2013 Sunflower Planting Date Trial

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UNIVERSITY OF VERMONT EXTENSION
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2013 SUNFLOWER PLANTING DATE TRIAL

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Sunflowers are being grown in the Northeast for their potential to add value to a diversified operation as fuel, feed, fertilizer, and an important rotational crop. However, pest pressures from seed-boring insects, disease, and birds can limit yield and quality, making the crop less viable for existing and potential growers. Addressing some of these pest pressures with agronomic management strategies may help mitigate yield losses. One cultural pest control strategy is manipulation of planting date. To evaluate the impacts of altered planting dates on sunflower pests, an on-farm trial was designed and implemented by the University of Vermont Extension's Northwest Crops & Soils Program in 2013.

MATERIALS AND METHODS

To assess the effect of varying planting dates on sunflower pest pressures, yield, and quality, a field trial was initiated at Borderview Research Farm in Alburgh, VT in 2013 (Table 1). The experimental design was a randomized complete block with split plots and four replications. The main plots were five planting dates, each spaced approximately one week apart (17-May, 28-May, 4-Jun, 10-Jun, and 19-Jun). The subplots were two varieties, 'Cobalt II' (early) and 'Torino' (med-full). Both varieties are Nuseed® (formerly Seeds 2000®) hybrids, treated with Cruiser Maxx® (thiamethoxam, azoxystrobin, fludioxonil, mefnoxam). Cobalt II is a Clearfield® (tolerant to Beyond® ammonium salt of imazamox herbicide) variety that is high-oleic (≥80% oleic acid); Torino is a Clearfield® NuSun® mid-oleic (approximately 65% oleic acid) variety.

Table 1. Agronomic field management of sunflower planting date trial, 2013, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Winter canola
Tillage operations	Fall chisel plow, disk and spike tooth harrow
Seeding rate (viable seeds ac^{-1})	34,000
Planting equipment	John Deere 1750 corn planter
Row width (in.)	30
Plot size (ft)	10' x 20'
Planting dates	17-May, 28-May, 4-Jun, 10-Jun, 19-Jun
Varieties	Seeds 2000 'Cobalt II' (Early), Seeds 2000 'Torino' (Med-Full)
Starter fertilizer (at planting)	200 lbs ac^{-1} 10-20-20
Weed control	1.5 pt ac^{-1} Trust® on 17-May, hand-weeded 14-Jun
Harvest dates	21-Oct and 14-Nov
Pressing dates	20-Nov and 25-Nov

The soil type at the site was a Benson rocky silt loam with an 8-15% slope. The previous crop was winter canola. The seedbed was prepared according to standard local practices, with fall chisel plow, disk, and spike tooth harrow. Sunflowers were planted in 30" rows with a John Deere 1750 corn planter fitted with sunflower finger pickups. Each 10'x20' plot was planted at 34,000 seeds per acre, and 200 lbs per acre of a 10-20-20 starter fertilizer were applied at planting. Trust® (trifluralin) was applied at 1.5 pints per acre on 17-May. On 14-Jun, all plots were hand-weeded with hoes and small rototillers.

Bloom dates were noted for each sunflower plot when at least 75% of the stand was in flower (at least at R5 stage). Sunflower plots were scouted thoroughly twice during the growing season, on 22-Jul and 19-Aug. Population counts for plant bugs (*Miridae* family) and banded sunflower moth (*Cochylis hospes*) larvae were statistically analyzed. The research trial was not protected from birds with netting or other strategies, in order to more accurately estimate the impact of bird pressure on seed yields and quality. Bird damage was severe, particularly in plants harvested in November (Figure 1).

Figure 1. Bird damage was severe in late-harvested sunflowers.

Plant stand characteristics such as bird damage, plant population, height, head width, disease incidence and lodging were measured just prior to harvest. Disease incidence was measured by scouting ten consecutive plants in each plot and noting white mold at specific locations on the plant, including head, stalk and base. Issues with white mold (*Sclerotinia sclerotiorum*), a fungus which can overwinter in the ground and spread quickly, especially in wet seasons, have proven problematic in the Northeast in the past. The first two planting dates (17-May and 28-May) were harvested on 21-Oct; the last three planting dates (4-Jun, 10-Jun, and 19-Jun) were harvested on 14-Nov. All plots were harvested with an Almaco SPC50 plot combine with a 5' head and specialized sunflower pans made to efficiently collect sunflower heads. At harvest, test weight and seed moisture were determined for each plot with a Berckes Test Weight Scale and a Dickey-john M20P moisture meter. Subsamples were assessed for seed damage from banded sunflower moth. Oil from a known volume of each seed sample was extruded on 20-Nov and 25-Nov with a Kern Kraft Oil Press KK40, and the oil quantity was measured to calculate oil content. Oil yield (in lbs per acre and gallons per acre) was adjusted to 10% pressing moisture and reported.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial 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 some cases, P-values are given at the bottom of tables to display levels of significance.

