2014

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 2014.

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 2014 (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 (14-May, 21-May, 29-May, 4-Jun, and 11-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, Alburgh, VT, 2014.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Corn with rye cover crop
Tillage operations	Fall chisel plow, disk and spike tooth harrow
Seeding rate (viable seeds ac^{-1})	36,000
Planting equipment	John Deere 1750 corn planter
Row width (in.)	30
Plot size (ft)	10 x 30
Planting dates	14-May, 21-May, 29-May, 4-Jun, 11-Jun
Varieties	Nuseed 'Cobalt II' (Early), Nuseed 'Torino' (Med-Full)
Starter fertilizer (at planting)	250 lbs. ac^{-1}, 10-20-20
Weed control	Cultivated 23-Jun, 3-Jul; handweeded 8-Jul
Harvest date	15-Oct
Pressing date	30-Dec

The soil type at the site was a Benson rocky silt loam with an 8-15% slope. The previous crop was corn with a rye cover crop. 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'x30' plot was planted at 36,000 seeds per acre, and 250 lbs. per acre of a 10-20-20 starter fertilizer was applied at planting. Trust® (trifluralin) was applied at 1.5 pints per acre on 17-May. Plots were cultivated on 23-Jun and 3-Jul and were also hand-weeded on 8-Jul with hoes and small rototillers.

'Torino' plots were scouted at each growth stage R2-R5 (Figure 1) for Banded Sunflower Moth (BSM) eggs, lavae, and adults, as well as adult spotted Sunflower Maggot Fly and striped Sunflower Maggot Fly (SMF). 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 (Figure 2).

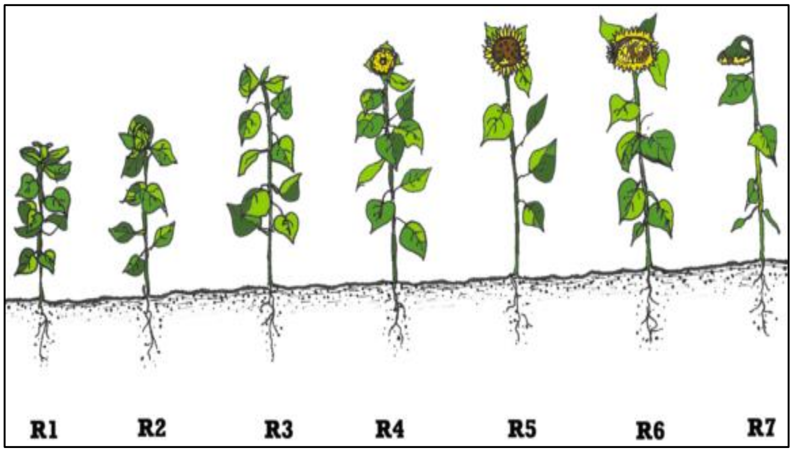

Figure 1. Sunflower reproductive growth stages from R1 to R7.

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, has proven problematic in the Northeast in the past. All planting dates were harvested on 15-Oct 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 30-Dec 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.

Figure 2. Bird damage can be severe especially in late-harvested sunflowers.

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. 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 2014 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 summer of 2014 was wetter than normal, with 4.85 inches of rain beyond the historical average between May and August. Fall, however, was much drier with 3.91 fewer inches of rain than normal between September and October. Temperatures remained relatively normal throughout the season. There were an accumulated 3276 GDDs for sunflower (calculated at a base temperature of 44°F), 17 more than normal.

Table 2. Consolidated weather data and GDDs for sunflowers 2014, Alburgh, VT.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	57.4	66.9	69.7	67.6	60.6	55.0
Departure from normal	1.0	1.1	-0.9	-1.2	0.0	6.8
Precipitation (inches)	4.90	6.09	5.15	3.98	1.33	2.00
Departure from normal	1.45	2.40	1.00	0.07	-2.31	-1.60
Growing Degree Days (base 44°F)	417	681	799	736	501	142
Departure from normal	33	27	-27	-31	3	12

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.

