

Squash: *Cucurbita moschata* (Duchesne ex Lam.) Duchesne ex Poir.

THE INTEGRATED USE OF BIOPESTICIDES WITH CONVENTIONAL FUNGICIDES TO CONTROL DOWNY MILDEW ON SQUASH, SPRING 2009.

Dr. Gary E. Vallad
University of Florida, IFAS, Gulf Coast Research & Education Center
Wimauma, FL 33598
Phone: 813-633-4121
Fax: 813-634-0001
Email: gvallad@ufl.edu

Pseudoperonospora cubensis

On 25 Feb. 2009, plots were established at the University of Florida's Gulf Coast Research and Education Center in Balm, FL to assess the effect of several fungicides on the severity of downy mildew on butternut squash. Plots consisted of 8 ft bed sections along 300 ft, raised beds with 4 ft center-to-center bed spacing. Beds were covered with black virtually impermeable mulch and irrigated with a drip system. Seeds of the squash cultivar Waltham butternut were planted at 30" spacing along beds skipping a 6 ft section between plots and every third bed as a buffer. Fungicide treatments were applied on 23-Apr, 1-May, 8-May, 15-May, 21-May, 29-May and 5-Jun with a CO₂ back pack sprayer calibrated to deliver 40 to 100 gal/A at 40 psi. A non-treated control was included to measure disease pressure. Treatments were arranged in a randomized complete block design with each treatment repeated 4 times. Plots were monitored regularly for downy mildew, and rated 2 Jun and 15 Jun after disease reached acceptable levels across the trial. Marketable yield was assessed from a single harvest of plots on 9 June.

Environmental conditions during the beginning of the trial were unusually dry. Only 1.34 inches of rain were recorded for April, while 10.86 inches was recorded for the month of May. Symptoms of downy mildew were first observed in control plots on 28-May. Disease developed a bit later than expected because of the dry conditions, but then progressed rapidly due to the susceptible nature of the cultivar and heavy rains. Alternating applications of Procure (4-8 floz/A) and Quintec (4-6 floz/A) were included as general maintenance sprays (not shown in treatment list) to minimize the impact of powdery mildew, which was critical as conducive conditions prevailed for much of the trial.

The severity of downy mildew (based on visible chlorosis and necrosis on adaxial side of leaf) was rated using the Horsfall-Barratt scale on 2 Jun, 97 days after planting (DAP), and ranged from 6 to 10 corresponding to mid-percentage values of 62.5 and 98.5%, respectively. By 15 Jun, 110 DAP, disease severity values ranged from 7 to 10 corresponding to 81.5 and 98.5%, respectively. Significant differences were detected among treatments on both dates (Table 1). Area under disease progress curves (AUDPC) were also calculated using the trapezoidal method and also revealed significant differences among treatments (Table 1).

Based on AUDPC values, all treatments, except 6, 11, 12 and 15, reduced the severity of downy mildew significantly relative to the non-treated control (Table 1). No significant differences were observed in disease severity between experimental treatments and standard applications of Bravo Weatherstik (chlorothalonil; treatment 9) or Penncozeb (mancozeb ; treatment 13).

Total number of marketable fruit and total weight was collected for the trial (Table 1). No significant difference was detected for any of the yield parameters. However, the untreated control yielded the fewest fruit and lowest total weights on average.

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Figure 1. Upper (left) and lower (right) butternut squash leaves with symptoms and signs of downy mildew caused by *Pseudoperonospora cubensis*.

