NORTHWEST CROPS & SOILS PROGRAM

2015 Dry Bean Planting Date Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2015 DRY BEAN PLANTING DATE 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 offer more locally-produced foods and dry beans are no exception. Farmers growing dry beans are trying to improve yields to meet these increased demands. Agronomic information for growing dry beans is geared towards major production regions outside of the northeastern region. Therefore, the University of Vermont Extension Northwest Crops and Soils Program (NWCS) is working with local farmers to develop best agronomic strategies for dry bean production in our problematic Northeastern climate. In 2015 as part of a USDA NE-SARE Partnership Grant (PG15-045), NWCS established dry bean planting date trials at Borderview Research Farm, Alburgh, VT and at our partnering farm, Morningstar Meadows Farm, Glover, VT in order to determine optimal planting dates for dry bean production in the Northeast.

MATERIALS AND METHODS

In 2015, the trials were conducted at Borderview Research Farm in Alburgh, VT and at Morningstar Meadows Farm, Glover, VT.

Borderview Research Farm, Alburgh, VT

The experimental design was a randomized complete block split design with four replications. The main plots were planting date and subplots were bean type (Table 1). Planting dates were initiated on 22-May and continued approximately every week for 4 weeks. The subplots were three dry bean types (pinto, yellow eye, and black beans) and were selected to represent types commonly grown in the northeast (Table 1). Plots were planted with a John Deere 1750 planter fitted with soybean cups (Table 2). Seeding rates were determined by calibrating the planter for each bean type's recommended seeding rate. Prior to planting, bean seed were treated with dry bean inoculant.

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

Dry bean types	Seed source	Seeding rate
		seeds ac^{-1}
Black Turtle	Borderview Research Farm, Alburgh, VT	99,000
Pinto	Morningstar Meadows Farm, Glover, VT	78,000
Yellow Eye	Morningstar Meadows Farm, Glover, VT	76,000

Table 2. Dry bean planting and emergence dates at Borderview Research Farm in Alburgh, VT.

Planting date	Black turtle bean emergence	Yellow eye and Pinto bean emergence
	Date	date
22-May	29-May	2-Jun
29-May	12-Jun	12-Jun
4-Jun	14-Jun	14-Jun
12-Jun	18-Jun	19-Jun

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. Before planting subsequent planting dates, the area to be planted was spike tooth harrowed. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 3).

The plots were 10'x 20', with 30-inch row spacing. Plant populations were taken on 30-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.

All plots were harvested on 22-Sep by hand, 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 3. Dry bean planting date trial specifics in Alburgh, VT, 2015.

Trial information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Tillage operations	Spring plow, disk, and spike tooth harrow
Plot size (feet)	10 x 20
Row spacing (inches)	30
Replicates	4
Cultivation	4-Row Brillion: 17-Jun and 7-Jul
Harvest date	22-Sep

Morningstar Meadows Farm, Glover, VT

The experimental design was a randomized complete block split design with three replications. The main plots were planting date and subplots were variety (Table 4). Planting dates were initiated on 29-May and continued approximately every week for 3 weeks with a White 140 planter using the red seeding plates (Table 5). The varieties were selected based upon varieties commonly grown on Morningstar Meadows Farm and relative maturity (Table 4). Prior to planting, bean seed were treated with dry bean inoculant.

An organic approved fertilizer called MicroSTART 60 (3-2-3) was applied as a starter fertilizer at 350 lbs ac^{-1}.

Table 4. Seed varieties and seed sources for the dry bean planting date trial at Morningstar Meadows Farm in Glover, VT.

Dry bean varieties	Seed source	Seeding rate
		seeds ac^{-1}
King of the Early	Morningstar Meadows Farm, Glover, VT	78,000
Yellow Eye	Morningstar Meadows Farm, Glover, VT	76,000

Table 5. Dry bean planting and emergence dates at Morningstar Meadows Farm in Alburgh, VT.

Planting date	Plant emergence
	date
29-May	9-Jun
7-Jun	17-Jun
12-Jun	23-Jun

The soil type at the project site was a sandy loam. The seedbed was prepared by spring moldboard plowed and followed by disk harrow. Before planting subsequent planting dates, the area to be planted was disk harrowed. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 6).

The plots were 10'x 25', with 30-inch row spacing. Plant populations were taken on 30-Jun by counting the number of plants in 10 feet of the two center rows of each plot. Planting date one was tineweeded on 7-Jun and planting dates 1 and 2 were tineweeded on 12-Jun. A John Deere 4-row C-shank with crop shields was used to cultivate planting date 1 on 17-Jun and all plots on 25-Jun.