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. 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 treatments 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 treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In the following 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. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

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

RESULTS

Weather data was collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2013 growing season (Table 2). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

In general, the spring of 2013 was much wetter than normal, with 6.88 inches of rain beyond the historical average. This delayed planting for many growers. The months of Jul through Oct were drier than normal. Throughout the season, there were an accumulated 3460 GDDs for sunflower (calculated at a base temperature of 44°F), 199 more than normal.

Table 2. Consolidated weather data and GDDs for May-Nov 2013, Alburgh, VT.

Alburgh, VT	May	Jun	Jul	Aug	Sep	Oct	Nov
Average temperature (°F)	59.1	64.0	71.7	67.7	59.3	51.1	35.1
Departure from normal	2.7	-1.8	1.1	-1.1	-1.3	2.9	-3.1
Precipitation (inches)	4.79	9.23*	1.89	2.41	2.20	2.22*	3.16
Departure from normal	1.34	5.54	-2.26	-1.50	-1.44	-1.38	0.04
Growing Degree Days (base 44°F)	476	607	863	740	465	275	34
Departure from normal	91	-47	37	-27	-33	144	34

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.

* June and Oct 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT.

Planting date x variety interactions

There was a significant interaction between planting date and variety for the date of bloom, suggesting that altering planting dates will have a different impact on the bloom date of one variety than it does on the bloom date of another. There was much more discrepancy in the bloom dates of the two varieties in the first and last planting dates than the less extreme planting dates (Figure 2). This indicates that the bloom dates of a short-season and a long-season variety are more affected by very early and very late planting dates than planting dates close to 1-Jun.

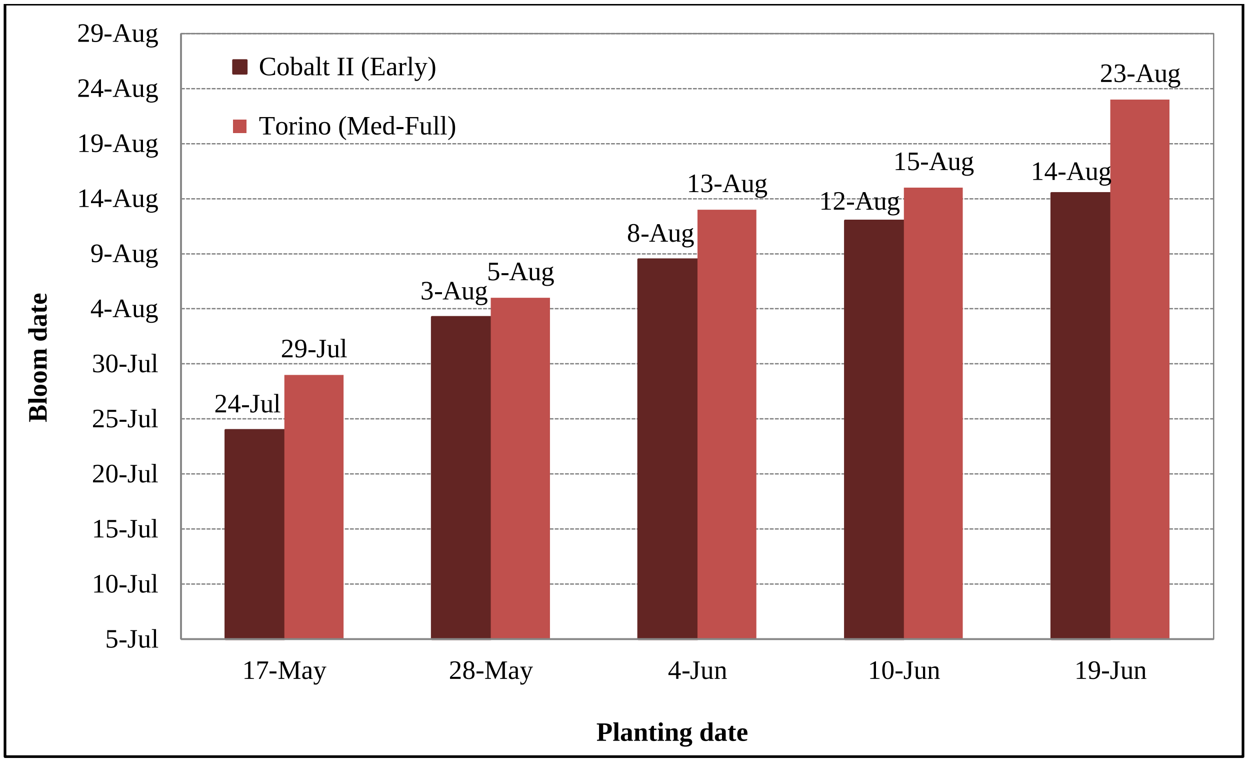

Figure 2. Effects of planting date on bloom date for two sunflower varieties, Alburgh, VT, 2013.