Planting date x variety interactions

There was a significant interaction between planting date and variety on the harvest moisture of sunflower seed (Figure 3). Although moisture was significantly lower for Cobalt II it is important to note that overall moistures were still above the target harvest moisture of 13%. Torino, a medium-full variety, produced seed that was close to 20% moisture at harvest regardless of planting date while Cobalt II, an early variety, when planted on 21-May produced seed close to the target harvest moisture. This difference suggests that Torino responded less to changes in planting date in terms of harvest moisture. Because Torino is a medium-full variety, it requires a longer growing season to reach physiological maturity and therefore dry down than Cobalt II. However, it is interesting that sunflowers planted on the first planting date (14-May) did not show as great of a difference between varieties as the second and third dates (21-May and 29-May respectively).

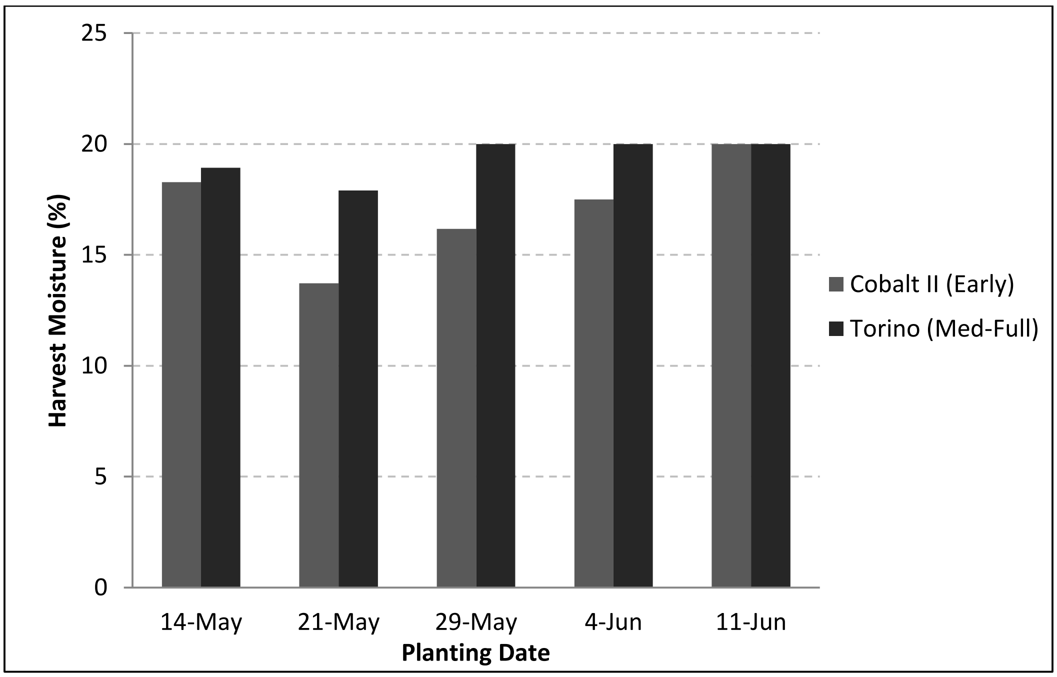

Figure 3. Effects of planting date on seed moisture at harvest for two varieties, Alburgh, VT, 2014.

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

Some plant stand characteristics were impacted by planting date (Table 3). Plant population averaged 19,667 plants per acre at harvest, though the fourth planting date (4-Jun) had statistically higher populations than all other planting dates. The incidence of sclerotinia (in the form of head rot) was not statistically significant by planting date. Incidence of sclerotinia in the form of stalk or base rot was not observed. Bird damage severity varied by planting date, with the least damage in the final planting date

(11-Jun). The highest bird damage was observed in the first two planting dates (14-May and 21-May) which saw 51.1% and 42.9% damage respectively. The third and fourth planting dates did not statistically differ from the final planting date. There was a statistical difference in plant height by planting date, with the tallest sunflowers in later planting dates (4-Jun and 11-Jun). There was also a statistical difference in lodging by planting date with less lodging in earlier planting dates. In addition, there was a moderately strong positive correlation (r = .476) between plant height and lodging indicating that lodging increased with increasing plant height.

Table 3. Plant stand characteristics by planting date, Alburgh, VT, 2014.

