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Pumpkin Powdery Mildew Fungicide Demonstration Trial Report - 2015

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Introduction

A powdery mildew (PM) fungicide evaluation trial was conducted on pumpkin at the Western Ag Research Station in South Charleston, OH. All treatments (Table 1) were applied to a powdery mildew susceptible hybrid (Solid Gold, Rupp Seeds) to determine the efficacy the compounds on foliage health; no yield data was taken.

Methods

The trial was direct seeded on May 29th using a Monosem vacuum seeder. Each plot consisted of three 65' long rows of Solid Gold pumpkin planted on 5' centers and thinned to a final density of 2' within the row. Plots were separated by a 15' drive lane on each side with a 10' fallow space between each plot. Both spacing measures were designed to minimize spray drift between plots. The seeds were treated with Farmore (thiamethoxam) to limit striped cucumber beetle feeding and minimize transmission of bacterial wilt.

Fertility across the field was added uniformly using a broadcast spreader with 50 lb N, 100 lb P, and 100 lb K actual applied per acre. Prior to vine tip each row was side dressed twice with liquid 28-0-0 at the rate of 25 lb per acre.

Weeds were managed by spraying Strategy (5 pt /A) plus Dual Magnum (1.6 pt /A) broadcast pre emerge followed two weeks later by an application of Sandea (1.0 oz/A) via shielded sprayer between the rows prior to vines running. Any weed escapes between the rows or between plots were either hand pulled or hoed out. There was no cover crop involved in this trial.

Powdery mildew was first detected in this trial on July 13th, nine days earlier than 2014. According to our protocol, this detection initiated treatment applications, which were first applied on July 16. Fifteen feet on the west side of each plot was not sprayed and served as a "check" plot to confirm the presence of PM and reflect what untreated foliage would look like. Prior to the application on July 16, all treatments were scouted for an initial disease rating on both the upper and lower leaf surfaces. Successive canopy and PM evaluations were conducted on July 28, August 7, August 18, August 25, and August 31.

For the first PM evaluation only five randomly chosen leaves were examined (upper and lower surface) for powdery mildew colonies; for the final five PM ratings, seven leaves were examined. Prior to and during each rating a pictorial guide (Fig. 1) representing percent infestation was used to calibrate visual assessment to better approximate the percent infestation seen on the leaf surface. During each evaluation an effort was made to choose leaves of a consistent age that represented product efficacy fairly. These two factors, calibration and consistency, are key to producing reliable powdery mildew efficacy data. The percent powdery mildew of each leaf surface was recorded and a mean value was calculated for use in the figures and tables below.

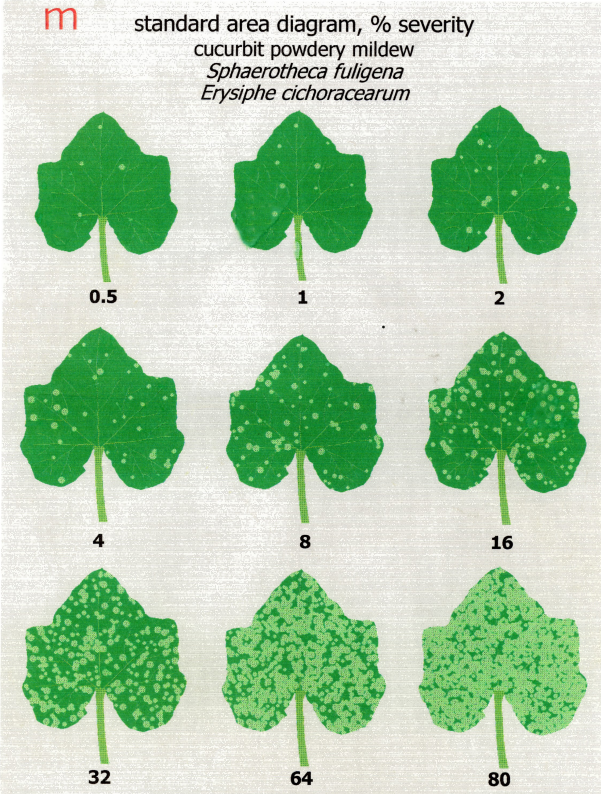

Figure 1. Percent powdery mildew infection chart.