All plots were harvested on 18-Sep by hand and threshed using an Almaco Large Vogel plot thresher. Beans were then weighed to calculate yield and a DICKEY-John MINI GAC Plus was used to determine bean moisture content and test weight.

Table 6. Dry bean planting date trial specifics in Glover, VT, 2015.

Trial information	Morningstar Meadows Farm Glover, VT
Soil type	Sandy loam
Previous crop	Mixed grain and wheat
Tillage operations	Moldboard plow and disk harrowed
Plot size (feet)	10 x 25
Row spacing (inches)	30
Replicates	3
Starter Fertilizer (lbs ac^{-1})	350 – MicroSTART 60 (3-2-3)
Tineweed	7-Jun (PD 1) and 12-Jun (PD 1 & 2)
Cultivation	John Deere 4-row C-shank w/ crop shields, 17-Jun (PD 1) and 25-Jun (all)
Harvest date	18-Sep

Data were 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, yields were analyzed using the PROC MIXED procedure in SAS using the Tukey-Kramer adjustment, which means that each variety and planting date was analyzed with a pairwise comparison.

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 7. The 2015 growing season brought a warmer and drier than average May followed by a 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 7. Temperature and precipitation summary for Alburgh, VT, 2015.

Alburgh, VT	May	Jun	Jul	Aug	Sep
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.
October 2013 precipitation data based on National Weather Service data from cooperative stations in Burlington, VT (http://www.nrcc.cornell.edu/page_nowdata.html).

The 2015 growing season at the Glover location brought a warmer than average May followed by cooler temperatures in June, July, August, and September (Table 8). Above average rainfall was recorded in the months of May, June, July, and September that totaled almost eight inches higher than the 30-year average. In Glover, there was an accumulation of 1448 Growing Degree Days (GDD), which is 687 GDDs below the 30-year average.

Table 8. Temperatures and precipitation summary for Glover, VT, 2015.

Newport, VT	May	Jun	Jul	Aug	Sep
Average temperature (°F)	54.9	54.6	62.4	62.9	59.0
Departure from normal	1.43	-11.0	-7.56	-4.88	-0.99
Precipitation (inches)	3.58	8.59	6.44	2.40	4.05
Departure from normal	0.22	4.58	2.32	-1.82	0.66
Growing Degree Days (base 50°F)	217	163	384	401	283
Departure from normal	20.0	-305	-234	-151	-16.8

Based on National Weather Service data from cooperative observation stations in Walden, VT. Historical averages are for 30 years of NOAA data (1981-2010) from St. Johnsbury, VT.
Data taken from Sutton, VT when Newport data was not available.

Borderview Research Farm

There were no interactions between planting date and bean type at this location.

Impact of Planting Date

Dry bean yields were significantly different across planting dates (Table 9, Figure 1). The highest yields were observed from the June planting dates. The lowest yielding planting date was 29-May (820 lbs ac^{-1}), but was not significantly different from the 22-May planting date.

Table 9. Dry bean yields across planting dates, Alburgh, VT, 2015

Planting date	Yield
	lbs ac^{-1}
22-May	1067bc
29-May	820c
4-Jun	1574ab
12-Jun	**1676a**
p-value	<0.0001

Within a column values followed by the same letter are not significantly different.

