NORTHWEST CROPS & SOILS PROGRAM

Impact of Planting Date and Variety on Soybean Yield

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2020 IMPACT OF PLANTING DATE AND VARIETY ON SOYBEAN YIELD
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In 2020, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of planting date and variety on soybean yield and quality at Borderview Research Farm in Alburgh, VT. Soybeans can be grown for human consumption, animal feed, and biodiesel. Livestock farmers are interested in producing more of their own grains and as a result, soybean acreage in Vermont is increasing. Given the short growing season in Vermont, it is important to understand optimum planting dates to obtain the highest yields. In an effort to support and expand the local soybean market throughout the northeast, the University of Vermont Extension Northwest Crop and Soils (NWCS) Program, as part of a grant from the Eastern Soybean Board, established a trial in 2020 to determine optimal planting dates for soybeans that maximize yield and quality in our northern climate.

MATERIALS AND METHODS

The soil types at the Alburgh location were Benson rocky silt loam and Covington silty clay loam. The seedbed was prepared using a moldboard plow and then disked prior to seeding. The previous crop was sweet corn. The plot design was a randomized block with split plots and four replications. The main plots were eight planting dates and the split plots were two varieties with varying maturities (Tables 1 and 2).

Table 1. Soybean varieties evaluated in Alburgh, VT, 2020.

Variety	Company	Traits	Maturity group
SG0975	Seedway, LLC	RR2Y	0.9
SG1776	Seedway, LLC	RR2Y	1.7

RR2Y – Roundup Ready 2 Yield soybeans contain genes to increase the number of 3, 4, and 5-bean pods per plant.

Table 2. Soybean trial specifics for Alburgh, VT, 2020.

	Borderview Research Farm Alburgh, VT
Soil types	Benson rocky silt loam and Covington silty clay loam
Previous crop	Sweet corn
Tillage operations	Moldboard plow and disc
Plot size (feet)	5 x 20
Row spacing (inches)	30
Replicates	4
Starter fertilizer (gal ac^{-1})	5 gal ac^{-1} 9-18-9
Planting dates	14-May, 21-May, 28-May, 5-Jun, 12-Jun, 19-Jun, 26-Jun, 2-Jul
Harvest date	14-Oct

Plots were planted approximately weekly from 14-May through 2-Jul with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA). Starter fertilizer (9-18-9) was applied at a rate of 5 gal ac^{-1}. Plots were 20' long and consisted of two rows spaced at 30 inches. The seeding rate was 185,000 seeds ac^{-1} treated with soybean inoculant. Plots were monitored for pest and disease pressure throughout the season. On 9-Jun, early planting dates were scouted for slug damage, however no damage was observed. Plots were assessed on 6-Aug and 15-Sep for growth stage, lodging, and pest/disease incidence. No major pest or diseases were observed so a formal scouting was not conducted.

On 14-Oct, the soybeans were harvested using an Almaco SPC50 small plot combine. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). They were then weighed for plot yield, tested for harvest moisture and test weight using a DICKEY-John Mini-GAC Plus moisture and test weight meter. Soybean oil was extruded from the seeds with an AgOil M70 oil press on 14-Nov, and the amount of oil captured was measured to determine oil content and oil yield.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were considered random effects, and treatments were treated as fixed. Treatment 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 hybrids 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 (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. In this example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another.

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

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 3). The season began with cooler than normal temperatures, but temperatures quickly increased and remained above normal for much of the season. Rainfall was below normal for much of the season with the region being designated as D0 or abnormally dry (Drought.gov) throughout the season. Much of the rain that fell throughout the season came in short duration storms. For example, in August there were only 6 rain events that accumulated at least 0.1”. Of these, 2 events totaled 1.53” and 2.98”, contributing 67% of the month’s entire accumulation. Furthermore, temperatures remained above normal for much of the mid-summer. In July, of 75% of the month saw temperatures climb above 80° F with some days reaching above 90° F. These temperatures contributed to above normal Growing Degree Days (GDDs) accumulations of 2611, 134 above the 30-year normal. In the fall, early frost occurred in September when soybeans were drying down.

