Applied Research Results on Vegetable Crop Disease Management

2018 Season

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LIST OF CONTRIBUTORS

<u>Commodity Groups and Organizations</u>

National Watermelon Growers Association

MarDel Watermelon Growers Association

Maryland Vegetable Growers Assoc.

Maryland Soybean Board

Fruit and Vegetable Growers Assoc. of Delaware

<u>Private Companies</u>

Syngenta Crop Protection, Inc.

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Evaluation of fungicide programs for management of foliar diseases on watermelon cv. Crunchy Red

Kate Everts and Taylor Walter

The experiment was conducted at the University of Maryland's Lower Eastern Shore Research and Education Center, in Salisbury, as a randomized complete block design with five fungicide programs and a non-treated control and four replications per treatment. Plots consisted of one raised bed, 90-ft long on 7-ft centers. On 2 May, 16-03-15 (N-P-K) preplant fertilizer was applied to the field at 675 lb/A. The beds were shaped and covered with 1.25-mil plastic over a single line of 8-in. emitter-spaced drip tape in a one-pass operation on 3 May. Four-week-old greenhouse-grown plants were treated with Admire (0.074 fl oz/gal applied over 12 72-cell trays) on 23 May and were transplanted with a starter solution of 20-20-20 (N-P-K) into the field 36 in. apart on 24 May. 'SP-6' pollinizers were transplanted in between every third and fourth plant on 29 May. Soil moisture was maintained by drip and overhead sprinkler irrigation as needed. Insects were managed with Sniper 5 fl oz/A on 8 Jun. Fungicide applications began on 7 Jun, when the vines met in the row, and were applied weekly until 9 Aug. Fungicides were applied with a tractor-mounted sprayer that delivered 45 gal/A at 43 psi through six D4-45 hollow-cone nozzles mounted in a directed pattern. Anthracnose (percent of foliage and vines with visible lesions) and gummy stem blight severities (percent of foliage with visible lesions) were assessed over the whole plot on 26 Jul and 19 Aug. However, on 19 Aug, the non-treated control plots were completely defoliated and only treated plots could be rated. All mature and marketable fruit from each plot were harvested, counted, and weighed on 1 Aug, 6 Aug, 10 Aug, and 23 Aug, and combined for analysis. On 1 Aug, 6 Aug, and 10 Aug, percent Brix of three representative fruit in each plot was determined for a total of nine fruit per plot over the season. Analysis of variance was conducted using the MIXED procedure of the Statistical Analysis System (version 9.4; SAS Institute, Cary, NC). Fungicide program was treated as a fixed effect and replication was treated as a random effect. Means were separated according to Fisher's protected least significant difference (LSD) test ($\alpha = 0.05$).

All fungicide programs reduced anthracnose and gummy stem blight compared to non-treated plots on 26 Jul. On 19 Aug, plants in non-treated plots had died and the predominant disease present was anthracnose. Fungicide program 2, where Rhyme was applied through the drip on 7 Jun and 21 Jun followed by Bravo Weather Stik plus Kocide alternated with Koverall, and followed with Luna Experience, then Topguard EQ plus Koverall, then Switch, then Topguard EQ; and fungicide program 3, where Bravo Weather Stik plus Kocide was alternated with Topguard EQ three times, followed by Luna Experience, then Topguard EQ, then Switch, both had significantly lower anthracnose on 19 Aug than fungicide programs 1 and 4. Fungicide program 5 was intermediate. However, because the treatment programs included multiple fungicides and the same fungicides applied at different timings, it was not possible to attribute the disease reduction to any single fungicide. Gummy stem blight progressed more slowly than anthracnose, and there were no significant differences among fungicide treatments on 19 Aug. There were no significant differences in percent Brix of fruit over the season (P = 0.2975, data not shown). There was significantly more fruit harvested from the treated plots compared to the non-treated plots. Likewise, the fruit weight per plot was significantly higher where fungicides were applied. However, there were no differences among the fungicide programs in number of fruit/plot or total fruit weight. No phytotoxicity was observed.

