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2011 Sunflower Planting Date Study

Dr. Heather Darby, UVM Extension Agronomist
Hannah Harwood, Erica Cummings, and Rosalie Madden
University of Vermont Crops and Soils Technicians
(802) 524-6501

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Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

Planting date and variety selection are practices implemented to maximize yield and often crop quality. Optimal planting dates for sunflowers have yet to be determined for the Northeast. In Vermont, farmers generally try to have their sunflower crop planted by late May to meet the long growing season required by this crop. Based on research conducted in other regions, modifying planting date and variety may also help reduce bird, insect, and disease pressure. Therefore, the goal of this project was to determine the impact of planting date and variety selection on sunflower yield and pest pressure. While the data presented is only representative of one year, this information can be combined with other research to aid in making planting date decisions for sunflowers in the Northeast.

MATERIALS AND METHODS

To evaluate the impact of planting date on sunflower yield and quality, a research trial was initiated at Borderview Farm in Alburgh, VT. Agronomic information for trial can be found in Table 1. The experimental design was a randomized complete block with split plots replicated three times. The plot size was 5'x20'. The main plots were 3 planting dates (25-May, 1-Jun, and 7-Jun). The subplots were a long and a short season sunflower variety. Croplan Genetics variety '306' had a relative maturity of 87 days and Syngenta variety '7120' a relative maturity of 95 days. The soil was a Benson rocky silt loam and plots prepared by with spring disking and harrowing, and finished with a spike-tooth harrow. A starter fertilizer with an analysis of 10-20-20 was applied at a rate of 260 lbs per acre at planting.

Table 1. Agronomic practices for the 2011 sunflower planting date study at Borderview Farm.

Location	Borderview Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn silage
Tillage operations	Spring disk, harrow, spike-toothed harrow
Weed control	Trifluralin, pre-plant, 2.5 pints/acre Hand-weeded and row cultivated
Seeding rate	32,000 plants/acre
Row width (in.)	30
Planting dates	25-May, 1-Jun, 7-Jun
Starter fertilizer (at planting)	260 lbs/acre, 10-20-20
Harvest dates	26-Sep and 12-Oct

Weeds were managed by a preplant application of Treflan® (trifluralin) at 2.5 pints per acre. For post-emergence weed control plots were hand-weeded (16-Jun) and cultivated with a Brillion 4-row cultivator (27-Jun).

In late July and early August, sunflowers began to flower, and when at least 75% of a given plot was in bloom, the date was noted. During the season, bird netting was used to discourage birds from damaging the developed sunflower seed heads. With this method, bird damage was kept to a minimum. Prior to harvest, sunflower population, height and head width, as well as the incidence of lodging and bird damage, was recorded. Bird damage was estimated using percent evaluations provided by North Dakota State University Extension. Incidence of white mold (*Sclerotinia sclerotiorum*) was noted at three locations on the plant: on the sunflower head, along the stalk, and at the base.

Figure 1. Almaco SP50 plot combine at Borderview Farm on harvest day.

Plots were harvested on September 26 with an Almaco SP50 plot combine with a 5' head and custom-made sunflower pans (Figure 1). Following harvest, the test weight was measured with a Berckes Test Weight Scale and a Dickey-John M20P moisture meter was used to measure harvest moisture levels. Harvested seeds were then cleaned with a Clipper fanning mill and evaluated for insect damage. Banded sunflower moth (*Cochylis hospes*) larvae have been found in the region, and are evidenced by round exit holes in seeds, caused by larvae burrowing in to feed (Figure 2). Banded sunflower moth can cause significant yield losses.

Prior to oil extraction, seed samples were dried and moisture levels quantified. Oil was extruded from a subsample of each harvested plot using a Kern Kraft Oil Press KK40. After pressing, oil content and yields were determined. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant (P< 0.10).


Figure 2. Banded sunflower moth larvae.

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 treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table a Least Significant Difference (LSD) value is presented for each variable (e.g. plant height). LSDs at the 10% level (0.10) of probability are shown. Where the difference between two treatments 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 values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk.

In the example at right, treatment C is significantly different from treatment A but not from treatment B. The difference between B and C is equal to 0.5, which is less than the LSD value of 2.7. This means that these treatments did not differ in yield. The difference between A and C is equal to 6.9, which is greater than the LSD value of 2.7. This means that the heights of these two treatments were significantly different from one another.