Determining percent powdery mildew infestation using this standard procedure can be confounded by the intrusion of diseases such as Downy Mildew and Bacterial Leaf Spot. In 2015, Downy Mildew damaged treatment plot 3 because it did not contain any fungicides capable of controlling this disease. There was also low levels of bacterial leaf spot on the foliage and fruit in all treatments.

Fungicide treatment sprays were applied on a 7-10 day schedule starting July 16, followed by July 23, July 31, August 7, August 18, and August 25. All trial treatments were applied from a hydraulic boom sprayer at 35 GPA using hollow cone nozzles at 60 PSI.

The primary fungicide of interest was applied on the first, third, and fifth sprays, alternated with compounds that have historically offered good PM efficacy and comply with current resistance management strategies on the second, fourth, and sixth sprays. Again, no sprays were applied to the west most 15 feet of each plot which served as the untreated check.

Results

Data for the six PM evaluations are listed by numeric treatment order (Table 1), with lower means equal to higher efficacy and higher means indicating lower efficacy for Tables 2-7 and Figures 2-7. The "untreated check" is represented by an average of 18 leaves, two taken from all nine treatments. Negative PM values are simply an artifact of displaying both the upper and lower leaf values for PM together in one figure; simply use the absolute (non-negative) value for comparison.

In the first evaluation on July 16, powdery mildew was not detected in treatments 1-3, and barely detectable (<1.0%) in treatments 4-9, including the untreated check, on either upper

or lower leaf surfaces. This confirms we began applying our treatments at a very early stage of disease infestation, as is our standard recommendation to growers.

The second evaluation was 12 days later (July 28), and PM was not found on treatments 1 or 2, but found in treatments 3-9, again at very low levels, ca. 1%. The check had > 3 % on the upper and > 1 % on the lower surface. Overall disease pressure at this point was still very low but building in all plots.

By the third evaluation 10 days later (August 7), PM colonies were detected on all treatments, with treatment 7 having 5% infestation on the lower leaf surface. The untreated check was at 30% for the upper and nearly 17% for the lower leaf surface. All other treatments still had minor upper and lower leaf infestations at this point.

The fourth evaluation 11 days later (August 18) had treatments 1-4 below 1% infestation for both the upper and lower leaf surface. For treatments 5-9, lower leaf infestation means ranged between 4-40% with the check nearly at 53%. Treatments 5-9, upper leaf surface PM ranged from 1 to nearly 7 %, with the check at 59%. Based on the check plots, PM spores are ubiquitous and infection status is high.

The fifth evaluation was 7 days later (August 25), and only treatments 2 and 4 remained at very low infestations, under 1%. Treatment 8 also registered both leaf surfaces under 1% infestation, down from the previous evaluation. Treatment 7 appears to have the highest level of PM on both the upper and lower leaf surface, 16 and 32% respectively, at this date. The check areas are holding steady at nearly 56 and 57% infestation on the top and bottom leaf surface.

The final canopy evaluation was performed 6 days later (August 31), 6 days after the last treatment spray. The upper leaf surface PM ratings were under 7% for all treatments, and the lower leaf surface ratings ranged from 0 to 70%. The check sections of the treatments had increased to 78% and 82% for the upper and lower leaf surface respectively, again, a clear indication that powdery mildew levels remained high in the plot area.

Conclusions

This goal of the powdery mildew demonstration trial is to evaluate the contribution and effectiveness of key compounds when used in combination with standard rotational fungicides to determine leaf and canopy health, ostensibly to maximize marketable yield and fruit quality. These fungicide programs have been designed to primarily manage powdery mildew, and may have inherent weaknesses against specific diseases such as downy mildew, bacterial diseases, and others.

The upper leaf surface and canopy is generally easier to protect with fungicide, and therefore typically has much lower levels of powdery mildew infestation. The lower leaf surface and mid to lower canopy is more difficult to protect due primarily to known limitations in application technology and complex plant architecture, but can reveal the extent to which materials are mobile on the upper leaf surface and exhibit translaminar or locally systemic activity. Using that criteria, this report focuses primarily on how well the

lower leaf surface is protected. All products in the trial are known to have some level of systemic activity, with the exception of the general protectant fungicides Manzate Pro Stick and Bravo Weather Stik.