Treatment and rate/A	Application date[z]	Anthracnose % 26 Jul	Anthracnose % 19 Aug	Gummy stem blight % 26 Jul	Gummy stem blight % 19 Aug	No. fruit/plot	Yield (lb/plot)
1. Bravo Weather Stik 6L 24 fl oz + Kocide 3000 1 lb	B,D,F						
Rhyme 2.08SC 7 fl oz (drip)	C, E						
Luna Experience 3.34SC 16 fl oz + NIS[y]	G						
Topguard EQ 4.29SC 8 fl oz + Koverall 2 lb + NIS	H						
Switch 62.5WG 14 oz + NIS	I						
Topguard EQ 4.29SC 8 fl oz + NIS	J	0.6 b[x]	11.0 a	0.7 b	4.5	39.8 a	593.5 a
2. Rhyme 2.08SC 7 fl oz (drip)	A,C						
Bravo Weather Stik 6L 24 fl oz + Kocide 3000 l lb	B,D,F						
Koverall 3 lb + NIS	E						
Luna Experience 3.34SC 16 fl oz + NIS	G						
Topguard EQ 4.29SC 8 fl oz + Koverall 2 lb + NIS	H						
Switch 62.5WG 14 oz + NIS	I						
Topguard EQ 4.29SC 8 fl oz + NIS	J	0.0 b	4.0 b	0.2 b	2.3	42.0 a	632.9 a
3. Bravo Weather Stik 6L 24 fl oz + Kocide 3000 1lb	B,D,F						
Topguard EQ 4.29SC 8 fl oz + Koverall 2 lb + NIS	C,E,G						
Luna Experience 3.34SC 16 fl oz + NIS	H						
Topguard EQ 4.29SC 8 fl oz + NIS	I						
Switch 62.5WG 14 oz + NIS	J	0.0 b	2.5 b	0.7 b	2.5	38.3 a	549.4 a
4. Bravo Weather Stik 6L 2 fl oz + Kocide 3000 1 lb	B,D,F						
Folicur 3.6F 8 fl oz + Gem 500SC 2 fl oz + Koverall 2 lb + NIS	C,E,G						
Luna Experience 3.34SC 16 fl oz + NIS	H						
Fontelis 1.67SC 16 fl oz + NIS	I						
Switch 62.5WG 14 oz + NIS	J	0.6 b	12.0 a	0.8 b	3.0	36.8 a	548.4 a
5. Bravo Weather Stik 6L 24 fl oz + Kocide 3000 1 lb	B,D,F						
Rhyme 2.08SC 7 fl oz + NIS	C,E						
Luna Experience 3.34SC 16 fl oz + NIS	G						
Topguard EQ 4.29SC 8 fl oz + Koverall 2 lb + NIS	H						
Switch 62.5WG 14 oz + NIS	I						
Topguard EQ 4.29SC 8 fl oz + NIS	J	0.8 b	7.0 ab	0.6 b	3.8	37.0 a	537.8 a
6. Non-treated control		13.6 a	---	5.0 a	---	27.5 b	369.8 b
P-value[w]		0.0001	0.0065	0.0001	0.1018	0.0082	0.0020

[z]Application dates were A=7 Jun; B=15 Jun; C=21 Jun; D=28 Jun; E=5 Jul; F=12 Jul; G=20 Jul; H=27 Jul; I=2 Aug; and J=9 Aug.

[y]A non-ionic surfactant (NIS) was added to the tank mix at a 0.25% v/v where noted.

[x]Means within a column followed by the same letter are not significantly different according to Fisher's protected LSD test ($\alpha = 0.05$).

[w]A *P*-value ≤ 0.05 indicates significant differences among treatments.

Evaluation of Miravis, Proline, and Rhyme fungicides for management of Fusarium wilt on watermelon

Kate Everts and Taylor Walter

The experiment was conducted at the University of Maryland's Lower Eastern Shore Research and Education Center, in Salisbury, as a randomized complete block design with seven fungicide treatments and four replications. The field had a history of Fusarium wilt, and in previous studies, we had isolated and identified *Fusarium oxysporum* f. sp. *niveum* races 1 and 2. Plots consisted of one raised bed, 80 ft long on 7-ft centers with 1.25-mil plastic and one line of 8-in. emitter spaced drip tape. The field was fertilized with 16-03-15 (N-P-K) at 675 lb/A on 2 May. The beds were shaped and covered with plastic in a one pass operation on 3 May. One-half of each bed (west end) was planted with the diploid, moderately resistant cultivar 'Crimson Sweet', and the other half (east end) was planted with the diploid, susceptible cultivar 'Sugar Baby'. Each cultivar was treated as a separate experiment, and the data were analyzed separately. Four-week-old seedlings were removed from the greenhouse, hardened off for one week, and transplanted into the field 36 in. apart with a 20-20-20 (N-P-K) (2.5 lb/150 gal water) starter solution on 29 May, immediately following treatment application A. Soil moisture was maintained by drip irrigation as needed. Additional irrigations were scheduled to apply fungicide applications for Fusarium wilt. Applications B, C, and E were applied through the drip irrigation on 30 May, 7 Jun, and 27 Jun, respectively. High volume spray applications A and D were applied at 86 gal/A and 30 psi using a backpack sprayer fitted with a Hardi fertilizer flood nozzle on 29 May and 7 Jun, respectively. Foliar diseases were managed with weekly foliar fungicide applications. Individual vine length was measured from two plants from each plot on 18 Jun. The wilt incidence as the number of wilted and dead plants was counted on 19 Jun. After individual plants could not be distinguished, wilt severity was rated on a 1 to 4 scale (1 = 1-20% of row wilted, 2 = 20-50% of row wilted, 3 = 50-80% of row wilted, and 4 = 80-100% of row wilted) on 23 Jun. The number and weight of 'Sugar Baby' marketable fruit was measured on 24 Jul, 2 Aug, and 7 Aug. The number and weight of 'Crimson Sweet' marketable fruit was measured on 2 Aug, 9 Aug, and 15 Aug. Percent brix (soluble solids) was also measured for both cultivars on the first two harvest dates. Analysis of variance was conducted using the MIXED procedure of the Statistical Analysis System (version 9.4; SAS Institute, Cary, NC). Fungicide program was treated as a fixed effect and replication was treated as a random effect. The wilt ratings on 23 Jun were back transformed to the mid-point of each scale prior to analysis, and back transformed data is presented. Means were separated according to Fisher's protected least significant difference (LSD) test ($\alpha = 0.05$).

