NORTHWEST CROPS & SOILS PROGRAM

# 2016 Dry Bean Seeding Rate Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

**2016 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 an effort to support and expend the local bean market throughout the northeast, the University of Vermont Extension Northwest Crops and Soils Program, as part of a USDA NE-SARE Partnership Grant (PG16-049), in 2016 established a second year of 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 2016 at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block split design with four replications. Main plots were seeding rate and subplots were 3 types of dry beans (Table 1).

**Table 1. Varieties, seed sources, seeding rates, and germination for the dry bean seeding rate trial at Borderview Research Farm in Alburgh, VT, 2016.**

| Dry bean varieties | Seed source | Seeding rate low | Seeding rate medium | Seeding rate high | Seed germination |
|---|---|---|---|---|---|
| | | seeds $ac^{-1}$ | | | % |
| Black Turtle | Borderview Research Farm, Alburgh, VT | 79,000 | 99,000 | 119,000 | 75.0 |
| King of the Early | Borderview Research Farm, Alburgh, VT | 58,000 | 78,000 | 98,000 | 95.0 |
| Yellow Eye | Borderview Research Farm, Alburgh, VT | 57,000 | 77,000 | 97,000 | 92.0 |

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).

The field was spring plowed, disked and spike tooth harrowed to prepare for planting. Seed germination tests were done on dry bean varieties before planting by wrapping 25 seeds in 2 absorbent paper towels like a burrito, sufficiently wetting the wrap, placing it in a plastic bag, and storing it in the dark at room temperature for 5 days. Each sample was done in duplicate. The samples were checked daily, germinated seed was removed and additional water added as needed. On the fifth day, the number of seed not germinated was counted and percent germination was calculated (Table 1). Plots were planted on 1-Jun

with a Monosem 2-row planter. Seeding rates were determined by calculating the desired target seeding rate and adjusting for percent germination. Prior to planting, bean seed was treated with dry bean inoculant (*Rhizobium leguminosarum biovar phaseoli*). Additionally, a starter fertilizer was applied at 150 lbs $ac^{-1}$ to the acre of 10-20-20 at the time of planting. The plots were 5'x 20', with 30-inch row spacing. Plant populations were taken on 23-Jun by counting the number of plants in 17.5 feet of both rows of each plot. Plots were mechanical cultivated with a four-row Brillion cultivator on 6-Jul and 11-Jul. At the time of harvest, plant populations were counted in one square meter per plot, plant height, and 10 pods from each plot were examined for the presence of disease. Plots were hand harvested in Alburgh on 26-Sep and were 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 was used to determine bean moisture content and test weight.

**Table 2. Dry bean seeding rate trial specifics in Alburgh, VT, 2016.**

| Trial information | Borderview Research Farm<br>Alburgh, VT |
|---|---|
| **Soil type** | Benson rocky silt loam |
| **Previous crop** | Sod |
| **Tillage operations** | Spring plow, disk, and spike tooth harrow |
| **Plot size (ft)** | 5 x 20 |
| **Row spacing (in)** | 30 |
| **Replicates** | 4 |
| **Starter Fertilizer (lbs $ac^{-1}$)** | 150 - (10-20-20) |
| **Planting date** | 1-Jun |
| **Cultivation** | 4-Row Brillion: 6-Jul and 11-Jul |
| **Harvest date** | 26-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 following 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, 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 AND DISCUSSION

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 the 2016 growing season was warmer and drier than average. Below average rainfall was recorded in June, July, August, and September and totaled 5.35 inches below the 30-year average. There was an accumulation of 2222 Growing Degree Days (GDDs), which is 195 GDDs above the 30-year average.

**Table 3. Temperature and precipitation summary for Alburgh, VT, 2016.**

| Alburgh, VT | Jun | Jul | Aug | Sep |
|---|---|---|---|---|
| Average temperature (°F) | 65.8 | 70.7 | 71.6 | 63.4 |
| Departure from normal | 0.01 | 0.13 | 2.85 | 2.90 |
| | | | | |
| Precipitation (inches) | 2.81 | 1.79 | 2.98 | 2.47 |
| Departure from normal | -0.88 | -2.37 | -0.93 | -1.17 |
| | | | | |
| Growing Degree Days (50-86°F) | 481 | 640 | 663 | 438 |
| Departure from normal | 7.2 | 1.4 | 81.9 | 104 |

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. Alburgh precipitation data from 8/17/16-10/31/16 was missing and replaced by data provided by the NOAA for Highgate, VT.