Planting date	Harvest population	Lodging	Head rot incidence	Bird damage	Plant height	Head width
	plants ac^{-1}	%	%	%	in	in
1 - 14-May	15863	**3.75***	3.75	51.1	131	**16.4***
2 - 21-May	20473	6.25*	**0.00**	42.9	134	14.3
3 - 29-May	15573	5.00*	1.25	25.8*	137	14.9
4 - 4-Jun	**27915**	35.0	1.25	24.6*	**158***	11.2
5 - 11-Jun	18513	36.3	3.75	**14.1***	151*	14.43
LSD (0.10)	5713	15.0	NS	18.9	11.6	1.33
Trial mean	19667	17.3	2.0	31.7	142	14.2

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).

Planting date had a statistically significant impact on harvest moisture, test weight, seed and oil yields, and oil content (Table 4). Moisture at harvest averaged 18.3% across planting dates. All were above the target moisture of 13%, however the second planting date (21-May) produced the lowest moisture of 15.8% compared to all other dates. Test weights averaged 29.7 lbs. per bushel with the highest value of 30.5 being observed in the 29-May planting date although this was not statistically different from the 4-Jun or 11-Jun dates. Seed yield was highest in the fifth planting date (11-Jun) at 1623 lbs. per acre, though this was not statistically greater than the third or fourth dates (29-May and 4-Jun).

Table 4. Seed and oil yield and quality by planting date, Alburgh, VT, 2014.

Planting date	Harvest moisture	Test weight	Seed yield	Oil content	Oil yield	
	%	lbs. bu^{-1}	lbs. ac^{-1}	%	lbs. ac^{-1}	gal ac^{-1}
1 - 14-May	18.6	27.6	958	28.2	278	36.5
2 - 21-May	**15.8**	29.6*	1271	**32.1***	418*	54.7*
3 - 29-May	18.1	**30.5***	1622*	28.9*	**460***	**60.3***
4 - 4-Jun	18.8	30.4*	1475*	30.1*	428*	56.0*
5 - 11-Jun	20.0	30.4*	**1623***	27.1	425*	55.6*
LSD (0.10)	1.44	1.03	274	3.74	108	14.1
Trial Mean	18.3	29.7	1390	29.3	402	52.6

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

The highest oil content was observed in the second planting date (21-May). The highest oil yield was seen in the third planting date (29-May) although this only differed statistically from the first planting date (14-May). Seed and oil yields over planting dates can be seen in Figure 4.