The longest vine length in the 'Sugar Baby' planting was in watermelons treated with Miravis through the drip on 30 May and 7 Jun (applications B and C), where vines were significantly longer than vines in non-treated plots. Although the non-treated 'Sugar Baby' watermelons had a numerically higher wilt incidence on 23 Jun and lower fruit number and yield than treated 'Sugar Baby,' they were not significantly different. No significant differences in vine length or wilt incidence were observed for 'Crimson Sweet'. The highest yield of 'Crimson Sweet' in fungicide-treated plots occurred in plots treated with Rhyme or Miravis applied through the drip on 30 May and 7 Jun (applications B and C) or Miravis applied as high volume applications on 29 May and 7 Jun (applications A and D), but these were not significantly better than the non-treated 'Crimson Sweet'. No phytotoxicity was observed.

Treatment, rate/A, (application date)[z]	'Sugar Baby' Vine Length (cm)	'Sugar Baby' Wilt incidence/ plot 19 Jun	'Sugar Baby' Wilt severity/ plot[y] 23 Jun	'Sugar Baby' Fruit no./ plot	'Sugar Baby' Fruit lb/ plot	'Crimson Sweet' Vine Length (cm)	'Crimson Sweet' Wilt severity/ plot 23 Jun	'Crimson Sweet' Fruit no./ plot	'Crimson Sweet' Fruit lb/ plot
Proline 480SC 5.7 fl oz (B,D)	13.2 bc[x]	0.3	37.5	14.5	113.7	12.3	50.0	12.0	183.8 bc
Miravis 1.67SC 8.55 fl oz (B,C)	19.1 a	0.3	50.0	14.0	99.4	14.6	23.8	13.8	206.2 ab
Miravis 1.67SC 8.55 fl oz (B,D)	16.5 ab	1.0	42.5	14.0	104.1	11.8	42.5	12.3	175.8 bc
Miravis 1.67SC 8.55 fl oz (A,D)	12.1 c	0.3	30.0	14.3	96.3	15.6	36.3	12.2	201.8 ab
Miravis 1.67SC 8.55 fl oz (B,E) Proline 480SC 5.70 fl oz (C)	16.6 ab	1.0	36.3	11.5	91.8	11.1	42.5	10.3	143.7 c
Rhyme 2.08SC 7 fl oz (B,C)	16.3 ab	1.3	22.5	14.0	107.0	15.0	16.3	14.0	236.4 a
Non-treated	12.8 bc	1.3	56.3	11.0	79.7	14.6	56.3	12.8	207.7 ab
P-value[w]	0.0176	0.1879	0.2908	0.4972	0.5922	0.2735	0.1377	0.1362	0.0240

[z]Application dates were: A = high volume spray on 29 May; B = drip on 30 May; C = drip on 7 Jun; D = high volume spray on 7 Jun; E = drip on 27 Jun.

[y]Wilt severity on 'Sugar Baby' and 'Crimson Sweet' was rated on a 1 to 4 scale (1 = 1-20% of row wilted, 2 = 20-50% of row wilted, 3 = 50-80% of row wilted, and 4 = 80-100% of row wilted), the data were back transformed to the mid-point of the scale prior to analysis.

[x]Means within a column followed by the same letter are not significantly different according to Fisher's protected LSD test (α=0.05).

[w]*P*-values ≤ 0.05 indicate significant differences among treatments.

Evaluation of fungicide programs for management of downy mildew (*Pseudoperonospora cubensis*) of processing cucumber, mid-season trial

K. L. Everts, T. L. Walter, and J. G. Jones, Department of Plant Science and Landscape Architecture, University of Maryland and G. C. Johnson, University of Delaware

The experiment was conducted at the University of Delaware's Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown. The experiment was a split plot with fungicide program as the main plot (five programs and a non-treated control) and five cultivars (susceptible 'Vlaspik' + 'Sire' pollinizer; susceptible 'Expedition' + 'Sire' pollinizer; moderately resistant 'Citadel' + 'SV2789CL' pollinizer; improved moderately resistant 'Peacemaker' + 'SV2789CL' pollinizer; and improved moderately resistant 'SVCN6404' + 'SV2789CL' pollinizer) as the subplot. Plots were arranged in a randomized complete block design with four replications. Main plots consisted of ten 18-ft rows, two rows of each cultivar, with 2.5 ft between rows and a 2-ft alley between treatments within the row. Plots were seeded with a Monosem planter at 60,000 plants/A on 27 Jun. Fungicides were applied using a battery-operated backpack sprayer that delivered 50 gal/A at 30 psi on 11 Jul, 20 Jul, or both days. The trial was overhead irrigated as necessary for plant growth. Downy mildew severity as the percent leaf area with necrosis or water soaking due to downy mildew was evaluated on the leaf at the fourth node on two plants/plot on 27 Jul. The mean of the two leaves was used for analysis. Analysis of variance was conducted using the MIXED procedure of the Statistical Analysis System (version 9.4; SAS Institute, Cary, NC). Fixed effects were cultivar (main plot) and fungicide treatment (subplot), and replication was treated as a random effect. Means were separated according to Fisher's protected least significant difference (LSD) test ($\alpha = 0.05$).