Planting date	**Height**
A	48.5
B	54.9*
C	**55.4***
LSD (0.10)	2.7

RESULTS

Using data from a weather station in close proximity to Borderview Farm in Alburgh, VT, weather data is summarized in Table 2. The 2011 growing season was wetter than normal, with very heavy precipitation in the spring and late summer. However, the months of June and July were close to average in overall rainfall, and temperatures were near normal. There were an accumulated 2,998 Growing Degree Days (GDDs) at a base temperature of 44°F; this was 238 more than the 30-year average.

Table 2. Summarized weather data for 2011 – Alburgh, VT.

	May	June	July	August	September	October
Average Temperature (°F) ±	58.7	67.1	74.4	70.4	63.8	51.5
Departure from Normal	2.1	1.3	3.3	1.6	5.8	4.5
Precipitation (inches) *	8.67	3.52	3.68	10.23	5.56	2.68
Departure from Normal	5.35	0.09	-0.29	6.38	2.10	0.10
Growing Degree Days (base 44° F)	454	716	942	749	591	434
Departure from Normal	63.6	62.1	103.9	-26.3	98.6	241.8

± Average temperature for August-September is taken from Burlington, VT.
* Precipitation for May-July is taken from Burlington, VT.
Based on National Weather Service data from cooperative observation stations in South Hero. Historical averages are for 30 years of data (1971-2000).

Planting Date by Variety Interactions

With the exception of oil yield, there were no significant interactions between sunflower planting date and variety. This suggests that the varieties performed similarly across planting dates. There was an interaction between planting date and variety for oil yield (see Figure 3). The early season variety ‘306’ had a higher oil yield than ‘7120’ when at the medium and latest (1-June and 7-June) planting dates. The longer season variety ‘7120’ had higher oil yields when planted on the earliest planting date. We would expect that the shorter season variety may outperform a later season variety as the planting date becomes delayed. Likewise we would expect a later season variety to outperform a shorter season variety at earlier planting dates. Further research needs to be conducted across a broader span of planting dates to confirm these predictions.

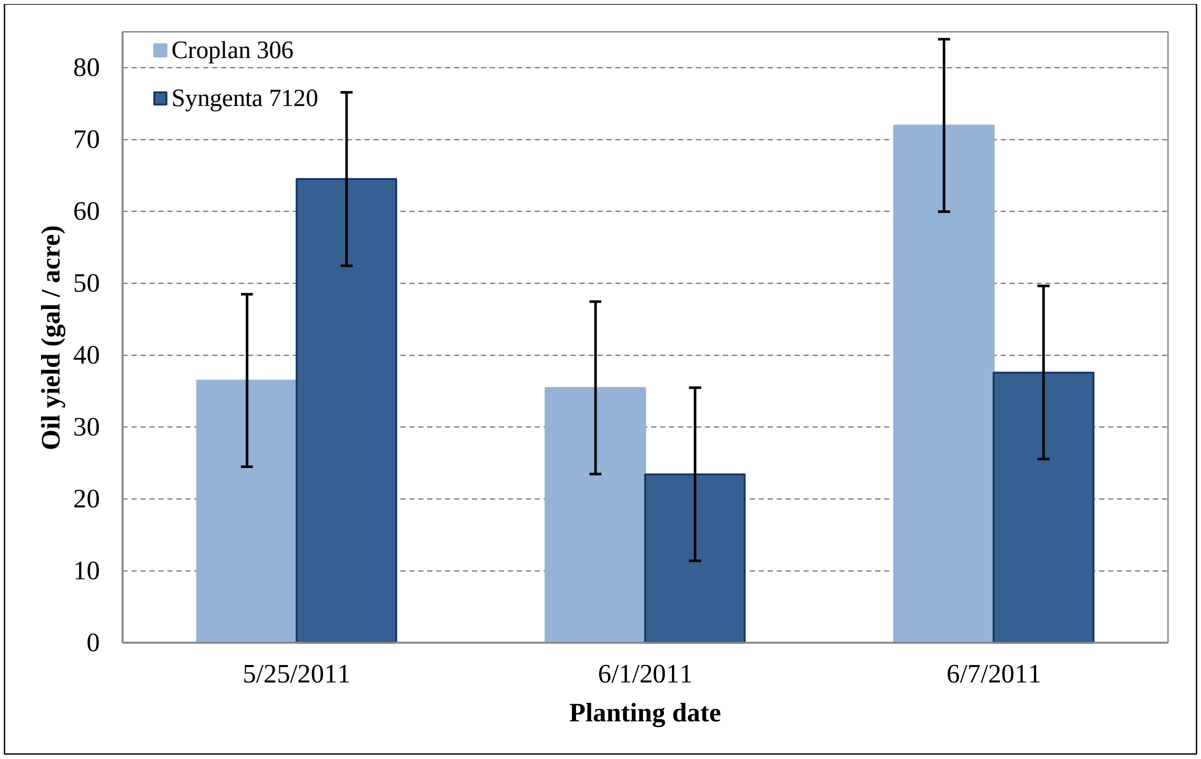

Figure 3. Effect of planting date and variety on oil yield. ***Vertical bars represent +/- one standard deviation.***