There was a significant interaction between planting date and variety on the number of banded sunflower moth (BSM) larvae observed while scouting (Figure 3). While there was no statistically significant difference in the incidence of BSM larvae between the two varieties, the insect larvae was much more prevalent on ‘Torino’ sunflowers planted in May, with little to no incidence in June planting dates. Interestingly, ‘Cobalt II’ sunflowers planted on 28-May and 4-Jun had the highest BSM prevalence with declining populations thereafter. There was no significant interaction between planting date and variety for the *Miridae* family of plant bugs observed while scouting.

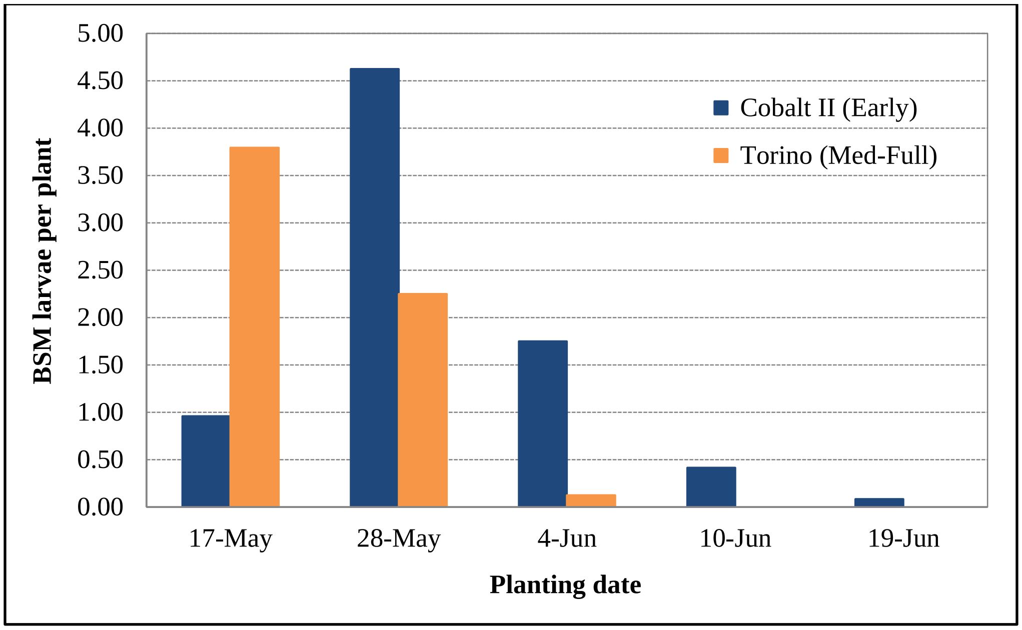

Figure 3. Effects of planting date on banded sunflower moth larvae for two varieties, Alburgh, VT, 2013.

There was a significant interaction between the effects of planting date and variety on stalk rot (Figure 4). Cobalt II, an early-season variety, had 0% stalk rot when planted early (17-May) but between 2.5% and 5% at all other planting dates. Interestingly, in early-planted (17-May) Torino sunflowers, stalk rot incidence was 15%—much higher than any other planting date or variety. Torino sunflowers only showed stalk rot when planted before 10-Jun.