Downy mildew was first observed on the farm the second week of Jul in an earlier cucumber planting (Trial 1). There was a significant interaction between cultivar and fungicide program ($P < 0.0001$). All cultivars performed well under the most effective fungicide program, Orondis Opti + Bravo Weather Stik applied on 11 Jul followed by Ranman + Bravo Weather Stik applied on 20 Jul, with very low downy mildew severity. However, where a single treatment of Orondis Opti + Bravo Weather Stik was applied on 11 Jul, the most susceptible cultivar, Vlaspik, had numerically, but not statistically, higher downy mildew severity than other cultivars. Likewise, where Ranman + Bravo Weather Stik was applied on 11 Jul only, both Vlaspik and Expedition had numerically, but not statistically higher downy mildew than other cultivars. Where Bravo Weather Stik was sprayed early on 11 Jul, Vlaspik had significantly more severe downy mildew than Peacemaker or SVCN6404. The late (at flop growth stage) fungicide program with Orondis Opti + Bravo Weather Stik performed significantly worse than the respective early application on Expedition and Vlaspik. A fungicide application at the 2-4 leaf stage (early application) provided significantly better downy mildew control on Vlaspik or Expedition than waiting until flop (late application). Resistant cultivars, SVCN6404, Peacemaker, and Citadel had significantly less downy mildew than Vlaspik or Expedition when no fungicide was applied or when fungicides were applied late (20 Jul). No phytotoxicity was observed.

Treatment and Rate/A	Application Date	Cultivar	% Downy Mildew Severity 27 Jul
Orondis Opti 3.37SC 1.75 pt		SVCN6404	0.5 g*
+ Bravo Weather Stik 6L 1 pt	11 Jul	Peacemaker	0.7 g
Ranman 400SC 2.75 oz		Citadel	2.2 fg
+ Bravo Weather Stik 6L 2 pt	20 Jul	Expedition	0.8 g
		Vlaspik	2.0 fg
Orondis Opti 3.37SC 1.75 pt		SVCN6404	0.0 g
+ Bravo Weather Stik 6L 1 pt	11 Jul	Peacemaker	0.0 g
		Citadel	3.7 fg
		Expedition	1.3 fg
		Vlaspik	11.7 defg
Ranman 400SC 2.75 oz		SVCN6404	1.2 g
+ Bravo Weather Stik 6L 2 pt	11 Jul	Peacemaker	8.7 defg
		Citadel	6.0 defg
		Expedition	11.3 defg
		Vlaspik	14.8 defg
Bravo Weather Stik 6SC 2 pt	11 Jul	SVCN6404	5.0 efg
		Peacemaker	15.0 defg
		Citadel	27.8 bcd
		Expedition	27.0 bcde
		Vlaspik	41.3 bc
Orondis Opti 3.37SC 1.75 pt		SVCN6404	11.7 defg
+ Bravo Weather Stik 6SC 1 pt	20 Jul	Peacemaker	22.2 cdefg
		Citadel	22.2 cdefg
		Expedition	75.8 a
		Vlaspik	85.5 a
Non-treated Control		SVCN6404	23.8 cdef
		Peacemaker	14.7 defg
		Citadel	49.7 b
		Expedition	83.0 a
		Vlaspik	90.8 a
**P value			0.0001

*Means within a column followed by the same letter are not significantly different according to Fisher's protected LSD test (α=0.05).
**P value ≤ 0.05 indicates significant differences among treatments.

Evaluation of fungicide programs for management of downy mildew (*Pseudoperonospora cubensis*) of processing cucumber, late-season trial

K. L. Everts, T. L. Walter, and J. G. Jones, Department of Plant Science and Landscape Architecture, University of Maryland and G. C. Johnson, University of Delaware

The experiment was conducted at the University of Delaware's Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown. The experiment was a split plot with the fungicide program as the main plot (five programs and a non-treated control) and five cultivars (susceptible 'Vlaspik' + 'Sire' pollinizer; susceptible 'Expedition' + 'Sire' pollinizer; moderately resistant 'Citadel' + 'SV2789CL' pollinizer; improved moderately resistant 'Peacemaker' + 'SV2789CL' pollinizer, and moderately resistant 'SVCN6404' + 'SV2789CL' pollinizer) as the subplot. Plots were arranged in a randomized complete block design with four replications. Main plots consisted of twelve rows, two rows of each of the five cultivars and an additional two rows of Vlaspik, with 2.5 ft between rows. The main plots were 18 ft long. Plots were seeded with a Monosem planter at 60,000 plants/A on 3 Aug. Fungicides were applied using a battery operated backpack sprayer (30 psi; 50 gal/A) at the 2-4 leaf stage on 17 Aug, at flop on 28 Aug, or both times. The trial was overhead irrigated as needed. Disease severity on the leaf at the fourth node on two plants per plot was assessed as the percent leaf area with sporulation, necrosis, or water soaking due to downy mildew on 5 Sep. Analysis of variance was conducted using the MIXED procedure of the Statistical Analysis System (version 9.4; SAS Institute, Cary, NC). Fixed effects were cultivar (main plot) and fungicide treatment (subplot), and replication was treated as a random effect. Means were separated according to Fisher's protected least significant difference (LSD) test ($\alpha = 0.05$).

