comparisons. Yields were calculated based on a 60 lb bushel weight and adjusted to 13.5% moisture.

Stripe rust began to develop shortly before heading in this trial. All fungicides and timings significantly reduced stripe rust relative to the untreated controls. All treatments increased test weights, but those including a treatment at FGS 10.5.1 were significantly higher than those applied at FGS 8 alone. All treatments significantly increased yields compared to untreated controls. However, yields were greatest in including either Trivapro or Priaxor applied at flag leaf, and either Trivapro, Aproach Prima, or Priaxor applied at flag leaf followed by Prosaro at FGS 10.5.1. No phytotoxicity or formulation issues were detected in this study.

Treatment	Timing	Stripe Rust		TWT		Yield	
control	…	**7.4**	**a**	**47.4**	**e**	**67.5**	**e**
Trivapro	Flag leaf	0.0	b	50.2	d	84.3	bc
Aproach Prima	Flag leaf	0.3	b	50.2	d	82.5	cd
Priaxor	Flag leaf	0.1	b	51.3	bc	86.7	ab
Prosaro	Flag leaf	0.1	b	49.8	d	81.0	cd
Trivapro FB Prosaro	Flag + Flower	0.0	b	52.3	a	88.1	ab
AP FB Prosaro	Flag + Flower	0.0	b	52.1	ab	89.0	a
Priaxor FB Prosaro	Flag + Flower	0.0	b	52.7	a	89.3	a
Prosaro	Flower	1.3	b	51.2	c	80.3	d

2016 Delaware Wheat Variety Trial Disease Ratings.

Additional information is posted at http://extension.udel.edu/ag/field-crop-resources/variety-trials-corn-hybrids-small-grains-soybeans/

Variety	Stripe rust	Powdery Mildew
VAW11-106 VaTech/VCIA	1.8	1.7
Hilliard VaTech/VCIA	0.0	1.2
MBX 14-K-297 Mercer	1.1	3.4
MBX 14-S-210 Mercer	0.3	0.9
MBX11-V-258 Mercer	0.0	1.4
MBX 15-E-229 Mercer	2.8	0.7
MBX 16-A-206 ****** Mercer	3.3	3.2
MBX16-B-203 Mercer	4.8	3.7
USG 3523 USG	0.3	2.7
USG 3404 USG	0.0	1.2
USG 3316 USG	2.3	3.9
USG 3895 USG	2.2	2.2
USG 3197 USG	0.0	2.6
USG 3201 USG	0.0	2.4
9223 Dyna -Gro	3.1	3.7
9552 Dyna -Gro	2.3	3.4
9522 Dyna -Gro	3.3	2.2
Shirley Dyna -Gro	4.6	1.7
9692 Dyna -Gro	0.0	3.9
WX15742 Dyna -Gro	0.6	1.9
FS 860 Grow Mark	0.6	2.2
FS 865 Grow Mark	0.0	4.9
FSX 870 Grow Mark	0.1	1.4
FSX 871 Grow Mark	0.6	3.4
FSX 872 Grow Mark	0.0	1.7
415 Agri-Maxx	4.3	2.4
444 Agri-Maxx	2.8	2.4
446 Agri-Maxx	0.0	3.2
454 Agri-Maxx	0.0	4.2
462 Agri-Maxx	2.3	2.4
Exp 1674 Agri-Maxx	0.0	1.7
15MW315 University of MD EXP	0.0	3.4
FS 850 Grow Mark	1.8	2.4
FS854 Grow Mark	0.0	2.2
SS-8360 Southern States	1.0	2.9
SS-8340 Southern States	0.0	2.7
SS-8513 Southern States	0.1	1.7
SS-8415 Southern States	0.6	1.4
SS-8530 Southern States	0.3	0.9

Scale 0-5 where 0 = no disease and 5 = heavy disease.

2016 Fusarium Head Blight Screening Nursery Results

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Overview

The misted nursery is a tool used to assess variety response to Fusarium head blight (FHB). The most significant losses due to FHB occur when flowering heads are infected with spores of the FHB pathogen, resulting in yield loss and probable elevation in vomitoxin (DON). Flowering occurs at different times in different varieties. Consequently, varieties may not be at a highly susceptible stage in development when environmental conditions favoring FHB infections occur (Figure 1). In addition, some seasons, conditions for FHB may not be favorable, resulting in little FHB and DON. The misted nursery helps to avoid these issues by prolonging the conditions that may be favorable for FHB infection, reducing the chance that varieties will escape infection due to sub-optimal environmental conditions and promoting disease development. In addition, because many companies provide ratings based only on their own standards, the misted nursery allows for head to head comparison of FHB responses across seed sources. The misted nursery data presented here should be used, in combination with data from the Virginia Tech Misted Wheat Nursery, to help guide growers in selecting high-yielding wheat varieties with moderate resistance to FHB and in particular, DON.

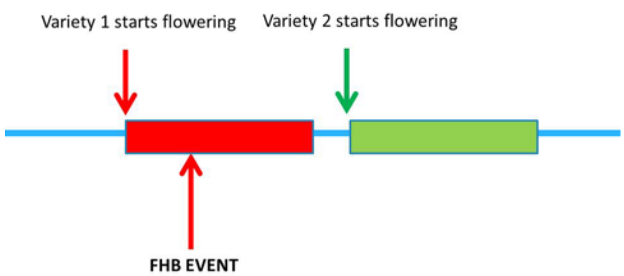

Figure 1. Varieties of wheat can vary significantly in maturity and flowering date. If natural conditions were used to assess FHB response, some varieties may escape disease, appearing to be moderately resistant, because they were not at the appropriate developmental stage when the FHB outbreak occurred. In addition, if conditions were not favorable for FHB during the growing season, little to no FHB may be observed.

Methods

The misted nursery was planted at Beltsville, MD, in a randomized complete block design with three replications. Entries were evaluated in 7-row plots that were trimmed to 5-feet in length prior to inoculation. A seeding rate of two million live seed per acre was used. Recommended fertility and pest control measures were be followed in the establishment and management of the tests. The field was artificially inoculated with corn kernels infested with aggressive *F. graminearum* isolated from infected wheat grain when plants reached approximately FGS 9. To increase infection by *F. graminearum* spores the field was misted for two, 20-minute intervals every night, with the intervals spaced 100 minutes apart, from inoculation until seven days before harvest. Plots were visually rated for symptoms of FHB approximately 21 days after flowering. Plots were harvested and samples were sent to the UMN wheat lab for assessment of DON.

Results

Table 1. DON, incidence (heads with any FHB symptoms), severity (amount of head with symptoms), and index (overall amount of plot with symptoms) for the 2016 wheat misted nursery trial located in Beltsville, MD. **Green = DON levels statistically similar to MR standard Jamestown. Dark green = reduced DON by >45% compared to MS/S standard, Shirley.**

Variety	DON (ppm)	Incidence (%)	Severity (%)	Index
MBX 15-E-229	7.9	36.0	14.1	5.1
MAS#67	8.9	34.7	19.0	7.0
FS 860	8.9	41.3	19.5	7.9
MAS#66	10.7	52.0	25.6	12.8
USG 3197	12.3	38.7	16.9	7.0
SW 59SR	12.5	37.3	23.8	8.6
FSX 871	12.6	29.3	23.3	7.4
JAMESTOWN	**13.2**	**54.7**	**36.4**	**20.5**
L 11941	14.2	45.3	15.1	7.0
SS8530	14.5	26.7	25.4	6.5
SY VIPER	14.9	62.7	25.9	15.5
SSEXP 8550	16.5	52.0	15.9	8.8
15 MDX 19	16.6	45.3	21.5	10.4
15 MDX 20	16.9	36.0	23.1	8.3
15 MW 134	17.4	48.0	14.1	6.7
SY 007	17.5	56.0	22.8	13.8
P 25R50	17.6	45.3	22.6	10.2
15 MW 133	17.7	48.0	20.3	9.9
USG 3201	18.0	48.0	18.2	8.7
SS8340	19.7	41.3	17.9	7.3
DG 9223	20.7	53.3	25.4	13.7
MBX 14-S-210	20.7	57.3	28.7	16.6
DG 9522	20.9	62.7	20.0	13.1
FSX 870	21.0	64.0	25.6	16.4
FS 854	21.1	52.0	21.3	11.2
15 MW 315	21.1	48.0	27.4	12.8
L 3677	21.4	77.3	31.5	24.4
USG 3316	21.9	46.7	25.1	12.8
USG 3523	21.9	49.3	19.0	9.6
SS8513	22.5	48.0	34.4	17.7
MBX 16-B-203	22.7	68.0	28.2	18.5
USG 3404	22.9	54.7	22.8	13.1
USG 3013	23.4	49.3	19.5	9.8
MAS#6	24.9	56.0	27.2	16.1
15 MW 64-134	25.0	60.0	38.2	23.2
FSX 872	25.1	60.0	36.2	22.2
WX 16771	25.9	38.7	21.8	8.6
DG SHIRLEY	**26.4**	**57.3**	**37.4**	**21.5**