Actual plant populations for all seeding rates and bean types were far below the target seeding rates (Table 4). The Black Turtle bean populations ranged from 29,434 plants $ac^{-1}$ (37.3% germination) to 67,456 plants $ac^{-1}$ (56.7% germination); King of the Early ranged from 32,359 plants $ac^{-1}$ (55.8% germination) to 56,192 plants $ac^{-1}$ (57.3% germination); and Yellow Eye populations ranged from 21,469 plants $ac^{-1}$ (37.7% germination) to 31,737 plants $ac^{-1}$ (32.7% germination). Interestingly, all varieties showed the seeding rates went from low to high although none met the target seeding rates. The below average rainfall combined with the low soil moisture, and higher than normal temperatures during planting may have contributed to low germination rates which resulted in poor stand establishment. Even though it was the largest of the bean type, the King of the Early had the highest overall plant populations. This bean variety is an heirloom that has a long history of cultivation in the Northeast, and therefore might be better adapted to the irregular growing conditions in our region.

**Table 4. Dry bean populations and percent germination by variety and seeding rate, 2016.**

| Variety | Target seeding rate | Actual plant population | Germination |
|---|---|---|---|
| | seeds $ac^{-1}$ | plants $ac^{-1}$ | % |
| Black Turtle | 79,000 (low) | 29,434 | 37.3 |
| Black Turtle | 99,000 (medium) | 49,347 | 49.8 |
| Black Turtle | 119,000 (high) | **67,456*** | **56.7** |
| *LSD (0.10)* | | 13,384 | NA |
| *Trial Mean* | | 48,746 | 47.9 |

| | | | |
|---|---|---|---|
| King of the Early | 58,000 (low) | 32,359 | 55.8 |
| King of the Early | 78,000 (medium) | 41,382 | 53.1 |
| King of the Early | 98,000 (high) | **56,192*** | **57.3** |
| *LSD (0.10)* | | 3,337 | NA |
| *Trial Mean* | | 43,311 | 55.4 |
| Yellow Eye | 57,000 (low) | 21,469 | 37.7 |
| Yellow Eye | 77,000 (medium) | 29,932* | **38.9** |
| Yellow Eye | 97,000 (high) | **31,737*** | 32.7 |
| *LSD (0.10)* | | 7,657 | NA |
| *Trial Mean* | | 27,712 | 36.4 |

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

Plant height, dry matter yield, and harvest moisture were significantly different between the Black Turtle bean seeding rate treatments (Table 5, Figure 1). The medium seeding rate (99,000 seeds $ac^{-1}$) was the tallest (46.5 cm), the highest yielding (1659 lbs $ac^{-1}$), the lowest harvest moisture (18.3%) and the highest test weight (59.2 lbs $bu^{-1}$), although not significantly different from the low seeding rate. There were no significant differences in plant height, pod disease, yield, harvest moisture and test weight in the King of the Early seeding rate treatments (Table 5). The highest yielding seeding rate treatment for the King of the Early was the middle seeding rate (78,000 seeds $ac^{-1}$) at 2323 lbs $ac^{-1}$. There were significant differences in pod disease in the Yellow Eye seed rate treatments. The highest seeding rate (97,000 seeds $ac^{-1}$) had the lowest amount of pod disease infection (2.50%). Even though not significantly different, the middle seeding rate (77,000 seeds $ac^{-1}$) of the Yellow Eye beans yielded the highest at 1896 lbs $ac^{-1}$. All of the harvest moistures for all bean types and seeding rates were above the recommended storage moisture of 13%, and therefore all samples had to be dried down. Additionally, none of the treatments met industry standards of 60 lbs $bu^{-1}$ for test weight.

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

| Variety | Target seeding rate | Plant height | Pod disease | Dry matter yield | Harvest moisture | Test weight |
|---|---|---|---|---|---|---|
| | seeds $ac^{-1}$ | cm | % | lb $ac^{-1}$ | % | lbs $bu^{-1}$ |
| Black Turtle | 79,000 (low) | 42.0 | **12.5** | 1437* | 19.5* | 57.6 |
| Black Turtle | 99,000 (medium) | **46.5*** | 15.0 | **1659*** | **18.3*** | **59.2** |
| Black Turtle | 119,000 (high) | 40.9 | 20.0 | 1182 | 21.9 | 58.0 |
| *LSD (0.10)* | | 3.47 | NS | 942 | 2.04 | NS |
| *Trial Mean* | | 43.1 | 15.8 | 1426 | 19.9 | 58.25 |
| King of the Early | 58,000 (low) | 33.9 | 47.5 | 1896 | **19.9** | 56.0 |
| King of the Early | 78,000 (medium) | **34.6** | 40.0 | **2323** | 21.8 | 56.1 |
| King of the Early | 98,000 (high) | 33.3 | **37.5** | 2082 | 20.4 | **56.8** |
| *LSD (0.10)* | | NS | NS | NS | NS | NS |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Trial Mean* | | 33.9 | 41.7 | 2100 | 20.7 | 56.3 |
| Yellow Eye | 57,000 (low) | 35.8 | 17.5 | 1776 | **21.1** | **58.9** |
| Yellow Eye | 77,000 (medium) | **37.6** | 20.0 | **1896** | 22.0 | 58.3 |
| Yellow Eye | 97,000 (high) | 37.1 | **2.50*** | 1887 | 23.0 | 58.3 |
| *LSD (0.10)* | | NS | 1.41 | NS | NS | NS |
| *Trial Mean* | | 36.8 | 13.3 | 1853 | 22.0 | 58.5 |

*Treatments that did not perform significantly different than the top-performing treatment (in bold) in a particular column by dry bean type are indicated with an asterisk.
NS-Treatments were not significantly different from one another.

