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Pumpkin Powdery Mildew Fungicide Demonstration Trial Report - 2020

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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 at 39.857672, -83.667513. All treatments were applied to a powdery mildew susceptible hybrid (Hybrid Pam, Rupp Seeds) to determine the efficacy of compounds on foliage health. No yield data was taken.

This goal of this powdery mildew demonstration trial is to evaluate the contribution and effectiveness of a primary fungicide when used in combination with rotational fungicides such as Procure, Manzate Pro Stick, Vivando or Quintec to determine leaf and canopy health, ostensibly to maximize marketable fruit and handle quality.

These fungicide programs have been designed to primarily manage powdery mildew and may have inherent weaknesses against specific diseases such as downy mildew and bacterial diseases.

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 spray 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.

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, losing the ability to photosynthesize and leaving fruit exposed to possible sunburn and marketable loss.

Remember the pumpkin hybrid we **intentionally** used in this trial is **PM susceptible**, which helps us to separate the genetic resistance the plant may offer from the efficacy of the fungicide program. 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.

In the 2020 trial, the weather was more like a “normal” summer with a heat spell in July but overall drier, especially in the early summer. From June 1 - September 15 which is the duration of the pumpkin growing season, the station recorded only 7.6” of rain. While this dry weather likely reduced the development of downy mildew and bacterial diseases, powdery mildew is one of only a few fungi that can develop in the absence of water, needing only high humidity to infest foliage.

Methods

The trial was direct seeded June 1 using a Monosem vacuum planter. Each plot consisted of one 80’ long row of Hybrid Pam pumpkin with a final stand 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 Strategy (4.5 pints/A) plus Dual Magnum (1.3 pints/A) pre-emerge June 2, followed by a shielded post application of Sandea (1oz/A) and glyphosate (32oz/A) between the rows on June 15. 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 26, 65 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 2020, Downy Mildew was never confirmed in Ohio on pumpkin. Regardless, the plots were protected by alternating Ranman (2.75 oz/A) and Zampro (14 oz/A) on Aug. 14, Aug. 21, Aug. 28, and Sept. 4. None of the Downy products should impact PM development. Bacterial Leaf Spot was not detected on the foliage or fruit in any of the treatments, therefore no copper protectant sprays were not applied.

Powdery mildew was first detected in the trial on July 27, with full scouting and data collection occurring on July 28; August 14, 21, 28; September 4 and 14. Disease ratings were taken at 10 AM for all dates. The fungicide treatments were applied on July 29; August 6, 14, 21, 28; and September 4. All treatments were applied using a hydraulic boom sprayer at 35 GPA using hollow cone nozzles at 65 PSI.

In each treatment plot, powdery mildew development was evaluated 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 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 were calculated for use in the tables below.