DG 9692	26.6	53.3	18.2	10.3
MBX 14-K-297	26.7	68.0	21.3	14.5
HILLIARD	26.8	70.7	30.8	21.6
SW 63SR	26.9	62.7	24.9	15.9
MAS#7	27.4	64.0	25.9	16.6
MBX 11-V-258	28.0	64.0	31.3	20.5
VA12W-72	29.2	57.3	22.1	13.0
USG 3895	29.8	77.3	29.7	23.3
FS 865	31.1	62.7	21.5	13.4
SY 547	31.5	42.7	22.6	9.6
USG 3251	31.8	65.3	27.7	18.0
MBX 16-A-206	33.1	80.0	25.4	20.3
SS8360	33.6	58.7	30.8	18.6
SS8415	48.9	80.0	51.5	40.9
MAS#425	50.5	72.0	21.5	15.6
DG 9552	53.8	77.3	28.5	22.0
FS 850	57.4	89.3	53.3	47.7
P 25R40	**60.6**	**68.0**	**36.9**	**25.0**
SY 483	97.2	69.3	39.0	29.0

Discussion

Growers should use this misted nursery data as a tool for selecting wheat varieties, but should understand that multiple sources of misted nursery results will provide more confidence in variety response. Growers should compare these responses with those available from other misted nurseries, which can be located at the scabsmart variety webpage: http://scabsmart.org/soft_red_winter_wheat_southern_region. Ultimately, continued use of a misted nursery in our region will allow for multi-year assessment of varieties.

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Special thanks to Christopher Ramage, Aaron Cooper, Louis Thorne, Alyssa Mills, Andy Kness, and Jake Jones for assistance with this project.

Corn

Corn yields averaged 170 and 152 bu/A in Delaware and Maryland, respectively on 170,000 (DE) and 460,000 (MD) acres. Weather resulted in delayed planting in some areas and consequently, lower yields than typical. Seedling disease caused minimal losses of stand in most fields, but Pythium was detected in several instances. Foliar diseases were low to moderate in many areas. Dry conditions around grain fill facilitated stalk rot issues from Fusarium stalk rot and Charcoal rot, although no major issues with lodging were reported. Ear rots were present to a minor degree and were composed predominantly by Fusarium ear rots.

CORN (*Zea mays*) 'Dynagro D49VC88'
Northern corn leaf blight; *Exserohilium turcicum*
Gray leaf spot; *Cercospora zeae-maydis*

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Evaluation of foliar fungicides for management of foliar diseases of field corn in Georgetown Delaware, 2016.

The experiment was conducted at the University of Delaware's Carvel Research and Education Center, Thurmond Adams Research Farm in Georgetown, Delaware. The experiment consisted of 12 fungicide treatments and an untreated control arranged in a spatially balanced, randomized complete block design with four replications. Plots consisted of 4 rows spaced 30 in. apart and 30 ft. in length. The two inner rows were used as treatment rows, and the two outer rows were used as a buffer between adjacent treatments. The plots were seeded into minimally tilled corn residue on 20 Apr at a population of 32,000 plants/A. Plots were managed for nutrients and weeds according to Delaware extension guidelines. Fungicides were applied to the center two rows at V5 on 2 June with a CO_2 backpack sprayer that delivered 10 gpa at 35 psi. The sprayer was equipped with a 6 ft. boom with TeeJet® 80V01 nozzles spaced 18 inches apart. Fungicides were also applied at VT on 15 Jul using a back sprayer fitted with a telescoping boom with specifications identical to those previously described. Eight leaves were arbitrarily selected from the inner two rows per plot and rated for percent disease on the leaf immediately below the ear leaf (Ear -1) on 9 Aug (R3) and the ear leaf on 20 Aug (R5). Plots were trimmed to 25 feet in length and the inner two rows harvested on 15 Sep using a small plot combine. Yields were adjusted to 15% moisture. Data were analyzed to ensure normality and statistically analyzed using the a random effects mixed model (JMP v12). Following significant ANOVA, means were separated using Fisher's LSD (α=0.05)

The season was dry prior to VT and uncharacteristically hot throughout the growing season. The main diseases detected were grey leaf spot and northern corn leaf blight, with the majority of lesions belonging to the former. No effects of treatments were detected for Ear-1 ratings, test weight (TWT), or yield. However, a significant treatment effect was detected for disease severity on the ear leaf. Quilt Excel (V5) FB Trivapro (VT), Trivapro (VT), and Headline AMP (VT) provided the greatest reduction of foliar disease. Fungicides applied at V5 had no impacts on disease severity. Overall levels of disease were low, with controls only containing approximately 2% severity at R5.

Treatment and rate/acre (crop growth stage at application)	Disease severity ear -1 (%)[z]	Disease severity Ear (%)	Yield (bu/a)	TWT (lbs/bu)
Untreated control	1.00	2.06 a	204.00	54.08
Trivapro SC 13.7 fl oz (V5)	0.90	1.65 abcd	194.76	53.78
Quilt Xcel 2.2 SE 10.5 fl oz FB[y] Trivapro 13.7 fl oz	0.79	0.92 e	219.17	53.98
Trivapro SC 13.7 fl oz (VT)	0.65	1.00 e	215.86	54.10
Priaxor 4.17 SC 4 fl oz (V5)	0.75	1.77 ab	215.82	54.45
Headline AMP1.68 SC 10 fl oz (VT)	0.58	0.90 e	203.02	53.93
Priaxor 4 fl oz (V5) FB Headline AMP 10 fl oz (VT)	0.65	1.10 cde	213.04	53.95
Aproach 2.08 SC 3 fl oz (V5)	0.90	1.67 abc	197.16	54.05
Aproach Prima 2.34 SC 6.8 fl oz (VT)	0.69	1.17 cde	211.09	54.03
Aproach 3 fl oz (V5) FB Aproach Prima 6.8 fl oz (VT)	0.75	1.38 bcde	211.60	53.80
Stratego YLD 4.18 SC 2 fl oz (V5)	0.73	1.40 bcde	203.80	54.23
Stratego YLD 4.0 fl oz (VT)	0.90	1.29 bcde	224.76	54.05
Stratego YLD 2.0 fl oz (V5) FB Stratego YLD 4.0 fl oz (VT)	0.65	1.06 de	219.04	54.08
P(*F*)	0.53	<0.001	0.45	0.57

[z] Means within a column followed by the same letter are not significantly different according Fisher's Protected LSD test (α=0.05).
[y] FB = followed by.

CORN (*Zea mays*) 'Dynagro D49VC88'
Northern corn leaf blight; *Exserohilium turcicum*
Gray leaf spot; *Cercospora zeae-maydis*

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Evaluation of foliar fungicides for management of foliar diseases of field corn in Middletown Delaware, 2016.