Through the first three evaluations, powdery mildew populations on treatments were present at very low levels on both leaf surfaces, with the highest level around 6% on the lower surface of treatment 7. At this point in the season the untreated check was at 30% and 17% on the upper and lower leaf surface respectively, indicating all treatments were exhibiting some level of control.

For the last three evaluations, treatments 1,2,3, and 4 were under 3% infestation on both the upper and lower leaf surface with the exception of the upper leaf surface on treatment 3 on August 25 which was 9%. Treatments 1 & 2 were the same except for swapping Rally for Procure in the alternate sprays, and treatments 3 & 4 were the same except for changes in the alternate sprays. These four treatments should be considered to have provided excellent protection of the leaves and canopy from powdery mildew, especially compared to the untreated check over this time frame, which reached 78% and 83% infestation for the upper and lower leaf surface.

During the last three evaluations, treatments 5 and 6, which are identical to each other with the exception of a different adjuvant, had peak infestation on August 25 at 20% on the lower leaf surface of treatment 6. The pattern of infestation on the lower leaf surface remained consistent over the entire evaluation period; treatment 6 having slightly higher PM infestation than treatment 5. In general, these treatments showed very good control against powdery mildew, especially compared to the untreated check over this time frame which reached 78% and 83% infestation for the upper and lower leaf surface.

During the last three evaluations, treatment 7 had PM infestation peak on the upper leaf surface on August 25 at 16% and on the lower leaf surface at 70% on August 31. While this was the highest infested treatment in the trial, it was still below the untreated check, and therefore demonstrated fair control against PM.

During the last three evaluations, treatment 8 peaked at < 5% PM on the lower leaf surface on August 18, while treatment 9 peaked at 13% on the lower leaf surface on August 31, but overall these treatments were very similar in their control performance. Both of these treatments showed very good control against powdery mildew, especially compared to the untreated check over this time frame which reached 78% and 83% infestation for the upper and lower leaf surface.

In the final analysis, treatments 1-6, 8, and 9 kept PM infestations on the lower leaf surface below 20% for the entire season, and therefore would be regarded as having very good control overall. Treatment 7 did not perform as well as the other treatments when it came to protecting the lower leaf surface over the entire season from infestation with a range of 32-70% over the second half of the season, therefore would be categorized as having fair control of powdery mildew.

In terms of performance over the past several years that inform recommendations to growers for a "standard" fungicide program in pumpkins, treatment 1 would be considered a sound program, but as you can see, several other fungicide programs have equal or nearly equal control as this program. Given that PM protection is equal or nearly equal among several fungicide programs, growers no doubt will consider the cost of these programs to help guide their final disease management decisions. For this report I have not factored in the cost of the various programs, which does impact grower decisions.

As you consider these findings remember that this trial was designed as a large plot demonstration without randomization and replication, therefore no statistical analysis of these treatments is possible, but these observations may reveal a pattern of efficacy worth further exploring.

A final word about this year's PM trial. Having conducted this type of trial since 1999, this year by far had the lowest level of infection I've ever seen at the research station. Even though the check plots showed significant infection at nearly 80% on both upper and lower leaf surfaces, typically by the end of the rating period these plants are all but dead due to a season of powdery mildew infestation.

In comparison to other years, from mid July through August we had very little rainfall at the station which may have contributed to lower available moisture for PM to develop on the plants. A second difference from other years is the lack of drip irrigation installed in the plots due to excessive moisture in the first half of the season, i.e., it was too wet to install. Without the ability to irrigate the plants, there was definitely less moisture in the soil to evaporate into the canopy, lowering the relative humidity of the microclimate within the canopy, therefore leading to conditions not favorable for PM development and sporulation. Although this scenario sounds very plausible, powdery mildew is one of the few fungi that can develop quite nicely under drier conditions, which conflicts with my first two assertions, so I am left only to speculate why the infestation was lower this year.

Table 1. 2015 Powdery mildew fungicide demonstration trial treatments.