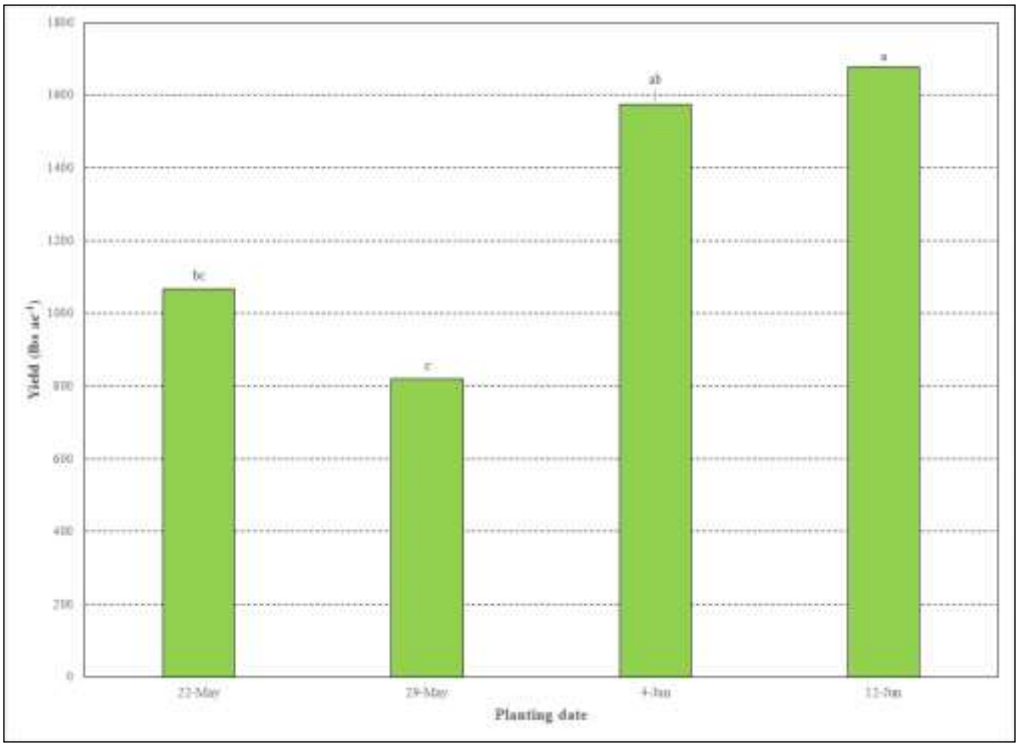

Figure 1. Impact of planting date on dry bean yield in Alburgh, VT, 2015.
Treatments that share a letter did not differ significantly by planting date.

Impact of Dry Bean Type

Dry bean yields varied significantly by type (Table 10, Figure 2). The highest yielding dry bean was the Black Turtle beans with 2240 lbs ac^{-1}. Yields of Yellow Eye and Pinto did not differ significantly in yield.

Table 10. 2015 Dry bean yield by variety, Alburgh, VT

Variety	Yield
	lbs ac^{-1}
Black Turtle	**2240a**
Pinto	843b
Yellow Eye	770b
p-value	<0.0001

Within a column values followed by the same letter are not significantly different.