The experiment was conducted at the University of Delaware's Research and Demonstration field located in Middletown, DE. The experiment consisted of 8 fungicide treatments and an untreated control arranged in a spatially balanced, randomized complete block design with five replications. Plots consisted of 4 rows spaced 30 in. apart and 30 ft. in length. The two inner rows were used as treatment rows, and the two outer rows were used as a buffer between adjacent treatments. The plots were seeded into minimally tilled corn residue on 22 Apr at a population of 32,000 plants/A. Plots were managed for nutrients and weeds according to Delaware extension guidelines. Fungicides were applied to the center two rows at VT on 23 July with a telescoping CO_2 backpack sprayer that delivered 10 gpa at 35 psi. The sprayer was equipped with a 6 ft. boom with TeeJet® 80V01 nozzles spaced 18 inches apart. Eight leaves were arbitrarily selected from the inner two rows per plot and rated for percent disease on the leaf immediately below the ear leaf (Ear -2) on 9 Aug (R3) and the ear leaf on 10 Sep (R6). Percent plot greenness was also rated on 10 Sep. Plots were trimmed to 25 feet in length and the inner two rows harvested on 15 Sep using a small plot combine. Yields were adjusted to 15% moisture. Data were analyzed to ensure normality and statistically analyzed using the a random effects mixed model (JMP v12). Following significant ANOVA, means were separated using Fisher's LSD (α=0.05)

The season was dry prior to VT and uncharacteristically hot throughout the growing season. The main diseases detected were grey leaf spot and northern corn leaf blight, with the majority of lesions belonging to the former. No effects of treatments were detected for any measured variables.

Treatment	Product	Timing	Rate (oz/A)	F-2	% green	TWT	Yield
a	untreated			1.17	55.16	55.07	169.31
b	Affiance	R1	10	0.83	49.95	55.23	169.44
c	Aproach Prima		6.8	0.94	46.13	55.14	171.08
d	Stratego YLD		4	1.35	56.50	54.93	165.60
e	Headline AMP		10	0.48	56.29	54.83	169.66
f	Priaxor		4	0.83	55.58	54.91	166.78
g	Quilt Excel		10.5	0.93	49.58	55.01	163.81
i	Aframe Plus		10.5	0.64	51.54	54.92	161.69
j	Fortix		4	1.04	46.54	55.20	169.66
			P(F)	0.12	0.54	0.98	0.97

Soybean

Soybean yields averaged 46 and 45 bu/A in DE and MD, respectively on 165,000 (DE) and 510,000 (MD) A. Planting dates were staggered this season due to persistent, wet weather early, resulting in some full season beans being planted at or near double cropped planting dates typical for the region. Predominant issues included Fusarium seedling diseases early on. Soybean cyst nematode, as usual, was the largest issue in soybean production. Root knot nematode was also observed at damaging levels in some soybean fields. Soybean vein necrosis disease was abundant and moderate in severity. Other viruses observed included soybean mosaic virus. Stem diseases including Diaporthe, charcoal rot, anthracnose, and brown stem rot were observed throughout the area. The most common foliar disease was Septoria brown spot. Frogeye leaf spot was largely absent. Phomopsis pod blight and Cercospora seed stain were found in several fields.

2016 Soybean Vein Necrosis Disease Survey

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Soybean Vein Necrosis Disease (SVND) is a relatively new viral disease affecting soybeans. The virus is transmitted by thrips, a small insect with piercing-sucking mouthparts. Immature thrips that feed on infected soybeans acquire the virus, and can transmit it the remainder of their lifetime. Our data indicate that cropping system and variety can impact viral symptoms, and that yield loss may occur in some variety x cropping system combinations. Over the past three seasons we have surveyed grower fields for symptoms of SVND to see when the disease occurs and if occurrence may be more severe at some points in time or cropping systems. This season, in addition to assessing SVNV, we assessed the thrips population to see what species of thrips occur on Delaware soybeans and where they can be found most often on the plant in different growth stages and cropping systems of soybeans. These data will help us better understand SVNV and its potential to impact soybeans in DE. We would like to thank you for allowing us to survey your fields and for participating in the survey.

Results

In 2016 a total of 23 soybean fields (11 double crop, 12 full season) were surveyed twice during the growing season. Full season was surveyed on 7/18-19 and again on 8/3-4, whereas double crop fields were surveyed on 8/12 and 8/25. For each field, twenty sites were randomly selected and a single plant assessed for the presence of SVND. At each site, a fully expanded trifoliate and, if present, a flower in the upper 1/3 of the canopy were sampled for thrips. SVNV samples were sent for confirmation of virus, whereas thrips samples were purified and individual thrips for each sample and part enumerated and identified to species. Data were statistically analyzed. Only significant results are presented here.

SVND was more severe in double crop soybeans than full season soybeans (Figure 1). Consistent with the past two seasons, SVND severity in double cropped soybeans sampled early were similar to full season soybeans sampled late (Figure 2). We speculate that this may result in a greater chance to observe yield impacts in double cropped soybeans, as the virus can spread and affect the crop more over time.

Figure 1. Foliar symptoms of SVND on a soybean leaf.

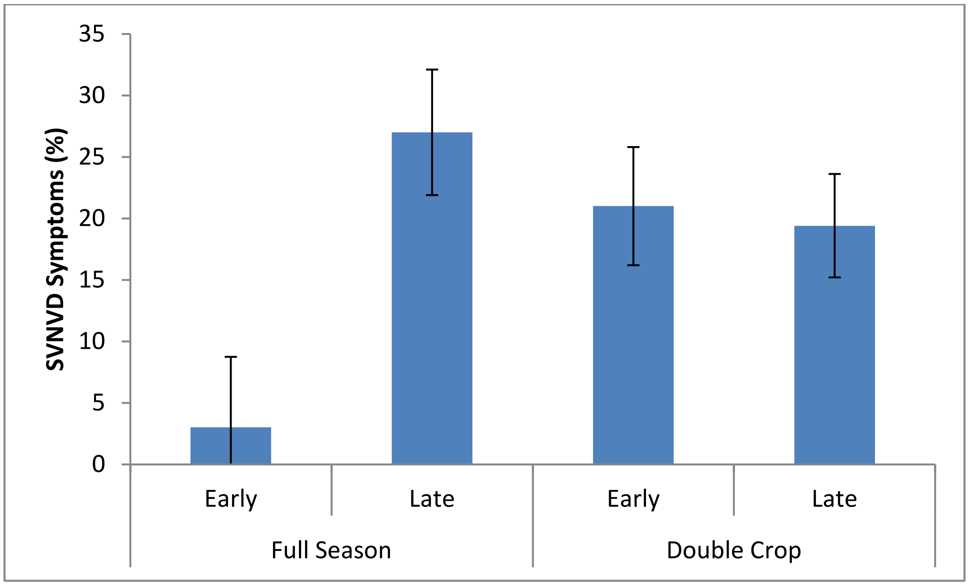

Figure 2. SVND severities for full season and double cropped beans as affected by sampling time. Early sampling dates targeted vegetative to early flowering periods (V4-R1), whereas late sampling dates targeted reproductive growth stages (R3-R5).

Consistent with SVND severity, thrips abundances were greater in double cropped soybeans than full season soybeans (Figure 3). Four species of thrips were detected including Soybean thrips, Western flower thrips, Eastern flower thrips, and Tobacco thrips (Figure 4). Research has shown the Soybean thrips and Western flower thrips can transmit the virus causing SVND.