TRT	Product, Rate, and FRAC Sprays 1, 3, and 5	Product, Rate, and FRAC Sprays 2, 4, and 6
1	Quintec (6 oz) + Manzate (2.5 lb) + Orus 0.39% v/v [frac 13 + M + NC]	Procure (8 oz) + Manzate (2.5 lb) + Orus 0.39% v/v gallon [frac 3 + M + NC]
2	Quintec (6 oz) + Manzate (2.5 lb) + Orus 0.39% v/v [frac 13 + M + NC]	Rally (5 oz) + Manzate (2.5 lb) + Orus 0.39% v/v gallon [frac 3 + M + NC]
3	(1st) Quintec 6 oz + Regalia 1 qt + Orus 0.39% v/v [frac 13 + P5 + NC] (3rd) Torino 3.4 oz + Regalia 1 at + Orus 0.39% v/v [frac U6 + P5 + NC] (5th) Merivon 4 oz + Regalia 1 qt + Orus 0.39% v/v [frac 7,11 + P5 + NC]	Procure 8 oz + Regalia 3 qt + Orus 0.39% v/v [frac 3 + P5 + NC] Procure 8 oz + Regalia 3 qt + Orus 0.39% v/v [frac 3 + P5 + NC] Procure 8 oz + Regalia 3 qt + Orus 0.39% v/v [frac 3 + P5 + NC]
4	(1st) Quintec 6 oz + Regalia 1 qt + Orus 0.39% v/v [frac 13 + P5 + NC] (3rd) Torino 3.4 oz + Regalia 1 at + Orus 0.39% v/v [frac U6 + P5 + NC] (5th) Merivon 4 oz + Regalia 1 qt + Orus 0.39% v/v [frac 7,11 + P5 + NC]	Procure 8 oz + Manzate 2.5 lb [frac 3 + M] Procure 8 oz + Manzate 2.5 lb [frac 3 + M] Procure 8 oz + Manzate 2.5 lb [frac 3 + M]
5*	Luna Experience (6oz) + Manzate (2.5 lb) + Activator 90 (0.125 v/v) (FRAC 7,3,M)	Bravo (1 PT/A) + Flint (2 oz/A) FRAC 11,M
6*	Luna Experience (6oz) + Manzate + Orus 0.39% v/v) (FRAC 7,3,M + NC)	Bravo (1 PT/A) + Flint (2 oz/A) FRAC 11,M
7	Regalia 3Qt + Manzate (2.5 lb) [frac P5 +M]	Procure (8 oz) + Regalia 2 Qt [frac 3 + P5]
8	Pristine (18 oz) + Orus 0.39% v/v [FRAC 7,11 + NC]	Procure (8 oz) + Orus 0.39% v/v [frac 3 + M + NC]
9	Quadris Opti + Orus 0.39% v/v [frac 11, M + NC]	Procure (8 oz) + Orus 0.39% v/v [frac 3 + M + NC]

* Not registered for use on pumpkin.

Figure 2. Mean percent powdery mildew ratings for five lower and upper leaf surface of Solid Gold pumpkin taken on July 16 by treatment.

