2017 Sunflower Planting Date x Variety 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 pest control strategy that has been shown to avoid pests is through manipulation of planting date. To evaluate the impacts of altered planting dates on sunflower pests and yields across varieties, an on-farm trial was designed and implemented by the University of Vermont Extension's Northwest Crops & Soils Program in 2017.

MATERIALS AND METHODS

To assess the effect of planting date of sunflower pest pressure, yield, and quality, a field trial was initiated at Borderview Research Farm in Alburgh, VT in 2017 (Table 1). The experimental design was a randomized complete block with split plots and four replications. The main plots were four planting dates, each spaced approximately one-week apart (19-May, 28-May, 5-Jun, and 12-Jun). The subplots were six varieties whose agronomic information is listed in Table 2.

Table 1. Agronomic field management, Alburgh, VT, 2017.

Location	Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Soybean
Replications	4
Plot size (ft.)	5 x 20
Planting equipment	Monosem 2-row air planter
Sunflower seeding rate (seeds ac^{-1})	32,000
Row width (in.)	30
Weed control	Select Max 2 qt ac^{-1} 22-Jun
Planting dates	19-May, 28-May, 5-Jun, and 12-Jun
Starter fertilizer (at planting)	10-20-20 200 lbs ac^{-1}
Harvest dates	26-Sep and 4-Oct

The soil type at the site was a Benson rocky silt loam and previous crop was soybean. The seedbed was prepared according to standard local practices, with chisel plow, disc, and spike tooth harrow. Sunflowers were planted in 30" rows with a Monosem NG-Plus 2-row precision air planter (Edwardsville, KS). Each 5'x 20' plot was planted with sunflowers at approximately 32,000 seeds ac^{-1}. Starter fertilizer consisting of 200 lbs ac^{-1} of a 10-20-20 analysis was applied at planting.

Table 2. Variety information for six sunflower varieties, 2017.

Variety	Maturity	Market	Traits
Camaro II	Medium	NuSun®	Clearfield®, DMR
Cobalt II	Early	High oleic	Clearfield®, DMR
Falcon	Medium	NuSun®/bird seed	Express Sun®
N5LM307	Med-Early	Conoil	Clearfield®, DMR
N4HM354	Med-Early	High oleic	Clearfield®, DMR
Torino	Med-Full	NuSun®	Clearfield®

Clearfield® = tolerant of Beyond® ammonium salt of imazamox herbicide;
ExpressSun® = tolerant of Express® tribenuron methyl herbicide; NuSun® = 55-75% oleic acid;
DMR = Downy Mildew resistant.

Populations were counted in each plot on 30-Jun. Dates when at least 75% of each plot was in full bloom were recorded on an ongoing basis. Plant stand characteristics including bird damage and disease incidence, were measured just prior to harvest. Issues with white mold (*Sclerotinia sclerotiorum*), a fungus which can overwinter in the ground and spread quickly in wet seasons, has proven problematic in the Northeast in the past. White mold presence on the stalk and heads of sunflowers was noted for each plot, however, a more thorough disease assessment was not conducted. Bird damage was measured by assessing 10 random plants in each plot and estimating the percentage of each head that was missing seed. All plots were harvested with an Almaco SPC50 plot combine with a 5' head and specialized sunflower pans. At harvest, test weight and seed moisture were determined for each plot with a Berckes Test Weight Scale and a Dickey-john Mini-GAC Plus moisture meter. An approximate 500g sample of seed from each plot was weighed and extruded using an AgOil M70 (Mondovi, WI) oil press on 6-Mar 2018. The oil was collected and weighed to determine oil content. Seed moisture was measured again prior to pressing with the Dickey-John Mini-GAC Plus moisture meter prior to extrusion.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications in 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 ($p<0.10$).

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 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. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, shown 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 summarized for the 2017 growing season (Table 3). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT. Overall, the summer was cooler and wetter than normal with some months seeing nearly 2 inches of precipitation above the 30-year average. Warmer and drier weather was observed in September with above average temperatures and below average rainfall. This mild fall weather provided some much needed drying conditions to allow for timely sunflower harvest. Overall, a total of 3133 GDDs were accumulated during the growing season which is 4 above the 30-year normal.