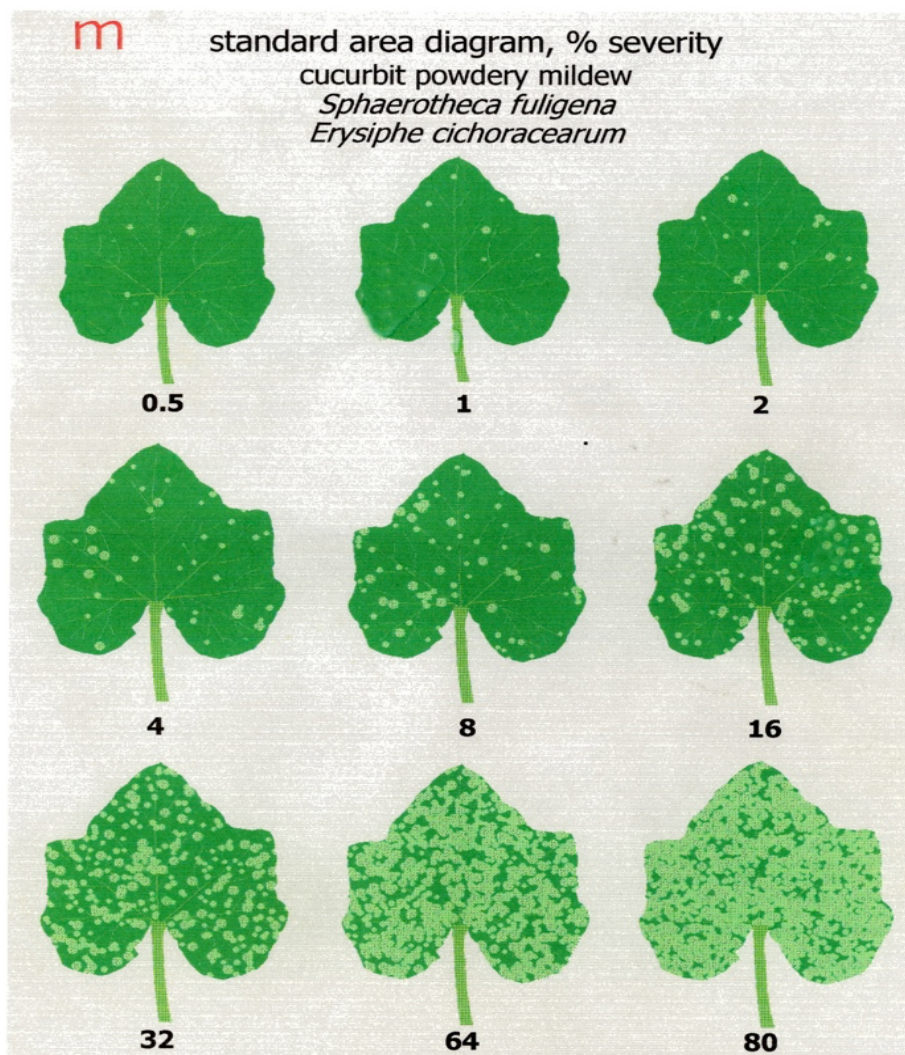


Figure 1. Percent powdery mildew infection chart.

Fungicide treatments are listed in **Table 1**. Rating data for the seven evaluations can be found in **Tables 2-7**. The “untreated check” was 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. 2020 Powdery mildew fungicide trial treatments, rates, FRAC and manufacturer.

TRT	Product, Rate, FRAC Sprays 1 (7/29), 3 (8/14), and 5 (8/28)	Product, Rate, FRAC Sprays 2 (8/6), 4 (8/21), and 6 (9/4)
1	Luna Experience 6 fl oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) [FRAC 7,3 +M] (Bayer, UPL)	Vivando 15.4 fl oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) FRAC [U8 + M] (BASF, UPL)
2	Luna Sensation 6 fl oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) (FRAC 7,11 + M) (Bayer, UPL)	Vivando 15.4 fl oz + Manzate Pro 2.5 lbs + Chemsurf 90 (0.125 v/v) FRAC [U8 + M] (BASF, UPL)
3	Procure 8 fl oz + Manzate Pro 2.5lbs + Vacciplant 14 fl oz (FRAC 3 + M +P4) (UPL)	Vivando 15.4 fl oz + Manzate Pro 2.5 lbs + Vacciplant 14 fl oz (FRAC U8 + M + P4) (BASF, UPL)
4	Procure 8 fl oz + Dexter MAX 3.2 lbs + Vacciplant 14 fl oz (FRAC 3 + M, 11 + P4) (UPL)	Vivando 15.4 fl oz + Manzate Pro 2.5 lbs + Vacciplant 14 fl oz (FRAC U8 + M + P4) (BASF, UPL)
5	Miravis Prime 11.4oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) [FRAC 7,12 +M] (Syngenta, UPL)	Procure 8 oz + Manzate Pro 2.5 lbs + Chemsurf 90 (0.125 v/v) [FRAC 3 + M] (UPL)
6	Inspire Super 20oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) [FRAC 9,3 + M] (Syngenta, UPL)	Vivando 15.4 fl oz + Manzate Pro 2.5lbs + Chemsurf 90 (0.125 v/v) FRAC [U8 + M] (BASF, UPL)
7	(1&3) Torino 3.4 oz + Manzate Pro 2.5 lbs; (5) Procure 8oz + Manzate Pro 2.5 lb [FRAC U6 +M] and [FRAC 3 + M] (Gowan, UPL)	Quintec 6oz + Manzate Pro 2.5lbs [FRAC 13 + M] (Gowan, UPL)

Results

The first PM evaluation was conducted on July 28 (Table 2) to provide a baseline verifying that PM infections could be found at very low levels on both upper and lower leaf surfaces (<0.3%) in most if not all treatments throughout the trial. No fungicides have been applied yet.

