2015 Dry Bean Seeding Rate 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 expands, consumers have requested stores stock more and more locally-produced foods and heirloom dry beans are no exception. Currently, the demand for heirloom dry beans has exceeded the supply. Little agronomic information exists for production of dry beans in New England. In 2015, as part of a USDA NE-SARE Partnership Grant (PG15-045) the UVM Extension Northwest Crops and Soils Program established a dry bean seeding rate trial to determine the optimal seeding rates for three types of dry beans.

MATERIALS AND METHODS

The trial was conducted in 2015 at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block split design with three replications. Main plots were seeding rate and subplots were varieties (Table 1).

Table 1. Seed varieties and seed sources for the dry bean seeding rate trial at Borderview Research Farm in Alburgh, VT, 2015.

Dry bean varieties	Seed source	Seeding rate low	Seeding rate medium	Seeding rate high
		seeds ac^{-1}	seeds ac^{-1}	seeds ac^{-1}
Black turtle	Borderview Research Farm, Alburgh, VT	71,000	99,000	126,000
Pinto	Morningstar Meadows Farm, Glover, VT	63,000	78,000	99,000
Yellow Eye	Morningstar Meadows Farm, Glover, VT	56,000	76,000	110,000

The soil type at the project site was a Benson rocky silt loam. The seedbed was prepared by spring plow, followed by disk and spike tooth harrow. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2).

Plots were planted on 29-May with a John Deere 1750 planter using the soybean cups. Seeding rates were determined by calibrating the planter for each bean variety and target seeding rate. Prior to planting, bean seed was treated with dry bean inoculant. The plots were 10'x 30', with 30-inch row spacing. Plant populations were taken on 26-Jun by counting the number of plants in 10 feet of the two center rows of each plot. Plots were mechanical cultivated with a four row Brillion cultivator on 17-Jun and 7-Jul. In addition, the plots were weeded by hand once in June and again in July. On 2-Jul, plots were scouted 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 were 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. All plots were harvested on 22-Sep by hand, and the harvest area was two 5-foot sections in each plot. The harvested bean plants were then bundled and hung to dry overnight. Beans were then threshed with an Almaco Large Vogel plot thresher. Beans were then weighed to calculate yields and a DICKEY-John M3G moisture tester was used to determine bean moisture content.

Table 2. Dry bean seeding rate trial specifics in Alburgh, VT, 2015.

Trial information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn with cover crop
Tillage operations	Spring plow, disk, and spike tooth harrow
Planting date	29-May
Plot size (feet)	10 x 30
Row spacing (inches)	30
Replicates	3
Plant emergence	11-Jun
Cultivation	4-Row Brillion: 17-Jun and 7-Jul
Harvest date	22-Sep

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 ($p<0.10$)

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. In the example below, 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, which 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 trial site is shown in Table 3. The 2015 growing season brought a warmer and drier than average May followed by cooler and wetter June. Below average rainfall was recorded in July, August, and September that totaled almost ten inches below the 30 year average. In Alburgh, there was an accumulation of 2578 Growing Degree Days (GDD), which is 367 GDDs above the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2015.

Alburgh, VT	May	Jun	Jul	Aug	Sept
Average temperature (°F)	61.9	63.1	70.0	69.7	65.2
Departure from normal	5.5	-2.7	-0.6	0.9	4.6
Precipitation (inches)	1.94	6.42	1.45	0.00	0.34
Departure from normal	-1.51	2.73	-2.70	-3.91	-3.30
Growing Degree Days (base 50°F)	416	416	630	624	492
Departure from normal	218	-58	-10	43	174

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Actual plant populations for all varieties trialed differed from the target seeding rates (Table 4). The black turtle bean population instead ranged from 51,691 (72.8% germination) to 80,731 (64.1% germination). The Pinto bean plant populations ranged from 21,490 (34.1% germination) to 34,848 (35.2% germination), far below the target seeding rates. Similarly, the Yellow eye bean populations were far below the target seeding rates, they ranged from 20,328 (37.4% germination) to 25,846 (23.5% germination). Interestingly, all varieties showed the seeding rates went from low to high although none met the target seeding rates. The actual plant populations of the medium and high seeding rates did not differ statistically from each other. There were no significant differences in the Pinto and Yellow eye bean seeding rate plant populations.