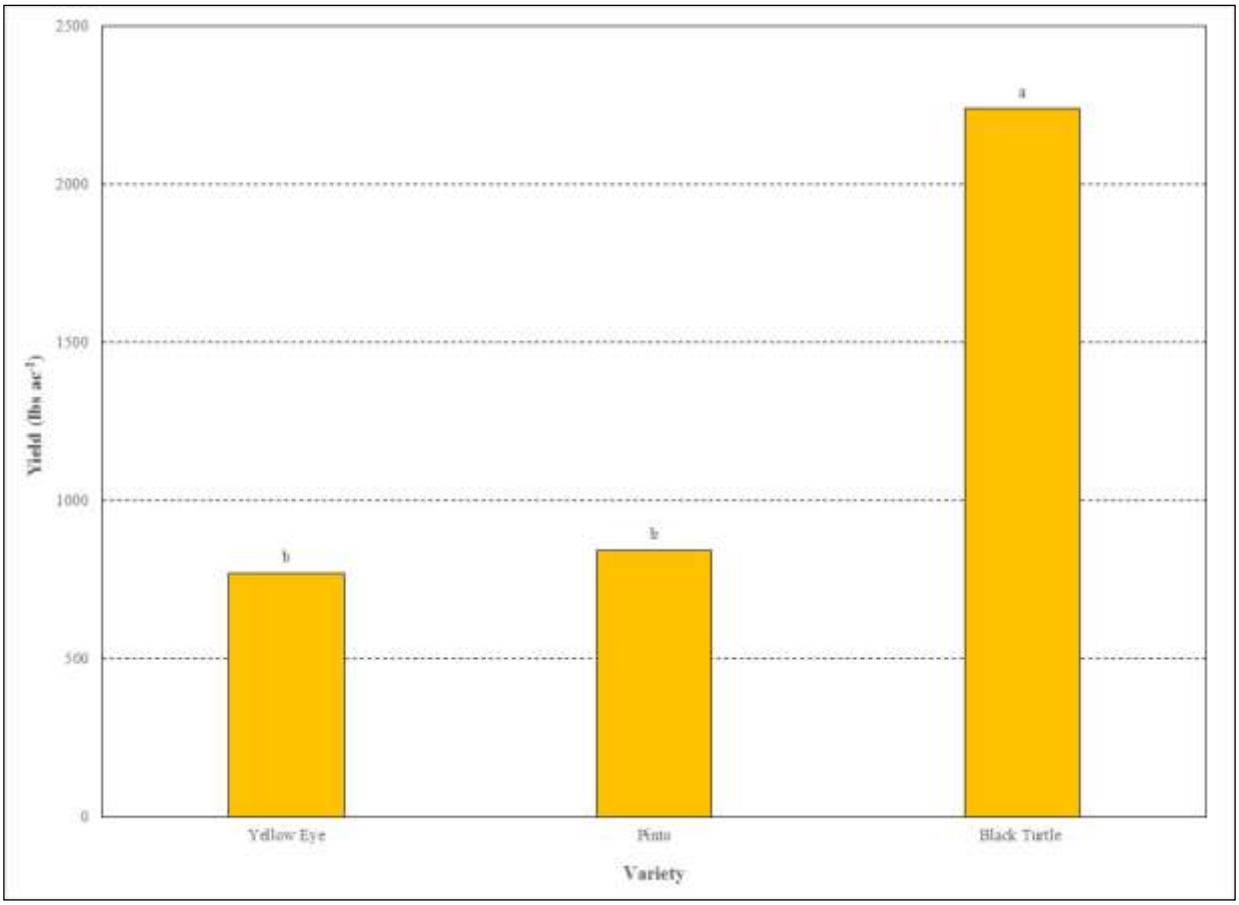

Figure 2. Yield between dry bean varieties across all planting dates in Alburgh, VT, 2015.
Treatments that share a letter did not differ significantly by variety.

Morningstar Meadows Farm

Planting Date x Variety Interactions

There were significant interactions between planting date and variety for dry bean plant population and the number of pods per plant. These interactions indicate that dry bean varieties respond differently across planting dates. The highest population counts of the Yellow Eye beans were on 7-Jun, conversely King of the Early beans had the lowest plant population on 7-Jun (Figure 3). The highest plant population of the King of the Early beans was the first planting date (29-May). The third planting date (12-Jun) had the lowest Yellow Eye bean populations. During mechanical cultivation, several bean plants were damage or pulled out which could have contributed to the fluctuation of bean plant populations.