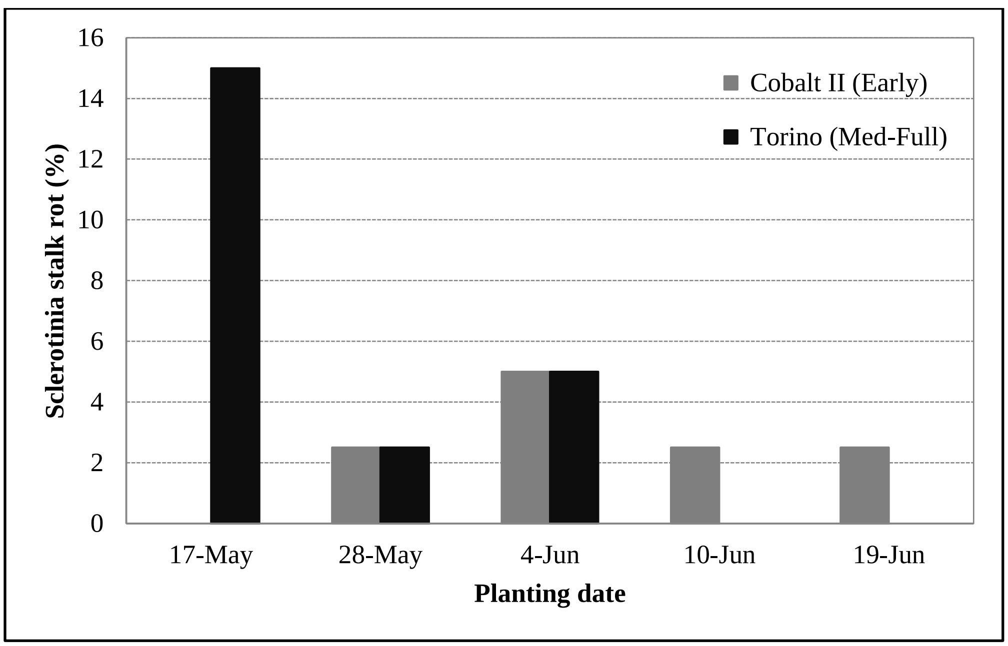

Figure 4. Effects of planting date on stalk rot incidence for two sunflower varieties, Alburgh, VT, 2013.

There were no significant interactions between planting date and variety for any other plant stand characteristics or for seed and oil yield or quality. This indicates that the impact of planting date on sunflower yield and quality was similar for both early and full-season varieties.

Impacts of planting date

Average bloom dates were different for each of the five planting dates evaluated (Table 3). In general, bloom dates were approximately one week apart, which is consistent with weekly plantings in the spring.

Table 3. Average bloom date for five sunflower planting dates, Alburgh, VT, 2013.

Planting date	Bloom date
1 - 17-May	26-Jul
2 - 28-May	4-Aug
3 - 4-Jun	10-Aug
4 - 10-Jun	13-Aug
5 - 19-Jun	18-Aug

Sunflowers were in varying reproductive growth stages when they were scouted on 22-Jul and 19-Aug (Table 4, Figure 5). On 22-Jul, sunflowers in the first two planting date treatments were in R4 and R2, respectively, while all others were in R1. On 19-Aug, the first planting date treatment (17-May) was in R7 stage, in which the back of the sunflower head has begun to turn yellow. The second planting date treatment (28-May) was in R6 stage, with ray flowers just beginning to wilt. The three later planting dates were all in R5 stage, flowering.

Table 4. Growth stage of sunflowers of varying planting date treatments by scouting date, Alburgh, VT, 2013.

Planting date	Scouting date	
	22-Jul	19-Aug
1 - 17-May	4	7
2 - 28-May	2	6
3 - 4-Jun	1	5
4 - 10-Jun	1	5
5 - 19-Jun	1	5

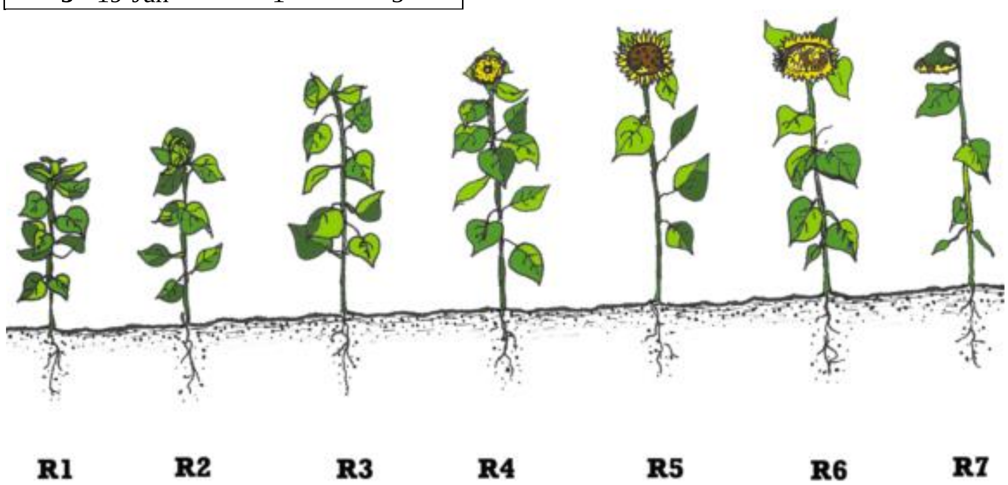

Figure 5. Sunflower reproductive growth stages from R1 to R7. ***Illustration by Amanda Gervais.***

Across both scouting dates, there was no significant difference in the incidence of plant bugs by planting date, though there was a slight trend towards lower insect populations in later-planted sunflowers (Table 5). There was a significant difference in the incidence of BSM larvae, with the least number of individual larva (0.04 per plant) in the latest planting date treatment (Figure 7).