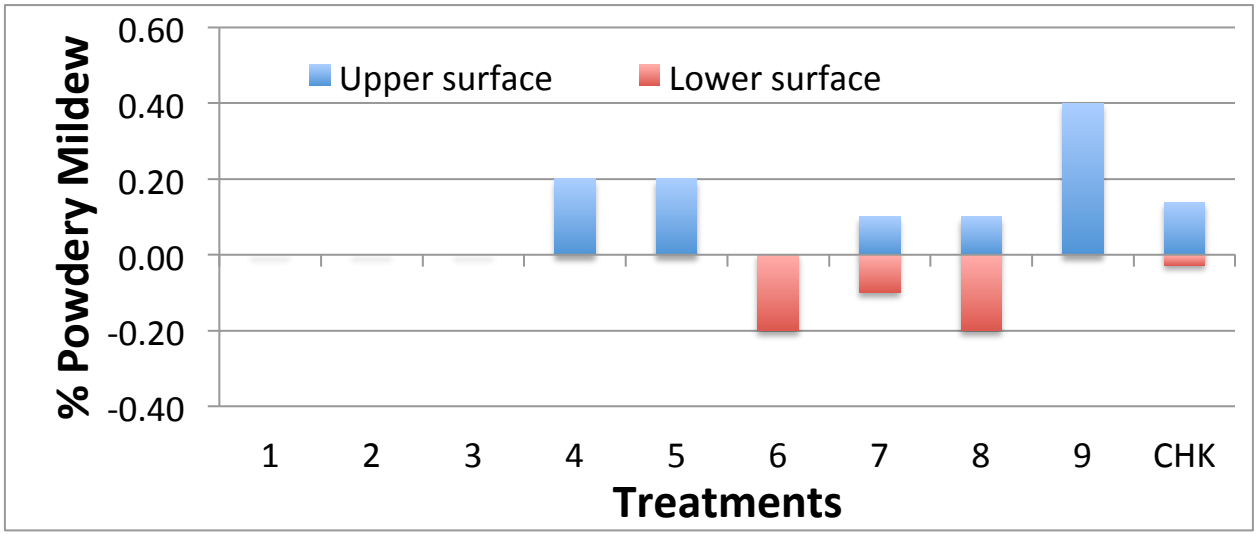

Figure 3. Mean percent powdery mildew ratings for seven lower and upper leaf surface of Solid Gold pumpkin taken on July 28 by treatment.

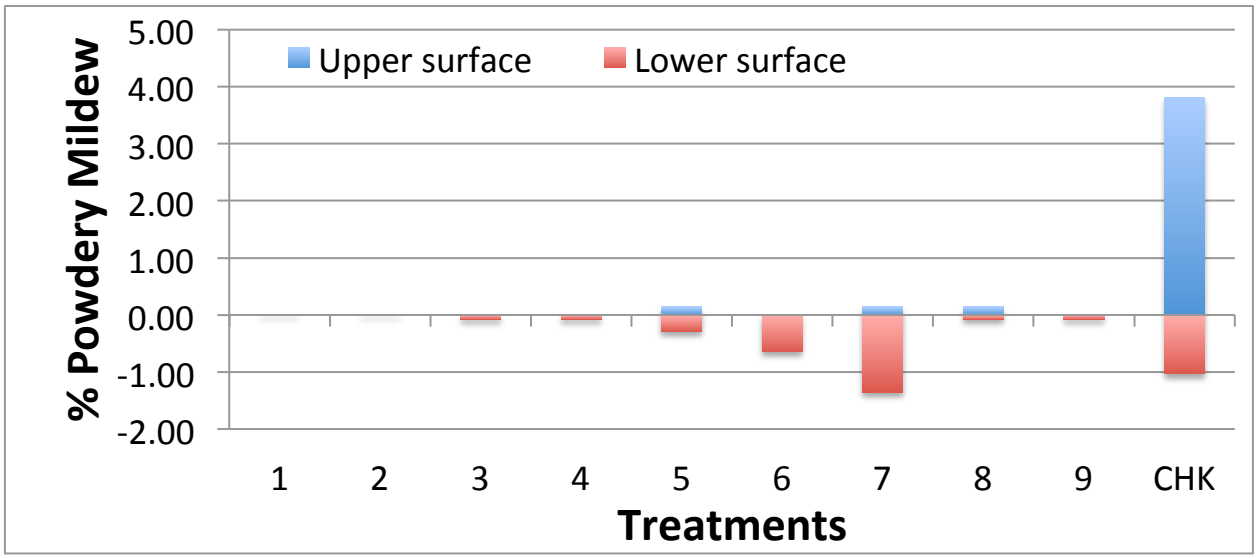

Figure 4. Mean percent powdery mildew ratings for seven lower and upper leaf surface of Solid Gold pumpkin taken on August 7 by treatment.