Table 3. Weather data for Alburgh, VT, 2020.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	56.1	66.9	74.8	68.8	59.2	48.3
Departure from normal	-0.44	1.08	4.17	0.01	-1.33	0.19
Precipitation (inches)	2.35	1.86	3.94	6.77	2.75	3.56
Departure from normal	-1.04	-1.77	-0.28	2.86	-0.91	0.00
Growing Degree Days (base 50°F)	298	516	751	584	336	126
Departure from normal	6	35	121	2	-24	-6

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.

Impact of Relative Maturity x Planting Date Interactions

There was a significant relative maturity x planting date interaction for yield, harvest moisture, and test weight indicating that the maturities responded differently in terms of these variables when planted on different dates. Generally, as planting dates become later, farmers must modify varieties, selecting relative maturities to fit the remaining length of the growing season. Hence, with later planting dates generally shorter season varieties begin to outperform longer season types. Although this trend was not observed in our 2018 and 2019 trials, in 2020 we saw soybeans in the early (0.9) maturity group produce higher test weight soybeans across all but the latest planting dates where they were more similar to the test weights of the late (1.7) maturity group (Figure 1). The highest test weight was obtained by planting the early maturing variety on the third planting date and the late maturing variety on the second planting date. The drop in test weight observed in both varieties planted after the fifth planting date is likely due to the relation of drought conditions to soybean growth stages associated with higher water demand including seed fill. Earlier planted soybeans reached these critical stages prior to the most severe conditions avoiding some of the damage to soybean test weights. Overall, however, all test weights were below the industry standard of 60 lbs bu^{-1} demonstrating the impact the dry conditions had on soybeans regardless of planting date. This was further exacerbated by early frost which also likely contributed to reduced test weights in later planted soybeans that were in earlier growth stages at the time.

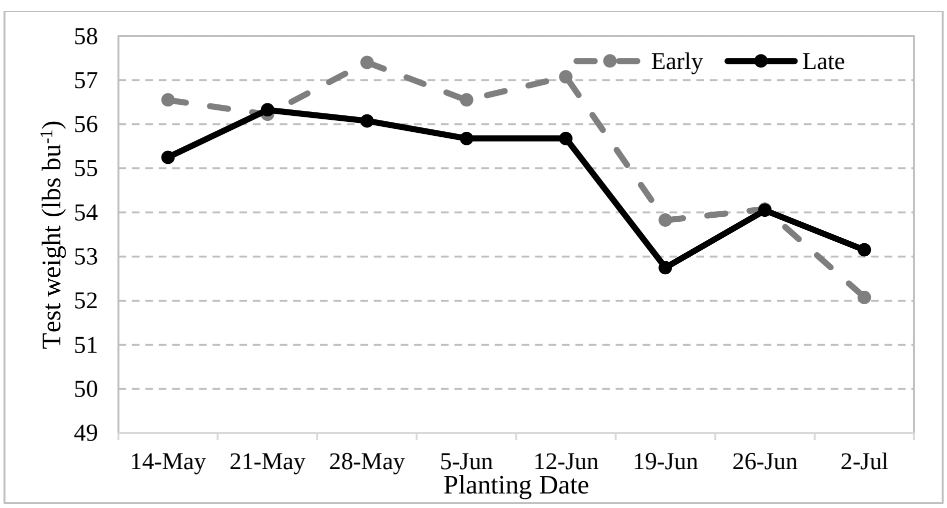

Figure 1. Soybean relative maturity x planting date interaction for test weight, 2020.

The significant interaction between relative maturity and planting date for harvest moisture indicates that soybeans of different maturity groups produced different responses in terms of harvest moisture to altering planting dates (Figure 2). Soybean harvest moisture is related to the plant's ability to reach physiological maturity thus reducing seed moisture content at the time of harvest. Therefore, we'd expect shorter season varieties to begin to outperform longer season varieties as planting dates are delayed. However, this is not the trend we observed in 2020. As planting dates were delayed, both the early and late maturity group varieties experienced a decline in harvest moisture until the 6th planting date, after which time the harvest moistures greatly increased.