Downy mildew was first observed on the farm the second week of Jul, and downy mildew pressure was very high during this trial. The four inner rows (the duplicated Vlaspik rows and the SVCN6404 rows) were not rated for this trial because of difficulty in separating the vines and identifying the cultivars on 5 Sep. Disease severity was very high during this trial, and only Peacemaker had significantly less disease than Expedition in the non-treated plots. The best single application fungicide programs were Ranman + Bravo Weather Stik and Orondis Opti + Bravo Weather Stik applied early at the 2-4 leaf stage. Downy mildew control was not improved when the early Orondis Opti + Bravo Weather Stik application was followed by a Ranman + Bravo Weather Stik application at flop. The application of Bravo Weather Stik only at the 2-4 leaf stage or plots treated with Orondis Opti + Bravo Weather Stik at flop had significantly reduced downy mildew severity compared to the non-treated plots. However, disease levels were still relatively high. No phytotoxicity was observed.

Treatment and rate/A	Application date	Cultivar	Downy mildew severity (%) 5 Sep
Orondis Opti 3.37SC 1.75 pt		Peacemaker	12.7 ghi*
+ Bravo Weather Stik 6L 1 pt	28 Aug	Citadel	25.5 fgh
		Expedition	61.7 cd
		Vlaspik	65.8 cd
Ranman 400SC 2.75 oz		Peacemaker	0.4 i
+ Bravo Weather Stik 6L 2 pt	17 Aug	Citadel	1.8 hi
		Expedition	0.5 i
		Vlaspik	3.8 hi
Orondis Opti 3.37SC 1.75 pt		Peacemaker	0.0 hi
+ Bravo Weather Stik 6L 1 pt	17 Aug	Citadel	0.0 hi
Ranman 400SC 2.75 oz		Expedition	1.8 hi
+ Bravo Weather Stik 6L 2 pt	28 Aug	Vlaspik	0.8 hi
Bravo Weather Stik 6L 2 pt	17 Aug	Peacemaker	29.0 efg
		Citadel	50.0 de
		Expedition	42.8 def
		Vlaspik	20.5 fghi
Orondis Opti 3.37SC 1.75 pt		Peacemaker	0.0 i
+ Bravo Weather Stik 6L 1 pt	17 Aug	Citadel	1.0 i
		Expedition	2.8 hi
		Vlaspik	1.7 hi
Non-treated Control		Peacemaker	75.0 bc
		Citadel	95.0 ab
		Expedition	100.0 a
		Vlaspik	95.0 ab
P-value**			0.0386

*Means within a column followed by the same letter are not significantly different according to Fisher’s protected LSD test (α = 0.05).

***P*-value ≤ 0.05 indicates significant differences among treatment

Evaluation of Elumin fungicide for management of downy mildew of processing cucumber cv. Jackson Supreme

Kate Everts and Taylor Walter

The experiment was conducted at the University of Maryland's Lower Eastern Shore Research and Education Center, in Salisbury, as a randomized complete block design with three fungicide programs and a non-treated control and four replications per treatment. The field was fertilized with 16-03-15 (N-P-K) at 675 lb/A on 18 Jun. The field was then seeded in eight 2-row beds using a Monosem planter. The rows were 4.75 ft apart, and the beds were on 7-ft centers. After plots were established, the intent was to initiate fungicide applications when plants had two fully expanded leaves; however, rain delayed when the first application could be made and provided favorable conditions for downy mildew development. One application (A) was applied prior to rating. Because symptoms were present before the application, this was termed a 'rescue' treatment. The first planting of the experiment was terminated; the field was plowed, fertilized again with 16-03-15 (N-P-K) at 675 lb/A on 21 Aug, and replanted the same day. For the second planting, fungicide applications were initiated on 4 Sep and continued weekly until 4 Oct. In the first planting, downy mildew severity was rated as percent leaf area with sporulation, necrosis, or water soaking due to downy mildew on leaves at the eighth and ninth node on two plants/plot on 6 Aug (rescue treatment). In the second planting, the leaf at the fourth node was rated on 1 Oct and the leaf at the seventh node was rated on 10 Oct on two plants/plot on each date. The mean of the two leaves was used for analysis. Analysis of variance was conducted using the MIXED procedure of the Statistical Analysis System (version 9.4; SAS Institute, Cary, NC). Fungicide program was treated as a fixed effect and replication was treated as a random effect. Means were separated according to Fisher's protected least significant difference (LSD) test ($\alpha = 0.05$).

Downy mildew was significantly less severe in plots that had received one Elumin application as a rescue treatment than a treatment of Ranman, Zampro, or no fungicide in the first planting. Cooler weather in late Sep and Oct resulted in slower downy mildew progress and less severe disease in the second planting. In the second planting, when fungicides were applied in a timelier manner, downy mildew severity remained significantly lower in all fungicide-treated plots compared to the non-treated plots. There were no differences among fungicide programs. No phytotoxicity was observed.