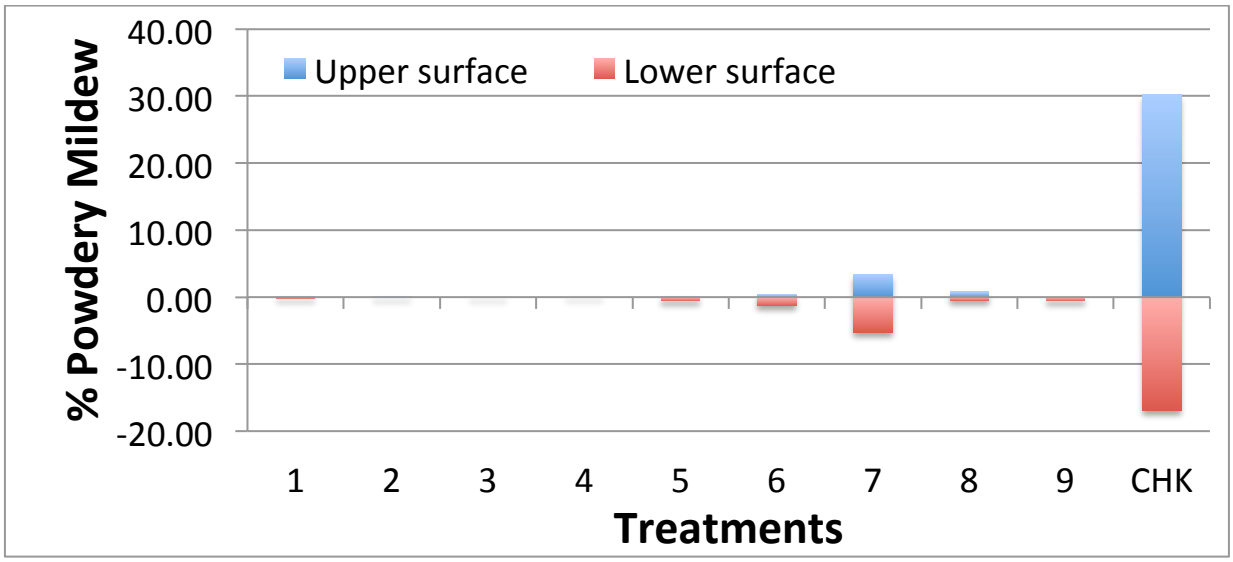

Figure 5. Mean percent powdery mildew ratings for seven lower and upper leaf surface of Solid Gold pumpkin taken on August 18 by treatment.

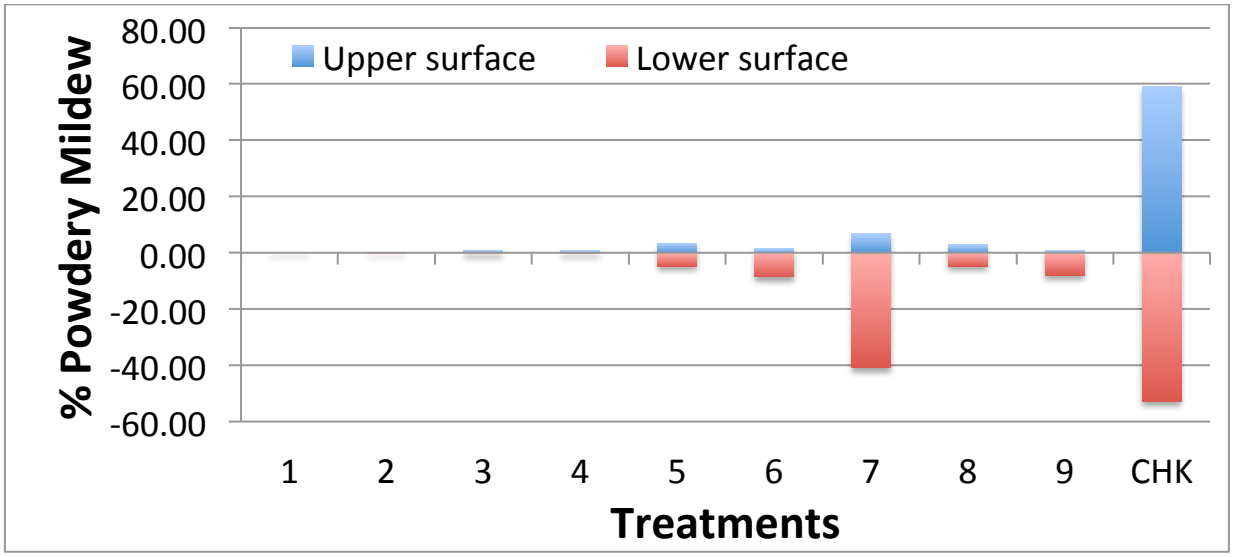

Figure 6. Mean percent powdery mildew ratings for seven lower and upper leaf surface of Solid Gold pumpkin taken on August 25 by treatment.