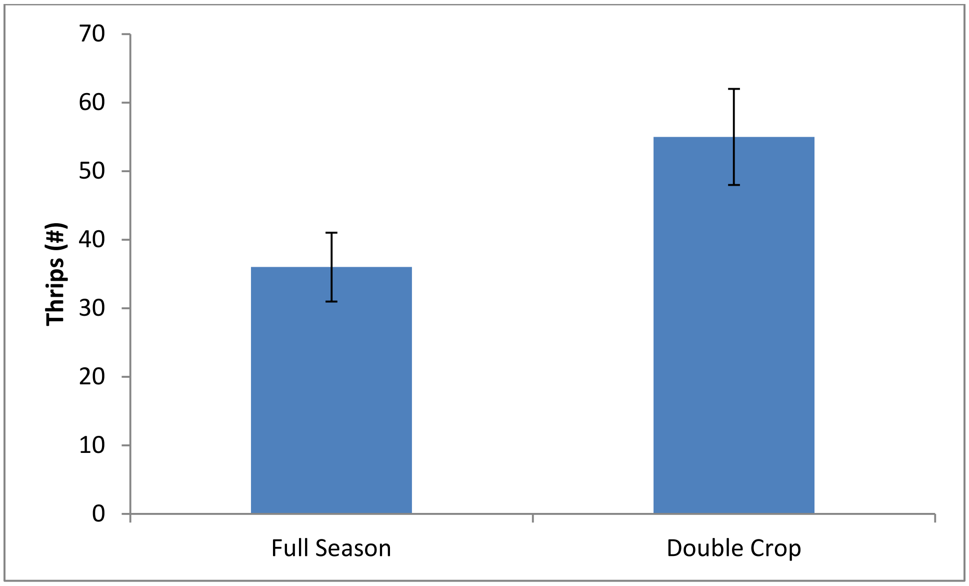

Figure 3. The average number of thrips found per field in full season and double cropped soybeans in Delaware, 2016.

Figure 4. An example of soybean thrips and thrips damage on a soybean leaf (image obtained from www.purdue.edu).

Both Soybean thrips and Western flower thrips abundancies differed with cropping system and plant part. Soybean thrips were more abundant in double cropped soybeans when compared to full season soybeans (Figure 5). Plants sampled early had more Soybean thrips in flowers as compared to on leaves. In late samples, the opposite was observed (Figure 6).

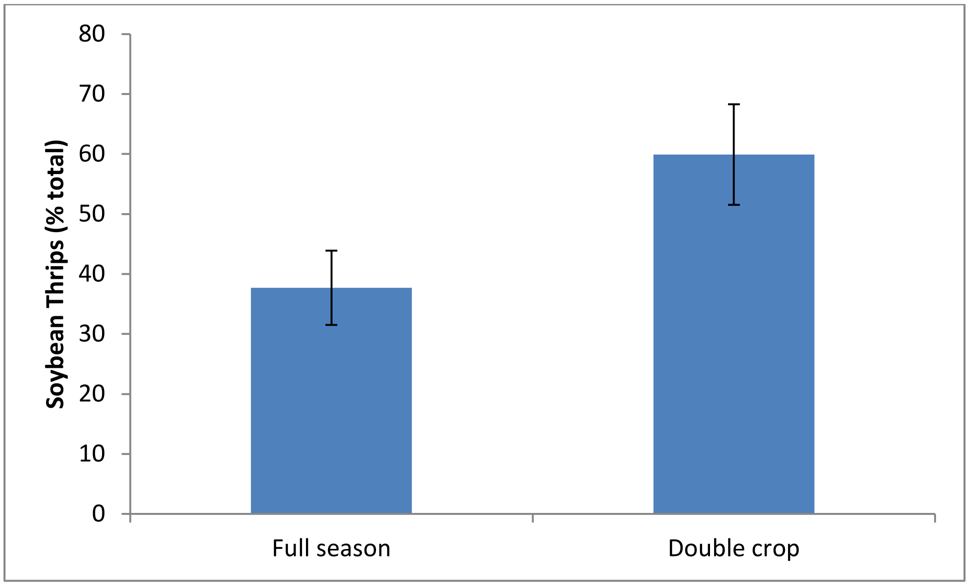

Figure 5. Average percentage of thrips that were Soybean thrips in full season soybeans surveyed in Delaware, 2016.

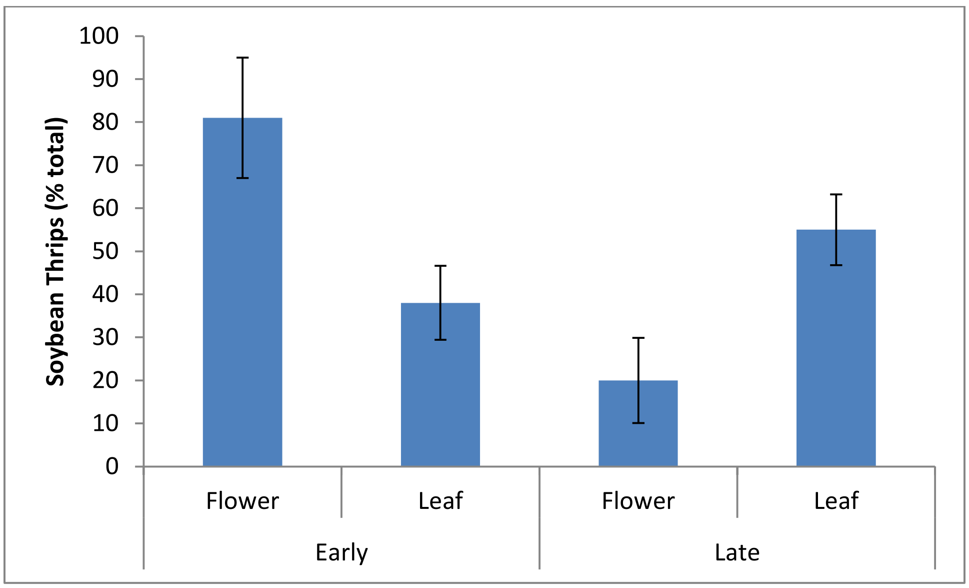

Figure 6. Average percentage of thrips that were Soybean thrips as affected by survey timing and plant part for soybeans surveyed in Delaware, 2016.

Western flower thrips were more abundant in full season beans surveyed late in the season, but were not commonly observed in double crop systems (Figure 7). In full season fields, more Western flower thrips were found in flowers as compared to the foliage in full season plants (Figure 8).

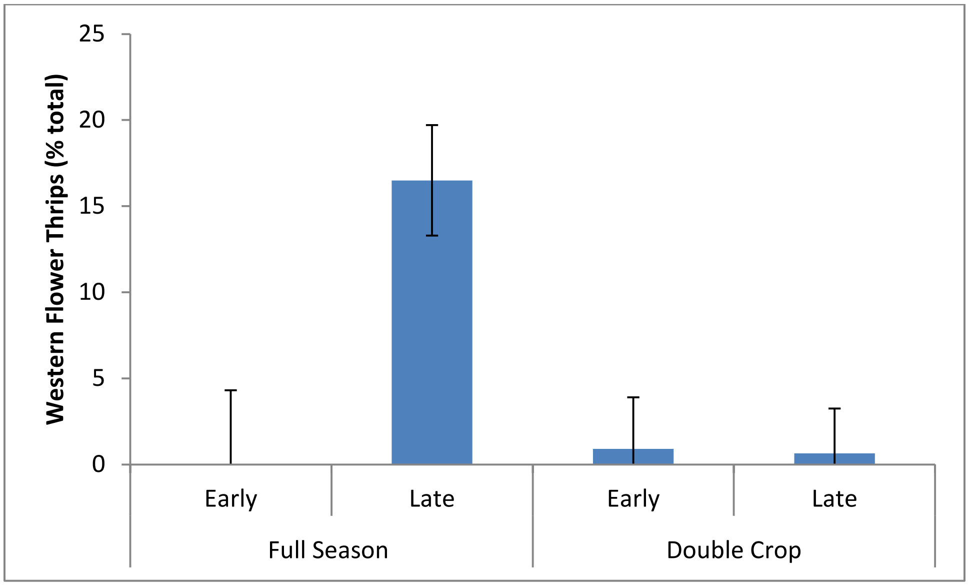

Figure 7. Percentage of total thrips that were Western flower thrips as affected by cropping system and survey timing for soybeans in Delaware, 2016.