Effect of Planting Date

As expected, the earliest planted sunflowers (25-May) bloomed earliest, by 27-July. Sunflowers planted on 1-June bloomed by 2-August and the latest planted sunflowers by 8-August. Essentially for every one week delay in planting there was approximately a one-week delay in bloom.

The 1-June planting date resulted in a significantly higher plant population compared to the other dates (Table 3). Having all been seeded at a rate of 32,000 seeds per acre, this means that the establishment rates for the three planting dates varied from 53% to 81%. Sunflowers planted on the third planting date (7-June) were the tallest (55.4 inches) and also had the widest seed head (7.5 inches).

Table 3. Effect of planting date on agronomic characteristics of sunflowers.

Planting date	Population	Height	Head width	Bird damage	Lodging	White mold incidence		
						Head rot	Stalk rot	Base rot
	plants / acre	in	in	%	%	%	%	%
5/25/2011	20600	48.5	5.9	23.5	**1.7**	**18.3**	**6.7**	**3.3**
6/1/2011	**25900***	54.9*	5.5	15.1	13.3	26.7	18.3	**3.3**
6/7/2011	17100	**55.4***	**7.5**	**6.6**	**1.7**	33.3	15.0	**3.3**
LSD (0.10)	3510	2.7	0.8	7.5	4.5	NS	6.9	NS
Trial Mean	21200	53.0	6.3	15.1	5.6	26.1	13.3	3.3

Treatments indicated in bold had the top observed performance.
* Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – No significant difference was determined between treatments.

Bird damage was lowest among the sunflowers planted on 7-June (6.6%) (Table 3; Figure 4). Lodging was significantly higher at the 1-June planting date than other planting dates. The incidence of white mold in the form of stalk rot was 6.7% in the first planting date (25-May), significantly lower than the second and third planting dates, which had 18.3% and 15.0% stalk rot, respectively (Table 3). There was no significant difference among planting dates for the incidence of white mold as either head rot or base rot.

