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Pumpkin Powdery Mildew Fungicide Demonstration Trial Report - 2014

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Introduction

In 2014, a powdery mildew 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 and fruit quality and yield.

The trial was direct seeded on May 29th using a Monosem vacuum seeder. Each plot consisted of four 60' long rows of Solid Gold 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.

Fertility across the field was added uniformly 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 using Strategy (5 pt /A) plus Dual Magnum (1.6 pt /A) applied pre emerge followed two weeks later by an application of Sandea (1.0 oz/A) between the rows prior to vines running. Any weed escapes between the rows 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 22nd, which initiated all 15 treatment applications on that same day (no application made to 16, untreated check). Prior to the application, all treatments were scouted for an initial disease rating on both the upper and lower leaf surfaces. Successive canopy evaluations were conducted on July 31st, August 12th, August 25th, and September 4th.

For the first two evaluations five randomly chosen leaves were examined (upper and lower surface) for powdery mildew colonies; for the final three evaluations nine leaves were evaluated for this disease. Prior to 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

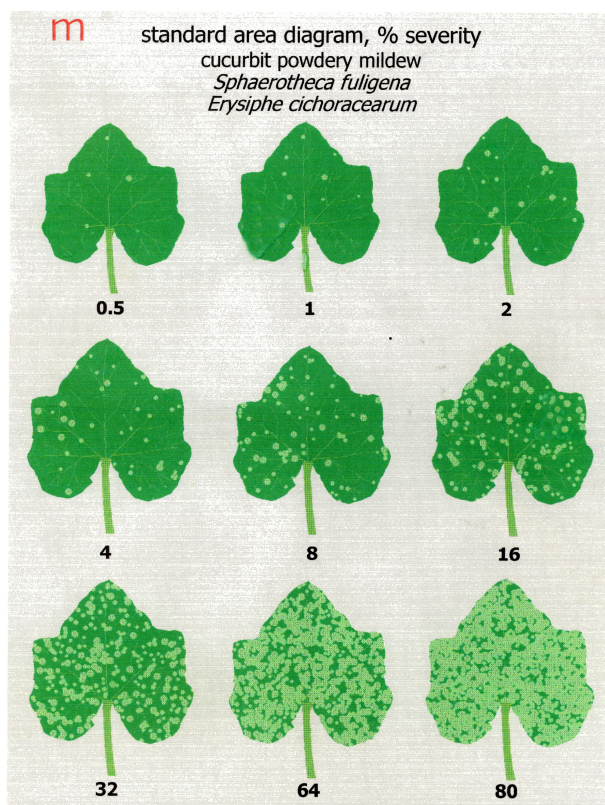


Figure 1. Percent powdery mildew infection chart.

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.

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, but these pathogens were not a factor in our 2014 trial.

Fungicide treatment sprays were applied on a 7 day schedule starting July 22nd, July 29th, August 5th, August 12th, August 19th, and August 26th. All trial treatments were applied from a hydraulic boom sprayer at 35 GPA and 60 PSI using hollow cone nozzles. Treatment 14, Oxidate 2.0, was applied on a 3-4 day schedule with the actual application

dates of July 22, 25, 29; August 1, 5, 8, 12, 19, 26, and 29.

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. Treatments 14 and 15 were not alternated in this way but used the same product for each application. No sprays were applied to the untreated check.

Results

Data for the five powdery mildew (PM) evaluations are sorted by lower leaf rating, from the lowest mean (e.g., higher efficacy) to the highest mean (e.g., lower efficacy) for that date (Figs. 2-6) and (Tables 2-6).

For the first evaluation on July 22nd of Solid Gold (Rupp Seed), a powdery mildew susceptible hybrid, both upper and lower leaf PM ratings were < 1.5% for all treatments, indicating this disease was just getting established in the plots.

The second evaluation nine days later (July 31st) showed treatments 1, 9, and 14 had exceeded 2% infestation on the upper leaf surface, and only treatments 9 and 14 exceeded 2% on the lower leaf surface. All other treatments were below 2% on both leaf surfaces, indicating overall disease pressure at this point was still very low but building in all plots.