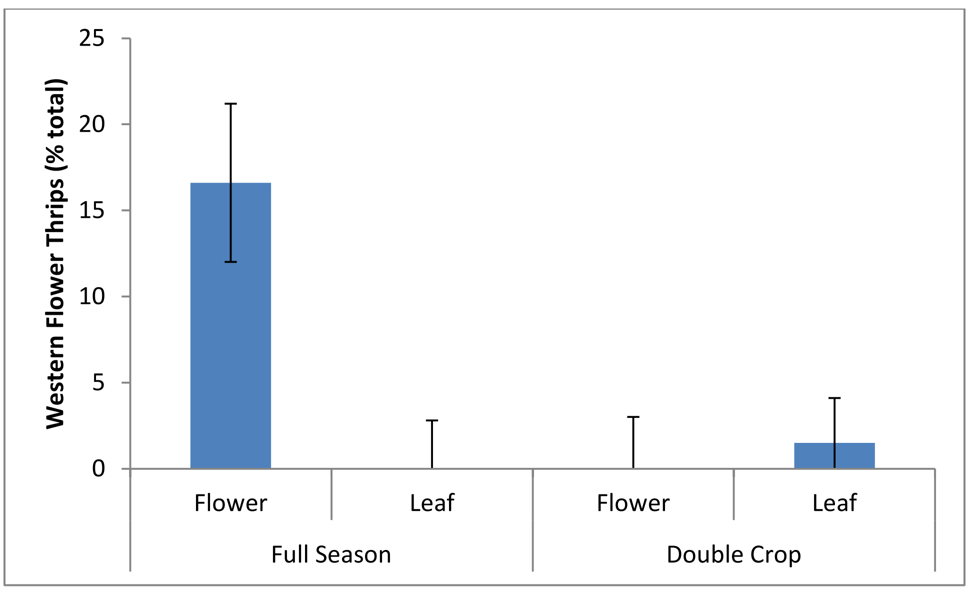

Figure 8. Percentage of total thrips that were Western flower thrips as affected by cropping system and plant part for soybeans in Delaware, 2016.

Summary

SVND occurs often in Delaware soybean fields. In full season fields, symptoms develop late in the growing season, often after pod set, whereas symptoms can develop earlier in double cropped soybeans. This is likely a function of thrips population dynamics during the growing season. We found four species of thrips in Delaware soybean fields, two of which are known to vector the virus causing SVND. Soybean thrips were the most common, and were found at higher abundances in double cropped fields than full season fields, tracking symptoms of disease. Western flower thrips were more common late in the season in full season fields but were relatively uncommon in double cropped fields. More soybean thrips were found in flowers during the early survey periods than those occurring later in the season. Thus, these thrips may remain protected from foliar applications of contact insecticides which may be aimed at suppressing these insects. In addition, systemic insecticides may not accumulate to a significant degree in flower tissues and therefore not reduce populations to a degree sufficient to reduce thrips populations. Research from Delaware indicates that, in addition to cropping system, variety plays a significant role in SVND effects and symptomology. It is likely that, if SVND becomes a consistent, yield-limiting issue, that variety selection will be a cost effective means for managing this disease. Additional research is needed to better understand this disease and its impacts on soybeans grown in the region.

Examining the capacity for *P. capcisi* to spread through Soybean
Final Report

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Summary

Issues with the oomycete pathogen *Phytophthora capcisi* have spread throughout the Midatlantic. *P. capcisi* is an aggressive, soil-borne pathogen of several crops grown in Delaware including cucurbits and lima beans, and many other vegetable crops. *P. capcisi* originates from the soil, infesting fruits in contact with the soil or leaf the soil surface. Crop losses occur due reduction in yield and fruit quality. *P. capcisi* is a difficult pathogen to manage due to lack of host resistance, its wide host range, and the persistence of the pathogen in soils. Current recommendations for growers with *P. capsici* issues include rotation away from vegetables to agronomic crops for at least two seasons. Planting into cover crop rye would be an additional recommendation for pumpkin growers, as the residue may provide a soil barrier that can reduce disease incidence. In late 2015 a vegetable grower in Kent Co, DE expressed concern about *P. capcisi* in his pumpkin crop. The grower had heard that soybeans may host the pathogen and was considering removing soybeans from his production system. A review of the literature indicated that Mary Hausbeck, from Michigan State, showed that *P. capcisi* can cause foliar symptoms on soybean foliage inoculated in the greenhouse. However, there are no data on this pathogen in soybean production fields in the literature. Due to the extended acreage of soybeans planted in the United States, it is unlikely that *P. capcisi* causes losses in soybeans. However, if soybeans serve as a latent host of *P. capcisi* it may allow the organism to increase in abundance and potentially result in greater losses if vegetables are planted in subsequent seasons. Some growers have indicated that they have encountered severe *P. capcisi* issues in cucurbits or lima beans that had not had a "host" in the field for several years. We hypothesize that soybeans may play a role in this observation.

In order to address the growers concerns, soybeans were sampled from fields planted to pumpkins the previous year. These fields had a history of *P. capsici* issues. PCR primers specific to *P. capsici* were used, and DNA extracted. Initial results indicate the presence of *P. capsici* in soybean residue. However, no living *P. capsici* could be recovered from tissues. To determine if *P. capsici* can infect living soybeans, a rapid, unreplicated greenhouse study was conducted, whereby soybeans grown in pots were challenged with a large amount of *P. capsici* mycelium and inoculum. We observed seedling death in plants exposed to these extremely high levels of inoculum. In plants that did not express symptoms, we detected *P. capsici* from asymptomatic stems through PCR, but again, no *P. capsici* was recovered from tissues. Thus, we have some evidence that soybeans may host *P. capsic*i, but this is a fairly unrealistic situation. In nature, young soybeans are more likely to be infected by motile zoospores, which move through wet soils. Thus, we conducted multiple greenhouse studies examining the capacity for *P. capsici* to infect roots, and the effects on soybeans.

Progress:

Multiple sets of studies were conducted and replicated throughout late 2016 and early 2017. These studies assessed the potential for *P. capsici* zoospores to infect soybean of 1) different ages, and 2) different varieties. These experiments were set up to determine what effects, if any, this oomycete may have on soybean growth and health, and if it can colonize tissues, thereby potentially contributing to epidemics in vegetable crops.

We conducted two separate studies examining the impact of plant age and three examining the effects of variety on *P. capsici* infection of soybean. Briefly, isolates of the fungus were grown in petri plates under aseptic (extremely clean) conditions at our lab in Newark, DE. After 10-14 days, the plates were flooded with sterile water and motile zoospores were collected, counted, and used to treat seedlings. For these studies, a 50:50 (vol:vol) mix of sterile sand and soil (collected from the Carvel Research and Education Center) was placed into sterile centrifuge tubes. A single seed of Essex soybean was added to each tube, and the tubes lightly watered with sterile water and capped. For variety tests, Essex, Syngenta S-42-E5, and USG 74B42R were selected and all plants were planted on the same day.. After 5-6 days seedlings had emerged and were placed into a growth chamber delivering light on a 12 hour cycle and holding temperature at 70 F at 90% RH. A second set of plants were germinated at this point in time and grown in the same way as the first batch. The end result were two sets of seedlings, one set having a true leaf emerging from the plant, whereas the other set was just emerging from the soil. The seedlings were randomized and blocked. Six plants of each age group were either inoculated with a zoospore suspension or sterile water only. The seedlings grew for 10 days. After this time the plants were harvested, roots rated for necrosis, health, and plant masses and heights determined. Root samples were taken for each plant and plated onto semi selective media, which allows for the growth of Phytophthora species. Growth was subcultured and grown onto new media, and allowed to grow for 10-14 days. After this time, plates were assessed for the presence of sporangia (spore bearing structures) characteristic of *P. capsici*. Another portion of the root was processed for Polymerase Chain Reaction (PCR) and DNA of specific target sequences amplified and compared to known *P. capsici* for confirmation. Data were statistically analyzed using a one-way random effects mixed model with experiment and block as random effects and treatment as a fixed effect. Following significant F-tests, means were separated using Fisher's LSD ($\alpha = 0.05$).

Results:

Plant Age Studies:

The study was repeated twice. The first study had a zoospore yield of over 30,000 spores per milliliter, whereas the inoculum density for trial 2 was 3,000 spores per milliliter. This was due to a gradual decline in the ability of our *P. capsici* isolates to produce sporangia in culture over time. We attempted to revive these isolates on cucumbers, but were unsuccessful.