Table 5. Insect scouting data by planting date, Alburgh, VT, 2013.

Planting date	Plant bugs	Banded sunflower moth larvae
	per plant	per plant
1 - 17-May	2.17	2.38
2 - 28-May	2.06	3.44
3 - 4-Jun	1.69	0.94
4 - 10-Jun	**1.63**	0.21
5 - 19-Jun	1.88	**0.04**
Trial mean	1.88	1.40
P-value	0.587	<0.0001

Treatments in **bold** were top performers for the given variable.
Statistical differences between treatments are indicated when the P-value is <0.10.

Some plant stand characteristics were impacted by planting date (Table 6). Plant population averaged 11,641 plants per acre at harvest, though the last planting date (19-Jun) had statistically lower populations than all other planting dates (Figure 6). Lodging was not statistically impacted by planting date, though the lowest incidence of lodging (0%) was in the third and fourth planting dates (4-Jun and 10-Jun). The incidence of sclerotinia (in the form of head rot, stalk rot, and base rot) was not statistically significant by planting date. Bird damage severity varied by planting date, with the least damage in the second planting date (28-May). There was a statistical difference in plant height by planting date, with the tallest sunflowers in early planting dates (17-May and 28-May). Head width was likewise impacted by planting date, with the widest heads in late-planted sunflowers (19-Jun).

Table 6. Plant stand characteristics by planting date, Alburgh, VT, 2013.

Planting date	Harvest population	Lodging	Sclerotinia incidence			Bird damage	Plant height	Head width
			Head rot	Stalk rot	Base rot			
	plants ac^{-1}	%	%	%	%	%	in	in
1 - 17-May	12006*	2.50	1.25	7.50	**0.00**	66.1*	**177***	15.1
2 - 28-May	**14348***	2.50	**0.00**	2.50	1.25	**51.6***	171*	14.0
3 - 4-Jun	12524*	**0.00**	**0.00**	5.00	**0.00**	75.3	155	18.2*
4 - 10-Jun	11979*	**0.00**	2.50	**1.25**	**0.00**	75.2	154	15.9
5 - 19-Jun	7351	1.25	**0.00**	**1.25**	**0.00**	69.2	138	**19.6***
LSD (0.10)	2813	NS	NS	NS	NS	14.6	19	1.9
Trial mean	11641	1.25	0.75	3.50	0.25	67.5	159	16.5