By the third evaluation 12 days later (August 12th), treatment 16 (untreated check) was at 70% infestation on the upper leaf and 31% on the lower leaf surface. Treatment 15 exceeded 20% on the upper leaf surface, and treatments 15, 5, and 14 all exceeded 40% infestation on the lower leaf surface. All other treatments had upper leaf infestation below 18% and lower leaf infestation below 15%.

The fourth evaluation 13 days later (August 25th) had treatment 16 (untreated check) at 98% PM infestation for both upper and lower leaf surfaces. Treatments 14 and 15 had upper leaf infestations at 73% or higher and treatments 6, 5, 15, and 14 exceeded 67% on their lower leaf surfaces. All other treatments had upper leaf infestations below 17% and lower leaf infestations below 31%.

The final canopy evaluation was performed on September 4th, 10 days after the last leaf evaluation and nine days after the last spray. Treatment 16 (untreated check) was observed at 97% and 96% PM infested on the upper and lower leaf surface respectively. Only treatments 14 and 15 exceeded 60% infestation on the upper leaf surface, while treatments 10, 6, 3, and 4 exceeded 42% PM infestation and treatments 5, 14, and 15, exceeded 80% PM infestation on the lower leaf surface. All other treatments were below 25% and 30% infestation for the upper and lower leaf surface respectively.

Yield and other measures of fruit quality were also taken from these demonstration plots (Figs. 7,8). The middle third of each treatment was harvested for yield and included all fruit found within a 20' long section across all four rows, or 80' of total row. Each fruit was individually weighed and graded for disease on the handle or rind itself (Table 7).

The number of marketable fruit in each harvested section were defined as orange fruit with no handle or disease defects. Fruit of this quality ranged from five to 49 in treatments 14 and 7 respectively. Likewise the number of non-marketable fruit, those fruit that were either green (immature), had powdery mildew or Sclerotinia infected handles, or graded as culls due to sunburn or other fruit rots, ranged from three in treatment 3 to 35 fruit in treatments 14 and 15.

Treatment 7 had the highest marketable yield at 970 pounds, with the lowest yield of 83 pounds in treatment 14. Treatments with the highest weight of pumpkins with powdery mildew handles, Sclerotinia handles, and culled fruit were 5, 14, and 2 respectively.

Conclusions

This powdery mildew demonstration trial rated two aspects of production, leaf or canopy health, measured in percent leaf coverage, and yield, measured by marketable fruit and fruit quality.

The upper leaf surface is easier to protect and deposit fungicide on, and therefore usually has much lower levels of powdery mildew infestation. The lower leaf surface is much more difficult to protect due primarily to known limitations in application technology and canopy architecture but can reveal the extent to which materials are mobile on the leaf

surface or exhibit any translaminar activity. Using that criteria, this report focuses primarily on how well the lower leaf surface is protected.

Through the first two evaluations, powdery mildew populations were present at very low levels (<4%). Although several treatments had disease pressure higher than the untreated check on both leaf surfaces, differences in overall treatment efficacy at this stage is difficult to document.

The lower leaf surface evaluation and subsequent efficacy from all treatments on August 12th can be broken into three groups; those treatments providing excellent protection against powdery mildew (trt's 2, 8, 1, 12, 13, 7); those treatments providing good or acceptable control (trt's 11, 10, 6, 3, 4, 9); and those treatments providing fair to poor control (trt's 16, 15, 5, 14). Treatments placed in these three categories are arbitrary since no real thresholds exist for this disease, and are used only to show relative treatment efficacy as of this date.

Following the same criteria for the August 25th evaluation, treatments 8, 2, 1, 13, and 7 provided excellent protection against powdery mildew infestation, treatments 12, 4, 11, 3, 9, and 10 provided good or acceptable control, and treatments 6, 5, 15, 16, and 14 exhibited fair to poor control. Again, treatments placed in these three categories are arbitrary since no real thresholds exist for this disease, and are used only to show relative treatment efficacy as of this date.

The final leaf evaluation on September 4th showed excellent control for treatments 8, 2, 12, 7, 1, 11, 13, and 9 having 30% or lower powdery mildew development over the season, good to acceptable control for treatments 10, 6, 3, and 4 having 42-55% powdery mildew infestation over the season, and fair to poor control for treatments 15, 5, 14, and 16 with powdery mildew ratings at 80% or higher over the season.

