



THE OHIO STATE UNIVERSITY

1512 S. US Highway 68, Suite B100 Urbana, OH 43078
937-484-1526 Jasinski.4@osu.edu

Pumpkin Powdery Mildew Fungicide Demonstration Trial Report - 2018

Jim Jasinski
Ohio State University Extension
IPM Program Coordinator

Introduction

A powdery mildew (PM) fungicide evaluation trial was conducted on pumpkin at the Western Ag Research Station in South Charleston, OH at 39.857672, -83.667513. All treatments were applied to a powdery mildew susceptible hybrid (Solid Gold, Rupp Seeds) to determine the efficacy of compounds on foliage health. No yield data was taken.

Methods

The trial was transplanted June 4 using a Mechanical Transplanter, model 912. Each plot consisted of two 70' long rows of Solid Gold pumpkin spaced on 5' row centers, planted 4' within the row. Fifteen feet on the east side of each plot was not sprayed and served as an "untreated check" section to confirm the presence of PM and reflect the condition of untreated foliage.

Treated plots were separated by a 15' drive lane on each side with a 20' fallow buffer between the header and end of each plot. These 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.

Weeds were managed by spraying glyphosate (32 oz /A) as a burn down on May 21 followed by a shielded post application of Sandea (1 oz / A) between the rows prior to vine tip on June 19. Any weed escapes in the row or between the plots were hand pulled or hoed out. The prior crop was soybean, and no cover crop was planted in the field.

Based on soil test results, no P or K was added to the field. On June 8, 75 pounds of nitrogen in the form of liquid 28-0-0 was side dressed six inches away from the row, approximately two inches deep in the soil.

In 2018, steps were taken to prevent Downy Mildew (DM) from being a confounding factor while rating the plots. Ranman (2.75 oz/A) was applied Aug. 1, 15, and 29 alternated with Tanos (8 oz/A) applied on Aug. 9 and 22. Bacterial leaf spot (BLS) was limited by applying Badge SC (1 pt /A) on July 25 and 30, and Aug. 3, 15, 22, and 29. No DM was detected in the

plots but moderate levels of BLS were detected on the foliage and fruit in all treatments. None of these products should have an impact on PM development.

Plectosporium is a soil borne disease that emerged mid-season and affected sections of all plots, regardless of the treatments. Compounds recommended to control this disease are known to affect PM development, therefore no attempt was made to control this disease using FRAC 11 strobilurin compounds.

Powdery mildew was first detected in the trial on July 18, a week earlier than 2017. According to protocol, this detection initiated scouting and treatment applications.

On July 19, all treatments were scouted for an initial disease rating on both the upper and lower leaf surfaces. Subsequent PM evaluations were conducted on July 27, August 6, 14, 22, 30 and September 7. Fungicide treatment sprays were applied immediately after each disease rating session except for the last spray which was applied August 31. No spray was applied on September 7, as this was the final rating. All treatments were applied using a hydraulic boom sprayer at 33 GPA using hollow cone nozzles at 65 PSI.

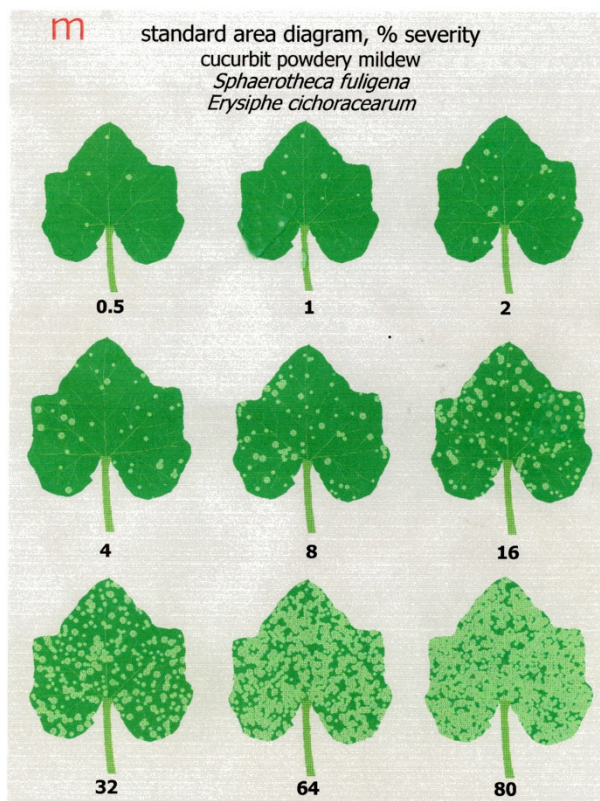


Figure 1. Percent powdery mildew infection chart.

