



2017 Heirloom Dry Bean Variety Trial



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Dry beans (*Phaseolus vulgaris*), a high-protein pulse crop, have been grown in the Northeast since the 1800's. As the local food movement continues to diversify and expand, consumers are asking stores to carry more and more locally-produced foods, and dry beans are no exception. Currently, the demand for heirloom dry beans has far exceeded the supply. In an effort to support and expand the local bean market throughout the northeast, the University of Vermont Extension Northwest Crops and Soils Program, established a third year of trials in 2017 to evaluate heirloom dry bean varieties to see which ones thrive in our northern climate.

MATERIALS AND METHODS

The trial was established at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block with four replications. The treatments were heirloom dry bean varieties. The heirloom dry bean varieties, seed sources, relative maturity, and vining tendencies are listed in Table 1.

Table 1. Varieties, seed sources, relative maturity, and vining of the 18 heirloom dry bean varieties planted in Alburgh VT, 2017.

Variety	Seed Source	Relative maturity	Vining
Black Calypso	Saved seed, Borderview Research Farm, VT	Early	No
Black Turtle	Saved seed, Borderview Research Farm, VT	Late	No
Hutterite Soup	University of Minnesota, MN	Medium	Yes
Jacob's Cattle Gold	University of Minnesota, MN	Medium	No
Jacob's Cattle	Saved seed, Borderview Research Farm, VT	Early	No
Kenearly Yellow Eye	University of Minnesota, MN	Early	No
King of the Early	Saved seed, Borderview Research Farm, VT	Medium	No
Lowe's Champion	Rusted Rooster Farm, ME	Medium	No
Lina Sisco	University of Minnesota, MN	Early	No
Light Red Kidney	Saved seed, Borderview Research Farm, VT	Medium	No
Marifax	Rusted Rooster Farm, ME	Medium	No
Orca	Saved seed, Borderview Research Farm, VT	Medium-late	Yes
Peregrin	University of Minnesota, MN	Medium	Yes
Raquel	Saved seed, Borderview Research Farm, VT	Medium-late	No
Spanish Tolasa	Saved seed, Borderview Research Farm, VT	Medium-late	Yes
Tiger's Eye	University of Minnesota, MN	Early	Yes
Vermont Appaloosa	Saved seed, Borderview Research Farm, VT	Early	No
Vermont Cranberry	Saved seed, Borderview Research Farm, VT	Early	Yes

The seedbeds at the Alburgh location were prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The previous crops planted were winter wheat and barley. The plot area was spring plowed, disked and spike tooth harrowed to prepare for planting. The plots were planted on 4-Jun with a Monosem 2-row planter precision air planter (Edwardsville, KS), at a rate of seven seeds per foot. Prior to planting, bean seed at was treated with dry bean inoculant (*Rhizobium leguminosarum biovar phaseoli*). The plot size was 5' x 20', with 30-inch row spacing.

Table 2. General trial management information of the 2017 heirloom dry bean variety trials in Alburgh, VT.

Location	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter wheat and barley
Tillage operations	Spring plow, disk, & spike tooth harrow
Plot size (ft)	5 x 20
Row spacing (inches)	30
Replicates	4
Planting date	4-Jun
Seeding rate	7 seed ft ² (~122,000 seeds ac ⁻¹)
Planter	Monosem 2-row planter
Tineweed	None
Cultivation	4-Row Brillion: 5-Jul
Pesticide	Pyganic (16 fl. oz. ac ⁻¹)
Harvest date	20-Sep and 4-Oct

In Alburgh, the plots were mechanically cultivated with a 4-row Brillion cultivator on 5-Jul. Plots were scouted on 12-Jul by using two, 0.5 meter quadrats for disease symptoms and insect damage in each plot. Quadrats were placed randomly within bean rows. In each quadrat, the number of plants was recorded. The number of plants with disease symptoms and insect damage were recorded. In addition, one plant per quadrat was pulled to examine roots for pest damage. Plants with unknown discoloration or damage were pulled, placed in a labeled plastic bag, refrigerated, and identified at the UVM Plant Diagnostic Laboratory. After scouting was completed, plots were sprayed 12-Jul with the OMRI approved pesticide Pyganic (MGK-9643) at a rate of 16 fluid ounces per acre, to help control potato leafhopper damage.