Comparing five paired treatments (1 vs. 2, 3 vs. 4, 5 vs. 6, 7 vs. 8, and 12 vs. 13) where only the adjuvant differed between the treatments, the number of pairings using Orus 009 with equivalent or reduced powdery mildew infestations on their lower leaf surface were 3/5 treatments (Quintec, Regalia, and Torino) on July 22nd, 3/5 treatments (Quintec, Regalia, and Merivon) on July 31st, 5/5 treatments on August 12th and August 25th, and 3/5 treatments (Quintec, Regalia, and Merivon) on September 4th.

In treatments 5, 6, 9, 14, 15, and 16, the number of non-marketable fruit was higher than the number of marketable fruit. Likewise, treatments 5, 6, 9, 14, 15, and 16 all have marketable yields under 400 pounds per harvested section. Treatments 5, 14, 15, and 16 also have the highest powdery mildew disease pressure as of the final leaf rating on September 4th, showing a relationship between canopy loss, lower fruit quality, and lower marketable yield.

The fungicide Vivando (trt's 10 & 11) is not registered for use on pumpkin and was placed in the trial as an experimental compound. This material showed good to fair powdery mildew leaf control through the season, and had yields and fruit quality that suggested no

phytotoxic effects or yield reduction was caused by use of this material in the trial. There appears to be a rate response, with the higher rate offering better leaf protection, more marketable fruit, and a higher marketable yield.

This trial was designed as a large plot demonstration trial 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.

Plot Images

This year we were fortunate enough to try aerial photography via an unmanned aerial vehicle (UAV) to support the percent leaf infestation as an overall measurement of canopy health (Figs. 9, 10). We were not able to get early shots of the plots for a complete season of treatment efficacy but we were able to get two shots mid to late season. This imagery is interesting as we can plainly see various levels of efficacy, from green (healthy foliage) to brown (dying foliage) to white (powdery mildew covered foliage).

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

Table 1. 2014 Powdery mildew fungicide demonstration trial treatments.

	Sprays 1, 3, 5 (7/22, 8/5, 8/19)	Sprays 2, 4, 6 (7/29, 8/12, 8/26)
TRT	Product, Rate, and FRAC	Product, Rate, and FRAC
1	Quintec (6 oz) + Bravo (1 pint) [frac 13 + M]	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
2	Quintec (6 oz) + Bravo (1 pint) + Orus 50oz/100 gallon [frac 13 + M]	Procure (8 oz) + Manzate (2.5 lb) + Orus (0.39% v/v) [frac 3 + M]
3	Pristine (18.5 oz) + Bravo (1 pint) [frac 11,7 + M] + Activator 90 (0.25 v/v)	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
4	Pristine (18.5 oz) + Bravo (1 pint) + Orus 50oz/100 gallon [frac 11, 7 + M]	Procure (8 oz) + Manzate (2.5 lb) + Orus (0.39% v/v) [frac 3 + M]
5	Regalia 2Qt + Bravo (1 pint) [frac P5 + M]	Procure (8 oz) + Regalia 1 Qt + Manzate (2.5 lb) + Orus 0.39% v/v [frac 3 + P5 + M]
6	Regalia 2Qt + Bravo (1 pint) + Orus 0.39% v/v [frac P5+M]	Procure (8 oz) + Regalia 1 Qt + Manzate (2.5 lb) + Orus 0.39 % v/v [frac 3 + P5 + M]
7	Merivon (4.0 oz) + Latron B (Franchise 2-4oz/A) + Bravo (1 pint) [frac 7,11 + M]	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
8	Merivon (4.0 oz) + Orus (0.39% v/v) + Bravo (1 pint) [frac 7,11 + M]	Procure (8 oz) + Manzate (2.5 lb) + Orus (0.39% v/v) [frac 3 + M]
9	Merivon 4 oz + Latron B (2 oz/A)	Regalia 1Qt + Procure (8 oz) + Manzate (2.5 lb) [frac P5 + 3 + M]
10	Vivando* (10.3 oz) + Bravo (1 pint) [frac U8 + M] + Activator 90 (0.25 v/v)	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
11	Vivando* (15.4 oz) + Bravo (1 pint) [frac U8 + M] + Activator 90 (0.25 v/v)	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
12	1. Torino (3.4 oz) + Activator 90 (0.25% v/v) [frac U6] 3. Torino (3.4 oz) + Activator 90 (0.25% v/v) [frac U6] 5. Merivon (4.0 oz) + Latron B (2 oz/A) + Bravo (1 pints) [frac 7,11 + M]	Procure (8 oz) + Manzate (2.5 lb) [frac 3 + M]
13	1. Torino (3.4 oz) + Orus (0.39% v/v) [frac U6] 3. Torino (3.4 oz) + Orus (0.39% v/v) [frac U6] 5. Merivon (4.0 oz) + Orus (0.39% v/v) + Bravo (1 pints) [frac 7,11 + M]	Procure (8 oz) + Manzate (2.5 lb) + Orus (0.39% v/v) [frac 3 + M]
14 ^{abc}	OxiDate 2.0 @ 1:40 (2.5% v/v) + Silwet ECO spreader (0.1% v/v)	OxiDate 2.0 @ 1:40 (2.5% v/v) + Silwet ECO spreader (0.1% v/v)
15 ^a	OxiPhos @ 5 Quarts/A	OxiPhos @ 5 Quarts/A
16	Untreated Check	Untreated Check