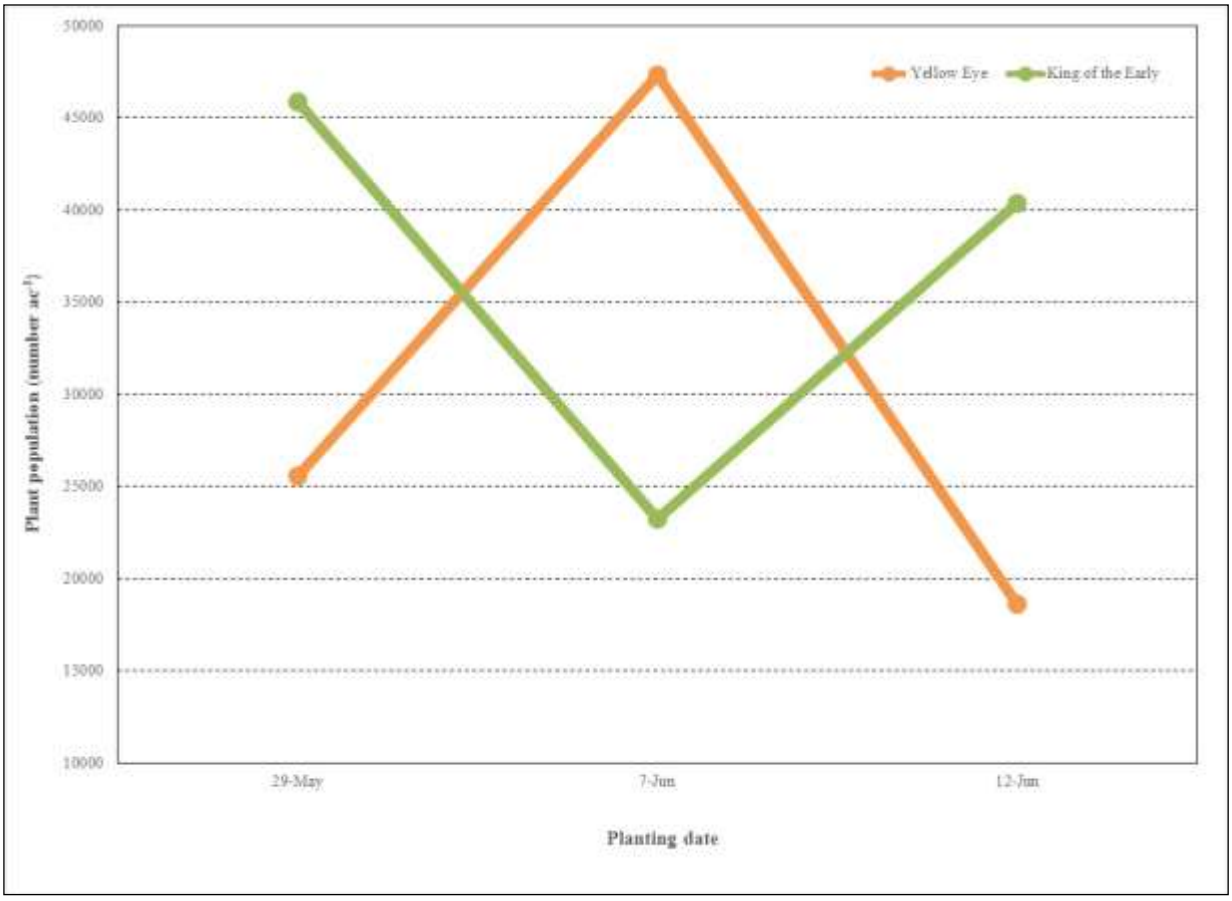

Figure 3. Planting date by variety interaction of plant population, Glover, VT.

The number of pods counted on the Yellow Eye bean plants gradually increased with the planting dates; lowest number pods were counted on the first planting and the highest number were counted on the third planting date (Figure 4). The King of the Early had the highest pod count on the first planting date (29-May). Interestingly, the King of the Early pod numbers did not vary considerably across planting dates.