At the time of harvest, plant height, relative maturity, plant vining, lodging, and pod distance to ground were determined, and 10 pods from each plot were examined for the presence of disease. Plots were hand harvested and then threshed with a portable thresher with a rasp bar rotor. Beans were then weighed to calculate yields and a DICKEY-John MINI GAC Plus meter or an OHAUS MB23 moisture balance was used to determine bean moisture content and test weight. Harvest occurred on 20-Sep for the early and medium maturing varieties and on 4-Oct for the later maturing varieties. Data was analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications were treated as

random effects and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p < 0.10$). In Alburgh, diseased pods, moisture, and test weight were analyzed using the PROC MIXED procedure in SAS using the Tukey-Kramer adjustment, which means that each variety was analyzed with a pairwise comparison. There were significant differences among the two locations for most parameters, and therefore, data from each location is reported independently.

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (e.g. yield). Least Significant Differences at the 10% level of probability are shown. Where the difference between two varieties within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two varieties. Wheat varieties that were not significantly lower in performance than the highest variety in a particular column are indicated with an asterisk. In this example, variety A is significantly different from variety C but not from variety B. The difference between A and B is equal to 725 which is less than the LSD value of 889. This means that these varieties did not differ in yield. The difference between A and C is equal to 1454 that is greater than the LSD value of 889. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that variety B was not significantly lower than the top yielding variety.

Variety	Yield
A	3161
B	3886*
C	4615*
LSD	889

RESULTS

Seasonal precipitation and temperature recorded at a weather station in close proximity to the Alburgh trial site is shown in Table 3. The weather during much of the 2017 growing season was cooler and wetter than average, followed by a warmer and drier September and October. Above average rainfall was recorded in June, July, and August that totaled 2.20 inches above the 30-year average. In Alburgh, there was an accumulation of 2335 Growing Degree Days (GDDs), which is 209 GDDs above the 30-year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2017.

Alburgh, VT	June	July	August	Sept	Oct
Average temperature (°F)	65.4	68.7	67.7	64.4	57.4
Departure from normal	-0.39	-1.90	-1.07	3.76	9.20
Precipitation (inches)	5.60	4.90	5.50	1.80	3.30
Departure from normal	1.95	0.73	1.63	-1.80	-0.31
Growing Degree Days (50-86°F)	468	580	553	447	287
Departure from normal	-7	-60	-28	129	175

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.

Historical averages are for 30 years of data provided by the NOAA (1981-2010) for Burlington, VT.

Heirloom Dry Bean Scouting

Several plant pests were identified on the dry beans during routine this season. Root rots, caused primarily by Fusarium, Rhizoctonia, and Pythium root rot, were detected in all varieties except for Black Turtle, Jacob's Cattle Gold, and Peregrin. There was no significant difference in Anthracnose infection, Common bacterial bean blight infection, or Potato leafhopper (*Empoasca fabae*) damage between varieties (Table 4). Varying degrees of Anthracnose (*Glomerella lindemuthiana*) infection was identified on seventeen of the 18 dry bean varieties. Hutterite soup was the only variety where symptoms of the disease were not observed. Common bacterial blight (*Xanthomonas axonopodis* pv. *phaseoli*) was identified in all of the varieties, in varying degrees. Jacob's Cattle Gold had the lowest severity (3.75%), while Vermont Cranberry had the highest rate of bacterial blight severity (39.5%). Interestingly, Vermont Cranberry also had the highest amount of potato leafhopper damage.

Table 4. 2017 Heirloom dry bean plant disease and pest severity in Alburgh, VT.