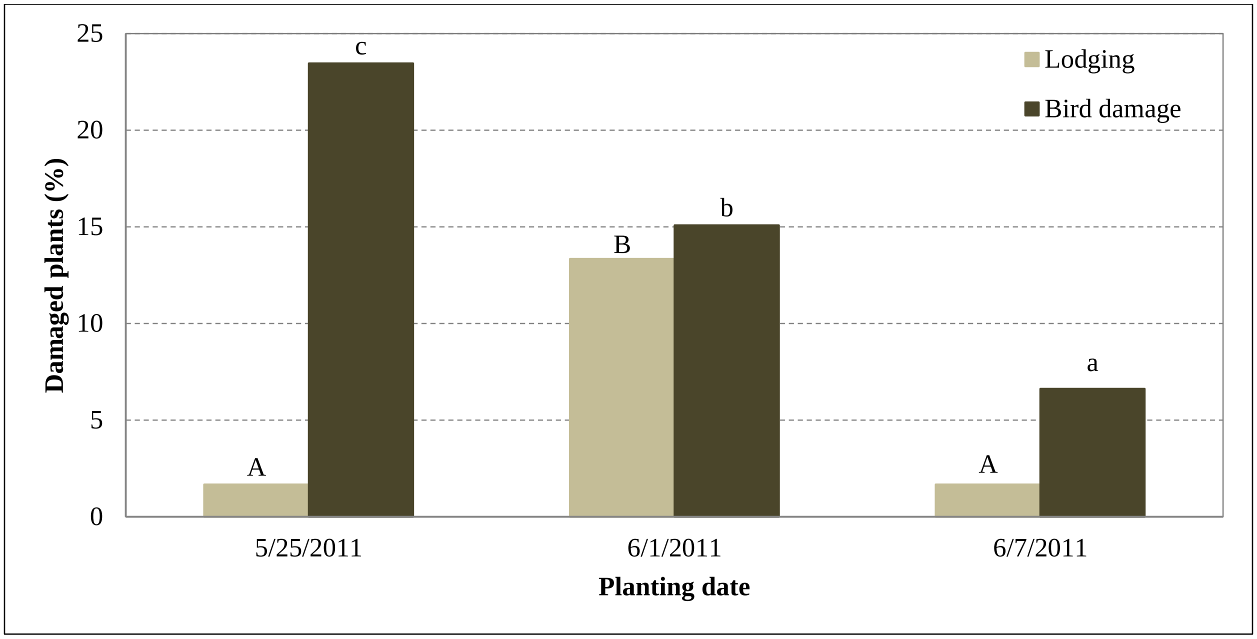

Figure 4. Effect of planting date on incidence of lodging and bird damage. Treatments with the same letter did not differ statistically (p=0.10; compare capital letters for lodging and lower-case letters for bird damage).

At harvest, seed moisture content was highest for the 7-June planting date (Table 4). The moisture level was 21.0% for this third planting date, significantly higher than earlier planting dates. Seed yield was also highest for the third planting date of sunflowers (1,540 lbs per acre), though not significantly higher than sunflowers planted on earlier dates. Test weight, a measure of seed density and also the amount of debris or trash in the yield, was highest in the third planting date. All planting dates had a test weight that met the industry standard. Oil content was highest in the earliest-planted sunflower seeds (28.7%), but not significantly higher than sunflower oil content from the second or third planting dates. The overall oil yield was highest in sunflowers planted on 7-June or 25-May.

Table 4. Effect of planting date on harvest yields and quality.

Planting date	Moisture at harvest	Seed yield	Test weight	Insect damage to seed	Oil content	Oil yield	
	%	lbs / ac	lbs / bu	%	%	lbs / ac	gal / acre
5/25/2011	13.0	1410	26.3	**15.3**	**28.7**	386*	50.5*
6/1/2011	16.0	1150	25.8	17.2	19.6	225	29.4
6/7/2011	**21.0***	**1540**	**27.8***	19.8	27.1	**418***	**54.8***
LSD (0.10)	2.8	NS	1.2	NS	NS	122	15.9
Trial Mean	16.7	1360	26.7	17.4	25.2	343	44.9

Treatments indicated in bold had the top observed performance.
* Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – No significant difference was determined between treatments.

Effect of Variety

With exception of lodging there were no significant differences between the two varieties (Table5; Table 6). The variety '306' had a significantly lower rate of lodging (2.2%) than the variety '7120' (8.9%). There was no significant difference between the two varieties trialed in population, height or head width, bird damage, or white mold incidence (Table 5).

Table 5. Effect of variety on agronomic characteristics of sunflowers.

Variety	Population	Height	Head width	Bird damage	Lodging	White mold incidence		
						Head rot	Stalk rot	Base rot
	plants / acre	in	in	%	%	%	%	%
Croplan 306	**22603**	**53.6**	6.1	16.9	**2.2**	27.8	**11.1**	4.4
Syngenta 7120	19844	52.4	**6.5**	**13.3**	8.9	**24.4**	15.6	**2.2**
LSD (0.10)	NS	NS	NS	NS	3.7	NS	NS	NS
Trial Mean	21223	53.0	6.3	15.1	5.6	26.1	13.3	3.3

Treatments indicated in bold had the top observed performance.
* Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – No significant difference was determined between treatments.

In this study there was no significant difference in harvest moisture, test weight, insect damage, or overall seed and oil yields by variety (Table 6). This indicates that both varieties perform similarly despite having different relative maturities.

Table 6. Effect of variety on harvest yields and quality.

Variety	Moisture at harvest	Seed yield	Test weight	Insect damage to seed	Moisture at pressing	Oil content	Oil yield	
	%	lbs / acre	lbs / bu	%	%	%	lbs / acre	gal / acre
Croplan 306	**17.5**	**1392**	26.6	**17.0**	**7.1**	**26.7**	**366**	**48.0**
Syngenta 7120	15.8	1334	**26.8**	17.9	6.3	23.6	320	41.8
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS
Trial Mean	16.7	1363	26.7	17.4	6.7	25.2	343	44.9

Treatments indicated in bold had the top observed performance.
* Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – No significant difference was determined between treatments.