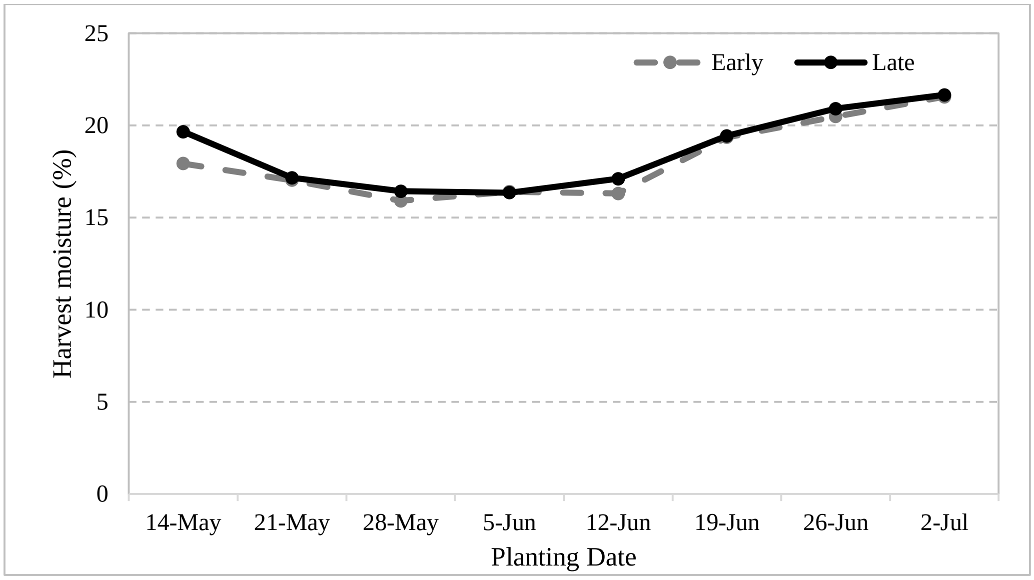

Figure 2. Soybean relative maturity x planting date interaction for harvest moisture, 2020.

The significant interaction between relative maturity and planting date for yield indicates that soybeans of different maturity groups have different yield responses to delaying planting dates (Figure 3). We would expect shorter season varieties to begin to out yield longer season varieties as planting dates are delayed. However, that is not what we observed in this trial. Although we did see the later maturing variety out yielding the early maturing variety in early planting dates, both varieties experienced significant yield declines as planting dates were delayed beyond mid-June and the early maturing variety did not outperform the late maturing variety at these dates. This indicates that, even for shorter season varieties, delaying planting until late June or later will have a significant impact on soybean yields. This was likely impacted by the early frost that negatively affected both maturities despite adequate GDDs. The extremely low yields experienced in the first two planting dates was likely due to an error in herbicide application that contributed to damage to early planted treatments, not a factor or the planting date itself. This is further evidenced by growth stage data collected throughout the season that shows the first two planting dates aligning with the growth stages of soybeans planted 3-4 weeks later.