* Not registered for use on pumpkin.

^a Applied at 50 GPA

^b Applied on 3-4 day schedule

^c Surfactant removed after 7/29/14 application due to phytotoxicity

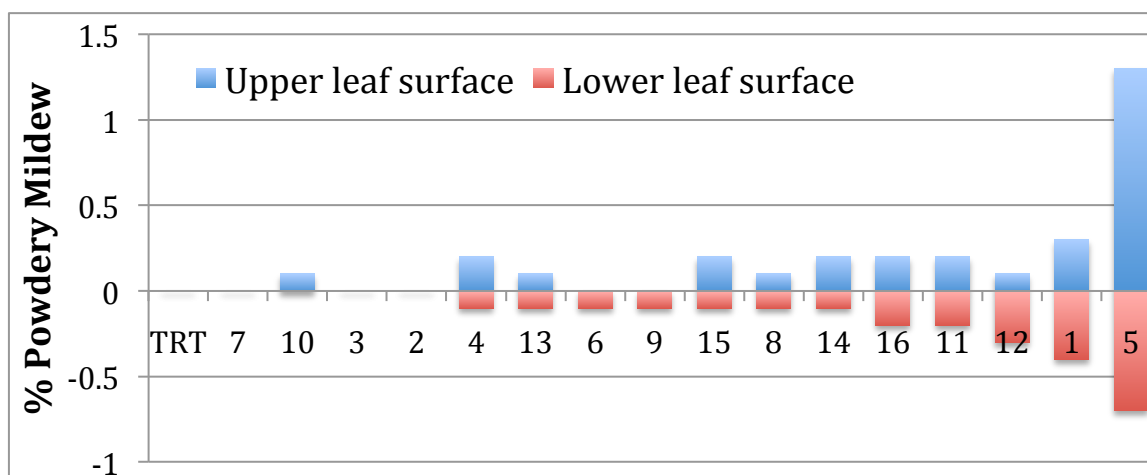


Figure 2. Mean percent powdery mildew ratings for five lower and upper leaf surface of Solid Gold pumpkin taken on July 22nd by treatment.