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

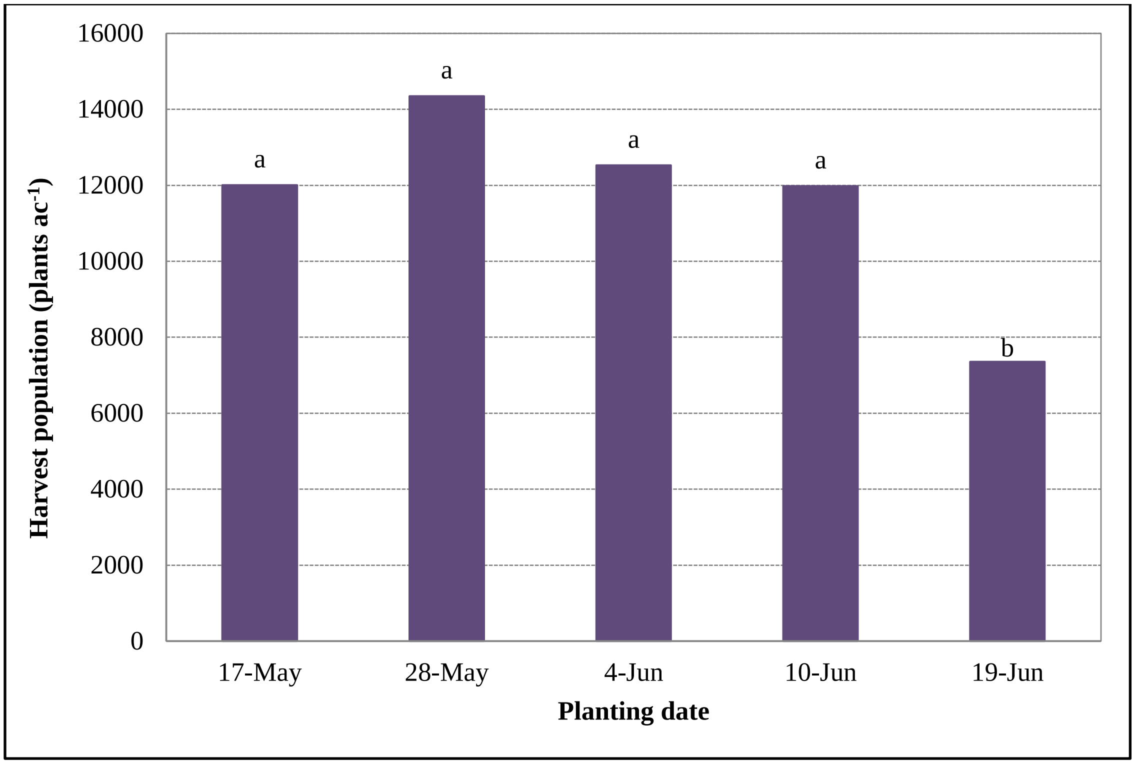

Figure 6. Impact of planting date on harvest population, Alburgh, VT, 2013. Treatments that share a letter were not statistically different from one another (p=0.10).

Planting date had no statistically significant impact on harvest moisture, test weight, or seed and oil yields (Table 7). Moisture at harvest (which occurred on two separate dates, according to physiological maturity) averaged 15.2% across planting dates. Test weights averaged 30.7 lbs per bushel and were not statistically different by planting date. Seed yield was highest in the fourth planting date (10-Jun) at 1118 lbs per acre, though this was not statistically greater than other planting dates. Banded sunflower moth (BSM) damage to seed, assessed in post-harvest seed samples, averaged 2.02% and was not significantly different by planting date, though later planting dates tended to have less damage (Figure 7).

Table 7. Seed and oil yield and quality by planting date, Alburgh, VT, 2013.

Planting date	Harvest moisture	Test weight	Seed yield	BSM damage	Oil content	Oil yield	
	%	lbs bu^{-1}	lbs ac^{-1}	%	%	lbs ac^{-1}	gal ac^{-1}
1 - 17-May	15.5	30.0	606	2.06	**28.0**	223	29.2
2 - 28-May	15.3	30.7	494	2.50	24.7	165	21.6
3 - 4-Jun	14.6	**31.3**	981	2.40	27.1	322	42.1
4 - 10-Jun	**15.7**	30.4	**1118**	1.63	25.6	**343**	**44.9**
5 - 19-Jun	14.7	30.8	709	**1.50**	24.9	189	24.7
Trial mean	15.2	30.7	782	2.02	26.0	248	32.5
P-value	0.9759	0.9056	0.1325	0.5397	0.8418	0.1488	0.1488

Treatments in **bold** were top performers for the given variable.
There were no statistical differences between treatments in any particular column (p<0.10).