Analysis indicated significant experiment x treatment effects and therefore studies were analyzed and reported separately. Significant effects of treatment were detected for plant height, and weight in both studies and root necrosis in Trial 1 (Table 1). In both trials, emerged seedlings were shorter than older seedlings, as expected. Although not significant, plant heights were numerically greater in newly emerged seedlings treated with *P. capsici* compared to untreated controls (Table 1; Table 2). The same trend was noted for plant weights. We propose two potential explanations for this. Frist, the addition of *P. capsici* may have increased available nutrients, such as N and P, as some of the spores likely died, decomposed, and released nutrients. The amount of nutrients released would likely have been minute, and may not adequately explain an increase in height. However, because emerged plants likely contained smaller root systems at the time of inoculation, this may have resulted in fewer zoospores colonizing root tissues due to less colonisable tissue/surface area. Thus, the emerged seedlings may have had access to additional nutrients resulting from decaying fungal spores. A second potential explanation is that *P. capsici* may stimulate growth of emerged seedlings through some external stimulus. Similar effects have been demonstrated in endophytic fungi, bacteria, and other microorganisms in other plant systems. However, this explanation would not explain why no difference was observed in older seedlings, unless the response only is realized in newly emerged seedlings. For example, the fungus could promote a hormonal release needed to increase rapid growth which may not occur at later stages in plant development. We may have noted greater differences if the plants were allowed to grow for a longer period of time. Further studies would be required to examine this phenomenon further to see if it translates to differences in plant growth at later stages in plant growth. In Trial 1, *P. capsici* was recovered from 100% of the newly emerged, treated plant roots and 66% of the older plants with true leaves emerged at the time of inoculation. However, we did not recover any *P. capsici* from roots in trial 2. No *P. capsici* was recovered from untreated controls in either study, indicating no cross contamination. The lack of recovery of the pathogen in trial 2 may indicate that the inoculum level was too low to allow sufficient colonization and proliferation within root tissues during the amount of time the experiment was conducted. There was a high degree of variability in experiment 2 as well, indicating that the effectiveness of the inoculation may have been limited. Regardless, the data indicate that given sufficient inoculum, *P. capsici* can colonize soybean tissues in a controlled environment. Colonization may be facilitated after seedling emergence; although no impacts on plant health (i.e. death) was observed, as is typical for a damping off pathogen. In addition, no stem symptoms were observed as is characteristic for Phytophthora affecting soybeans.

Table 1. Treatment effects on height, weight, root necrosis, and *P. capsici* recovered from roots in age study 1, conducted on Essex soybeans. 6.5 ml of a 30,000 spore per ml solution were added to treated plants.

Trial 1: 30 k / ml		Height (cm)		Weight (g)		Root Necrosis (%)		*P capsici* (% total)
Untreated	Emerged	3.8	b	0.6	b	5.3	c	0
	True leaf	20.9	a	1.6	a	22.6	bc	0
Treated	Emerged	8	b	0.9	ab	6.2	c	100
	True leaf	20	a	1.7	a	53.3	a	66
	P value	**<0.0001**		**0.0247**		**0.0004**		

Different letters indicate significant differences at α = 0.05 using Fisher's LSD.

Table 2. Treatment effects on height, weight, root necrosis, and *P. capsici* recovered from roots in age study 2, conducted on Essex soybeans. 6.5 ml of a 3,000 spore per ml solution were added to treated plants.

Trial 2: 3 k / ml		Height (cm)		Weight (g)		Root Necrosis (%)		*P. capsici* (% total)
Untreated	Emerged	7.8	b	0.7	c	1.7	b	0
	True leaf	17	a	1.2	ab	13.3	ab	0
Treated	Emerged	10.5	b	0.9	bc	17.5	ab	0
	True leaf	18	a	1.5	a	24.2	a	0
	P value	**<0.0001**		**0.0014**		0.06		

Different letters indicate significant differences at α = 0.05 using Fisher's LSD.

Variety Studies:

This study was replicate three times. Inoculum density was fairly low (3,000-4,000 spores per ml) for the reasons previously explained. Analysis indicated no significant interaction between treatment and experiment, and therefore all data were analyzed across studies. In both studies a low yield of spores was obtained (3,000-4,000 spores per ml). However, even at this rate, plants still received roughly 19,000 spores per plant. There were significant effects of variety on plant height; however, these differences were largely the result of variety, not *P. capsici* treatment (Table 3). The same trend was observed for plant weight. Within each variety, inoculation with *P. capsici* increased the percent of necrotic root tissue, although this difference was not statistically significant for Essex soybeans. There were no differences between varieties when comparing root necrosis ratings of treated plants (Table 3). Root health ratings showed a significant improvement in health in untreated plants only within the Syngenta variety, meaning that treatments appeared to have no effect on the health of the other soybean varieties. *P. capsici* was recovered from 50% of the root systems of Essex soybeans and 17% of stems. No *P. capsici* was recovered from any other variety or treatment (Table 3).

Table 3. Variety and treatment effects on plant height, weight, root necrosis, root health, and P. capsici recovery from root and shoot systems.

		Height (cm)		Weight (g)		Root Necrosis (%)		Root Health[X]		roots	shoots
Essex	treated	17.3	c	2.3	b	15	abc	1.9	bc	50	17
	control	20.3	bc	2.3	b	8.8	c	1.8	c	0	0
USG	treated	22.4	abc	3.4	a	22.2	a	2.5	a	0	0
	control	20.7	bc	3.2	ab	11.1	bc	2.3	abc	0	0
Syngenta	treated	26.4	a	3.6	a	19.4	ab	2.4	ab	0	0
	control	22.7	ab	3	ab	8.3	c	1.8	c	0	0
	P value	**0.0395**		**0.0458**		**0.0424**		**0.0285**			

[X] Root health scale where 0 = healthy, white, large root systems and 3 = dead, decayed root systems. Different letters indicate significant differences at $\alpha = 0.05$ using Fisher's LSD.

Summary:

The data indicate that given sufficient inoculum, *P. capsici* can colonize soybean tissues in a controlled environment. Colonization may be facilitated after seedling emergence; although no impacts on plant health (i.e. death) was observed, as is typical for a damping off pathogen. In addition, no stem symptoms were observed as is characteristic for other Phytophthora species that can affect soybeans. Colonization can occur at low levels in some varieties. For example, we were able to recover *P. capsici* from Essex soybeans at low levels in the variety experiments but not the second age experiment. Essex is no longer grown for soybean production, and therefore the results here may not translate into newer commercial varieties. Indeed, we were unable to recover any *P. capsici* from either commercial variety used in the variety test, which would support this statement. However, it is not known if the high levels of inoculum we used in the initial age related study would result in colonization of newer varieties. We would need to conduct another set of variety trials with higher levels of inoculum to determine if this is the case. Thus, we cannot state that soybeans should or should not be grown in rotation with *P. capsici* prone vegetables at this time. In addition, it is not known what level of inoculum might be encountered in a field setting. Regardless, **our data do not indicate that this organism is a significant threat to soybean production.** We currently are conducting an additional study examining the effects of soybeans to influence oospore production in overwintering soils. These data may provide additional insight as to the potential role of soybeans in *P. capsici* outbreaks in vegetables.

Thank you to Colin Scanlan and Don Seifrit for assistance with this project.

SOYBEAN (*Glycine max*) ‘Dynagro DS39RY65’)
Phomopsis seed decay; *Phomopsis longicola*
Purple seed stain; *Cercospora kikuchii*

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Evaluation of foliar fungicides for management of seed diseases of soybean in Delaware, 2016.