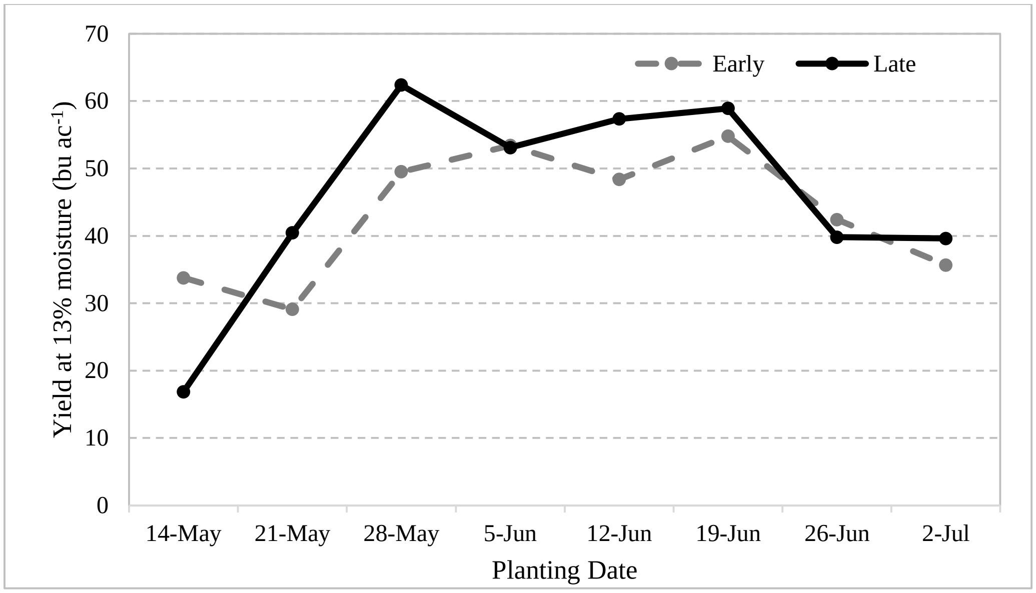

Figure 3. Soybean relative maturity x planting date interaction for yield, 2020.

Impact of Variety

The two soybean maturities performed significantly different in terms of harvest moisture and test weight, but were statistically similar in all other harvest characteristics (Table 4). Moisture at harvest was 0.5% lower in the short season variety, however, both varieties were above a safe storage moisture and required additional drying prior to storage. Similar moisture content between maturity groups suggests that both the longer and shorter season varieties reached similar maturity by the time of harvest. Test weights varied slightly between varieties with the earlier maturing variety producing seed with a test weight of 0.6 lbs bu^{-1} higher than the later maturing variety. However, both were below the target of 60 lbs bu^{-1} likely due to low rainfall throughout the growing season leading to reduced seed fill. Yields averaged 2683 lbs ac^{-1} or 44.7 bu ac^{-1} and did not differ statistically between the two varieties. Oil content and oil yield also did not differ between varieties. Oil content averaged 10.8% while oil yield averaged 288 lbs ac^{-1} or 37.7 gal ac^{-1}.

Table 4. Harvest characteristics of soybeans by variety, 2020.

Variety	Maturity group	Harvest moisture	Test weight	Yield @ 13% moisture		Oil content	Oil yield	
		%	lbs bu^{-1}	lbs ac^{-1}	bu ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
SG0975	0.9	**18.1**	**55.5**	2603	43.4	**11.3**	**295**	**38.6**
SG1776	1.7	18.6	54.9	**2763**	**46.1**	10.3	281	36.8
LSD (p = 0.10)		0.302	0.404	NS	NS	NS	NS	NS
Trial Mean		18.3	55.2	2683	44.7	10.8	288	37.7

The top performing variety is indicated in **bold**.
NS- Not statistically significant.

Impact of Planting Date

Soybean planting dates performed statistically differently in all harvest characteristics except for oil content (Table 5). Harvest moistures ranged from 16.2% to 21.6% with lower moistures being produced when planting dates ranged between 21-May through 12-Jun. Test weights ranged from 52.6 to 56.7 lbs bu^{-1}. Higher test weights were produced when soybeans were planted between 21-May through 12-Jun, however, all planting dates produced soybeans with test weights below the industry standard of 60 lbs bu^{-1}. Planting date also significantly impacted soybean yield (Figure 4). Soybean yields ranged from 1519 to 3411 lbs ac^{-1} or 25.3 to 56.9 bu ac^{-1} with the highest yields being obtained when planting between 28-May and 19-Jun. However, the first two planting date yields were likely negatively impacted by an erroneous herbicide application. These data suggest that delaying planting to late June and beyond negatively impacts soybean yields in this region. However, some of the later dates may not support such high yields in years where weather conditions are less conducive to soybean productivity.

Table 5. Harvest characteristics of soybeans by planting date, 2020.