Variety	Anthracnose	Common bacterial bean blight	Potato leafhopper
	%	%	%
Black Calypso	1.00	8.75	25.0
Black Turtle	1.75	5.00	15.0
Hutterite Soup	0.00	7.00	18.8
Jacob's Cattle	25.0	13.0	25.0
Jacob's Cattle Gold	5.00	3.75	21.3
King of the Early	3.75	5.00	23.8
Light Red Kidney	5.00	14.3	21.3
Lina Sisco	8.00	5.75	17.5
Lowe's Champion	7.50	5.25	10.8
Marifax	1.25	7.75	20.0
Orca	0.50	7.00	29.5
Peregrin	0.75	4.50	13.8
Raquel	7.00	6.75	31.3
Spanish Tolasna	5.00	18.8	30.0
Tiger's Eye	5.75	6.75	28.8
Vermont Appaloosa	2.50	13.0	21.3
Vermont Cranberry	20.3	39.5	46.3
Kenearly Yellow Eye	3.00	11.8	30.0
<i>LSD (0.10)</i>	NS	NS	NS
<i>Trial Mean</i>	5.72	10.2	23.8

Values shown in **bold** are of the highest value or top performing. NS-Not significantly different.

Potato leafhopper damage was severe and impacted all varieties. Potato leafhoppers feed with piercing-sucking mouthparts on host plant vascular tissue (Image 1). This restricts phloem and eventual xylem flow to the rest of the leaf resulting in leaf edge yellowing and curling. At high infestation levels, stunted internodes can be observed. Visual damage caused by potato leafhopper is called "hopperburn" (Image 2).

Hopperburn is not present until 5-7 days after leafhopper feeding has occurred. The first sign is yellowing of the leaf at the tip followed by necrosis and leaf curling. These symptoms are the result of the plant shutting down photosynthesis in the leaf in response to leafhopper feeding. As this pest weakens a plant, it becomes more vulnerable to disease. All varieties had varying degrees of potato leafhopper damage (Figure 1). The dry bean variety Lowe’s Champion had the lowest amount of potato leafhopper damage (10.8%).



Image 1. Potato leafhoppers on heirloom dry beans, Alburgh, VT.



Image 2. Dry bean “hopperburn”, Alburgh, VT.