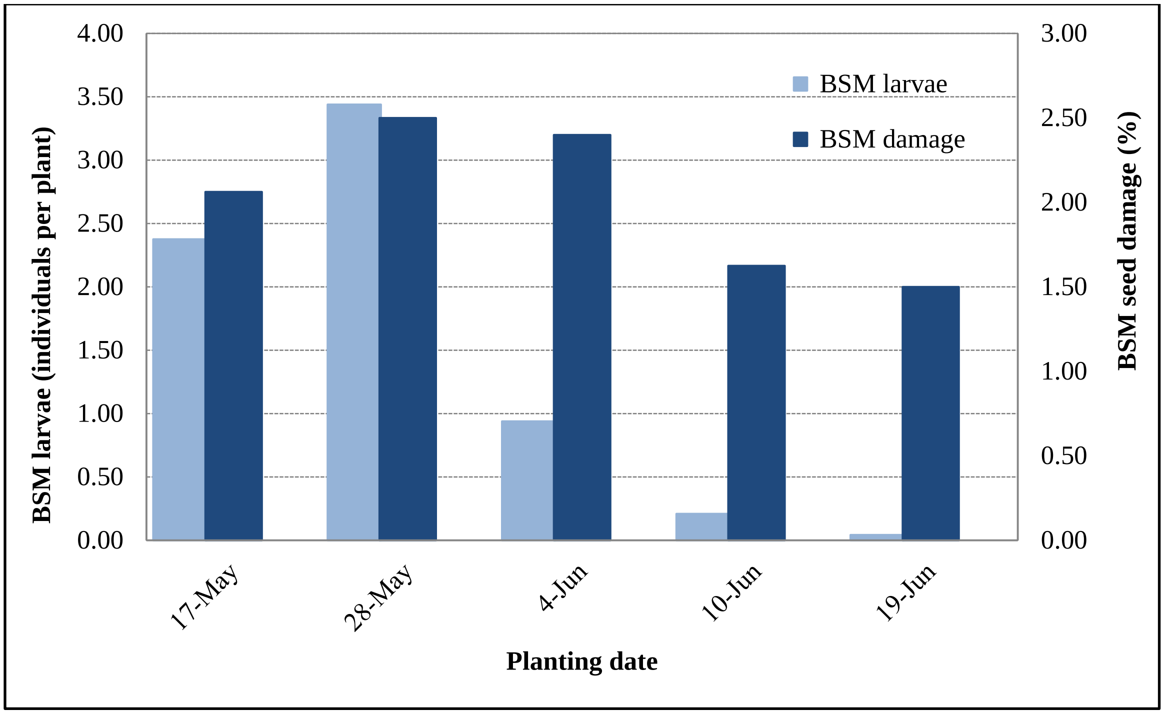

Figure 7. Impact of planting date on banded sunflower moth (BSM) larvae incidence and damage to seed, Alburgh, VT, 2013. The incidence of BSM larvae varied significantly by planting date, but there were no statistically significant differences in BSM damage by planting date (p=0.10).

Oil content did not differ significantly by planting date, though the first planting date (17-May) had the greatest oil content (28.0%). Average oil content was 26.0%, and oil yields averaged 248 lbs (or 32.5 gallons) per acre (Figure 8).

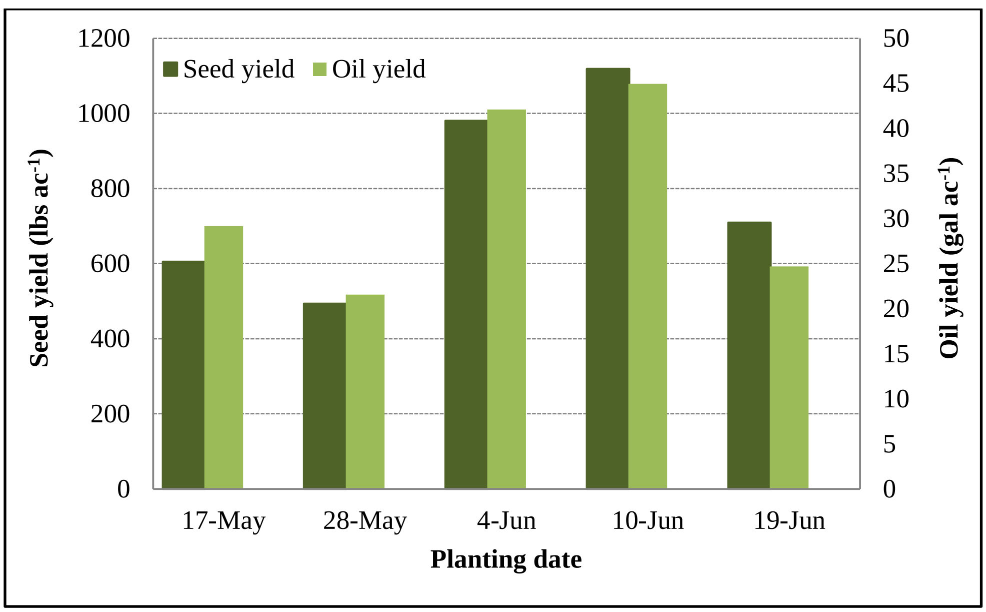

Figure 8. Impact of planting date on seed and oil yields of sunflower, Alburgh, VT, 2013. There were no statistically significant differences in yields by planting date (p=0.10).

Impacts of variety

Across all planting dates, the average bloom dates for Cobalt II and Torino sunflowers varied. The average date of 75% or more plants being in R5 stage for Cobalt II, the early-season variety, was 6-Aug, while Torino bloomed on 10-Aug (Table 8).

Table 8. Bloom dates by variety, Alburgh, VT, 2013.

Variety	Bloom date
Cobalt II	6-Aug
Torino	10-Aug

There was no significant difference in the number of plant bugs or BSM larvae by variety (Table 9). Though overall, Torino sunflowers had slightly fewer insect individuals observed across both planting dates, the difference was not statistically significant.

Table 9. Insect scouting data by variety, Alburgh, VT, 2013.

Variety	Plant bugs	Banded sunflower moth larvae
	per plant	per plant
Cobalt II	1.97	1.57
Torino	**1.80**	**1.23**
Trial mean	1.88	1.40
P-value	0.5028	0.3299

Treatments in **bold** were top performers for the given variable.
There were no statistical differences between treatments in any particular column (p<0.10).

There was little impact of variety on sunflower plant stand characteristics (Table 10). Harvest population was not impacted significantly by variety. Lodging and sclerotinia incidence was lower in Cobalt II, but the difference was not statistically significant. Bird damage was significantly lower in Cobalt II across planting dates (62.3%, as opposed to 72.6% in Torino). Torino sunflower plants were significantly taller (170 in) and had wider heads (17.8 in) than Cobalt II.

Table 10. Plant stand characteristics by variety, Alburgh, VT, 2013.