The actual plant populations were much lower than the target seeding rates for Yellow Eye, King of the Early, and Black Turtle Beans. Factors that may have limited germination rates include low soil moisture at the time of planting, possible planter error, and little rainfall after planting. Overall, yields for all bean types and seeding rates were higher in 2016 than in 2015. The medium seeding rate for all bean types yielded the highest. The drought like conditions did help to reduce weed pressure and plant disease. More research needs to be conducted in order to determine the ideal seeding rates for dry beans in our ever-changing climate.

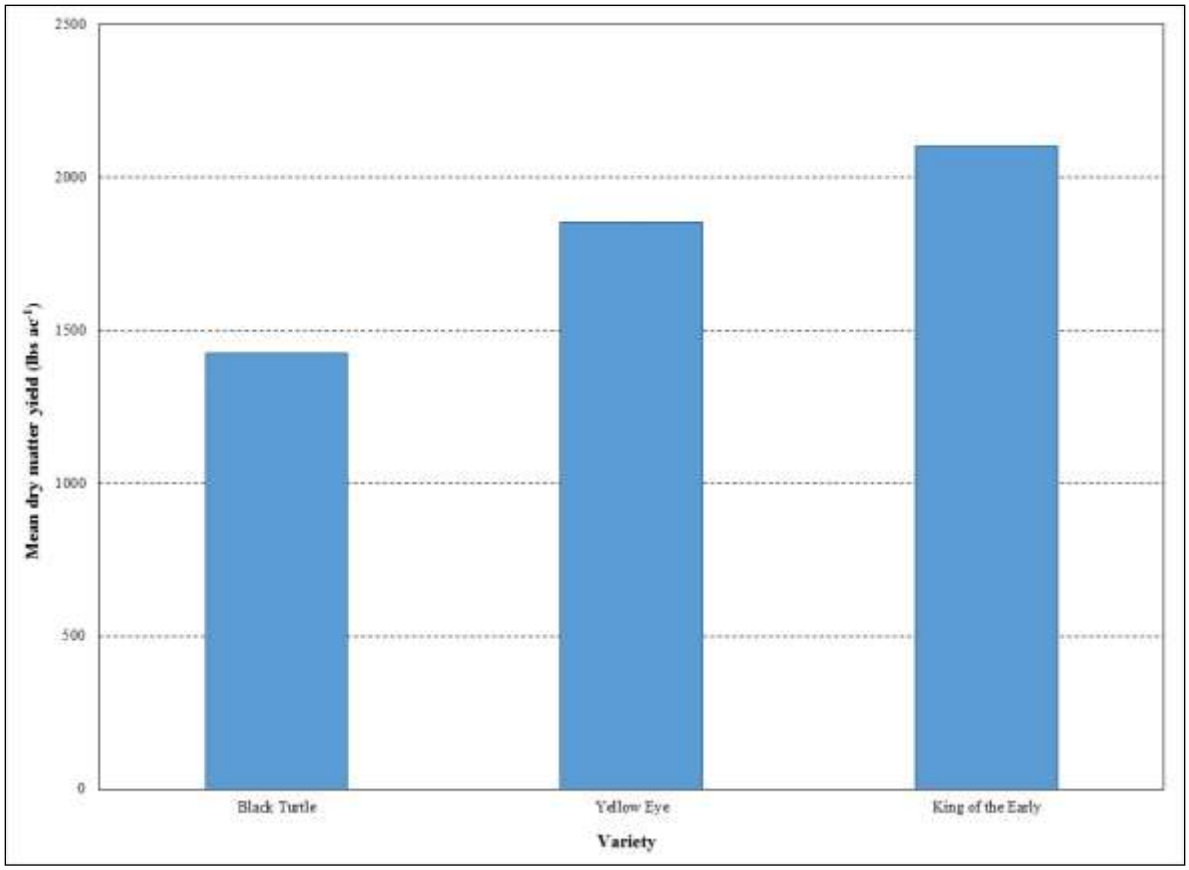


**Figure 1. 2016 mean yields, of Black Turtle, King of the Early, and Yellow Eye dry beans, Alburgh, VT.**

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