Treatment and rate/A	Application date[z]	Downy mildew severity (%)		
		First planting, rescue	Second planting	
		6 Aug	1 Oct	10 Oct
Elumin 4SC 8 fl oz Orondis Opti 3.37SC 2 pt	A,C,E B,D	67.3 b	2.5 b[y]	1.5 b
Ranman 400SC 2.75 fl oz Orondis Opti 3.37SC 2 pt	A,C,E B,D	89.4 a	2.9 b	1.0 b
Zampro 4.38SC 14 fl oz Orondis Opti 3.37SC 2 pt	A,C,E B,D	88.1 a	3.8 b	1.4 b
Non-treated		97.5 a	18.0 a	14.5 a
P value[x]		0.0288	0.0015	0.0004

[z]The date for the only application made to the first planting (rescue treatment) was A=2 Aug. Application dates for the second planting (1 Oct and 10 Oct ratings) were A = 4 Sep; B = 11 Sep; C = 18 Sep; D = 29 Sep; and E = 4 Oct.
[y]Means within a column followed by the same letter are not significantly different according to Fisher's protected LSD test ($\alpha = 0.05$).
[x]P value ≤ 0.05 indicates significant differences among treatments.

Evaluation of resistance of watermelon cultivars to Phytophthora fruit rot

K. L. Everts and T. L. Walter, Department of Plant Science and Landscape Architecture, University of Maryland; and G. C. Johnson, University of Delaware

The objective of this study was to evaluate currently used watermelon varieties (cultivars) for resistance/susceptibility to Phytophthora fruit rot of watermelon.

An experiment was conducted at the University of Delaware's Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown (38.641746, -76.456602) to evaluate 37 watermelon cultivars for their susceptibility to Phytophthora fruit rot. Four fruit (replicates 1 to 4) from each cultivar were harvested and labeled 7 Aug, and a single fruit was considered one replicate. The cultivars tested are those grown in the region, and all were triploid except Sugar Baby, which is diploid. Twenty-four cultivars were transported to the building, placed in a 0.6% sodium hypochlorite solution for three minutes, and fruit were rinsed with tap water and dried. Each fruit was inoculated by placing a 5mm V-8 agar plug from an actively growing *Phytophthora capsici* isolate gently on the watermelon rind surface without wounding (Figure 1a). Fruit were placed in an incubation room (Figure 2b) that was maintained at 80ºF with a RH>95% and with continuous illumination with fluorescent lights for six days. The second set of 13 cultivars were collected from the field one day later and similarly surface disinfested, rinsed, inoculated, and incubated. After six days, lesion and pathogen growth diameters were measured and sporulation intensity was subjectively rated on a scale of 0-5, where 0 = no sporulation visible and 5 = profuse sporulation. Because the first set of fruit was inoculated the day of harvest, and the second set of fruit was inoculated one day after harvest, statistical analysis was performed on each set separately.

We also harvested a third set of fruit from each plot, which was to be replicates 5 and 6. The replicate 5 and 6 fruit were inoculated and incubates similar to the previous set. However, the water source for humidity was cut off while we were incubating these replicates. Because the humidity was not uniform in the room, we were unable to include that data. Analysis and conclusions are based on the initial four replicates that were successfully completed.

The lesion diameter was large on all fruit and there were no significant differences in lesion diameter among the cultivars in either set. In the first set (Table 1) there were significant differences in pathogen growth diameter among the cultivars. However, the area that sporulated was still large and may not provide any benefit in field production. The sporulation intensity was high among cultivars, and in the first set, significant differences in sporulation intensity were observed from a low of 1.8 in Summer Breeze and Cut Above, to a high of 4.5 in Sugar Baby. There were no significant differences in lesion diameter, pathogen growth diameter, or sporulation intensity among cultivars in the second set tested.

Figure 1 a) Inoculation of watermelon fruit with *P. capsici*; b) Lesion development and sporulation on different cultivars; c) Plant pathology technician, Taylor Walter measures lesion and sporulation size.

Table 1. First set of watermelon cultivars tested.

Cultivar	Company	Lesion Diameter (cm)	Pathogen Growth Diameter (cm)		Sporulation Intensity
ORS6064	Origene Seeds	17.2	14.7	a[y]	3.8 ab
0241WA	Seminis	17.7	14.4	ab	2.3 def
Warrior	Nunhems	17.3	14.3	ab	3.3 bcd
Sugar Baby	Johnny's	18.1	14.2	abc	4.5 a
Captivation	Syngenta	17.9	14.1	abcd	2.8 cde
9601	Nunhems	17.0	14.0	abcde	2.5 def
Red Amber	Enza Zaden	17.2	13.9	abcdef	2.5 def
7197	Nunhems	17.1	13.8	abcdef	3.5 bc
Unbridled	Sakata	17.1	13.8	abcdef	3.8 ab
Wolverine	Highmark	16.8	13.4	abcdefg	2.8 cde
Bottle Rocket	Seminis	16.3	13.4	abcdefg	2.8 cde
ORS6151	Origene Seeds	16.7	13.3	abcdefgh	2.8 cde
Excursion	Syngenta	16.5	13.1	abcdefgh	3.5 bc
Premont	Clifton Seed Co.	15.6	13.0	abcdefgh	3.0 bcde
Kingman	Sakata	16.4	12.9	bcdefgh	2.8 cde
Summer Breeze	Seminis	15.4	12.6	bcdefgh	1.8 f
ORS6181	Origene Seeds	15.9	12.6	bcdefgh	2.3 ef
ORS60599	Origene Seeds	15.7	12.6	bcdefgh	2.5 ef
Cut Above	Clifton Seed Co.	15.9	12.5	cdefgh	1.8 f
Road Trip	Seminis	16.3	12.4	defgh	3.0 bcde
Secretariat	Sakata	15.6	12.1	fgh	2.8 cde
Red Garnet	Enza Zaden	15.7	11.9	gh	2.3 ef
ORS6203	Origene Seeds	14.8	11.5	h	2.3 ef
Tailgate	Seminis	14.2	11.3	efgh	3.0 bcdef
P value[x]		0.0797	0.0235		0.0001