In each treatment plot, powdery mildew development was evaluated around 10am on six randomly chosen leaves. Each leaf selected was examined on the upper and lower surface for powdery mildew colonies. Prior to each rating, a pictorial guide (**Figure 1**) representing percent PM infestation was used to calibrate visual assessment to fairly approximate the percent infestation seen on each leaf surface. This chart was carried during the evaluation and periodically referred to for accuracy. During each evaluation period an effort was made to randomly choose leaves of a consistent age from both the middle and upper canopy that represented the product efficacy fairly. These two factors, chart calibration and leaf age consistency, are key to producing a reliable powdery mildew efficacy data set. The percent powdery mildew of each leaf surface was recorded and a mean value plus its standard deviation was calculated for use in the tables below.

Results

Fungicide treatments are listed in **Table 1**. Rating data for the seven evaluations can be found in **Tables 2-8**. Recall that Treatment 8 is an “untreated check” created by taking two

leaves from each untreated plot area, for an average of 14 leaves per rating, on both the upper and lower surface.

Table 1. 2018 Powdery mildew fungicide trial treatments.

TRT	Product (Rate), FRAC Sprays 1, 3, and 5	Product (Rate), FRAC Sprays 2, 4, and 6
1	Luna Experience (6 fl oz) + Chemsurf 90 (0.125 v/v) [FRAC 7,3]	Vivando (15.4 fl oz) + Manzate (2.5lb) + Chemsurf 90 (0.125 v/v) FRAC [U8 + M]
2	Luna Sensation (6 fl oz) + Chemsurf 90 (0.125 v/v) (FRAC 7,11 + M)	Vivando (15.4 fl oz) + Manzate (2.5 lb) + Chemsurf 90 (0.125 v/v) FRAC [U8 + M]
3	Quintec (6 oz) + Manzate (2.5 lb) + Chemsurf 90 (0.125 v/v) [FRAC 13 + M]	Procure (8 oz) + Manzate (2.5 lb) + Chemsurf 90 (0.125 v/v) [FRAC 3 + M]
4	PerCarb (3 lb/100 gal) + Chemsurf 90 (0.125 v/v) FRAC [?]	Procure (8 oz) + Manzate (2.5 lb/A) + Chemsurf 90 (0.125 v/v) [FRAC 3 + M]
5	Oxidate (1.28oz/gal) + Merivon (4.0 oz) + Chemsurf 90 (0.125 v/v) [FRAC 7,11]	Oxidate (1.28oz/gal) + Procure (8 oz) + Chemsurf 90 (0.125 v/v) [FRAC 3]
6	TopGuard EQ (7 fl oz) + Chemsurf 90 (0.125 v/v) [FRAC 3,11]	(#2) Torino (3.4 fl oz) [FRAC U6] (#4) Vivando (15.4 fl oz) [FRAC U8] (#6) Torino (3.4 fl oz) [FRAC U6] Chemsurf 90 (0.125 v/v) for all
7	Banish (3.8ml/gal) + Chemsurf 90 (0.125 v/v) FRAC [?]	Banish (3.8ml/gal) + Chemsurf 90 (0.125 v/v) FRAC [?]
8	Untreated Check	Untreated Check

The first PM evaluation on July 19 (Table 2) provided a baseline to verify that PM infections could be found at very low levels on both upper and lower leaf surfaces (<0.5%) throughout the trial; no fungicides have been applied yet. The Oxidate + Mervion treatment was the only treatment where no PM colonies were detected during the rating.

