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Pumpkin Fungicide and Cultivar Evaluation, 2017

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Pumpkin has been a profitable crop for many Kentucky growers over the years. However, powdery and downy mildews have been serious production problems, as these diseases can destroy foliage prematurely, resulting in pumpkins with thin walls, poor quality stems, and poor storage characteristics. Seed companies have developed a number of pumpkin varieties that have powdery mildew resistance or tolerance to improve marketable yields and storability. In this study nine pumpkin varieties, most with powdery mildew resistance, were evaluated in a replicated trial to determine their performance in Central Kentucky under a high-input fungicide program, a low-input fungicide program and a minimal program that did not include any powdery mildew-specific fungicides.

Materials and Methods

Varieties were seeded on 6 June 2017 into a field of Maury Silt Loam manually with Stand and Plant seeders at the University of Kentucky Horticulture Research Farm in Lexington. This study was laid out in a split-plot design with powdery mildew fungicide spray treatments as main plots and varieties as sub plots. Four fields were used as replications with each field (replication) containing randomly assigned spray treatments: no treatment for powdery mildew, a low input powdery mildew fungicide program, and a high input fungicide program for powdery mildew. All plots were sprayed identically for downy mildew and insect management. Spray treatments are shown in Table 1. Individual plots were 21 feet long and consisted of two rows, each containing eight seeds set 3 feet apart in the row with 6 feet between rows. Individual plots were separated from the next plot by 6 feet. Guard rows were planted on both sides of each field or replication. Drip irrigation provided water and fertilizer as needed.

Fifty pounds of N/A as urea were incorporated into the field prior to planting. Plots were drip irrigated as needed and fertigated with a total of 16 lbs N/A as calcium nitrate divided into five applications over the season beginning on 19 July and ending on 23 August.

A tank mix of 1.33 pt of Dual II Magnum plus 0.66 oz Sandea herbicides /A was applied on 7 June for weed control. Bindweed and morning glory seedlings that emerged were hand pulled and spot sprayed with glyphosate once pumpkin plants emerged. Greenhouse grown pumpkin transplants were set in the field where seeds did not emerge. Following plant emergence the systemic insecticide, Macho 2.0 FL (Imidacloprid) at the rate of 20 fl oz/A (1.38 fl oz/1,000 linear foot of row) was applied as a drench to each plant with a backpack sprayer at 1.0 fl oz of solution per plant for squash bug control on 21 June.

Disease ratings were completed on August 11. The upper and lower side of 20 leaves per plot were evaluated for disease severity using the Horsfall-Barratt scale. Individual data points were transformed to the midpoint of the rating range prior to means calculation. Analysis of variance was conducted using PROC Mixed in SAS 9.4, followed by LSMEANS comparison using the Tukey post-hoc test (P = 0.05).

Harvest began on 18 September and continued through 3 October. Pumpkins were cut and piled in the field for each treatment and rated for fruit shape, smoothness, ribbing, color, and stem quality. The number of cull and green pumpkins were counted and all pumpkins were weighed. All pumpkins were lifted by their stems during loading and a separate stem rating was made for number of rotten stems and those that broke upon lifting.

Results and Discussion

The spring season was cool and wet. Powdery mildew fungicide spray treatment results are shown in Table 2 and variety results are shown in tables 3 and 4. Yields in lb/A were significantly higher (8.3%) for the high input spray treatment than the other treatments, Table 2. However, there was no difference in the number of pumpkins harvested between treatments. Thus the high input spray treatment increased pumpkin weight across all varieties, but not the number of pumpkins harvested. There was no significant difference in the number of culls between spray treatments. There was no significant interaction between fungicide treatments and variety for any of the yield parameters. All varieties responded similarly to each of the fungicide treatments.
Overall, **Kratos, Aladdin,** and **Apollo** were the best yielding varieties in this trial. **Camaro** had the lowest powdery mildew severity, followed by **Kratos** and **El Toro**. Camaro yielded well, but its light color reduces its value in many Kentucky markets. Notable were **Early King,** which was a very tall, elongated pumpkin with very nice stems and **Cronus,** a low yielding variety, with some of the largest, most attractive fruit with outstanding stems. All varieties but Howden had intermediate resistance to powdery mildew.