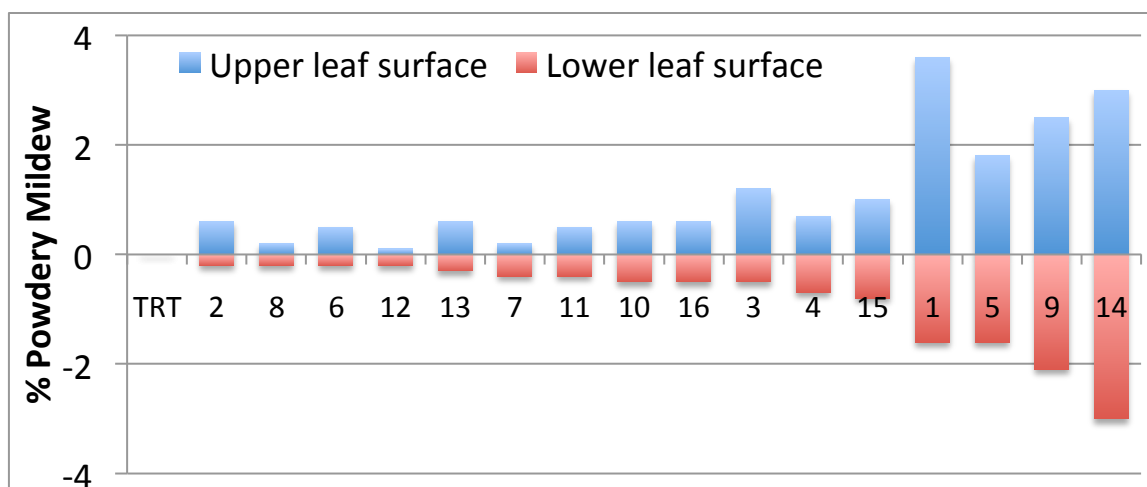


Figure 3. Mean percent powdery mildew ratings for five lower and upper leaf surface of Solid Gold pumpkin taken on July 31st by treatment.

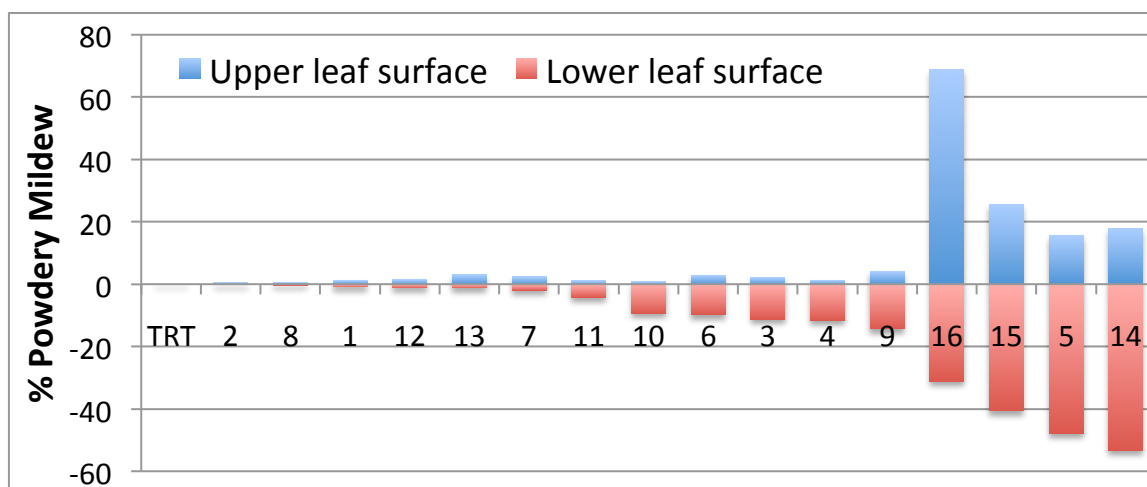


Figure 4. Mean percent powdery mildew ratings for nine lower and upper leaf surface of Solid Gold pumpkin taken on August 12th by treatment.

