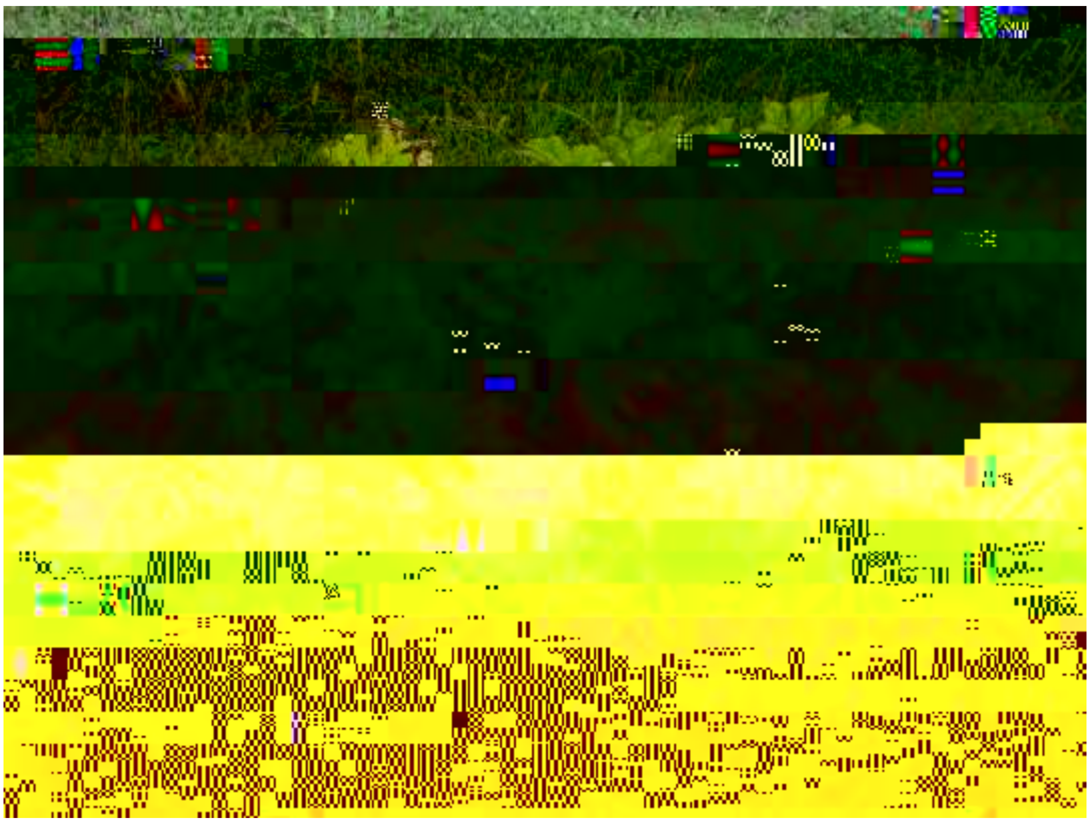
Evaluating the Efficacy of Organic Approved Fungicides for the Control of Powdery Mildew in Squash



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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2016 EVALUATING THE EFFICACY OF ORGANIC APPROVED FUNGICIDES FOR THE CONTROL OF POWDERY MILDEW IN SQUASH

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Powdery mildew grows well in environments with high humidity and moderate temperatures and can be problematic on crops in the Northeast. Cucurbit crops face powdery mildew and often downy mildew on a yearly basis and significant yields losses have been reported. The family of cucurbits is an important part of the diversified crop mix of a typical commercial vegetable farm in Vermont and throughout the Northeast. Growers have been using cultural practices, fungicides, and multiple plantings to mitigate crop loss from powdery mildew, however, the impact of the disease is seasonally dependent and still represents a consistent loss.

Image 1. Powdery mildew on squash stem (left) and leaf (right), Alburgh, Vermont, 2016.

Consumers have become more aware and concerned about the potential health risks and environmental impacts of pesticide use and increased their demand for organic products. As a result, there is greater interest in biopesticides as a potential low-impact management tool. Biopesticides contain microorganisms that work as the active ingredient, which produce a toxin, prey on disease, and/or induce plant resistance. Most of the microorganisms occur naturally in soil or on plant surfaces. These products have not been adequately evaluated in the northeast. Exploring the applications of biofungicides on the broad family of cucurbit crops has potential to positively impact these crops as well as other specialty crops that may benefit from these novel biofungicides. The main objective of this project is to determine the efficacy of organically approved biofungicides for control of powdery mildew in cucurbits.