Kratos, Camaro, Aladdin, Apollo, and Early King were the highest yielding pumpkins based on pounds of marketable pumpkins per acre, Table 3. Kratos, Camaro, Aladdin, and Apollo produced some of the highest numbers of marketable pumpkins per acre. Early Giant and Cronus produced the largest pumpkins in the trial, while Apollo and Howden had on average the smallest pumpkins. Apollo, Kratos, and Cronus had the fewest cull fruits, while Early Giant had the most cull fruits, primarily due to stem decay, and also the highest powdery mildew pressure (Table 3). One cause of stem decay is excessive powdery mildew.

All varieties had dark orange skins except for Camaro which was light orange, Table 4. This reduced its price at the Lincoln County Auction in Kentucky. Most of the varieties had a blocky shape, but Camaro, Kratos, El Toro, and Howden shapes varied more from blocky to round. Early Giant and Early King produced mostly tall, elongated pumpkins. Cronus and Early King had rougher skin, which was not objectionable, and Camaro had a very smooth skin. Kratos and Cronus had deeper, very apparent ribbing, while Camaro had little ribbing. The Kratos and Cronus varieties had very large, attractive, green stems, many of which were indented into the fruit and buttressed.

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Table 1. Pumpkin fungicide and insecticide main plot spray treatments.

Spray Number and Date	High Input Spray[1]	Low Input Spray[2]	Minimal program[3]	Insecticides for All Plots
1 June 29	PM- Aprovia Top + mancozeb	mancozeb	Mancozeb	Permethrin
2 July 10	PM- Fontelis + mancozeb	Topsin		Permethrin
3 July 19	PM- Quintec + mancozeb	mancozeb	mancozeb	Permethrin
4 July 26	PM- Aprovia Top + chlorothalonil	Topsin		Assail
5 Aug. 2	PM- Fontelis + chlorothalonil	Chlorothalonil	Chlorothalonil	Assail
6 August 9	PM- Quintec + mancozeb DM- Ranman	Topsin + Ranman	Ranman	
7 August 16	PM- Aprovia Top + chlorothalonil DM-Previcur Flex	Chlorothalonil + Previcur Flex	Chlorothalonil Previcur Flex	Permethrin
8 August 23	PM- Fontelis + chlorothalonil DM- Ranman	Topsin + Ranman	Ranman	No insecticide
9 August 30	PM- Quintec + chlorothalonil DM-Previcur Flex	Chlorothalonil + Previcur Flex	Previcur Flex	Assail
10 September 6	PM- Aprovia Top + chlorothalonil DM- Ranman	Topsin + Ranman	Ranman	No insecticide
Approximate season-long PM fungicide cost[4]	$517.20	$226.05	$101.72	

[1]High Input program, PM = fungicides applied for powdery mildew; DM = fungicides applied for downy mildew
[2]Low Input program lists fungicides applied for powdery and downy mildew
[3]Minimal program lists fungicides applied for downy mildew and Plectosporium blight. Mancozeb and chlorothalonil have protectant activity against powdery mildew.
[4]Total cost per acre, based on a Kentucky fungicide supplier's 2017 price list. This approximate cost does not include downy mildew fungicides or insecticides.

Table 2. Powdery mildew fungicide pumpkin yield, fruit size, percent culls, and powdery mildew severity on the upper and lower leaf surfaces on August 11.

Treatment[1]	Yield (lb/A)[2,3]	Yield (No./A)[2,3]	Fruit Size (lb)[3]	Culls (%)[3]	PM severity on upper leaf surface (%)[4]	PM severity on lower leaf surface (%)[4]
High input	57,567 a	2,849 a	20.9 a	15 a	5.26 a	9.81 a
Low input	48,538 b	2,727 a	18.6 b	20 a	20.23 ab	29.05 b
Minimal	47,787 b	2,643 a	18.8 b	21 a	25.79 b	36.86 b

[1]Spray program details in Table 1.
[2]Yield averaged across all varieties.
[3]Means in the same column followed by the same letters are not significantly different (Waller-Duncan multiple range test LSD *P* = 0.05).
[4]Powdery mildew severity was rated on the upper and lower sides of 20 leaves per replicate on August 11, using the Horsfall-Barratt scale. Data were transformed to the midpoint prior to conducting analysis of variance on the split-plot design. Means in the same column followed by the same letters are not significantly different (Tukey test *P* = 0.05).