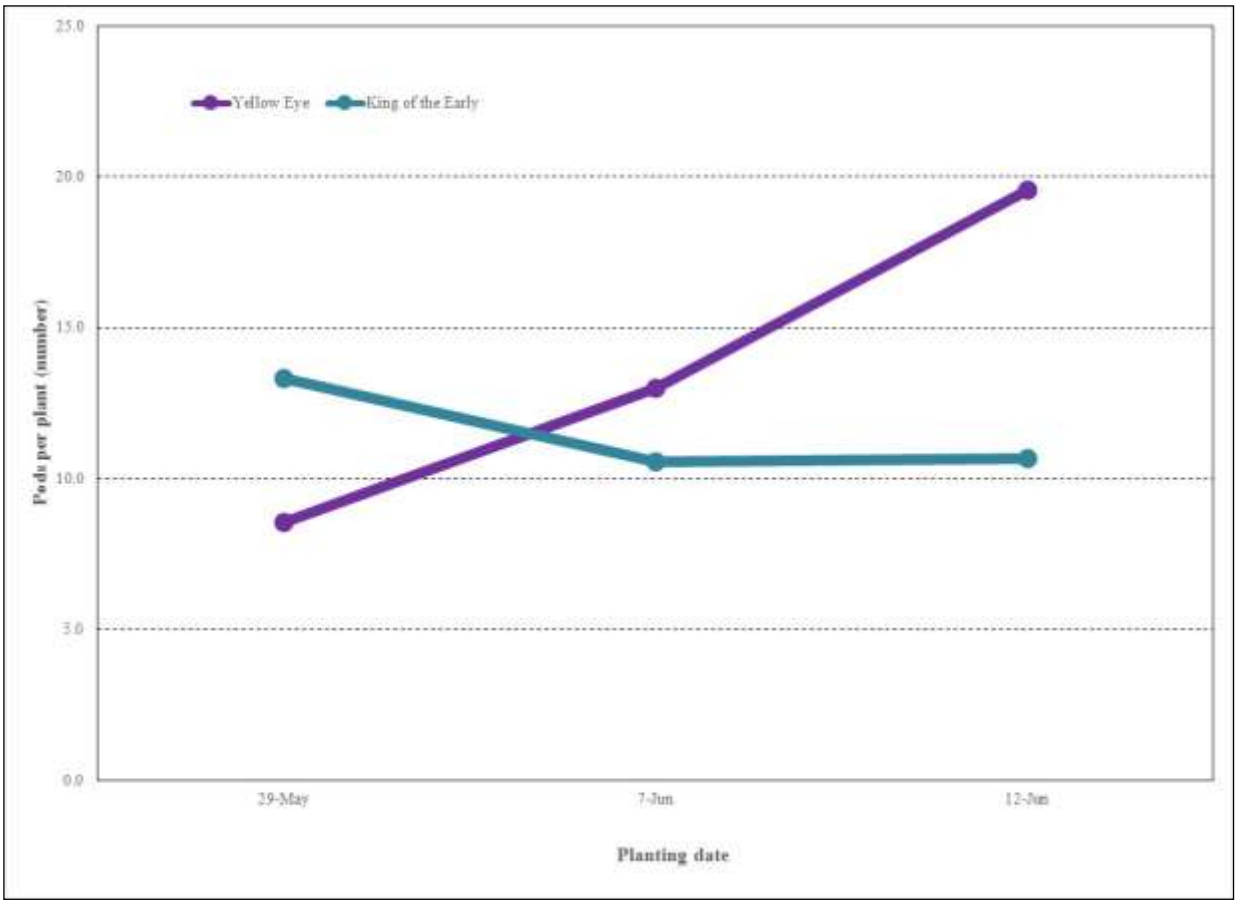

Figure 4. Planting date by variety interaction of number of pods per plant, Glover, VT

Impact of Planting Date

There were not significant differences in plant populations, pod number per plant, yield, harvest moisture, and test weight across planting dates (Table 11). Plant populations at harvest averaged 33,493 plants ac^{-1} for the trial. This population was roughly half of the seed rate (78,000 seeds ac^{-1}). The 12-Jun planting date had the greatest number of pods per plant (15 pods) and was the highest yielding (1577 lbs ac^{-1}) (Figure 5).

Table 11. Harvest results by planting date, Glover, VT, 2015.

Planting Date	Plant population	Pods per plant	Yield	Harvest moisture	Test weight
	plants ac^{-1}	number	lbs ac^{-1}	%	lbs bu^{-1}
29-May	**35719**	11	679	**18.4**	57.0
7-Jun	35284	12	1149	19.7	**62.6**
12-Jun	29476	**15**	**1577**	18.8	61.6
LSD (0.10)	NS	NS	NS	NS	NS
Trial Mean	33493	13	1135	19.0	60.4

Values shown in **bold** are of the highest value or top performing.
NS-Treatments were not significantly different from one another.

All planting dates had harvest moistures greater than 13%, necessary for proper storage, and therefore had to be dried down. The average test weight (60.4 lbs bu^{-1}) for the trial was just above the industry standard of 60 lbs bu^{-1}.