In the second PM evaluation on July 27 (Table 3), all lower leaf infestations remained very low, below 1.3% on the lower leaf surface and 1.4% on the upper leaf surface. Banish and PerCarb had higher PM on the lower leaf surface compared to the UTC, while Luna Sensation, TopGuard, Banish, and PerCarb had higher PM on the upper leaf surface compared to the UTC. Overall, the PM infections are still quite low.

Table 2. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for July 19, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Oxidate + Merivon	0.0	± 0	0.0	± 0
Untreated Check	0.0	± 0	0.0	± 0.1
TopGuard	0.1	± 0.2	0.1	± 0.2
Quintec	0.1	± 0.2	0.2	± 0.3
PerCarb	0.1	± 0.2	0.2	± 0.3
Banish	0.0	± 0	0.3	± 0.3
Luna Experience	0.1	± 0.2	0.4	± 0.8
Luna Sensation	0.3	± 0.4	0.5	± 0.8

Table 3. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for July 27, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Luna Experience	0.1	± 0.2	0.1	± 0.2
Oxidate + Merivon	0.2	± 0.3	0.1	± 0.2
Luna Sensation	0.6	± 0.5	0.2	± 0.3
Quintec	0.1	± 0.2	0.2	± 0.4
TopGuard	0.6	± 0.8	0.3	± 0.4
Untreated Check	0.5	± 0.6	0.3	± 0.3
Banish	0.6	± 0.4	0.9	± 0.7
PerCarb	1.4	± 2.4	1.3	± 2.3

In the third evaluation on August 6 (Table 4), PM infestations begin to rise on both upper and lower leaf surfaces. PerCarb and Banish lower leaf ratings are higher than the UTC, while there are no treatments were higher than the UTC for the upper leaf surface.

Table 4. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 6, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Quintec	0.3	± 0.4	0.7	± 0.3
Luna Experience	0.3	± 0.3	0.8	± 0.4
Oxidate + Merivon	1.7	± 1.8	1.0	± 1
TopGuard	2.1	± 1.3	1.4	± 0.9
Luna Sensation	3.2	± 3.8	2.2	± 1.5
Untreated Check	14.1	± 13.4	5.5	± 2.7
PerCarb	3.6	± 3	8.7	± 10.9
Banish	7.0	± 1.7	10.7	± 3.7

In the fourth evaluation on August 14 (Table 5), PM infestation in the UTC rises dramatically to 50% and 54% on the upper and lower leaf surface respectively. The Luna Experience, Quintec and Oxidate + Merivon treatments are the only treatments with ratings below 10% for both the upper and lower leaf surface. All treatments are below the UTC for upper leaf surface ratings, and only Banish is higher than the UTC for lower leaf ratings.

Table 5. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 14, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Luna Experience	1.3	± 1.5	3.0	± 2
Quintec	3.8	± 5	5.7	± 3.9
Oxidate + Merivon	6.8	± 3.5	6.8	± 3
TopGuard	11.0	± 7.9	11.3	± 3.2
Luna Sensation	2.7	± 3.5	15.3	± 22.5
PerCarb	14.5	± 7.7	36.7	± 24.4
Untreated Check	50.0	± 34	54.3	± 20.2
Banish	39.7	± 25.6	72.5	± 14.7

The fifth evaluation was conducted on August 22 (Table 6). Significant development of PM was observed on the lower leaf surface of most treatments, while most upper leaf surface ratings remained relatively stable. Only Luna Experience remained under 10% for upper and lower leaf ratings at this point in the season. Only Luna Sensation, Quintec, and TopGuard had less than 10% PM on the upper leaf surface. No treatments had higher upper leaf ratings compared to the UTC and only Banish was 1% higher than the UTC in lower leaf ratings.