Table 2. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for July 28.

28-Jul	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 1 - Luna Experience	0.17	0.26	0.33	0.41
TRT 2 - Luna Sensation	0.00	0.00	0.25	0.27
TRT 3 - Procure 1	0.00	0.00	0.08	0.20
TRT 4 - Procure 2	0.00	0.00	0.08	0.20
TRT 5 - Miravis Prime	0.00	0.00	0.08	0.20
TRT 6 - Inspire Super	0.00	0.00	0.17	0.26
TRT 7 - Torino	0.00	0.00	0.17	0.26

UTC - Untreated Check	0.04	0.13	0.07	0.18
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In the second evaluation (Table 3), the UTC had higher PM infestation than all treatments except for the lower leaf of Luna Experience. Infestations in all treatments were 5% or lower on both leaf surfaces except for the lower leaf of Luna Experience at 10.5%.

Table 3. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 14, sorted by lower leaf surface.

14-Aug	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 3 - Procure 1	0.9	1.6	1.6	0.9
TRT 4 - Procure 2	1.2	1.6	1.6	0.9
TRT 7 - Torino	0.6	0.5	2.8	1.2
TRT 2 - Luna Sensation	0.1	0.2	3.2	1.5
TRT 5 - Miravis Prime	0.3	0.4	3.6	2.9
TRT 6 - Inspire Super	0.8	1.2	5.0	3.9
UTC - Untreated Check	9.0	9.8	9.0	7.7
TRT 1 - Luna Experience	2.0	2.2	10.5	5.7

In the third evaluation (Table 4), the UTC showed the highest rate of infection compared to any treatment, with 36 and 33% for the upper and lower leaf surface respectively. The upper leaf surface infections of all treatments were below 2.5%. Lower leaf infestations were below 20% with the exception of Luna Experience at nearly 29%. Both Procure treatments, Inspire Super and Miravis Prime were still under 10%.

Table 4. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 21, sorted by lower leaf surface.

21-Aug	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 4 - Procure 2	0.2	0.4	3.0	3.3
TRT 6 - Inspire Super	0.0	0.0	4.5	2.9
TRT 3 - Procure 1	0.2	0.4	6.5	3.9
TRT 5 - Miravis Prime	0.3	0.5	7.2	4.1
TRT 7 - Torino	1.3	1.5	17.3	8.1
TRT 2 - Luna Sensation	0.0	0.0	17.8	15.3
TRT 1 - Luna Experience	2.5	6.1	28.8	26.5
UTC - Untreated Check	35.9	31.6	33.0	22.5

In the fourth evaluation (Table 5), PM infestation on the UTC more than doubles to 78% and 90% on the upper and lower leaf surfaces respectively. All treatments remain at 3% or lower on the upper leaf surface, but the lower leaf surface infestations begin to separate. The Procure 2 treatment is under 10%, both Procure 1 and Inspire Super are below 20%, Miravis Prime and both Luna treatments are in the lower 40's, and the Torino treatment is showing the highest infection rate at 73%.

Table 5. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for August 28, sorted by lower leaf surface.

28-Aug	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 4 - Procure 2	0.5	0.8	8.8	4.4
TRT 3 - Procure 1	0.3	0.5	17.2	12.1
TRT 6 - Inspire Super	0.8	1.6	18.7	18.6
TRT 5 - Miravis Prime	2.3	2.5	41.3	26.9
TRT 1 - Luna Experience	0.7	0.8	42.5	28.8
TRT 2 - Luna Sensation	1.8	3.0	42.5	24.2
TRT 7 - Torino	3.0	4.1	73.3	7.5
UTC - Untreated Check	77.9	27.2	89.6	16.2

In the fifth evaluation (Table 6), the untreated check had the highest infested upper and lower leaf infestations at 82 and 96% respectively. Still referring to the upper leaf surface, Miravis Prime had the highest level of infestation at 8% with the other six treatments at 3% or lower. For the lower leaf infestations, there continued to be significant separations. Procure 2 was the lowest infected at 12%, followed by Procure 1 at 29%, Luna Experience and Inspire Super both at 50%, Luna Sensation at 61%, Miravis Prime at 70%, and Torino at 88%.