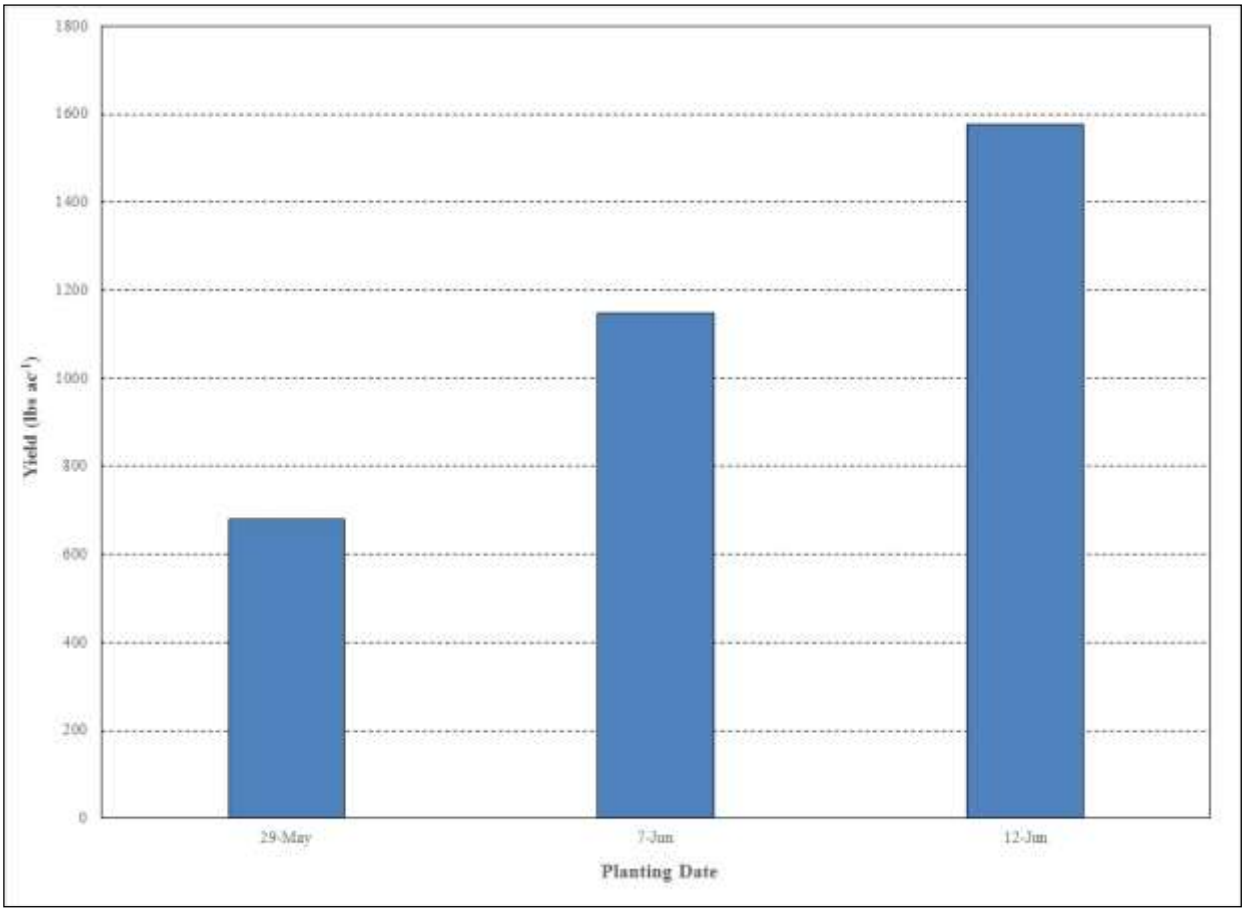

Figure 5. Yield between planting dates across dry bean varieties in Glover, VT, 2015.

Impact of Variety

There were significant differences in plant populations and yield (Table 12, Figure 6). King of the Early had the highest plant population (36,494 plants ac^{-1}) and yield (1467 lbs ac^{-1}). There were no significant differences in the number of pods per plant, harvest moisture, and test weight.

Table 12. Harvest results by variety, Glover, VT, 2015.

Variety	Plant population	Pods per plant	Yield	Harvest moisture	Test weight
	plants ac^{-1}	number	lbs ac^{-1}	%	lbs bu^{-1}
King of the Early	**36494**	12	**1467**	**18.4**	**62.3**
Yellow Eye	30492	**14**	803	19.6	58.4
LSD (0.10)	5106	NS	406	NS	NS
Trial Mean	33493	13	1135	19.0	60.4

Values shown in **bold** are of the highest value or top performing.
NS-Treatments were not significantly different from one another.