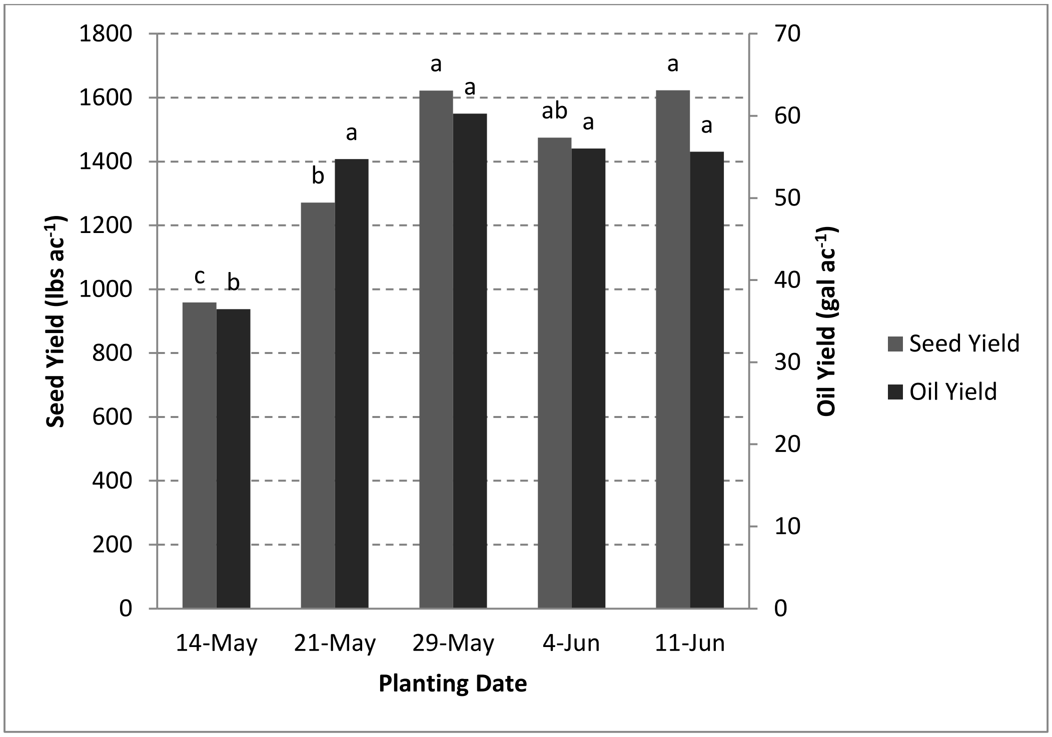

Figure 4. Impact of planting date on seed and oil yields of sunflower, Alburgh, VT, 2014. Treatments that share a letter are not statistically different (*p*=0.10)

The lowest seed yield was observed in the first planting date (14-May). This appears to be due to bird pressure (Figure 5). The planting date with the lowest yield (14-May, 958) had the highest bird damage of 51.1%. Alternatively, the planting date with the highest yield (11-Jun, 1623) had the least bird damage of 14.1%.

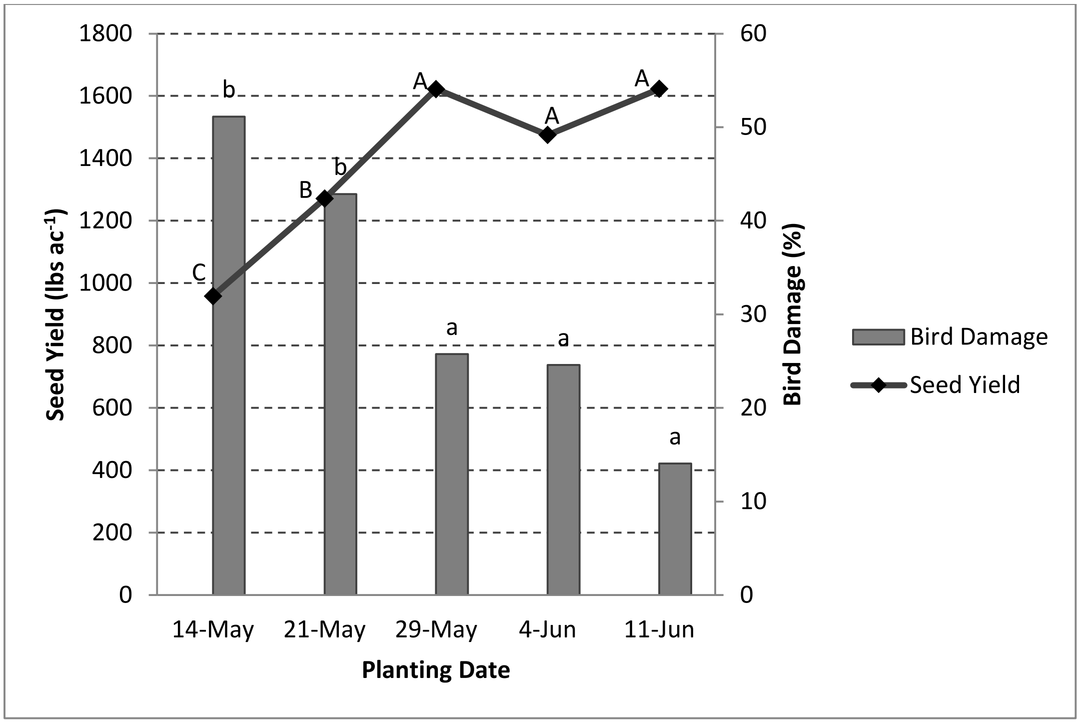

Figure 5. Impact of planting date on seed yield and bird damage of sunflower, Alburgh, VT, 2014.

It is interesting that we see a very clear negative relationship between planting date and bird damage. In previous years we have observed that early planting can help sunflowers reach maturity earlier, avoiding fall bird damage thus increasing yields. This year we see exactly the opposite, the earliest plantings saw the worst bird damage and consequently lowest yields.

In addition to bird and disease pressures, sunflowers also face pressure from various insect pests. Torino plots were scouted at four growth stages for BSM, spotted SMF and striped SMF. The SMF data was not shown as very low levels of this pest were present in 2014. Figure 6 and Tables 5 and 6 show the average number of BSM eggs found in each growth stage R2-R5 and across the five planting dates.