[y]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test ($\alpha = 0.05$).

[x]*P* value ≤ 0.05 indicate significant differences among treatments.

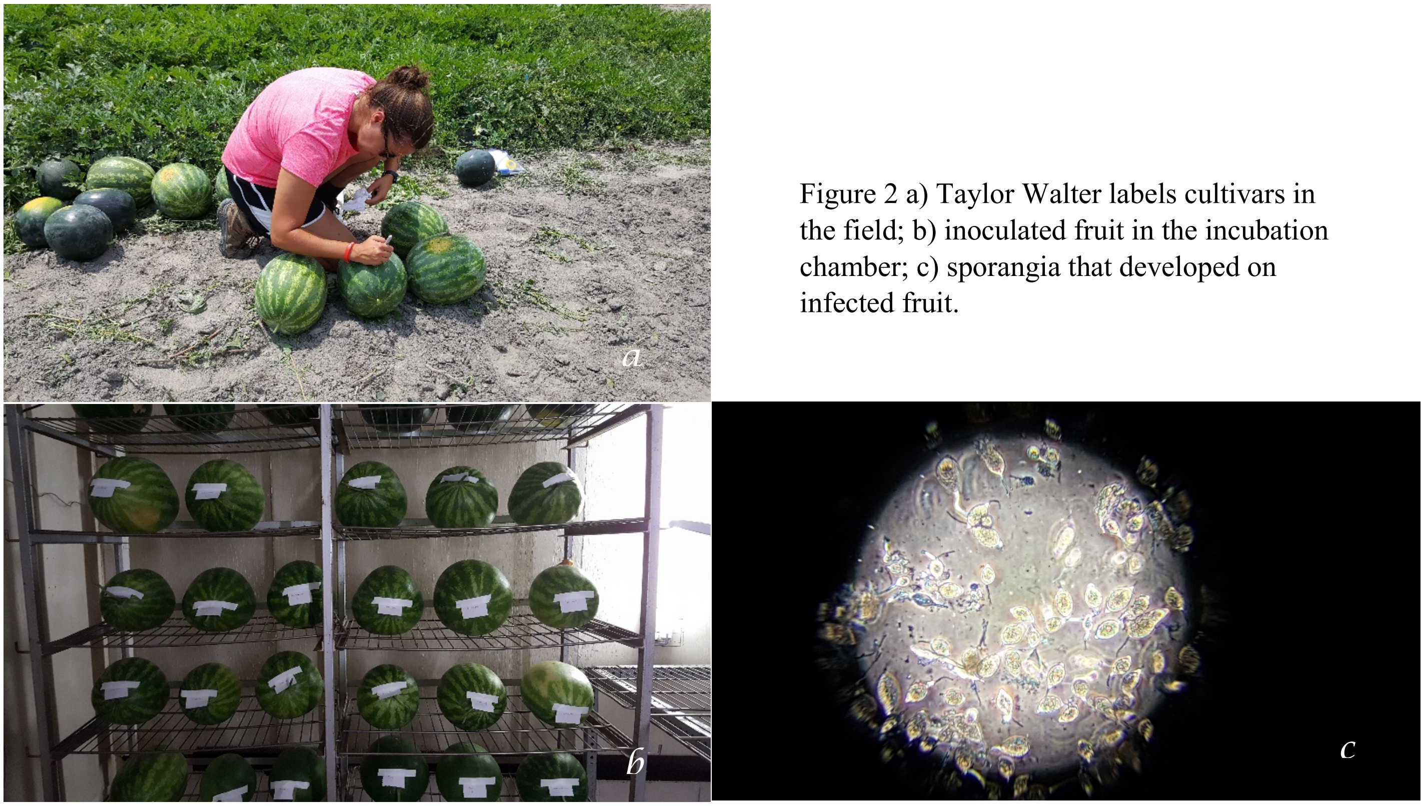

Figure 2 a) Taylor Walter labels cultivars in the field; b) inoculated fruit in the incubation chamber; c) sporangia that developed on infected fruit.

Table 2. Second set of watermelons tested.