MATERIALS AND METHODS

The trial was conducted at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block with split plots and four replications. Main plots were five spray treatments (all approved by the Organic Materials Review Institute (OMRI)) and one control, with no fungicide applied (Table 1). Spray treatments consisted of four biofungicides: Regalia (plant extract), Cease *(Bacillus subtilus)*, Sonata *(Bacillus pumilus)*, Actinovate *(Streptomyces lydicus)*, and a copper-based fungicide, Champ.

Table 1. Spray treatment information, 2016.

Spray	Active ingredient
Actinovate	*Streptomyces lydicus*
Cease + Milstop adjuvant	*Bacillus subtilus*(Cease)
Champ	Copper based
Regalia	Plant extract
Sonata	*Bacillus pumilus*

The split plots consisted of two varieties of acorn squash: 'Reba,' which is resistant to powdery mildew and 'Jet,' which is susceptible to powdery mildew. Plots were 12' x 23' with 5' buffers to prevent cross-contamination from biofungicide spray. Squash was spaced 5' between rows and 2' within the row. The previous crop was dry beans. The field was rototilled prior to planting. General plot management is listed in Table 2.

Table 2. General plot management, biofungicide efficacy in squash trial,

is greater than the LSD value of 2.0. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that B was not significantly lower than the top yielding variety.

Variety	Yield
A	6.0
B	7.5*
C	9.0*
LSD	**2.0**

RESULTS AND DISCUSSION

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. The growing season was dryer than normal with May-September getting 7.27 fewer inches of precipitation as compared to historical averages (Table 3). Temperatures in June-July were comparable to normal averages, while May and August-September were at least 1.8 degrees warmer than normal, per month. Overall, there were an accumulated 2562 Growing Degree Days (GDDs) this season, approximately 268 more than the historical average.

Table 3. Seasonal weather data collected in Alburgh, VT, 2016.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	58.1	65.8	70.7	71.6	63.4
Departure from normal	1.80	0.00	0.10	2.90	2.90
Precipitation (inches)	1.50	2.80	1.80	3.00	2.50
Departure from normal	-1.92	-0.88	-2.37	-0.93	-1.17
Growing Degree Days (base 50°F)	340	481	640	663	438

Table 4. The effect of spray treatment on plot characteristics across acorn squash varieties Jet and Reba, Alburgh, VT, 2016.

Treatment	Marketable fruit	Unmarketable fruit	Marketable fruit	Harvested plants
	fruit ac^{-1}	fruit ac^{-1}	% of total	% of total plants from plot
Actinovate	15000	1300	92.4	99.0*
Cease	14000	868	94.2	99.0*
Champ	14600	1100	93.2	99.0*
Regalia	13800	1260	92.4	**100.0***
Sonata	14700	552	96.6	93.8
Control	14400	1340	92.0	97.9*
LSD (0.10)	NS	NS	NS	3.32
Trial mean	14400	1070	93.5	98.1

*Treatments marked with an asterisk were not statistically different top performing treatment shown in **bold** (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Powdery mildew severity rates, across both varieties of squash, was lowest for Champ with 11.3% of the plant biomass infected and Regalia was statistically comparable (Table 5). No significant difference was seen between treatments for storage life or yield.

Table 5. The effect of spray treatment on disease, storage, and yield across acorn squash varieties Jet and Reba, Alburgh, VT, 2016.

Treatment	Powdery mildew	Storage^	Yield
	% of total biomass infected	% shelf-stable	tons ac^{-1}
Actinovate	50.0	95.6	13.3
Cease	58.8	100.0	13.1
Champ	**11.3***	93.8	13.9
Regalia	18.8*	95.8	12.8
Sonata	61.3	100.0	13.5
Control	61.3	97.4	13.2
LSD (0.10)	18.0	NS	NS
Trial mean	43.5	97.1	13.3

Table 7. The effect of acorn squash variety, Jet and Reba, on disease, storage, and yield across all spray treatments, Alburgh, VT, 2016.