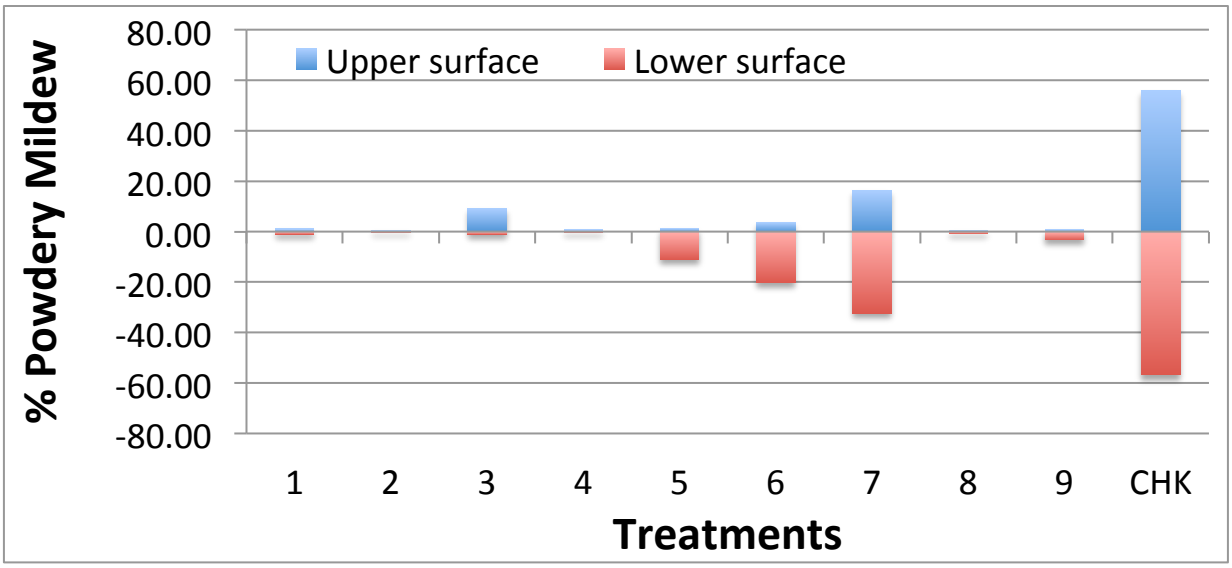

Figure 7. Mean percent powdery mildew ratings for seven lower and upper leaf surface of Solid Gold pumpkin taken on August 31 by treatment.