Tables 5 and 6. Observed BSM eggs per 100 plants over five planting dates and 4 growth stages

Planting Date	BSM Eggs # 100 plants^{-1}
1 - 14-May	5.2
2 - 21-May	3.8
3 - 29-May	**1.0***
4 - 4-Jun	1.5*
5 - 11-Jun	1.3*
LSD (0.10)	2.3
Trial Mean	2.5

Growth Stage	BSM Eggs # 100 plants^{-1}
R2	1.7
R3	2.5
R4	**2.3**
R5	3.7
LSD (0.10)	NS
Trial Mean	2.5

Treatments in **bold** indicate top performers in that column
NS – No significant difference.
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

The other insects and BSM developmental stages besides eggs are left out here as the BSM eggs were observed in the greatest numbers. Eggs were only found in the R2 stage in the first two planting dates and were higher in the first than the second with an average of about 6 eggs per 100 plants. However, BSM eggs did not statistically differ across growth stages (Figure 6). Eggs were found in the R3 stage in all planting dates except the third. The highest number found in the R3 stage was in the fourth planting date at 5 eggs per 100 plants. Eggs were found in the R4 stage in all planting dates with the highest number of 4 eggs per 100 plants found in the third planting date. Eggs were only found in the R5 stage in the first two planting dates where they each had about 9 eggs per 100 plants.

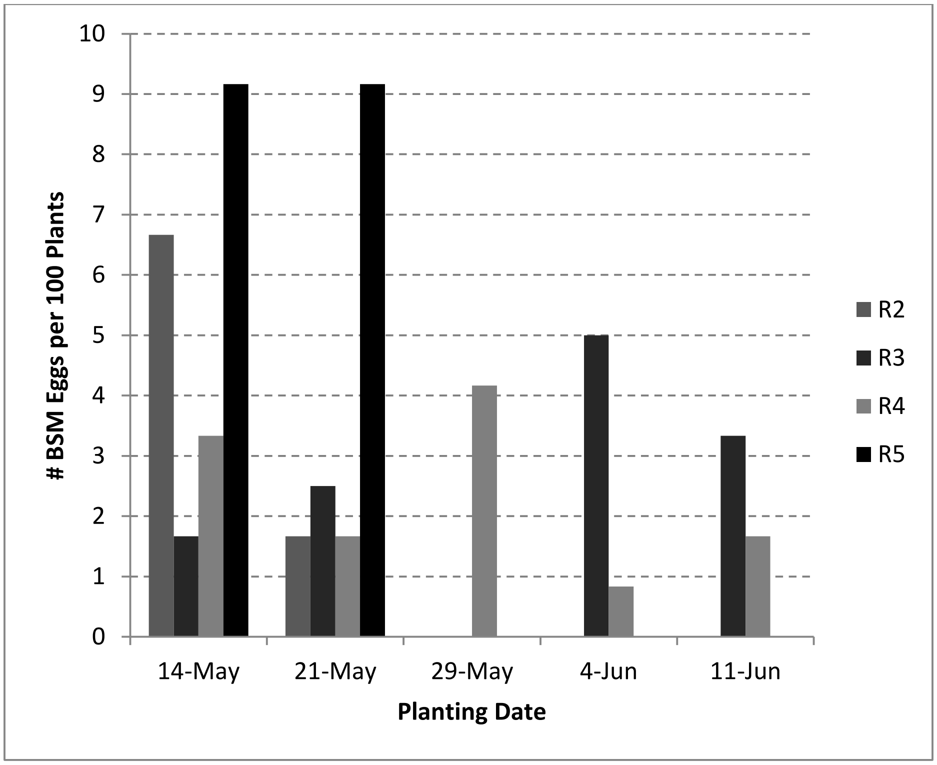

Figure 6. BSM eggs per 100 plants in four growth stages (R2-R5) across planting dates.