Table 6. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 22, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Luna Experience	0.9	± 0.7	9.3	± 3.3
Luna Sensation	0.9	± 1.5	31.2	± 24.9
Quintec	9.7	± 10.5	35.3	± 35.3
Oxidate + Merivon	27.0	± 23.7	40.3	± 19.7
TopGuard	8.2	± 3.9	50.0	± 17.9
PerCarb	15.8	± 15.5	50.8	± 19.9
Untreated Check	55.4	± 25.7	78.9	± 24.3
Banish	44.5	± 35.3	80.0	± 27.6

In the sixth evaluation on August 30 (Table 7), PM infestations on the UTC continue to rise. The upper and lower leaf surface ratings for all treatments are below the UTC. Luna Experience, Luna Sensation, Quintec and PerCarb are at or below 10% for upper leaf infestation, with the other treatments ranging between 21 and 31%. Luna Experience, Luna Sensation and Oxidate + Merivon treatments are all below 35% infestation on the lower leaf surface. The other treatments ranged from 56 – 92% infestation on the lower leaf surface. This is the final week the plots were treated with fungicide.

Table 7. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 30, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Luna Experience	1.1	± 2.4	21.5	± 18.2
Oxidate + Merivon	23.8	± 28.5	34.5	± 25.6
Luna Sensation	1.9	± 4	34.7	± 22.2
Quintec	4.3	± 2.1	56.7	± 19.4
PerCarb	10.7	± 5.8	65.8	± 29.6
TopGuard	21.3	± 24.8	68.3	± 21.1
Banish	31.3	± 26.1	91.7	± 11.3
Untreated Check	69.6	± 22.3	97.5	± 3.8

In the final evaluation on September 7 (Table 8), the UTC has stabilized at 72% for the upper and 91% for the lower leaf surface, meaning both sides of the leaf were nearly covered with PM colonies. All treatments on both leaf surfaces were at least 40% and 20% lower respectively for the upper and lower leaf surface than the UTC. Both Luna treatments and Quintec were under 6% infestation on the upper leaf, with TopGuard at 11%. The highest infestation on the upper leaf surface was the Banish treatment at 32%. Luna Experience on the lower leaf surface was rated at 14%, the lowest of all treatments. The remaining treatments ranged between 38-69% infestation on the lower leaf surface.

Table 8. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for September 7, sorted by lower leaf surface.

TRT	Avg % PM Upper Leaf	ST Dev Upper Leaf	Avg % PM Lower Leaf	ST Dev Lower Leaf
Luna Experience	2.9	± 6	14.0	± 7.4
Luna Sensation	1.3	± 1.9	38.2	± 26.6
TopGuard	11.5	± 6.6	50.0	± 13
Oxidate + Merivon	24.0	± 16.8	56.7	± 21.1
Quintec	6.2	± 6.1	66.7	± 18.9
PerCarb	22.0	± 22.5	67.0	± 31.3
Banish	32.0	± 25.3	69.3	± 42.7
Untreated Check	72.1	± 16.7	91.4	± 6.6

Project Scope

This goal of this powdery mildew demonstration trial is to evaluate the contribution and effectiveness of a primary fungicide when used in combination with standard rotational fungicides such as Procure and Manzate Pro Stick, to determine leaf and canopy health, ostensibly to maximize marketable fruit and handle quality. Due to resistance management guidelines, other products such as Vivando and Torino were also included as rotational partners; both have been shown to be at least as efficacious as the standard rotational products in the other treatments.

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 Plectosporium as described in the introduction.

In general, the upper leaf surface and upper canopy is easier to protect with fungicides, and therefore typically has lower levels of powdery mildew infestation. The lower leaf surface and mid to lower canopy is more difficult to protect due in part to known limitations in application technology and complex plant architecture, but can reveal the extent to which materials are mobile or locally systemic. **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 Oxidate, PerCarb, and Manzate Pro Stick.

The scouting threshold for PM is conservative and uses initial detection to determine the onset of fungicide applications. In terms of relative product comparisons, lower percent infestation is considered better. When leaves become colonized by PM in the 70+% range, they quickly begin to show symptoms of chlorosis, necrosis, and disintegrate, leaving fruit exposed to possible sunburn.

Conclusions

In the 2018 trial, all treatment combinations looked good through the third evaluation on August 6 where all treatments were below 10% infestation on both leaf surfaces, but the UTC was showing slightly heavier colonization at 14% on the upper surface.