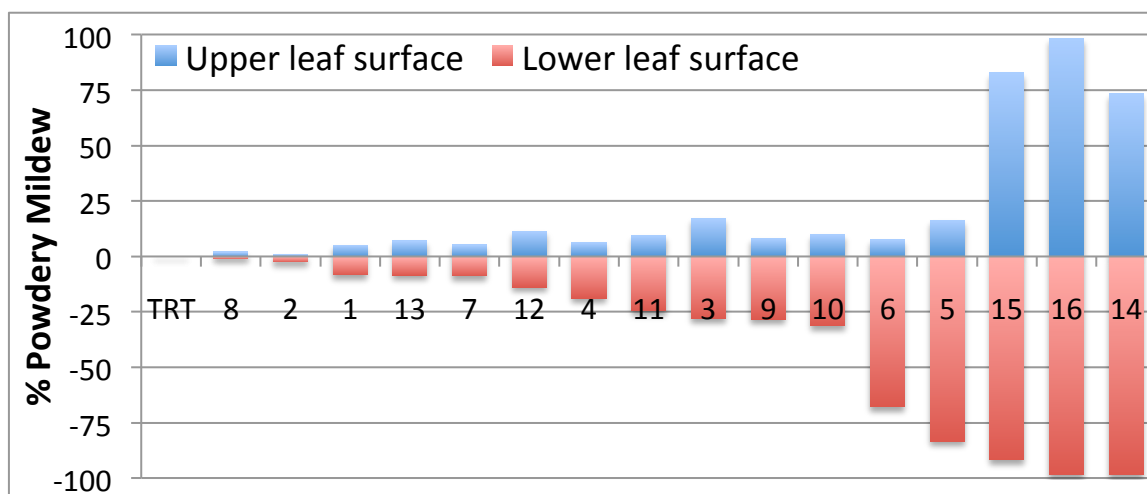


Figure 5. Mean percent powdery mildew ratings for nine lower and upper leaf surface of Solid Gold pumpkin taken on August 25th by treatment.

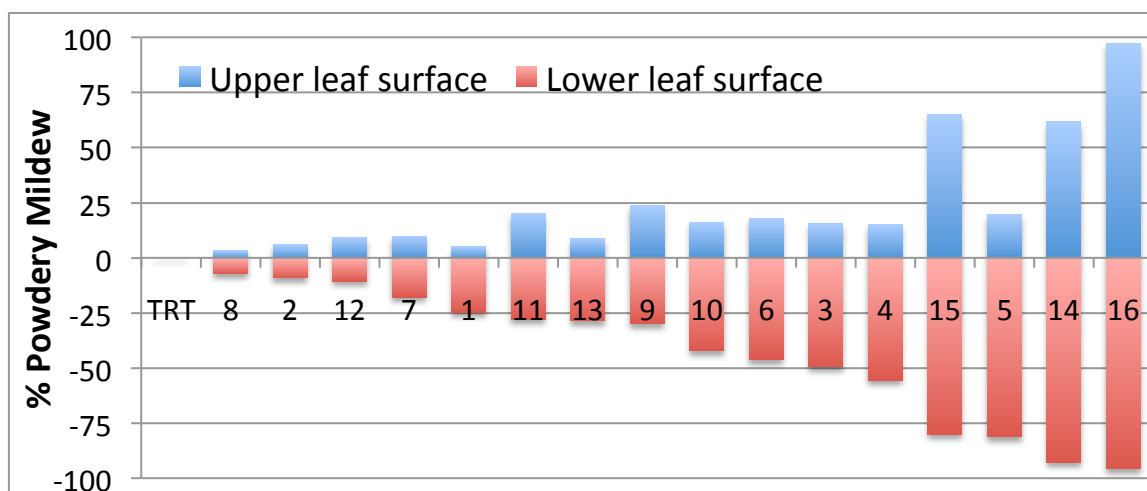


Figure 6. Mean percent powdery mildew ratings for nine lower and upper leaf surface of Solid Gold pumpkin taken on September 4th by treatment.