Table 4. Dry bean populations and percent germination by variety and seeding rate, 2015.

Variety	**Target seeding rate**	**Actual plant population**	**Germination**
	seeds ac^{-1}	plants ac^{-1}	%
Black turtle	71,000 (low)	51,691	72.8
Black turtle	99,000 (medium)	72,890*	**73.6**
Black turtle	126,000 (high)	**80,731***	64.1
LSD (0.10)		9107	NA
Trial Mean		68438	70.2

Pinto	63,000 (low)	21,490	34.1
Pinto	78,000 (medium)	30,492	**39.1**
Pinto	99,000 (high)	**34,848**	35.2
LSD (0.10)		NS	NA
Trial Mean		28,943	36.1
Yellow eye	56,000 (low)	20,328	**37.4**
Yellow eye	76,000 (medium)	20,909	27.5
Yellow eye	110,000 (high)	**25,846**	23.5
LSD (0.10)		NS	NA
Trial Mean		22,361	29.5

*Treatments that did not perform significantly lower than the top-performing treatment (in **bold**) in a particular column are indicated with an asterisk.
NS-Treatments were not significantly different from one another.
NA-Not statistically tested.

The yield and harvest moisture were not significantly different between the Black turtle bean seeding rate treatments (Table 5). The medium seeding rate yielded the highest at 3247 lbs ac^{-1}, and the high Black turtle bean seeding rate resulted in the lowest yield (2596 lbs ac^{-1}). All of the harvest moistures were above the recommended storage moisture of 13%, so all samples had to be dried down. There were no significant differences between actual plant populations, yield, and harvest moisture in the Pinto and Yellow eye bean seeding rate treatments. The high seeding rate treatment of both the Pinto (1342 lbs ac^{-1}) and Yellow eye beans (929 lbs ac^{-1}) yielded the highest. All of the seeding rate moistures for the Pinto beans were above the recommended 13% moisture for storage, and therefore did not have to be dried down. Only the Yellow eye beans had harvest moistures below 13%.

Table 5. Dry bean yield and harvest moisture by variety and target seeding rates.

Variety	Target seeding rate	Yield	Harvest moisture
	seeds ac^{-1}	lbs ac^{-1}	%
Black turtle	71,000 (low)	2811	17.3
Black turtle	99,000 (medium)	**3247**	**16.7**
Black turtle	126,000 (high)	2596	17.3
LSD (0.10)		NS	NS
Trial Mean		2885	17.1
Pinto	63,000 (low)	650	**13.1**
Pinto	78,000 (medium)	842	13.3
Pinto	99,000 (high)	**1342**	13.3
LSD (0.10)		NS	NS
Trial Mean		945	13.3
Yellow eye	56,000 (low)	610	12.5
Yellow eye	76,000 (medium)	581	12.4
Yellow eye	110,000 (high)	**929**	**12.1**
LSD (0.10)		NS	NS
Trial Mean		707	12.3

Top-performers are in **bold**.
NS-Treatments were not significantly different from one another.

Black Turtle beans had the highest overall average yield of 2885 lbs ac^{-1}; 1940 lbs ac^{-1} more than the average yield of the Pinto beans (945 lbs ac^{-1}) and 2178 lbs ac^{-1} more than the Yellow Eye beans (707 lbs ac^{-1}) average yield (Figure 1).