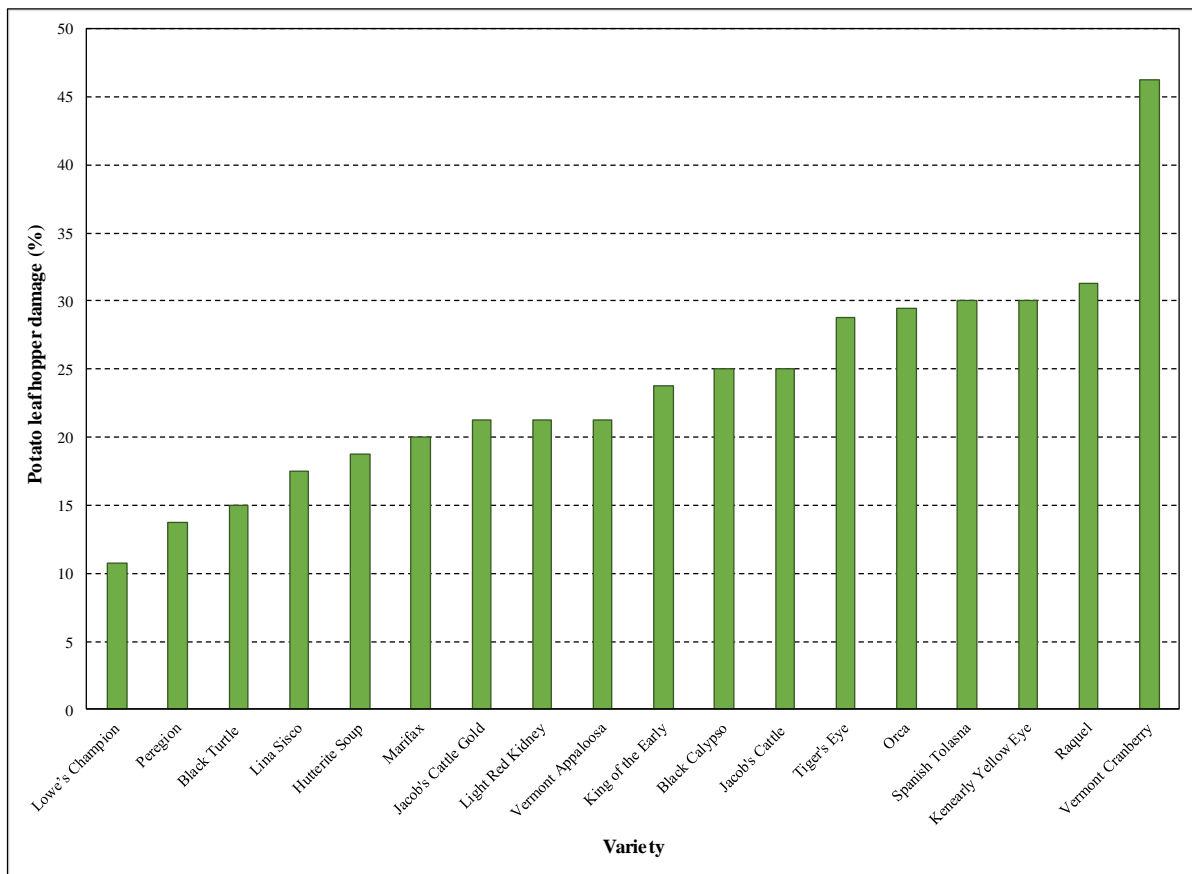


Figure 1. 2017 Potato leafhopper damage of heirloom dry bean varieties in Alburgh, VT

Heirloom Dry Bean Harvest

In Alburgh, there were significant differences in plant height, lodging, pod distance to ground, and pod disease (Table 5). The tallest variety was Black Turtle at 47.8 cm and the shortest variety was Jacob's Cattle Gold (20.3 cm). There was no lodging recorded in Black Turtle, Jacob's Cattle Gold, King of the Early, Light Red Kidney, Lina Sisco, Lowe's Champion, Raquel, and Vermont Appaloosa. The variety that lodged the most was Hutterite Soup (40.0%). Black Turtle beans had the highest pod distance from the ground (15.3 cm) and the least amount of pod disease (15.0%). Another variety with high pod height (11.3 cm) and low pod disease (15.0%) was Peregrin.

Table 5. 2017 Heirloom dry bean pre-harvest measurements, Alburgh, VT.

Variety	Plant height	Lodged	Pod distance to ground	Pod disease
	cm	%	cm	%
Black Calypso	22.8	2.50*	7.17	100
Black Turtle	47.8*	0.00*	15.3*	15.0*
Hutterite Soup	21.9	40.0	4.67	67.5
Jacob's Cattle	21.3	2.50*	4.75	80.0
Jacob's Cattle Gold	20.3	0.00*	7.58	77.5
King of the Early	25.5	0.00*	4.50	75.0
Light Red Kidney	27.3	0.00*	6.50	60.0
Lina Sisco	23.6	0.00*	8.08	100
Lowe's Champion	29.6	0.00*	9.25	90.0
Marifax	27.8	2.50*	6.25	72.5
Orca	30.6	8.75*	8.58	47.5
Peregrin	31.5	17.5	11.3*	15.0*
Raquel	28.3	0.00*	5.75	65.0
Spanish Tolasna	30.3	6.25*	6.17	85.0
Tiger's Eye	25.3	5.00*	4.83	80.0
Vermont Appaloosa	28.3	0.00*	6.00	70.0
Vermont Cranberry	30.0	12.5	7.58	60.0
Kenearly Yellow Eye	21.9	2.50*	6.00	47.5
<i>LSD (0.10)</i>	7.75	8.81	4.12	25.8
<i>Trial Mean</i>	27.5	5.56	7.24	67.1

Values shown in **bold** are of the highest value or top performing.

* Dry beans that did not perform significantly lower than the top performing variety in a particular column are indicated with an asterisk.