The experiment was conducted at the University of Delaware’s Carvel Research and Education Center, Thurmond Adams Research Farm in Georgetown, Delaware. The experiment consisted of 11 fungicide treatments and an untreated control arranged in a spatially balanced, randomized complete block design with four replications. Plots consisted of 8 rows spaced 15 in. apart and 30 ft. in length. The four inner rows were used as treatment rows, and the four outer rows were used as a buffer between adjacent plots. The plots were seeded into minimally tilled soybean residue on 20 Jun at a population of 150,000 plants /A. Plots were managed for nutrients and weeds according to Delaware extension guidelines. Fungicides were applied to the center four rows on 5 Jul (V5), 8 Aug (R1), and 17 Aug (R3) with a CO_2 backpack sprayer that delivered 10 gpa at 35 psi. The sprayer was equipped with a 6 ft. boom with four TeeJet® 80V01 nozzles spaced 18 inches apart. Grain was harvested with a small plot combine on 20 Oct. and yields were corrected to 13.5% moisture. A 250 g subsample of harvested grain was collected for each plot, and 60 seeds were rated visually for percent Phomopsis and purple seed stain. Seed weight of 1000 seeds were measured from each subsample. Data were analyzed to ensure normality and statistically analyzed using a random effects mixed model (JMP v12). Following significant ANOVA at (α=0.1), means were separated using LSD (α=0.05).

Soybeans were planted later in the growing season than what is typical for the region as a result of persistent rains throughout the latter half of June. The majority of the growing season was hot and dry prior to R3. Consequently, no foliar diseases developed to a ratable level. The main seed diseases detected were purple seed stain caused by *Cercospora kikuchii* and Phomopsis seed decay. Trivapro (V5) followed by Quadris Top (R3), Trivapro (R3) Affiance (R1) and Affiance (R3) all significantly reduced purple seed stain relative to the untreated control. Trivapro (V5) followed by Quadris Top (R3) and Quadris Top (R3) reduced Phomopsis seed decay compared to the control. Trivapro (V5) followed by Quadris Top (R3), Trivapro (R3) and Quadris Top (R3) all reduced total seed disease compared to the control. All other treatments were similar to the untreated control for total diseased seed. The 1000 seed weight was greater than control for the Trivapro (V5) followed by Quadris Top (R3), Trivapro (R3) and Aproach Prima (R1) treatments. No effects of yield were detected. No phytotoxicity was evident.

Treatment and rate/acre	Crop Stage at Application	Cercospora (%)	Phomopsis (%)		Total diseased seed (%)		1000 seed weight (g)		Yield (bu / A)
Untreated control		35.0	23.8	ab[z]	58.8	ab	130.8	cd	54.1
Trivapro 2.2 SE 13.7 fl oz FB Quadris Top 2.72 SC 8 fl oz	V5 FB[y] R3	21.7	4.2	c	25.8	e	148.3	a	63.3
Trivapro 13.7 fl oz	R3	18.3	20.0	ab	38.3	cde	142.5	ab	60.0
Quadris Top 8 fl oz	R3	23.1	6.0	c	29.7	de	138.1	abcd	61.1
Quadris Top 8 fl oz FB Trivapro 13.7 fl oz	V5 FB R3	31.7	17.9	b	49.6	abc	139.6	abcd	64.2
Aproach Prima 2.34 SC 6.8 fl oz	R1	29.2	27.1	ab	56.3	abc	129.6	d	45.6
Aproach Prima 6.8 fl oz	R3	25.8	20.8	ab	46.7	abcd	136.7	bcd	60.4
Priaxor 4.17 SC 4 fl oz	R3	33.3	30.0	a	63.3	a	134.2	bcd	55.1
Domark 230 ME 4 fl oz	R1	33.8	27.5	ab	61.3	a	137.9	bcd	53.6
Domark 4 fl oz	R3	30.4	20.8	ab	51.2	abc	136.7	bcd	52.8
Affiance 1.5 SC 10 fl oz	R1	23.3	23.3	ab	46.7	abcd	140.0	abc	63.2
Affiance 10 fl oz	R3	22.5	19.2	ab	41.7	bcde	140.8	abc	63.4
	P(*F*)	0.069	0.001		0.034		0.060		0.12

[z] Means within a column followed by the same letter are not significantly different according Fisher's Protected LSD test (α=0.05).
[y] FB = followed by.

CUCUMBER (*Cucumis sativus* ‘Vlaspik’ and ‘Citadel’)

Downy mildew; *Pseudoperonospora cubensis*

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Evaluation of fungicide programs for management of downy mildew of cucumbers – Trial 2, 2016.

The experiment was conducted at the University of Delaware’s Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown. The experiment was a split plot with fungicide program as the main plot (four programs and a nontreated control) and cultivar (susceptible ‘Vlaspik’ and moderately resistant ‘Citadel’) as the subplot. Plots were arranged in a randomized complete block design with four replications. Main plots consisted of 4 20-ft rows, 2 rows of the susceptible and resistant cultivars were planted side-by-side, with 2.5 ft between rows and a 5-ft alley between treatments within the row. Seeds were planted with a Monosem planter at 60,000 plants per acre on 20 Jun. Downy mildew was present in an adjacent field on the farm when seedlings emerged. A total of 100 lb/A of nitrogen was applied and a standard herbicide program (Curbit plus Command) was used along with mechanical cultivation. Assail and Bifenthrin insecticides were used for cucumber beetle control. Trials were overhead irrigated as necessary. Percent downy mildew severity was evaluated on five leaves of similar maturity in each plot on 3 and 15 Aug as the percent of the leaf area with necrosis or water soaking due to downy mildew. Fungicide applications began on 30 Jun. Fruit in a 20-ft section of one inner row of each cultivar per plot were harvested, counted, weighed, and graded on 8 Aug.

Disease severity ratings were lower on 15 Aug than on 3 Aug because downy mildew was assessed on younger leaves on the second rating date. There was a significant cultivar x fungicide program interaction for disease severity on both assessment dates. Citadel had a lower numerical downy mildew severity rating than Vlaspik on 3 and 15 Aug, although the difference was only significant when Bravo Weather Stik was applied alone, and for the nontreated control. There were no significant differences among fungicide spray programs on Citadel on either date. However, on the susceptible cultivar Vlaspik, plots sprayed five times with the Ranman, Previcur Flex plus Bravo Weather Stik (BWS) alternation and the plots sprayed with the rotation of Orondis, Ranman, Previcur Flex plus BWS had lower downy mildew severity ratings than the BWS only plots. There was no interaction between cultivar and fungicide program for yield. Citadel produced significantly more fruit than Vlaspik (19.8 lb/plot vs. 13.1 lb/plot, $P<0.0001$). All fungicide programs improved yield compared to no fungicide application. There were no significant differences among fungicide programs. No phytotoxicity was observed.

Treatment and rate/A	Application dates[z]	Cultivar	% Downy mildew severity 3 Aug	% Downy mildew severity 15 Aug	Yield[x] lb/plot
Bravo Weather Stik 2 pt	1-5	Vlaspik	40.1 b[y]	23.3 bc	18.1a
		Citadel	15.4 cd	6.4 e	
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	1,3,5	Vlaspik	24.1 c	9.4 de	18.1a
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	2,4	Citadel	15.3 cd	5.6 e	
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	1,5	Vlaspik	10.5 d	17.4 cd	18.7a
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	3	Citadel	5.1 d	8.8 e	
Orondis 34 fl oz + Bravo Weather Stik 2 pt	1	Vlaspik	13.4 cd	9.7 de	19.0 a
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	3	Citadel	11.0 cd	5.4 e	
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	5				
Nontreated		Vlaspik	62.8 a	59.7 a	8.4 b
		Citadel	37.7 b	27.6 b	
P value[w]			0.0061	0.0001	0.0001

[z]Application dates were 1= 30 Jun; 2= 7 Jul; 3= 14 Jul; 4= 21 Jul; 5=28 Jul.

[y]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test (α=0.05).

[x]Yield pooled across cultivars within each fungicide program to analyze the main effect of fungicide program on yield.

[w]*P* values ≤ 0.05 indicate significant differences among treatments.

CUCUMBER (*Cucumis sativus* 'Vlaspik' and 'Citadel')

Downy mildew; *Pseudoperonospora cubensis*

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Evaluation of fungicide programs for management of downy mildew of cucumbers – Trial 3, 2016.