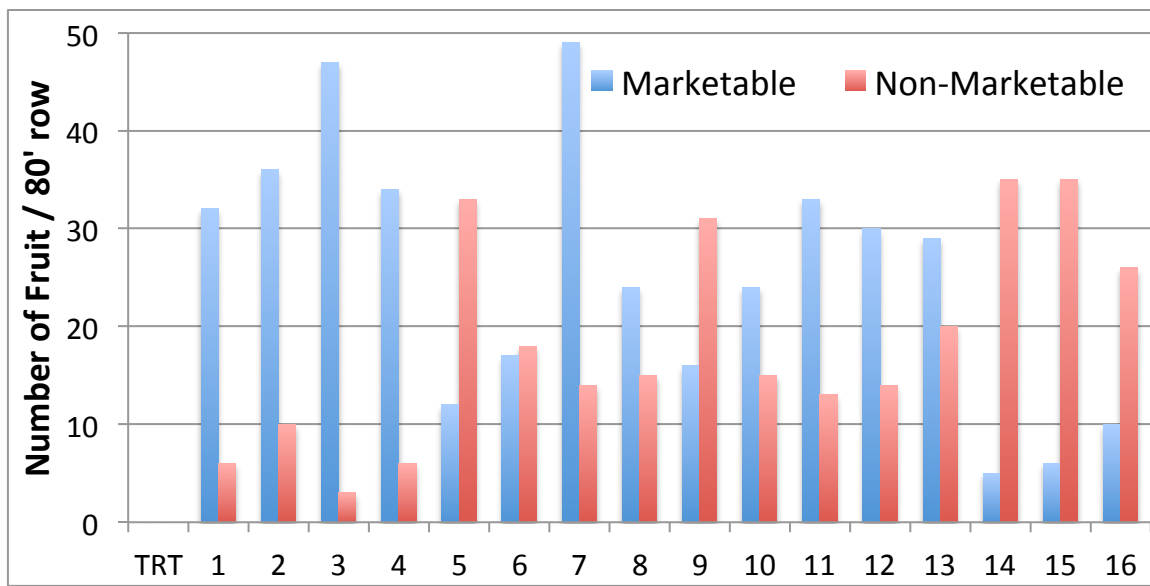


Figure 7. Number of marketable and non-marketable fruit harvested from 80' of row in the pumpkin powdery mildew demonstration trial.

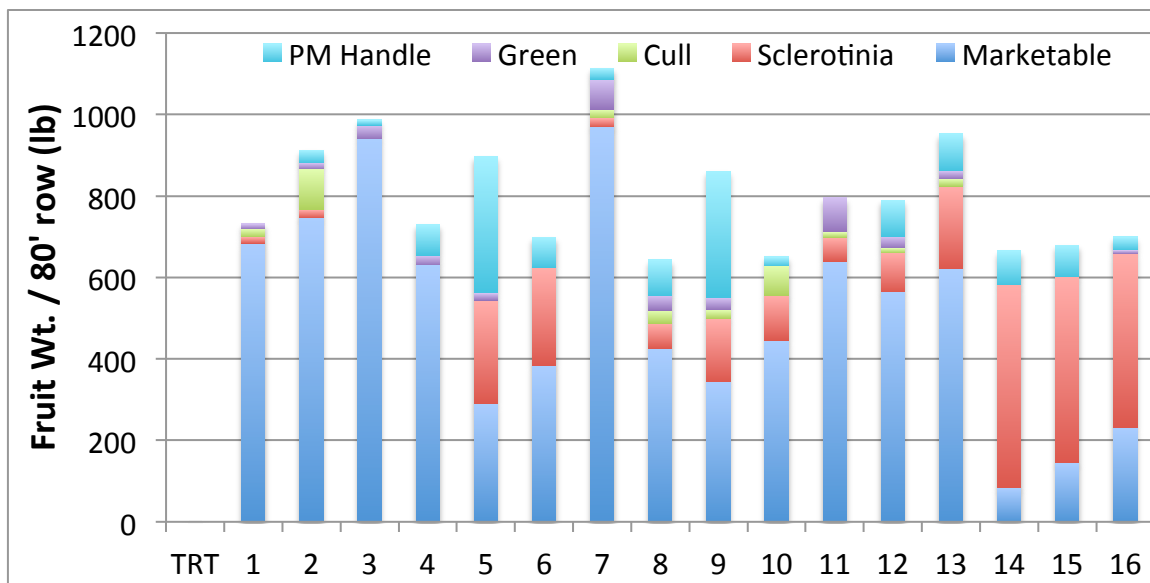


Figure 8. Weight of marketable and non-marketable fruit (powdery mildew handles, green fruit, culls, Sclerotinia rotted handles) harvested from 80' of row in the pumpkin powdery mildew demonstration trial.

Table 2. Percent powdery mildew ratings for July 22nd. Means are taken from five leaf samples.

TRT	Upper leaf surface	Lower leaf surface
7	0.0	0.0
10	0.1	0.0
3	0.0	0.0
2	0.0	0.0
4	0.2	0.1
13	0.1	0.1
6	0.0	0.1
9	0.0	0.1
15	0.2	0.1
8	0.1	0.1
14	0.2	0.1
16	0.2	0.2
11	0.2	0.2
12	0.1	0.3
1	0.3	0.4
5	1.3	0.7

Table 3. Percent powdery mildew ratings for July 31st. Means are taken from five leaf samples.