In Alburgh, there were significant differences in the yield, harvest moisture, and test weight (Table 6). The highest yielding variety was Black Turtle (1,582 lbs ac⁻¹) and the lowest yielding was Tiger's Eye with 248 lbs ac⁻¹ (Figure 2). The variety with the lowest harvest moisture was Spanish Tolasna (13.1%) and the highest moisture at harvest was Tiger's Eye (25.0%). All of the harvest moistures, except for Spanish Tolasna, were above the recommend level for proper storage and therefore, had to be dried down

to below 14% moisture. The variety with the highest test weight was Hutterite Soup (65.9 lbs bu⁻¹) and the lowest was Jacob's Cattle at 43.0 lbs bu⁻¹. Except for Jacob's Cattle, none of the other dry bean varieties were significantly different from each other. However, only nine varieties: Black Calypso (65.0 lbs bu⁻¹), Spanish Tolasna (64.0 lbs bu⁻¹), Orca (63.4 lbs bu⁻¹), Black Turtle (62.4 lbs bu⁻¹), Lowe's Champion (61.7 lbs bu⁻¹), Peregrion (61.5 lbs bu⁻¹), Marifax (60.9 lbs bu⁻¹), Jacob's Cattle Gold (60.6 lbs bu⁻¹), Vermont Appaloosa (60.2 lbs bu⁻¹), and Kenearly Yellow Eyes (60.1 lbs bu⁻¹) had test weights that met or exceeded industry standards of 60 lbs bu⁻¹.

Table 6. 2017 Heirloom dry bean harvest measurements, Alburgh, VT.

Variety	Yield @ 13.0% moisture	Harvest moisture	Test weight
	lbs ac ⁻¹	%	lbs bu ⁻¹
Black Calypso	293	22.0	65.0*
Black Turtle	1818*	19.6	62.4*
Hutterite Soup	935	19.0	65.9*
Jacob's Cattle	410	18.4	43.0
Jacob's Cattle Gold	530	19.2	60.6*
King of the Early	947	20.0	59.4*
Light Red Kidney	762	20.8	58.4*
Lina Sisco	829	19.9	57.0*
Lowe's Champion	651	19.8	61.7*
Marifax	786	18.6	60.9*
Orca	1430*	15.4*	63.4*
Peregrion	1303	22.5	61.5*
Raquel	641	18.6	59.6*
Spanish Tolasna	499	13.1*	64.0*
Tiger's Eye	285	25.0	57.3*
Vermont Appaloosa	665	20.7	60.2*
Vermont Cranberry	784	14.5*	57.0*
Kenearly Yellow Eye	352	18.9	60.1*
<i>LSD (0.10)</i>	452	3.71	9.04
<i>Trial Mean</i>	773	19.2	59.9

Values shown in **bold** are of the highest value or top performing.

* Dry beans that did not perform significantly lower than the top performing variety in a particular column are indicated with an asterisk.