Variety	Harvest population	Lodging	Sclerotinia incidence			Bird damage	Plant height	Head width
			Head rot	Stalk rot	Base rot			
	plants ac^{-1}	%	%	%	%	%	in	in
Cobalt II	11478	**0.50**	**0.50**	**2.50**	**0.00**	**62.3***	147	15.2
Torino	**11805**	2.00	1.00	4.50	0.50	72.6	**170***	**17.8***
LSD (0.10)	NS	NS	NS	NS	NS	9.2	12	1.2
Trial mean	11641	1.25	0.75	3.50	0.25	67.5	159	16.5

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

Harvest moisture was slightly greater in Torino, the longer-season variety, but there was no statistical difference between the two varieties (Table 11). Test weight did not differ significantly by variety, though it was slightly greater in Torino (31.2 lbs per bushel). Seed yield was slightly greater in Torino (839 lbs per acre), but not statistically significant. There was no statistical difference in BSM damage between varieties, and no difference in oil content. Oil yield was greater in Torino (269 lbs or 35.3 gallons per acre), but not statistically greater than the oil yield of Cobalt II (227 lbs or 29.7 gallons per acre).

Table 11. Harvest data and seed and oil yields by variety, Alburgh, VT, 2013.

Variety	Harvest moisture	Test weight	Seed yield	BSM damage	Oil content	Oil yield	
	%	lbs bu^{-1}	lbs ac^{-1}	%	%	lbs ac^{-1}	gal ac^{-1}
Cobalt II	14.8	30.1	724	**1.88**	24.4	227	29.7
Torino	**15.5**	**31.2**	**839**	2.15	**27.7**	**269**	**35.3**
Trial mean	15.2	30.7	782	2.02	26.0	248	32.5
P-value	0.5893	0.2074	0.4904	0.5615	0.1381	0.4294	0.4294

Treatments in **bold** were top performers for the given variable.
There were no statistical differences between treatments in any particular column (p<0.10).

DISCUSSION

The interactions between planting date and variety were notable in bloom date, BSM larvae incidence, and stalk rot incidence. The variation in effects of planting date on the two varieties' average bloom dates was most noticeable in extreme (the earliest and latest) planting dates. While bloom dates were only two or three days apart for the two varieties when planted close to 1-Jun, at either end of the spectrum there was a much greater discrepancy between bloom dates for the two varieties. The early-season Cobalt II consistently bloomed before Torino, but when both varieties were planted late in the season (19-Jun), the difference between the average bloom dates was nine days.

The interaction between planting date and variety on the number of individual BSM larvae observed during scouting implies that the effects of altering planting dates may impact insect communities differently according to the variety (and relative maturity) of sunflower. BSM larvae were much more prevalent in early-planted Torino sunflowers and in late-planted Cobalt sunflowers.

Interestingly, the med-full season 'Torino' only had an incidence of stalk rot in the first three planting dates, but when planted on 10-Jun or later, had 0% incidence. Conversely, the early-season variety 'Cobalt II' sunflowers had 0% stalk rot when planted on 17-May, but stalk rot was noted in sunflowers planted on 28-May, 4-Jun, 10-Jun, and 19-Jun. This indicates that planting a full-season variety early in the season resulted in a higher incidence of stalk rot, while planting a shorter-season variety early on did not result in stalk rot.

The five varying planting dates evaluated in this study had no statistical impact on lodging and disease. Harvest population, bird damage, plant height and head width were all impacted by planting date. Similar to the 2012 study, there was a slight trend towards less insect (banded sunflower moth) damage in later-planted sunflowers, though it was not statistically significant. There were no significant differences in seed and oil yields by either planting date or variety.

Bird damage to sunflower heads (averaging 67.5% overall) was detrimental to yields. The notable differences in populations, plant height, and head width by planting date were consistent with other sunflower research trials. Typically, greater sunflower plant populations result in taller plants and narrower heads. The average yields for the trial (782 lbs of seed or 32.5 gallons of oil per acre) were poor in comparison to typical sunflower yields. This was likely due to low populations, early-season weed competition, and severe bird damage.

There were few statistically significant impacts of variety in this trial, suggesting that the two varieties performed similarly across planting dates in plant stand characteristics and yield. Both varieties were similarly susceptible to pest pressures from insects, lodging, disease, and birds. There was a difference in plant height and head width—Torino plants were taller with wider heads.

Overall, the strategy of sunflower shifting plants dates has potential as a pest control strategy. While there were no significant differences in yield in this 2013 study, there were trends towards lower bird damage in early-planted sunflowers and lower insect populations and damage in late-planted sunflowers. It is important to remember that these data represent results from only one year and one location. More research should be generated and consulted before making agronomic decisions.

ACKNOWLEDGEMENTS

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