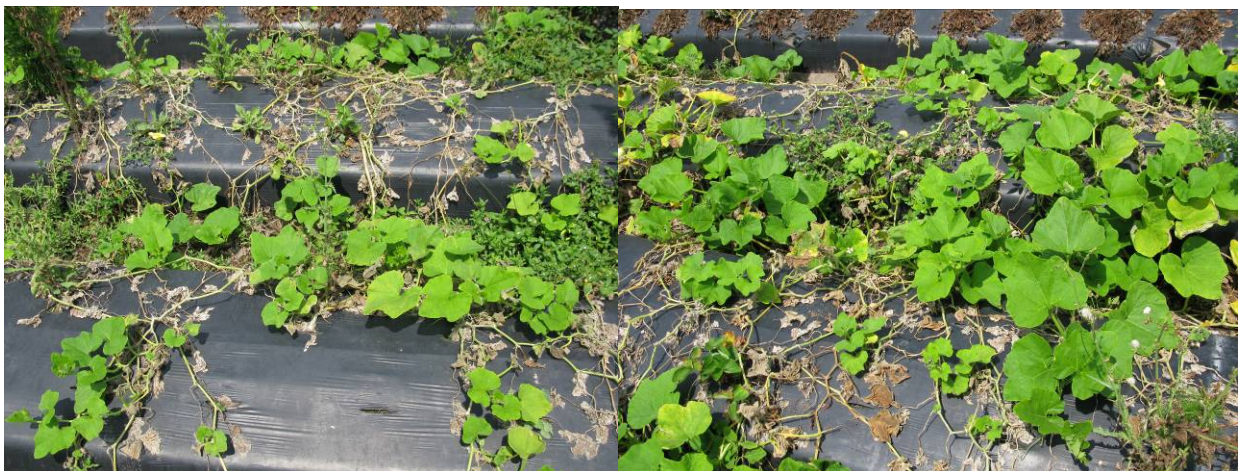


Figure 2. Image of a non-treated control plot (left) and a treated plot (right) showing the extent of defoliation caused by downy mildew on 15 Jun, 110 days after planting; also note difference in vine coverage based on dead foliage.

Table 1. Effect of fungicides and biopesticides on the LS Mean (95% confidence interval) of downy mildew and butternut squash yields during spring 2009 field trial at GCREC, Wimauma, FL.