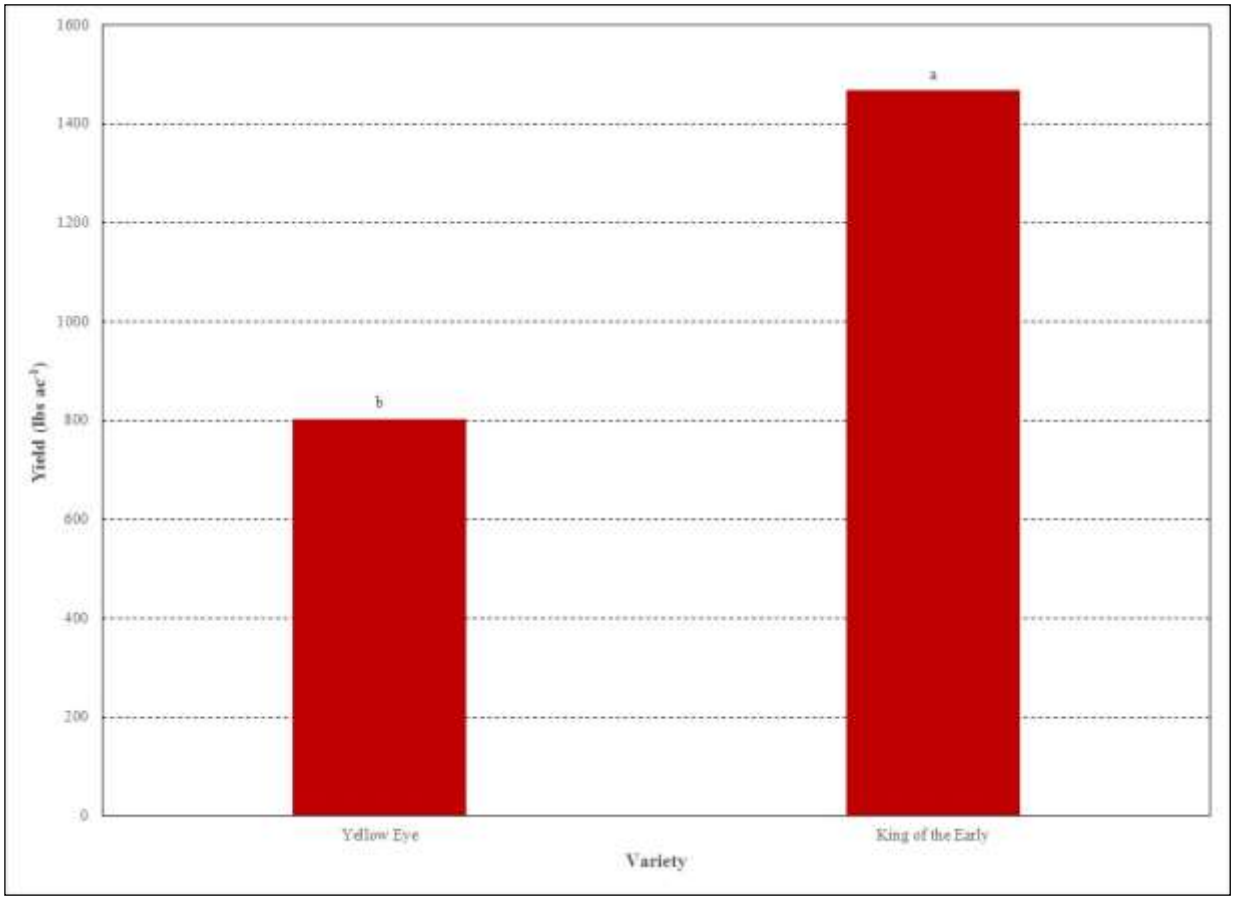

Figure 6. Yield between dry bean varieties across all planting dates in Glover, VT, 2015.
Treatments that share a letter did not differ significantly by variety.

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 at both locations. At the Alburgh location, the warm and dry temperatures in May allowed the first planting date of all the varieties to emerge in 7-10 days.

However, the weather changes in June to below average temperatures and higher than average rainfall resulted in 14 days for the second planting date, of all the bean varieties, to emerge. These cool and wet conditions prevented or delayed mechanical cultivation in Alburgh, and in turn created ideal conditions for weed growth and potentially increases in root rot diseases. At both trial locations, early season root rot diseases rhizoctonia, pythium, and fusarium were identified. The combination of poor seed quality and the root diseases severely decreased plant populations allowing for even higher weed pressure. Hand cultivation wasn't even enough to knock back the weeds. In Alburgh, the low plant populations and consequently high weed pressure likely resulted in lower than expected yields. Overall, the Black Turtle beans yielded significantly higher than the other two varieties, this could be attributed to better seed quality of the Black Turtle beans compared to those of the Pinto and Yellow Eye beans. In addition, the denser plant canopy helped to minimize weed pressure and resulted in higher yields.

The weather at Morningstar Meadows Farm can be summed up as cool, 687 GDD's below the 30-year average, and wet, eight inches above normal. Interestingly, the emergence of both varieties, across all planting dates, were consistently ten days from planting. Weeds were also an issue at this site, however, the sandy soil allowed for better drainage and therefore, more mechanical cultivation was used to help reduce weed pressure. Unfortunately, some of the bean plants were pulled out or snapped off during the second tineweeding which reduced plant populations. The plant populations of both the Yellow Eye and King of the Early beans were about half of the seeding rate. This was likely attributed to low seed quality and losses from mechanical cultivation. Similar to the Alburgh trial, the last planting date in the Glover trial, had the highest yield. This could be attributed to warmer soil temperatures at adequate soil moisture at the time of planting.

More research needs to be done to determine the ideal dry bean planting date and therefore, the Northwest Crops and Soils team plans on repeating this trial in 2016 at both trial locations.

ACKNOWLEDGEMENTS

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