The fourth evaluation on Aug. 14 showed an initial performance split between Luna Experience, Quintec, Oxidate + Merivon, Top Guard, and Luna Sensation all at or below 15% on the lower leaf surface. PerCarb was at 37%, the UTC was at 54% and Banish was at 72% infestation on the lower leaf surface.

During the last three evaluations, product performance was beginning to stabilize, and by looking more broadly at the performance of the products in the treatments by averaging the upper and lower leaf ratings for the next three evaluations (Aug. 22 – Sept. 7), helped sort out the product combinations numerically. In terms of lower leaf surface ratings, Luna Experience had the lowest infestation at 15%, followed by Luna Sensation (35%), Oxidate + Merivon (44%), Quintec (53%), TopGuard (56%), PerCarb (61%), Banish (80%), and UTC (89%). In terms of upper leaf infestation, the lowest was Luna Sensation (1.3%), followed

by Luna Experience (1.6%), Quintec (7%), TopGuard (14%), PerCarb (16%), Oxidate + Merivon (25%), Banish (36%) and UTC (66%).

The best performing fungicide program in this trial based on season long lower leaf surface PM control would be Luna Experience alternated with Vivando, which did not exceed 22% throughout the trial. The mode of action (MOA) or fungicide resistance action committee (FRAC) numbers in this treatment included 7(SDHI) and 3(DMI), alternated with U8 (benzophenone).

The second tier of fungicide programs in this trial based on lower leaf ratings were Luna Sensation and Oxidate + Merivon treatments, although Luna Sensation had reduced upper and lower leaf surface ratings compared to Oxidate + Merivon. The MOA/FRAC numbers for these two treatments are both 7 (SDHI) plus 11(QoI) alternated with U8 (benzophenone) or 3 (DMI).

The third tier of treatments would include Quintec, TopGuard, and PerCarb. These three compounds averaged over 50% infestation on the lower leaf surface during the last three ratings. While they gave good control of PM on the upper leaf surface throughout most of the season, around mid August the lower leaf infestation began to noticeably increase and outpace other treatments. The MOA / FRAC numbers include 13(quinoxifen) for Quintec, 3 (DMI) and 11(QoI) for TopGuard, but an unknown MOA for PerCarb alternated with a 3(DMI) for both Quintec and PerCarb, but U6 (benzamidoxime) and U8 (benzophenone) for TopGuard.

In terms of historic product performance, **prior** to 2017, treatment 4 (Quintec alternated with Procure) was consistently the highest rated “standard” recommended fungicide program, meaning relative to its performance, other fungicide programs could be compared. In 2017 and 2018, we observed a significant loss of efficacy for this product combination in our trials and will likely not be able to give a strong recommendation for this product combination in the future.

The fourth tier of treatments would include Banish alternated with Banish. This treatment had upper and lower leaf ratings consistent with the untreated check. The MOA / FRAC for this compound is unknown.

Given the differences in efficacy between the fungicide treatments in this trial, the Luna Experience treatment performed very well on both leaf surfaces and would be highly recommended to commercial growers looking for nearly season long total control of PM.

Both the Luna Sensation and Oxidate + Merivon programs would be considered above average performers in this trial and a good choice for commercial growers, though Luna would be considered a slightly better combination for controlling PM on both leaf surfaces, especially later in the year.

Quintec, Top Guard, and PerCarb programs would be considered acceptable for use in commercial spray programs, especially in the first half or two thirds of the season but stretching spray intervals into the 10-14 day range may result in decreased efficacy.

The final treatment in this trial, Banish, with the active ingredient of geranium oil, did not provide acceptable control of PM on either leaf surface and would not be recommended as a stand-alone treatment on a commercial farm.

As you review this report remember 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.

Recall that the pumpkin hybrid we intentionally used in this trial is susceptible to PM, meaning these results reflect the worse-case scenario in terms of efficacy. As part of our IPM program standard recommendations, we strongly recommend growers select a PM tolerant or resistant hybrid when possible to maximize foliage and handle quality throughout the season. Even marginal spray programs provide much better control when used in combination with these other tolerant or resistant hybrids.

If you have any questions about the results of this trial, please contact me.

Respectfully,

Jim Jasinski
Extension Educator
IPM Program Coordinator