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

4-Sep	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 4 - Procure 2	0.5	1.2	12.2	4.7
TRT 3 - Procure 1	0.0	0.0	28.8	19.5
TRT 1 - Luna Experience	2.7	2.2	49.5	22.0
TRT 6 - Inspire Super	1.3	1.4	50.0	21.0
TRT 2 - Luna Sensation	1.0	2.0	60.8	22.7
TRT 5 - Miravis Prime	7.5	13.5	70.0	15.8
TRT 7 - Torino	3.0	2.5	87.5	8.2
UTC - Untreated Check	81.8	16.9	96.1	9.6

During the final evaluation (Table 7), many leaves in the untreated check have been killed by PM but those that remained were nearly 100% covered with colonies. On the upper leaf surface all treatments were at or below 3% infestation except Torino which averaged 7%. On the lower leaf surface, Procure 2 and Inspire Super treatments were virtually identical at 37 and 38% infestation, followed by Procure 1 at 62%, Luna Experience at 68%, Luna Sensation at 74%, Miravis Prime at 83% and Torino at 90%.

Table 7. Percent powdery mildew and standard deviation of seven fungicide treatments plus an untreated check for September 14, sorted by lower leaf surface.

14-Sep	Avg PM % Upper Leaf	St. Dev. (±)	Avg PM % Lower Leaf	St. Dev. (±)
TRT 4 - Procure 2	0.9	0.7	36.7	13.7
TRT 6 - Inspire Super	1.0	1.1	37.5	12.9
TRT 3 - Procure 1	1.0	1.1	61.7	5.2
TRT 1 - Luna Experience	1.7	2.0	68.3	12.5
TRT 2 - Luna Sensation	1.7	1.6	74.2	16.9
TRT 5 - Miravis Prime	3.2	2.2	82.5	18.9
TRT 7 - Torino	7.0	4.7	90.0	10.5
UTC - Untreated Check	93.0	9.5	99.0	3.2

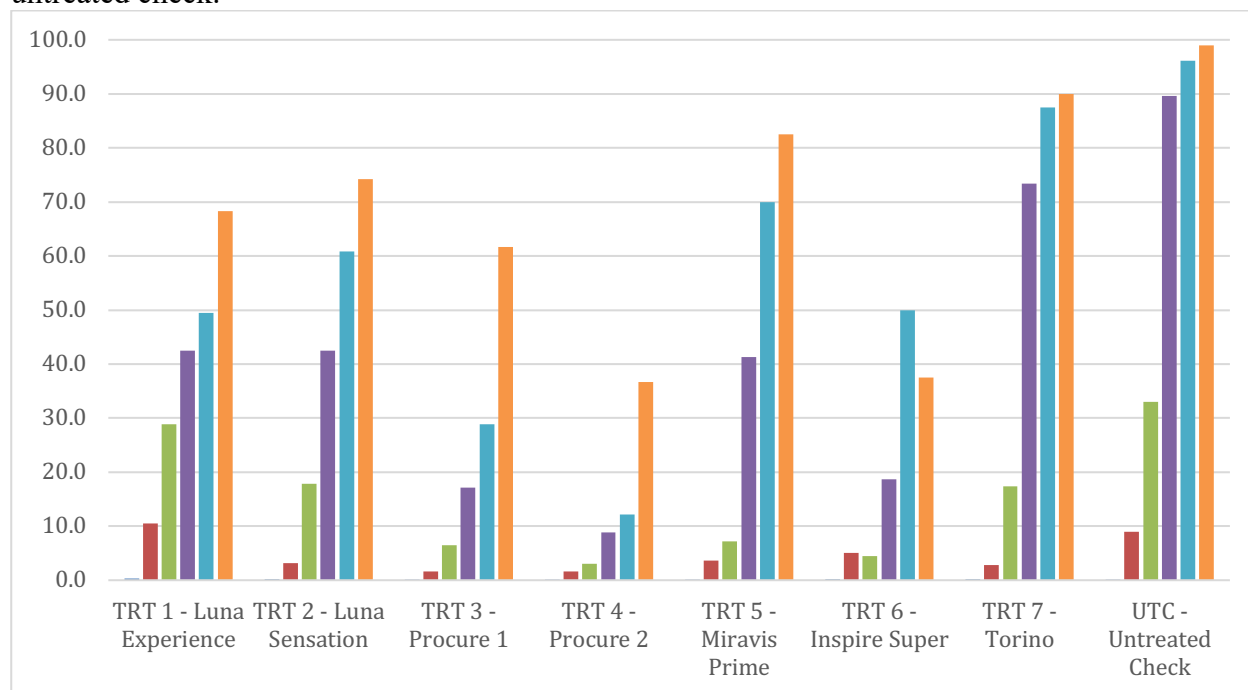
While weekly percent disease infestation ratings are useful to consider efficacy on any particular date, to compare treatments over the season, the Area Under the Disease Progress Curve (AUDPC) is perhaps a better tool. In Table 8, the Procure 2 treatment clearly had the least amount of disease development, nearly 50% lower than the next closest treatment. The Procure 1 and Inspire Super treatments performed similarly, followed by the trio of Luna Sensation, Luna Experience, and Miravis Prime which likewise had a similar amount of disease accumulation. The Torino treatment had the highest amount of disease accumulation but was still lower than the untreated check.