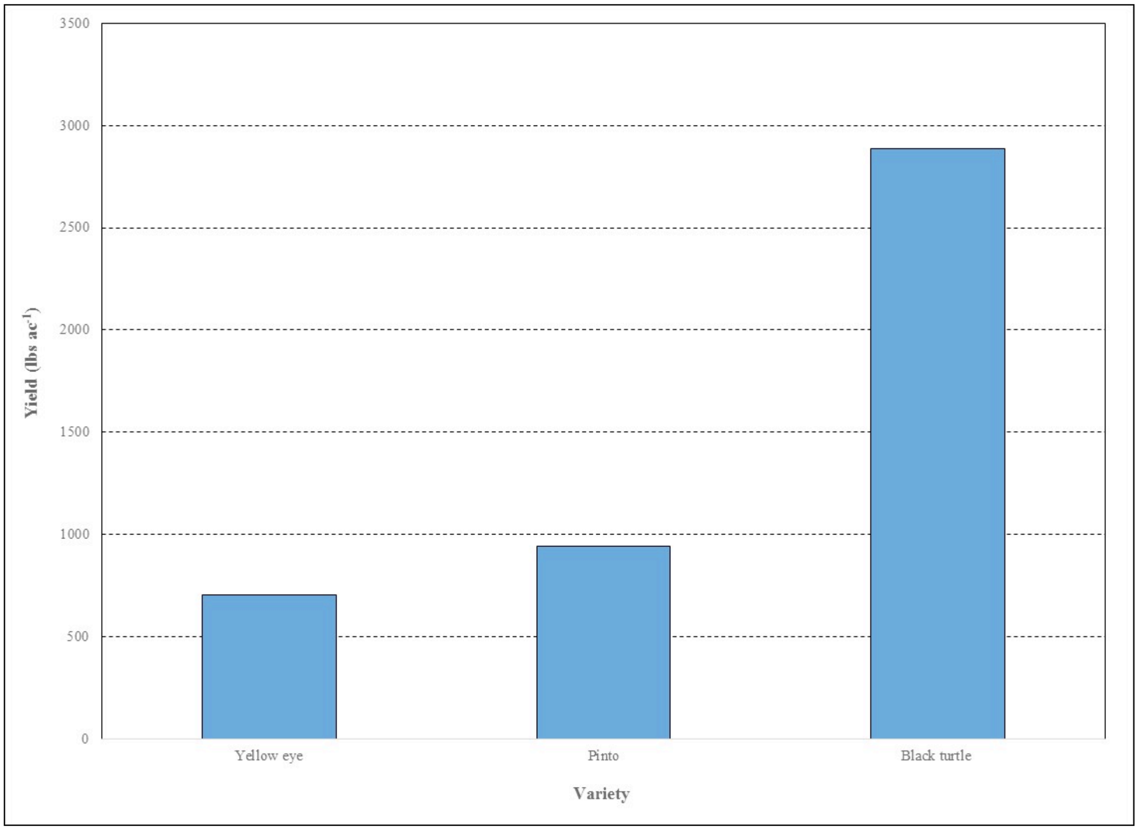

Figure 1. 2015 mean yields, of Black turtle, Pinto, and Yellow eye dry beans, Alburgh, VT

DISCUSSION

It is important to remember that the results only represent one year of data. The 2015 growing season brought many challenges during the growing season. The actual plant populations were much lower than the target seeding rates for Yellow eye, Pinto, and Black turtle beans. There were several factors that may have limited germination rates including poor seed quality, low moisture at planting time, and planter error. The Black turtle beans had a much higher germination rate compared to the other two varieties. The relatively small seed size of the black bean could have been a factor by requiring less moisture to germinate thus resulting better germination rates.

Following a dry May, the below average temperatures and higher than average rainfall in June may have further delayed plant germination and growth, which created the ideal conditions for weed growth and root diseases. The wet conditions throughout June made it challenging to cultivate mechanically which allowed for the weeds to take hold and thrive. Even hand cultivation wasn't enough to knock back the weeds, and the low plant populations allowed for even greater weed pressure. The lower than expected plant populations and the high weed pressure likely resulted in low yields. Overall, the Black Turtle beans yielded significantly higher than the other two varieties. This could be attributed to higher plant populations of the Black turtle beans compared to those of the Pinto and Yellow eye beans. The denser plant canopy helped to minimize weed pressure and resulted in higher yields. More research needs to be done to determine the ideal dry bean seeding rates. Therefore, the Northwest Crops and Soils Program plans on repeating this trial in 2016.

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