Treatment	Powdery mildew	Storage^	Yield
	% of total biomass infected	% shelf-stable	tons ac^{-1}
Jet	57.9	99.1	**14.6**
Reba	**29.2**	95.1	12.0
LSD (0.10)	10.4	NS	1.37
Trial mean	43.5	97.1	13.3

^Percent of squash shelf-stable 3 months after harvest.
Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

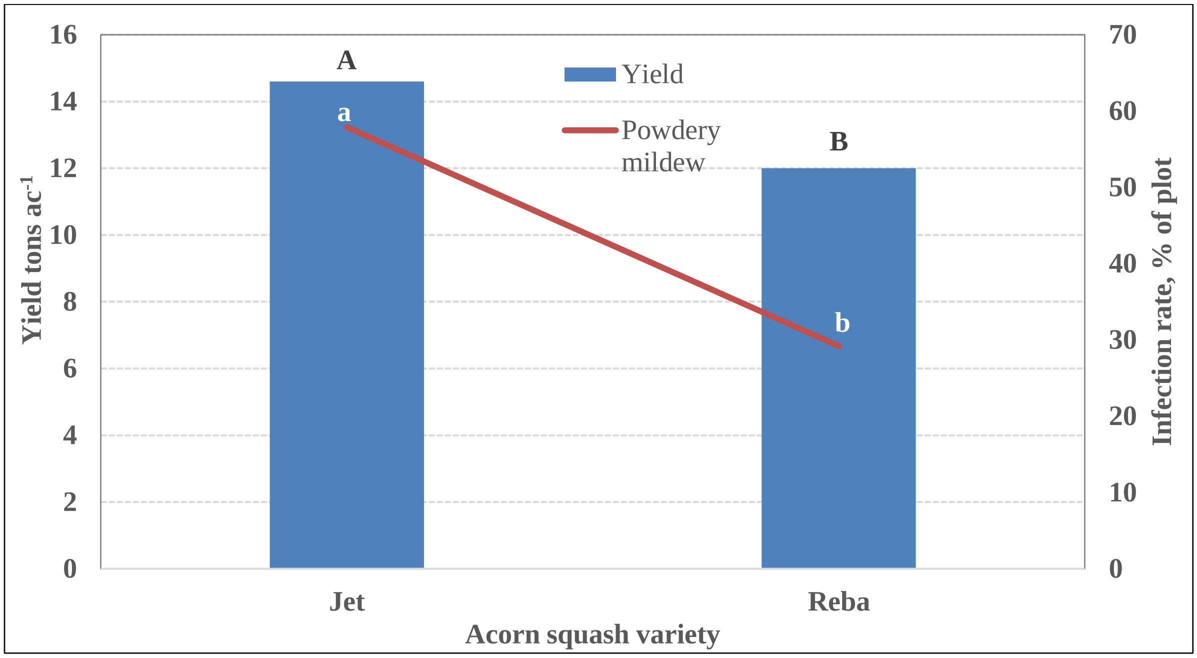

Figure 1. The effect of Jet and Reba varieties on yield across all spray treatments. Treatments with the same letter did not differ significantly from each other (p=0.10). Alburgh, Vermont, 2016.

Interaction of Variety x Biofungicide Treatment

Interactions were observed between squash variety and biofungicide treatment. This indicates that the varieties responded differently to the treatments. This is partially expected since the varieties differed in their susceptibility to powdery mildew.

When comparing all spray treatments on plot characteristics for the acorn squash variety Reba, no significant differences were seen for marketable fruit, unmarketable fruit, or the percentage of plants that produced fruit and were harvested (Table 8).

Table 8. The effect of spray treatments on plot characteristics for the acorn squash variety Reba, Alburgh, VT, 2016.

Treatment	Marketable fruit	Unmarketable fruit	Marketable fruit	Harvested plants
	fruit ac^{-1}	fruit ac^{-1}	% of total	% of total plants from plot
Actinovate	15800	1740	50.0	98.0
Cease	14900	947	94.1	100.0
Champ	14500	1580	90.1	98.0
Regalia	14800	1820	89.3	100.0
Sonata	16200	789	95.2	91.7
Control	16000	1740	90.6	98.0
LSD (0.10)	NS	NS	NS	NS
Trial mean	15400	1430	91.6	97.6

NS – There was no statistical difference between treatments in a particular column (p=0.10).

The acorn squash variety Reba, showed no significant difference for storage life or yield between spray treatments (Table

No significant difference was seen for storage life or yield across all treatments for the squash variety, Jet (Table 11). A significant difference was seen for severity of powdery mildew symptoms on plant biomass, where Champ was the best performer at 13.8% of the plot diseased and Regalia showed statistically similar results (Table 11, Figure 2).

Table 11. The effect of spray treatments on disease, storage, and yield for the acorn squash variety Jet, Alburgh, VT, 2016.

Treatment	

Overall, powdery mildew pressure during 2016 was relatively low due to dry weather. When comparing acorn squash varieties, Reba, which is resistant to powdery mildew, had significantly lower powdery mildew severity, however yielded significantly lower than Jet, which is susceptible to powdery mildew. In future years, with potentially worse outbreaks of powdery mildew, the benefits of a disease resistant variety may transfer to a yield benefit as well.