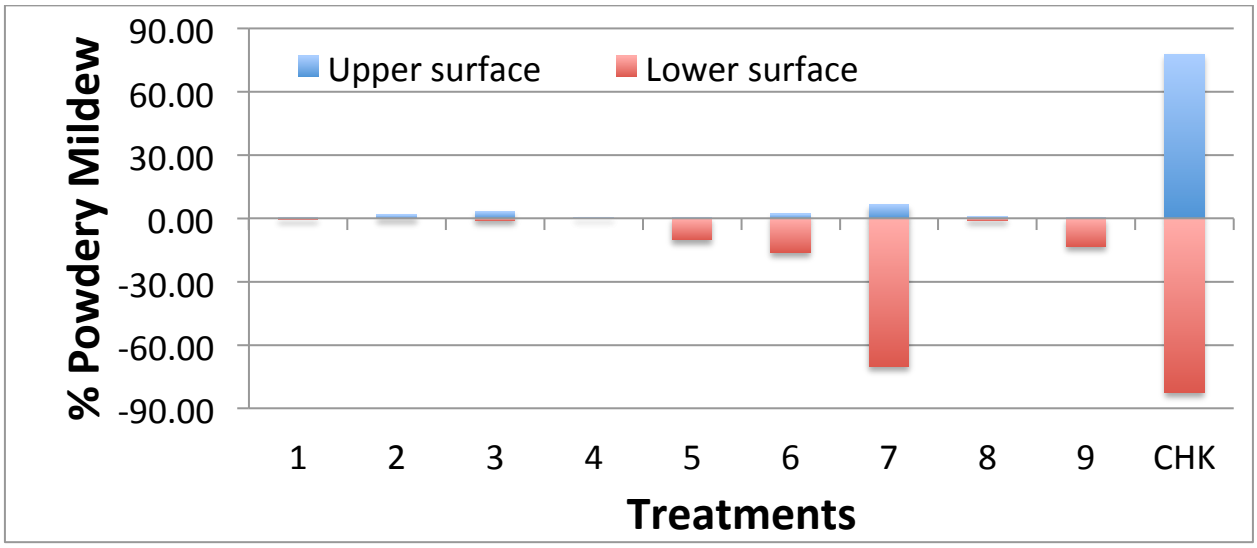

Table 2. Percent powdery mildew ratings for July 16.
Means are taken from five leaf samples.

TRT	Upper surface	Lower surface
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.20	0.00
5	0.20	0.00
6	0.00	0.20
7	0.10	0.10
8	0.10	0.20
9	0.40	0.00
CHK	0.14	0.03

Table 3. Percent powdery mildew ratings for July 28.
Means are taken from seven leaf samples.

TRT	Upper surface	Lower surface
1	0.00	0.00
2	0.00	0.00
3	0.00	0.07
4	0.00	0.07
5	0.14	0.29
6	0.00	0.64
7	0.14	1.36
8	0.14	0.07
9	0.00	0.07
CHK	3.81	1.03

Table 4. Percent powdery mildew ratings for August 7.
Means are taken from seven leaf samples.

TRT	Upper surface	Lower surface
1	0.14	0.21
2	0.14	0.07
3	0.00	0.07
4	0.00	0.00
5	0.14	0.57
6	0.43	1.29
7	3.43	5.29
8	0.79	0.50
9	0.00	0.57
CHK	30.17	16.94

Table 5. Percent powdery mildew ratings for August 18.
Means are taken from seven leaf samples.

TRT	Upper surface	Lower surface
1	0.00	0.00
2	0.14	0.14
3	0.93	0.36
4	0.71	0.21
5	3.43	4.71
6	1.43	8.57
7	6.71	40.86
8	2.86	4.71
9	0.79	8.00
CHK	59.17	52.78

Table 6. Percent powdery mildew ratings for August 25.
Means are taken from seven leaf samples.

TRT	Upper surface	Lower surface
1	1.07	1.00
2	0.50	0.21
3	9.29	1.00
4	0.64	0.14
5	1.36	11.14
6	3.79	20.29
7	16.29	32.29
8	0.43	0.71
9	0.86	3.29
CHK	55.83	56.78

Table 7. Percent powdery mildew ratings for August 31.
Means are taken from seven leaf samples.

TRT	Upper surface	Lower surface
1	0.50	0.64
2	1.71	0.29
3	3.36	0.93
4	0.29	0.00
5	0.57	10.14
6	2.07	16.14
7	6.57	70.00
8	0.79	1.00
9	0.29	13.29
CHK	77.78	82.50

Plot Images

For the second year, we captured periodic aerial images via an unmanned aerial vehicle (UAV) to accompany the percent leaf ratings as an overall measurement of canopy health. Included here are two shots taken mid and late season (Figs. 8 and 9). This imagery is interesting to review as we can plainly see various levels of efficacy by treatment, from green (healthy foliage) to brown (dying foliage) to white (powdery mildew covered foliage).

If you would like detailed shots specific treatment plots, please contact me.

Figure 8. Image taken ca. 65 meters above powdery mildew demonstration trial at Western Ag Research Station, July 24th, 2015. Treatments are as follows: top row, left to right: 9, 8, 7; middle row from left to right: 6, 5, 4; bottom row from left to right: 3, 2, 1.

Figure 9. Image taken ca. 65 meters above powdery mildew demonstration trial at Western Ag Research Station, August 31st, 2015. Treatments are as follows: top row, left to right: 9, 8, 7; middle row from left to right: 6, 5, 4; bottom row from left to right: 3, 2, 1.