Table 3. Pumpkin variety yield, size and percent culls.

Variety	Seed Source	Days to Harvest[1]	Yield (lb/A)[2]	Yield (No/A)[2]	Size (lb)[2]	Culls (%)[2]	PM severity, upper leaf surface (%)[3]	PM severity, lower leaf surface (%)[3]	Disease Resistance[4]
Kratos	SW	115	66,435 a	3,718 a	17.9 cd	12 cd	14.8 ab	18.8 ab	IR: pm
Camaro	BL	110	61,117 ab	3,441 a	17.8 cd	18 bc	6.8 a	6.0 a	IR: pm
Aladdin	SW	110	59,731 abc	3,290 ab	18.3 cd	22 b	15.8 ab	24.5 bc	IR: pm
Apollo	SW	110	57,728 abc	3,769 a	15.3 e	9 d	21.5 ab	25.8 bc	IR: pm
Early King	SI	90	54,161 abc	2,798 bc	19.3 c	20 bc	22.7 b	28.1 bc	IR: pm
Early Giant	SI	95	49,386 bc	1,739 d	28.0 a	33 a	27.3 b	37.7 c	IR: pm
El Toro	SI	95	47,171 c	2,483 c	18.8 cd	20 bc	12.9 ab	18.8 ab	IR: pm
Cronus	SW	115	34,213 d	1,550 d	22.1 b	16 bcd	15.8 ab	33.2 bc	IR: pm
Howden	BL	115	31,732 d	1,865 d	17.1 de	29 bc	12.7 ab	34.1 bc	IR: br

[1]Days to harvest as listed by seed companies.
[2]Means in same column followed by same letters are not significantly different (Waller-Duncan multiple range test LSD $P = 0.05$).
[3]Powdery mildew severity was rated on upper and lower sides of 20 leaves per replicate on August 11, 2017 using the Horsfall-Barratt scale. Data were transformed to the midpoint prior to conducting analysis of variance on the split-plot design. Means in the same column followed by the same letters are not significantly different (Tukey test $P = 0.05$).
[4]Disease resistance as published by seed companies: IR = Intermediate resistance; pm = powdery mildew; br= black rot

Table 4. Pumpkin fruit characteristics.

Variety	Color[1]	Shape (1-5)[2]	Smoothness (1-5)[3]	Ribbing (1-5)[4]	Stem (1-5)[5]	Comments
Kratos	do	2.4	3.8	4.0	4.5	Very attractive fruit, very nice stems
Camaro	lo	2.6	4.3	2.4	3.9	Thinner stems
Aladdin	do	2.0	3.8	2.9	3.3	Thinner stems
Apollo	do	2.2	3.1	3.3	3.9	Very attractive fruit, good stems
Early King	do	2.1	2.7	3.5	4.0	Variable fruit size and shape, good stems
Early Giant	do	2.0	3.5	3.6	3.1	Attractive tall pumpkins, more decayed stems
El Toro	do	2.4	3.5	3.6	4.2	Attractive fruit, very nice stems
Cronus	do	2.3	2.3	4.0	4.7	Very attractive fruit; very large, embedded, buttressed stems
Howden	do	2.4	3.1	3.7	3.3	Variable fruit size and shape

[1]Pumpkin skin color: do = dark orange; lo = light orange.
[2]Shape: 1 = oblate; 2 = blocky; 3 = round; 4= flat; 5= highly variable.
[3]Smoothness; 1= rough warty; 5 = very smooth.
[4]Ribbing; 1 = no ribbing; 5 = heavy ribbing.
[5]Stem quality; 1= poor; 5 = excellent.