Cultivar	Company	Lesion Diameter (cm)	Pathogen Growth Diameter (cm)	Sporulation Intensity
7187	Nunhems	16.9	13.2	3.8
Charisma	Sakata	16.9	13.2	4.0
Crunchy Red	Harris Moran	16.0	12.1	3.5
Eclipse	Sakata	16.9	12.6	3.0
Exclamation	Syngenta	17.6	12.0	3.5
Fascination	Syngenta	16.9	13.6	3.3
Joyride	Seminis	13.6	11.2	2.8
Maxima	Origene Seeds	16.6	12.3	2.3
ORS6260	Origene Seeds	16.8	13.3	3.0
Paradigm	Sostena	15.6	11.7	3.3
Tailgate	Seminis	15.3	11.7	3.8
Troubadour	Harris Moran	17.6	13.6	3.5
Turnpike	Harris Moran	16.5	11.8	3.5
P value[x]		0.4571	0.5085	0.3134

[x]*P* value ≤ 0.05 indicate significant differences among treatments.

Evaluation of fungicide application method for management of Phytophthora fruit rot on watermelon

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Season Weather: Weather in 2018 was highly conducive to Phytophthora fruit rot throughout the mid-Atlantic region. Fruit rot was first observed in the experimental plots on pollinizer fruit in a non-treated plot on 27 July (Figure 1).

Objectives/goals of the project: The objective of this study was to determine the optimum fungicide application method for control of Phytophthora fruit rot of watermelon. We examined the efficacy of drip application on fruit rot.

The experiment was conducted at the University of Delaware's Thurmond Adams Research Farm, Carvel Research and Education Center near Georgetown, as a randomized complete block design with six treatments, a non-treated control, and 4 replications per treatment. Each plot consisted of one raised bed, 60-ft long, on 7-ft centers. The beds were shaped and covered with 1 mil micro-embossed black plastic over a single line of 8 in. emitter spaced irrigation tape on 3 May. Five-week-old greenhouse grown plants 'Captivation' were transplanted on 24 May. Pollinizers 'SP7' were placed between every third and fourth plant in the row. The field was fertilized with 50, 0, 160, and 72 lb/A of N, P_2O_5, K_2O, and S, respectively, prior to the plastic being laid. Additional N was applied three times by fertigation during the fruiting period at 3-week intervals (40, 40, and 30 lb/A). Soil moisture was maintained by drip irrigation as needed. The field was inoculated with a 2.5 x 10^4/ml suspension of sporangia of *Phytophthora capsici* on 5 and 26 Jul using a backpack sprayer that delivered 45 gal/A at 42 psi over the foliage of the plants. Fungicide treatments began on 18 Jul and were applied weekly until 29 Aug. All mature and marketable fruit from each plot were harvested, counted, and weighed on 16, 24, 31 Aug and 12 Sep. Symptomatic fruit were counted and removed from each plot.

Figure 1.

Table 1. Performance of fungicide programs on Phytophthora fruit rot, marketable fruit number and weight of watermelon.

Treatment and rate/A	Application type and date[z]		Rotted fruit no./plot	Marketable fruit no./plot	Yield lb/plot
Zampro 4.38 SC 14 fl oz	Foliar	(ACE)			
Orondis Ultra 2.33 SC 8 fl oz	Foliar	(BDF)	20.7	28.4 a	290.8 a
Revus 2.08 S 8 fl oz	Foliar	(ACE)			
Presidio 4 SC 4 fl oz	Foliar	(BDF)	23.3	26.0 ab	280.1 a
Orondis Gold 200 1.67 SC 9.6 fl oz	Drip	(AC)			
Revus 8 2.08 S fl oz	Foliar	(BE)			
Presidio 4 SC 4 fl oz	Foliar	(DF)	18.3	23.1 b	255.3 ab
Presidio 4 SC 4 fl oz	Drip	(AC)			
Zampro 4.38 SC 14 fl oz	Foliar	(BE)			
Orondis Ultra 2.33 SC 4 fl oz	Foliar	(DF)	20.3	22.8 b	233.7 b
Orondis Gold 200 1.67 SC 9.6 fl oz	Drip	(AC)	33.3	10.3 c	105.0 c
Presidio 4 SC 4 fl oz	Drip	(AC)	32.8	9.0 c	97.1 c
Non-treated			33.7	11.4 c	116.8 c
P value[x]			0.1433	0.0001	0.0001

[z]Application dates were A=18 Jul; B=25 Jul; C=6 Aug; D=14 Aug; E=20 Aug; F=29 Aug.

[y]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test ($\alpha = 0.05$).

[x]*P* value ≤ 0.05 indicate significant differences among treatments.

Although there were no statistically significant differences in number of rotted fruit/plot, foliar application-only treatments and treatments that had drip applications in alternation with foliar treatments had numerically fewer rotted fruit. The number of marketable fruit was significantly greater in plots that received six foliar applications of Zampro alternated with Orondis Ultra than plots that received only two drip applications or two drip applications of either Orondis Gold or Presidio and four foliar applications. Likewise, total yield/plot was greater when six foliar sprays were applied of either Zampro alternated with Orondis Ultra or with Revus alternated with Presidio than non-treated or drip only treatments. Plots that were treated with two drip applications and four foliar applications had yields that were intermediate. No phytotoxicity was observed.