DISCUSSION

The lowest plant establishment rates (64% and 53%) were in the earliest and latest planting date, respectively, and may have been due to weather events surrounding the plantings. In the week of the first planting date (25-May), northern Vermont had 5.67 inches of precipitation above normal, according to USDA weather data from Burlington, VT (30-year average from 1961-1990). The week of the second planting date (1-June), which had the highest emergence rate, also had above average rainfall, but slightly lower than the observed increase one week earlier (3.92 inches above normal). The final planting date (7-June) fell within a week that had 7.62 inches of rainfall, or 4.66 inches greater than normal. While the entire spring planting season had high precipitation (for example, the five weeks between 16-May and 19-June included 23.45 inches greater than historical averages), significant rainfall events occurred during the weeks of the first and last planting dates, possibly accounting for lower emergence rates and eventual populations.

Insect and bird damage likely is correlated to the life cycles of the major pests for sunflowers. Banded sunflower moth (*Cochylis hospes*), which is a major insect pest in sunflowers in northern states, feeds on sunflower seeds and reduces kernel weight and overall yield. The adult moths are generally prevalent from mid-July to mid-August, and lay eggs on sunflower bracts. These eggs hatch and larvae burrow into sunflower heads between mid-July and mid-September, feeding on kernels and wreaking havoc. Though not significantly different, the levels of insect damage (exit holes distinctive to sunflower moth damage) were lowest in the sunflowers planted earliest. This suggests that the sunflowers planted on 25-May this year, which had, for the most part, bloomed by 27-July, may have already reached physiological maturity when pests such as banded sunflower moths became most active, and the younger plants had more desirable seed heads at the time. Damage to seedheads is most severe when the buds have just begun to elongate but have not yet opened.

Bird damage was significantly greatest (23.5%) among the sunflowers planted earliest, probably because they had already formed full, palatable seeds when migrating flocks first began to pass through Alburgh, VT. The most destructive birds in the northeast, American goldfinches (*Spinus tristis*) and red-winged blackbirds (*Agelaius phoeniceus*), migrate in the fall and can cause great amounts of damage while traveling in large flocks. Blackbirds have been known to pass through northern Vermont in the end of August as well, which may account for the higher percentage of bird damage in the earliest sunflowers, which had bloomed and begun to form seed by August, when the birds were storing up fat reserves for long flights. The latest planted sunflowers suffered bird damage of 6.6%, perhaps because they developed palatable seeds between the two large waves of bird flocks.

It is not surprising that the sunflowers planted on the latest planting date had the highest moisture levels, since they had not had as much time in the field to mature and dry. While seed yields were not significantly different among planting dates, oil yields did differ according to the timing of spring planting. Sunflowers planted on the third planting date of the study (7-June) yielded the highest oil quantities (418 lbs or 54.8 gal per acre). Sunflowers planted on the first date (25-May) did not have significantly lower oil yields (386 lbs or 50.5 gal per acre).

Generally, early season planting allows the farmer to plant a full season variety. Full season varieties often yield higher as they have an extended growth period. Once the planting date is delayed often farmers must change to a shorter season variety that will be able to mature during the allotted growing season. If a full season variety is grown at later planting dates it may not have enough time to properly mature and yield potential and quality will be compromised. The goal of this project is to identify optimum planting dates as well as sunflower maturities for this region. The full and short season sunflower varieties in the study had varying oil yields depending on the timing of planting. The full season variety '7120' had higher oil yields when planted on the earliest planting date and the shorter season variety '306' had higher oil yields at the latest planting date. We would expect that the shorter season variety may outperform a later season variety as the planting date becomes delayed. Likewise we would expect a later season variety to outperform a shorter season variety at earlier planting dates. Further research needs to be conducted across a broader span of planting dates to confirm these predictions.

Planting date is a strategy that can be used to increase yields and quality of crops as well as manage pest issues. The first year of the study indicates that an early or later planting date may reduce pest issues and not impact yield or quality. The planting dates occurring in late May appeared to result in sunflower bloom and ripening close to pest and bird migratory patterns. While a general rule of thumb suggests that sunflowers should be planted as soon as possible after the spring soils have warmed to at least 50-55°F, 2011 was a very unusual year for weather. Wet soil conditions postponed spring planting for many Vermont growers, and Tropical Storm Irene, which hit Vermont in late August of 2011 with heavy rainfall and catastrophic winds, caused damage and difficulty in harvesting for many farmers. Especially with this anomalous weather, it is important to bear in mind that the results discussed here represent only one year's worth of data, and are specific to one location in northern Vermont. Decisions should not be based solely on this information, but rather a compilation of research across varying seasons and locations should be considered.

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