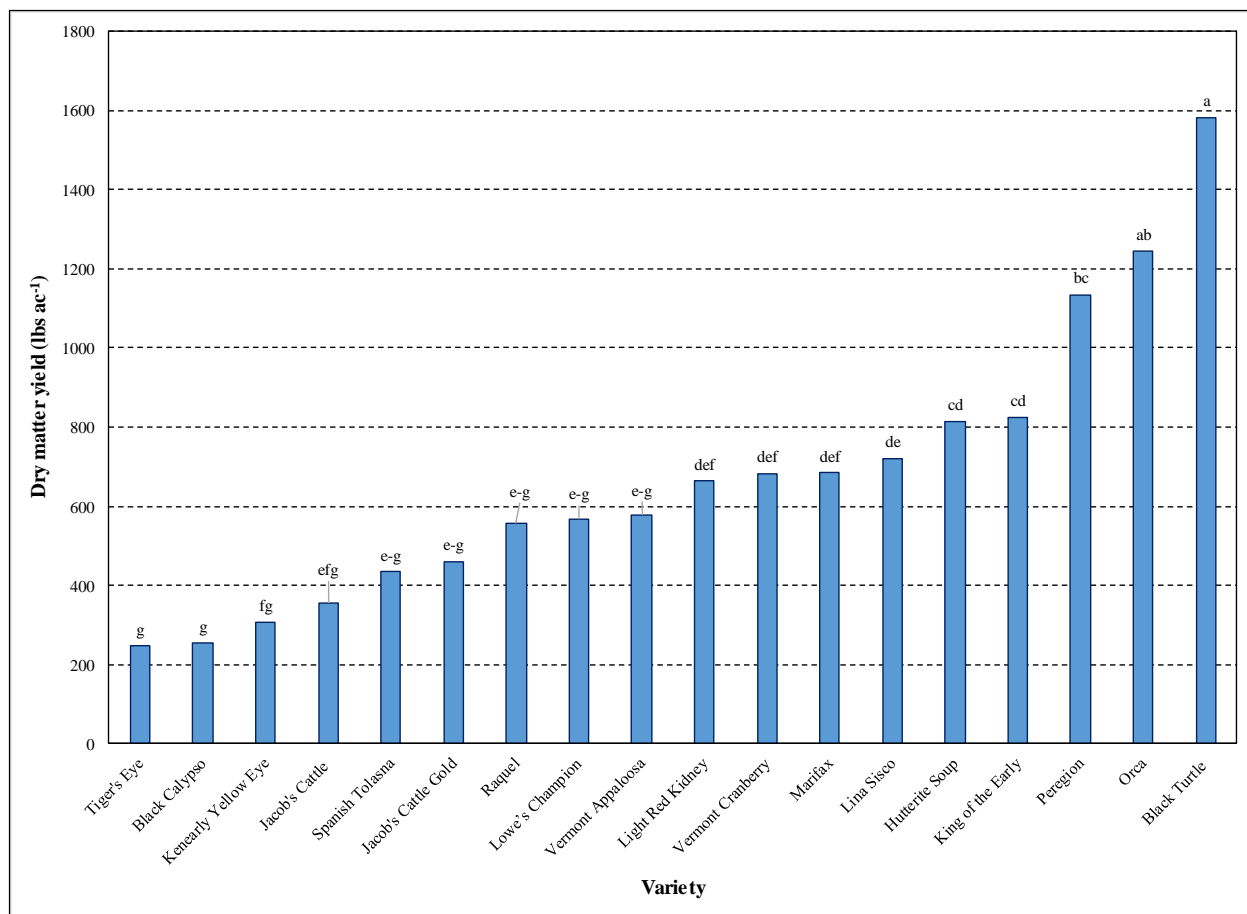


Figure 2. 2017 Heirloom dry bean yields, Alburgh, VT.
 Varieties with the same letter did not differ significantly in yield.

DISCUSSION

It is important to remember that the results only represent one year of data. Seed quality continues to be an important issue in dry bean production. Before variety trials were planted, percent seed germination was determined for each variety and seeding rates adjusted and those varieties with low germination rates were eliminated from the 2017 trials.

Overall, the 2017 growing season was challenging for growing dry beans. The cooler than average temperatures along with higher than normal rainfall throughout much of the growing season likely had impact on dry bean yields and created the ideal conditions for fungal pathogens. The average yield in 2017 was 673 lbs ac⁻¹, 480 pounds less than the mean yield in 2016. Interestingly, even though the yields were low, the beans produced were relatively high quality, given that eleven out of the eighteen varieties trialed met or exceeded industry standards for test weight (60 lbs ac⁻¹).

The cool and wet conditions in June delayed plant emergence and slowed plant development. Interestingly, weed pressure was not a major issue this season in part because timely cultivation was possible and the weather conditions also slowed weed growth.

Potato leafhopper damage was observed on all varieties trialed. Interestingly, Vermont Cranberry, Raquel, Kenealy Yellow Eye, and Spanish Talosna appeared to be particularly susceptible to leafhopper damage whereas Lowe's Champion and Peregrine were relatively tolerant. As a result of the leafhopper damage "hopperburn", we saw an increase in secondary plant disease infections, primarily common bacterial bean blight. Overall, the variety Peregrine outperformed all the other heirloom dry bean varieties for both yield and quality. Other heirloom dry bean varieties that performed relatively well this season for both yield and quality included Black Turtle and Orca.

More research needs to be done to determine which varieties thrive in our climate and therefore, the Northwest Crops and Soils team plans to repeat this trial in 2018.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to thank the Borderview Research Farm and the UVM Plant Diagnostic Clinic for their generous help with the trial. We would like to acknowledge Kelly Drollette, Hillary Emick, Abha Gupta, Freddy Morin, Lindsey Ruhl, Matt Sanders, Stuart Wolff-Goodrich and Sara Ziegler for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

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