The experiment was conducted at the University of Delaware's Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown. The experiment was a split plot with fungicide program as the main plot (four programs and a nontreated control) and cultivar (susceptible 'Vlaspik' and moderately resistant 'Citadel') as the subplot. Plots were arranged in a randomized complete block design with four replications. Main plots consisted of 4 20-ft rows, with 2 rows of each cultivar planted side by side, 2.5 feet between rows and a 5-ft alley between treatments within the row. Seeds were planted with a Monosem planter at 60,000 plants per acre on 20 Jul. Downy mildew was present in an adjacent field on the farm when seedlings emerged. A total of 100 lb/A of nitrogen was applied. A standard herbicide program (Curbit plus Command) was used along with mechanical cultivation. Assail and Bifenthrin insecticides were used for cucumber beetle control. Trials were overhead irrigated as necessary. Percent downy mildew severity was evaluated on five leaves of similar maturity in each plot on 15 and 25 Aug, 2 and 8 Sep and measured as the percent of the leaf area with necrosis or water soaking due to downy mildew, and AUDPC was calculated based on the four assessments. Fungicide applications began on 28 Jul. Fruit in a 20 ft section of one inner row of each cultivar per plot were harvested, counted, weighed, and graded on 9 Sep.

There was no significant fungicide program x cultivar interaction for AUDPC (*P*=0.8729) or yield (*P*=0.7187). However both cultivar and fungicide program had significant main effects. Citadel had a significantly lower downy mildew AUDPC value than Vlaspik (150.3 vs. 198.6 AUDPC, *P*= 0.0171). All fungicide programs significantly reduced AUDPC values compared to the nontreated plots. Ranman plus Bravo WeatherStik (BWS) alternated with Previcur Flex plus BWS on a weekly schedule had the lowest AUDPC value, which was significantly lower than the BWS only program, and the two programs on a 14 day schedule. Citadel yielded more fruit than Vlaspik (20.3 vs. 17.4 lb/plot, *P*=0.0371). Only the Ranman plus BWS alternation with Previcur Flex plus BWS applied weekly had significantly higher marketable yield than the nontreated control plots. No phytotoxicity was observed.

Treatment and rate/A	Application dates[z]	AUDPC	Yield lb/plot
Bravo Weather Stik 2 pt	1-6	199.0 b[y]	18.9 ab
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	1,3,5		
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	2,4,6	35.2 c	22.8 a
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	1,5		
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	3	194.6 b	17.3 b
Orondis 34 fl oz + Bravo Weather Stik 2 pt	1		
Ranman 2.75 fl oz + Bravo Weather Stik 2 pt	3		
Previcur Flex 1.2 pt + Bravo Weather Stik 2 pt	5	136.4 b	19.7 ab
Nontreated check		306.9 a	15.7 b
P-value[x]		0.0010	0.0290

[z]Application dates were 1=28 Jul; 2=4 Aug; 3=11 Aug; 4=18 Aug; 5=25 Aug, 6=1 Sep.

[y]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test (α=0.05).

[x]*P*-values ≤ 0.05 indicate significant differences among treatments.

WATERMELON (*Citrullus lanatus* ‘Crunchy Red’)
Gummy stem blight; *Didymella bryoniae*
Anthracnose; *Colletotrichum orbiculare*

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Evaluation of fungicides for management of foliar diseases on watermelon, 2016.

The experiment was conducted at the University of Maryland’s Lower Eastern Shore Research and Education Center, Salisbury, as a randomized complete block design with ten fungicide treatments and four replications. Plots consisted of one raised bed, 40-ft long, on 7-ft centers. The beds were shaped and covered with 1.25-mil plastic over a single line of 8-in. emitter spaced drip tape in a one-pass operation on 20 May. Three-week-old seedlings were moved outside to begin hardening off on 20 May. They were transplanted into the field 36 in. apart with a 20-20-20 (N-P-K) (2.5 lb/150 gal water) starter solution on 30 May. One week later, pollinizers ‘SP-6’ were planted between every third and fourth plant in the row. Soil moisture was maintained by drip and overhead sprinkler irrigation as needed. Cucumber beetles were managed on 25 May with Admire (2.2 ml per gal) applied to the transplant trays. Fungicide applications began 1 Jul and were applied weekly until 11 Aug. Fungicides were applied with a tractor-mounted sprayer that delivered 45 gal/A at 43 psi through six D4-45 hollow-cone nozzles mounted in a directed pattern. The percent severities of gummy stem blight and anthracnose were evaluated as the percent of leaves, petioles and vines in each plot showing symptoms on 31 Jul and 17 Aug. All mature and marketable fruit from each plot were harvested, counted, and weighed on 9, 17, 29 Aug and 7 Sep.

Gummy stem blight and anthracnose occurred in all plots during the season. On 31 Jul, all fungicide programs significantly reduced gummy stem blight compared to non-treated plots, but there were no significant differences among fungicide treatments. On 17 Aug, all treatment programs again reduced gummy stem blight compared to non-treated plots, and there were significant differences among treatments. When A20259 was applied at the higher rate of 13.7 fl oz in an alternation program that also included Quadris Opti and Folicur, gummy stem blight was significantly lower than when A20259 was applied at 11 fl oz. The treatment of ManKocide followed by Bravo Weather Stik alone and then in combination with Switch and Luna Experience resulted in some of the lowest levels of both gummy stem blight and anthracnose on 17 Aug overall. There were no significant differences in yield. No phytotoxicity was observed in any plots.

Treatment and rate/A	Application dates[z]	Gummy stem blight (%) 31 Jul	Gummy stem blight (%) 17 Aug	Anthracnose (%) 17 Aug	Yield (lb/plot)
Fontelis 1.67SC 1 pt	1-7				
Bravo Weather Stik 6SC 2 pt	1-7	1.3 b[y]	4.3 b	1.1 e	300.3
Bravo Weather Stik 6SC 1.5 pt	1,3,5				
Fontelis 1.67SC 1 pt	2,4				
Bravo Weather Stik 6SC 1.0 pt	2,4				
Folicur 3.6F 8 fl oz	6,7	0.8 b	4.3 b	1.9 de	329.9
ManKocide 3 lb	1				
Bravo Weather Stik 6SC 2 pt	2-7				
Switch 6.25WG 14 oz	5,7				
Luna Experience 3.34SC 17 fl oz	3,6	1.2 b	1.6 d	0.9 e	336.5
Quadris Opti 5.53C 3.2 pt	1,2,3				
Inspire Super 2.8F 16 fl oz	4,5,7				
Folicur 3.6F 8 fl oz	6	0.9 b	1.9 d	1.5 de	375.2
Quadris Opti 5.5SC 3.2 pt	1,2,3				
Aprovia Top 8.5 fl oz	4,5,7				
Folicur 3.6F 8 fl oz	6	1.0 b	4.2 bc	4.5 bcd	376.5
Bravo Weather Stik 6SC 2 pt	1,2,4				
Inspire Super 2.8F 16 fl oz	3,5				
Pristine 38WG 18.5 fl oz	6,7	-	4.2 bc	2.4 de	341.2
Quadris Opti 5.5SC 3.2 pt	1,2,3				
Aprovia Top 1.62EC 10.5 fl oz	4,5,7				
Folicur 3.6F 8 fl oz	6	0.6 b	3.1 bcd	3.9 cd	333.0
Quadris Opti 5.5SC 3.2 pt	1,2,3				
A20259 11 fl oz	4,6,7				
Folicur 3.6F 8 fl oz	5	0.5 b	5.7 b	7.4 bc	375.9
Quadris Opti 5.5SC 3.2 pt	1,2,3				
A20259 13.7 fl oz	4,6,7				
Folicur 3.6F 8 fl oz	5	0.9 b	2.1 cd	11.5 ab	297.0
Non-treated		11.0 a	34.4 a	24.2 a	237.3
P value[x]		0.0001	0.0001	0.0001	0.0505

[z] Application dates were 1=1 Jul, 2=7 Jul, 3=13 Jul, 4=20 Jul, 5=28 Jul, 6=4 Aug, 7=11 Aug.

[y] Mean values in each column followed by the same letter do not significantly differ according to Fisher's protected LSD ($P = 0.05$).

[x] P values $\leq$ 0.05 indicate significant differences are likely to exist among treatments.