TRT	Upper leaf surface	Lower leaf surface
2	0.6	0.2
8	0.2	0.2
6	0.5	0.2
12	0.1	0.2
13	0.6	0.3
7	0.2	0.4
11	0.5	0.4
10	0.6	0.5
16	0.6	0.5
3	1.2	0.5
4	0.7	0.7
15	1.0	0.8
1	3.6	1.6
5	1.8	1.6
9	2.5	2.1
14	3.0	3.0

Table 4. Percent powdery mildew ratings for August 12th.
Means are taken from nine leaf samples.

TRT	Upper leaf surface	Lower leaf surface
2	0.5	0.2
8	0.7	0.3
1	1.3	0.9
12	1.6	1.1
13	3.2	1.2
7	2.4	1.9
11	1.2	4.2
10	0.8	9.3
6	2.9	9.8
3	2.2	11.2
4	1.3	11.7
9	4.2	14.3
16	68.9	31.1
15	25.6	40.6
5	15.6	47.8
14	17.9	53.3

Table 5. Percent powdery mildew ratings for August 25th.
Means are taken from nine leaf samples.

TRT	Upper leaf surface	Lower leaf surface
8	2.1	1.0
2	1.0	2.4
1	5.2	8.3
13	7.0	8.4
7	5.2	8.8
12	11.3	13.8
4	6.3	18.8
11	9.4	24.6
3	17.0	28.1
9	8.1	28.3
10	9.8	31.1
6	7.6	67.8
5	16.3	83.3
15	82.8	91.7
16	98.3	98.3
14	73.3	98.3

Table 6. Percent powdery mildew ratings for September 4th. Means are taken from nine leaf samples.

TRT	Upper leaf surface	Lower leaf surface
8	3.6	7.2
2	6.1	9.1
12	9.4	10.6
7	9.9	17.8
1	5.2	24.9
11	20.0	27.8
13	9.0	28.6
9	23.9	29.9
10	16.1	42.2
6	18.0	46.2
3	15.4	49.4
4	15.2	55.6
15	65.0	80.0
5	19.6	81.1
14	61.7	92.8
16	97.2	95.6

Table 7. Yield, number, and fruit quality data for pumpkins harvested from 80' of row.

TRT	Marketable (# fruit)	Non-Marketable (# fruit)	Marketable (lb)	Sclerotinia (lb)	Cull (lb)	Green (lb)	PM Handle (lb)
1	32	6	684.3	16.3	19.2	12.4	0.0
2	36	10	747.0	20.7	98.8	15.2	31.4
3	47	3	940.5	0.0	0.0	33.5	13.2
4	34	6	630.7	0.0	0.0	23.4	75.5
5	12	33	291.0	253.4	0.0	17.6	335.2
6	17	18	383.4	240.7	0.0	0.0	75.2
7	49	14	970.1	22.0	20.5	73.7	27.7
8	24	15	425.6	62.5	32.0	36.2	86.7
9	16	31	343.9	155.7	21.5	29.4	309.7
10	24	15	446.3	109.5	72.5	0.0	22.3
11	33	13	640.0	58.9	12.8	84.5	0.0
12	30	14	564.8	96.8	11.2	27.9	88.9
13	29	20	620.9	203.7	17.8	19.8	91.0
14	5	35	83.2	498.4	0.0	0.0	84.0
15	6	35	144.9	456.5	0.0	0.0	78.2
16	10	26	232.4	426.7	0.0	8.5	32.0



Figure 9. Image taken at ca. 65' above powdery mildew demonstration trial at Western Ag Research Station via UAV, August 19th, 2014. Treatments are as follows: top row, left to right, 1, 2, 3, 4; second row from top left, 5, 6, 7, 8; third row from top left, 9, 10, 11, 12; bottom row left to right, 13, 14, 15, 16.



Figure 10. Image taken at ca. 65' above powdery mildew demonstration trial at Western Ag Research Station via UAV, August 29th, 2014. Treatments are as follows: top row, left to right, 1, 2, 3, 4; second row from top left, 5, 6, 7, 8; third row from top left, 9, 10, 11, 12; bottom row left to right, 13, 14, 15, 16.