Planting date	Harvest moisture	Test weight	Yield @ 13% moisture		Oil content	Oil yield	
	%	lbs bu^{-1}	lbs ac^{-1}	bu ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
14-May	18.8	55.9	1519	25.3	**13.8**	216	28.3
21-May	17.1	56.3*	2086	34.8	10.8	221	28.9
28-May	**16.2**	**56.7**	3357*	56.0*	10.3	361*	47.3*
5-Jun	16.4*	56.1*	3195*	53.3*	11.3	360*	47.2*
12-Jun	16.7*	56.4*	3172*	52.9*	10.9	344*	45.0*
19-Jun	19.4	53.3	**3411**	**56.9**	10.9	**365**	**47.8**
26-Jun	20.7	54.1	2467	41.1	9.80	241*	31.6*
2-Jul	21.6	52.6	2259	37.6	8.73	196	25.6
LSD (p = 0.10)	0.604	0.808	480	8.00	NS	126	16.5
Trial Mean	18.3	55.2	2683	44.7	10.8	288	37.7

The top performing planting date is indicated in **bold**.
Within a column, planting dates with the asterisk (*) did not differ significantly from the top performer.
NS- Not statistically significant.

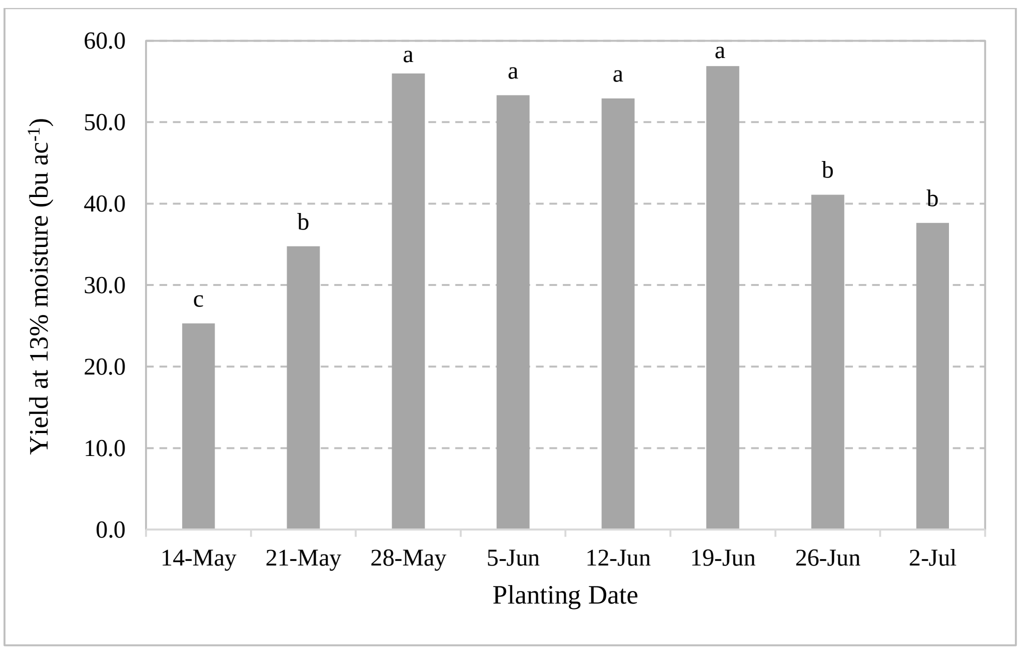

Figure 4. Soybean yield across eight planting dates, 2020.
Treatments that share a letter were statistically similar.

DISCUSSION

Soybean yields were significantly impacted by planting date, with the highest yields observed when soybeans were planted between late-May and mid-June. These data suggest that delaying planting of soybeans beyond this is likely to result in depressed yields. An erroneous herbicide application likely impacted the first two planting dates. There was no significant difference in oil content between planting dates. Soybean yield was not significantly impacted by relative maturity of the variety as both varieties were able to reach maturity and produce high yields. However, these trends may not hold in years with more normal GDDs accumulation.

In conducting soybean planting date evaluations since 2017, we have identified that soybean can be planted as late as mid-June in this region without typically exhibiting any yield loss. However, in years where cool wet weather was present on either end of the growing season, soybean performance was negatively impacted. Therefore, early season planting should only occur if weather and soil conditions are advantageous for soybean germination and growth. A range of maturities can be utilized to help mitigate risks associated with poor weather conditions late in the season. These data suggest that soybean varieties ranging from 0.9 to 1.7 relative maturity can tolerate delayed planting dates in this region. Further research over additional years and environments will help develop optimum planting date ranges for Vermont.

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