Table 8. The Area Under the Disease Progress Curve (AUDPC) for powdery mildew based on sampling dates July 28-September 14.

Treatment	AUDPC
TRT 4 - Procure 2	389.9
TRT 3 - Procure 1	739.3
TRT 6 - Inspire Super	836.6
TRT 2 - Luna Sensation	1350.9
TRT 1 - Luna Experience	1389.9
TRT 5 - Miravis Prime	1391.1
TRT 7 - Torino	1863.3
UTC - Untreated Check	2278.9

Individual treatment disease ratings were also graphed over time to give a visual perspective of disease development over the season (Figure 2). For all treatments except Inspire Super, the disease ratings increased at every sampling date. Inspire Super dipped slightly during the last sampling date.

Figure 2. Development of powdery mildew infestation (%) on the lower leaf surface only by sampling dates from July 28 through September 14, across seven fungicide treatments and untreated check.



Conclusions

All treatments had at least four MOAs that were alternated during the season, with only the Procure 2 treatment using five MOAs (Table 9). All treatments included the protectant fungicide Manzate Pro-Stick (FRAC M) with every spray and is the only common product between the treatments. Six of the seven treatments incorporated a FRAC 3 product.

Procure 2 and Procure 1 are nearly identical treatments except for the addition of a strobiluron product in Procure 2. Strobiluron products are known to have very little efficacy against PM so the difference in disease development between these treatments is interesting.

Looking at the Procure 1 and Inspire Super treatments which had similar disease accumulation over the season, Procure 1 had the addition of Vacciplant (stimulant of plant defenses) while Inspire Super has the addition of FRAC 9, the only occurrence of this FRAC in the trial.

The next grouping of both Luna treatments and Miravis Prime differed by several FRAC combinations with no distinct pattern except all shared FRAC 7 and M. The treatment with FRAC 11 had slightly lower disease pressure than the rest. The novel FRAC 12 compound in Miravis Prime did not seem to confer much disease protection advantage in this grouping.

The final treatment, Torino, included two FRAC compounds (13 and U6) that were not used in any other treatment.

Historical performance, general product or program efficacy can be affected over time by many things such as plant genetics, resistance development, initial infestation date, spray interval,

spray technology, weather, etc., and is of course subjective from year to year. In the general context of having observed most of these products over several years, this season the Procure 1 and 2 treatments performed better than expected, while both Luna Experience and Sensation, Inspire Super and Miravis Prime treatments which have shown great efficacy over the past few years performed below average. The Torino treatment has not been in our PM trial for several years so its recent relative performance cannot be determined.

Table 9. Final ranking and grouping of treatments by AUDPC and their MOA/Frac designations of all fungicides in the treatment.

Treatment	AUDPC	MOA/Frac	Historical Performance
TRT 4 - Procure 2	389.9	3, 11, P4, U8, M	Above Avg.
TRT 3 - Procure 1	739.3	3, P4, U8, M	Above Avg.
TRT 6 - Inspire Super	836.6	3, 9, U8, M	Below Avg.
TRT 2 - Luna Sensation	1350.9	7, 11, U8, M	Below Avg.
TRT 1 - Luna Experience	1389.9	3, 7, U8, M	Below Avg.
TRT 5 - Miravis Prime	1391.1	3, 7, 12, M	Below Avg.
TRT 7 - Torino	1863.3	3, 13, U6, M	NA
UTC - Untreated Check	2278.9	NA	NA

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.

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

Respectfully,

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