TRT	Treatment, rate/acre (application) ^y	Disease Severity ^z			Marketable Yield			
		2-Jun	15-Jun	AUDPC	No. Fruit	Weight (lbs)	Avg. Fruit Size (lbs)	
1	Untreated	95.9 (90.8 - 100)	97.8 (94.9 - 100)	4135 (3947 - 4322)	30 (23 - 37)	28.1 (19.8 - 36.3)	0.94 (0.80 - 1.08)	
2	Revus, 8oz (1,3,5,7); Induce, 0.25% (1,3,5,7); Curzate, 5oz (2); Presidio, 4oz (4); Previcur Flex, 1.2pt (6); Bravo, 1.5pt (1,2); Bravo, 2.0pt (3-7)	81.5 (76.4 - 86.6)	86.3 (83.4 - 89.1)	3535 (3348 - 3723)	40 (33 - 47)	39.5 (31.3 - 47.7)	0.99 (0.85 - 1.14)	
3	Previcur Flex 6F, 0.6pt (2); Gavel 75DF, 2lb (4,6); Induce, 0.25% (1-7); Bravo Weather Stik 1.5 pt (1-2), 2.0 pt (3,5,7)	80.3 (75.2 - 85.3)	91.0 (88.2 - 93.8)	3521 (3333 - 3708)	37 (30 - 43)	38.4 (30.1 - 46.6)	1.05 (0.91 - 1.20)	
4	Previcur Flex 6F, 0.6pt (2); GWN-4700 80WP, 4oz (4,6); Induce, 0.25% (1-7); Bravo Weather Stik 1.5 pt (1-2), 2.0 pt (3,5,7)	81.5 (76.4 - 86.6)	92.1 (89.3 - 94.9)	3574 (3386 - 3761)	42 (35 - 49)	42.8 (34.6 - 51.1)	1.02 (0.88 - 1.16)	
5	GWN-4620, 0.25qt/50gal (1-7); Bravo Weather Stik, 1.5pt(1,2), 2.0pt(3-7)	86.3 (81.2 - 91.3)	93.3 (90.4 - 96.1)	3754 (3567 - 3942)	30 (23 - 37)	37.3 (29.1 - 45.6)	1.22 (1.08 - 1.36)	
6	GWN-4620, 0.75qt/50gal (1-7); Bravo Weather Stik, 1.5pt(1,2), 2.0pt(3-7)	92.1 (87.1 - 97.2)	95.5 (92.7 - 98.3)	3983 (3796 - 4171)	32 (25 - 39)	35.4 (27.1 - 43.6)	1.10 (0.96 - 1.25)	
7	GWN-4620, 1.5qt/50gal (1-7); Bravo Weather Stik, 1.5pt(1,2), 2.0pt(3-7)	81.5 (76.4 - 86.6)	91.0 (88.2 - 93.8)	3566 (3379 - 3754)	32 (25 - 39)	33.2 (25.0 - 41.4)	1.04 (0.89 - 1.18)	
8	GWN-4620, 2.25qt/50gal (1-7); Bravo Weather Stik, 1.5pt(1,2), 2.0pt(3-7)	86.3 (81.2 - 91.3)	88.6 (85.8 - 91.4)	3724 (3537 - 3912)	31 (24 - 37)	30.2 (21.9 - 38.4)	1.00 (0.85 - 1.14)	
9	Bravo Weather Stik, 1.5pt(1,2), 2.0pt(3-7)	81.5 (76.4 - 86.6)	91.0 (88.2 - 93.8)	3566 (3379 - 3754)	36 (29 - 42)	37.5 (29.2 - 45.7)	1.06 (0.91 - 1.20)	
10	Previcur Flex, 1.2pt (1,3,5,7); Reason 500SC, 5.5oz (2,4,6); Penncozeb 75DF, 1.5lb (1-7)	87.4 (82.3 - 92.4)	92.1 (89.3 - 94.9)	3788 (3601 - 3975)	35 (28 - 42)	36.9 (28.7 - 45.1)	1.07 (0.92 - 1.21)	
11	Regalia SC, 1% (2,4); Bravo Weather Stik, 2pt (1,3,5); Regalia SC, 0.5% v/v (6,7); Penncozeb 75DF, 3lb (6,7)	93.3 (88.2 - 98.3)	97.8 (94.9 - 100.6)	4039 (3852 - 4226)	39 (32 - 45)	37.3 (29.1 - 45.5)	0.97 (0.83 - 1.11)	
12	Regalia SC, 1% (2,4); Bravo Weather Stik, 2pt (1,3,5); Pristine 38WG, 12.5 oz (6); Regalia SC, 0.5% v/v (6,7); Penncozeb 75DF, 3lb (7)	94.4 (89.3 - 99.4)	96.3 (93.4 - 99.1)	4070 (3883 - 4258)	38 (31 - 45)	38.8 (30.5 - 47.0)	1.02 (0.88 - 1.17)	
13	Penncozeb 75DF, 2lb (1-5); Penncozeb 75DF, 3lb (6,7)	87.4 (82.3 - 92.4)	92.1 (89.3 - 94.9)	3788 (3601 - 3975)	35 (28 - 42)	33.8 (25.6 - 42.1)	0.99 (0.85 - 1.14)	
14	Actigard 50 WG, 0.33oz (1,2); 0.5oz (3-5); 0.75oz (6,7); Bravo Weather Stik 1.5 pt (1,2); 2.0pt (3-7)	81.5 (76.4 - 86.6)	86.3 (83.4 - 89.1)	3535 (3348 - 3723)	38 (31 - 44)	38.5 (30.3 - 46.7)	1.04 (0.90 - 1.19)	
15	Serenade Max, 1lb (1-7); Bravo Weather Stik 1.5pt (1,2); 2.0pt (3-7)	92.1 (87.1 - 97.2)	94.4 (91.6 - 97.2)	3976 (3789 - 4163)	36 (29 - 43)	38.1 (29.8 - 46.3)	1.06 (0.92 - 1.21)	
		<i>P > F</i>	<i>< 0.0001</i>	<i>< 0.0001</i>	<i>< 0.0001</i>	<i>0.3503</i>	<i>0.3624</i>	<i>0.2186</i>

^y Treatments (TRT) were applied 23-Apr, 1-May, 8-May, 15-May, 21-May, 29-May and 5-Jun corresponding with applications 1 to 7, using a backpack sprayer calibrated initially for 40, 60 and then 100 gallons per acre. Listed treatment rates are on a per acre basis unless noted otherwise. Seeds were planted 25-Feb.

^z The severity of downy mildew was assessed as the percentage of canopy affected with chlorosis and necrosis on the adaxial side of leaves. The Horsfall-Barratt scale was used for all ratings, but values were converted to mid-percentages prior to statistical analyses. Area under disease progress curve (AUDPC) was calculated for each treatment using the trapezoidal method. Values in parentheses represent *t*-type confidence intervals ($\alpha = 0.95$) for each mean.