Overall, the highest number of BSM eggs was found in the R5 stage on the first two planting dates. The lowest occurrence of BSM eggs was found in the third planting date where only 1.0 egg per 100 plants was seen (Table 5). This only differed from the first two planting dates which saw about 5 and 4 eggs per 100 plants respectively. However, it is important to note that although statistically different, all planting dates experienced low numbers of BSM eggs. The economic injury level (EIL) for BSM eggs on sunflowers is the number of BSM eggs on 6 bracts that would cause economic damage, therefore, the cost of treatment, the market value of the crop, and the plant population are considered. For example, if the average insecticide treatment costs $8.00 per acre with a plant population of 20,000 per acre and a seed value of $0.16 per acre, then the economic injury level from BSM eggs would be 3.6 eggs per 6 bracts (North Dakota State University Extension). The highest level observed was 9 eggs per 100 plants. Overall, it appears as though the earlier May planting dates were most susceptible to BSM damage. In order to better measure BSM damage, mature seed samples should be evaluated for exit holes to establish a percentage of seed that was fed on by BSM larvae. We were unable to obtain these data this season.

Impacts of variety

There was little impact of variety on sunflower plant stand characteristics (Table 7). Harvest population, head rot incidence, lodging, and bird damage did not statistically differ by variety. Plant height and head width were statistically impacted by variety with 'Torino' growing to an average height and width of 148.3 and 14.7 inches respectively.

Table 7. Plant stand characteristics by variety, Alburgh, VT, 2014.

Variety	Harvest population	Lodging	Head rot incidence	Bird damage	Plant height	Head width
	plants ac^{-1}	%	%	%	in	in
Cobalt II	**20212**	**15.5**	2.50	31.7	136	13.8
Torino	19123	19.0	**1.50**	**31.7**	**148**	**14.7**
LSD (0.10)	NS	NS	NS	NS	7.30	0.84
Trial mean	19667	17.3	2.0	31.7	142	14.2

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).

Torino out-performed Cobalt II in all harvest parameters except moisture (Table 8). Although harvest moisture was statistically lower for Cobalt II at 17.1%, both were well above the target harvest moisture and therefore required drying. Torino had the higher test weight, seed and oil yield, and oil content of 30.0 lbs. per bushel, 1574 lbs. per acre, 30.5%, and 61.1 gallons per acre respectively.

Table 8. Harvest data and seed and oil yields by variety, Alburgh, VT, 2014.

Variety	Harvest moisture	Test weight	Seed yield	Oil content	Oil yield	
	%	lbs. bu^{-1}	lbs. ac^{-1}	%	lbs. ac^{-1}	gal ac^{-1}
Cobalt II	**17.1**	29.4	1206	28.0	337	44.1
Torino	19.4	**30.0**	**1574**	**30.5**	**467**	**61.1**
LSD (0.10)	0.91	NS	173	2.36	68.1	8.92
Trial Mean	18.3	29.7	1390	29.3	402	52.6

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

DISCUSSION

The only significant interaction between variety and planting date was observed in harvest moisture. Torino consistently produced seed with moistures at harvest around 20%. Conversely, Cobalt II showed lower harvest moistures when planted on the second or third planting dates (21-May and 29-May). Although this indicates that Cobalt II was impacted more greatly by planting date, all moistures were above the target harvest moisture and required drying.

Varying planting across the dates evaluated in this study impacted all plant stand and harvest characteristics except for disease incidence. Disease incidence was quite low in terms of head rot while stalk and base rot were not observed throughout the trial. This could be due to less favorable conditions for sclerotinia as we experienced a drier and warmer fall than normal, limiting the ability for the pathogen to infect and proliferate. Overall yields were much higher than previous years, perhaps due to better conditions early in the season allowing for earlier planting, timely cultivation, and better stand establishment.

Bird damage to sunflower heads was detrimental to yields of early planting dates. In previous years, we have seen a trend towards lower bird damage in early planted sunflowers, but lower insect damage in late planted sunflowers. This year, however, we saw the opposite as the earliest planting dates had the highest bird damage which lowered yields considerably. Lodging occurred more with taller sunflowers which were produced by late planting dates. Planting sunflowers in late May showed shorter plants with less lodging, less bird damage, and therefore high yields.

Both varieties were similarly susceptible to disease, birds, and had similar stand establishment. There was a difference in plant height as Torino plants were taller. In all harvest characteristics besides moisture, Torino out-performed Cobalt II.

Overall, the strategy of sunflower shifting planting dates has potential as a pest control strategy. However, the relationship we have seen in the past between pest pressure, yield, and planting date needs to be investigated further as we have found contradicting evidence. 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.

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