Table 3. Consolidated weather data and GDDs for sunflowers 2017, Alburgh, VT.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	55.7	65.4	68.7	67.7	64.4
Departure from normal	-0.75	-0.39	-1.90	-1.07	3.76
Precipitation (inches)	4.13	5.64	4.88	5.54	1.84
Departure from normal	0.68	1.95	0.73	1.63	-1.80
Growing Degree Days (base 44°F)	384	637	766	736	610
Departure from normal	0	-17	-60	-31	112

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.

Impacts of planting date

Planting dates significantly varied in a number of production characteristics (Table 4). Populations ranged from 17,497 to 31,127 plants ac^{-1} averaging 24,548 plants ac^{-1}. Typically, sunflowers are planted at about 32,000 seeds ac^{-1} to attain a target population of 28,000 to 30,000 plants ac^{-1}. Populations were well below the target range for the two later planting dates, but approximately on target for the first two planting dates. These differences are likely due to varying conditions at the planting dates resulting in uneven emergence and survival. Flowering dates ranged from 69 to about 78 days after planting, with earlier planting dates taking longer to reach full bloom than later dates. Planting dates differed drastically in bird damage and Sclerotinia incidence. Bird damage ranged from about 6 to 43% with significantly higher levels of damage in earlier planting dates. A similar trend was observed for Sclerotinia stalk rot where earlier planting dates resulted in lower disease incidence. However, overall disease incidence was low despite wet and cool conditions and did not seem to severely impact sunflower performance. The trend of decreasing bird damage with delayed planting dates has been observed in previous years of this trial.

Table 4. Stand characteristics by planting date, 2017.

Planting date	Population	Flowering	Bird damage	Sclerotinia head rot	Sclerotinia stalk rot
	plants ac^{-1}	DAP	% of head	plants ac^{-1}	
19-May	27261	77.8	42.9	36.3	90.8
28-May	**31127***	72.5	35.7	36.3	18.2*
5-Jun	22306	72.8	10.7*	90.7	0.00*
12-Jun	17497	**69.3***	**5.90***	**36.3**	**0.00***
LSD (*p*= 0.10)	3240	1.17	8.95	NS	49.7
Trial mean	24548	73.1	23.9	43.4	27.2

DAP - days after planting.
*Treatments with an asterisk * performed statistically similar to the top performer in **bold**.
NS - No significant difference.

Planting dates also varied significantly in multiple harvest characteristics (Table 5). Seed moistures at harvest ranged from 15.4 to 27.5% and increased with later planting dates. Due to wet conditions throughout the season, all planting dates resulted in moisture contents above the target of 13% and required extra drying prior to storage. Test weights were largely similar across planting dates except for the third planting date which was statistically lower than the others, but overall test weights were well below the target of 28 lbs bu^{-1}. Yields ranged from 904 to 1434 lbs ac^{-1} with the highest yield produced from sunflowers planted at the third and fourth planting date (Figure 1). Overall, despite poor weather conditions, yields were approximately average or slightly below average for this region. Oil contents ranged from 22.7 to 30.5% and decreased with delayed planting dates. However, oil yields did not differ statistically across planting dates averaging just over 40 gal ac^{-1}.

Table 5. Harvest characteristics by planting date, 2017.

Planting date	Harvest moisture	Test weight	Seed yield at 13% moisture	Oil Content	Oil yield at 10% moisture	
	%	lbs bu^{-1}	lbs ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
19-May	**15.4***	24.4*	976	**30.5***	329	43.1
28-May	19.8	**24.8***	904	29.5*	267	35.0
5-Jun	23.2	23.5	**1434***	24.8	**366**	**47.9**
12-Jun	27.5	24.1*	1273*	22.7	289	37.9
LSD (*p*= 0.10)	3.13	0.822	275	1.80	NS	NS
Trial mean	21.4	24.2	1147	26.9	313	41.0

*Treatments with an asterisk * performed statistically similar to the top performer in **bold**.
NS- No significant difference.

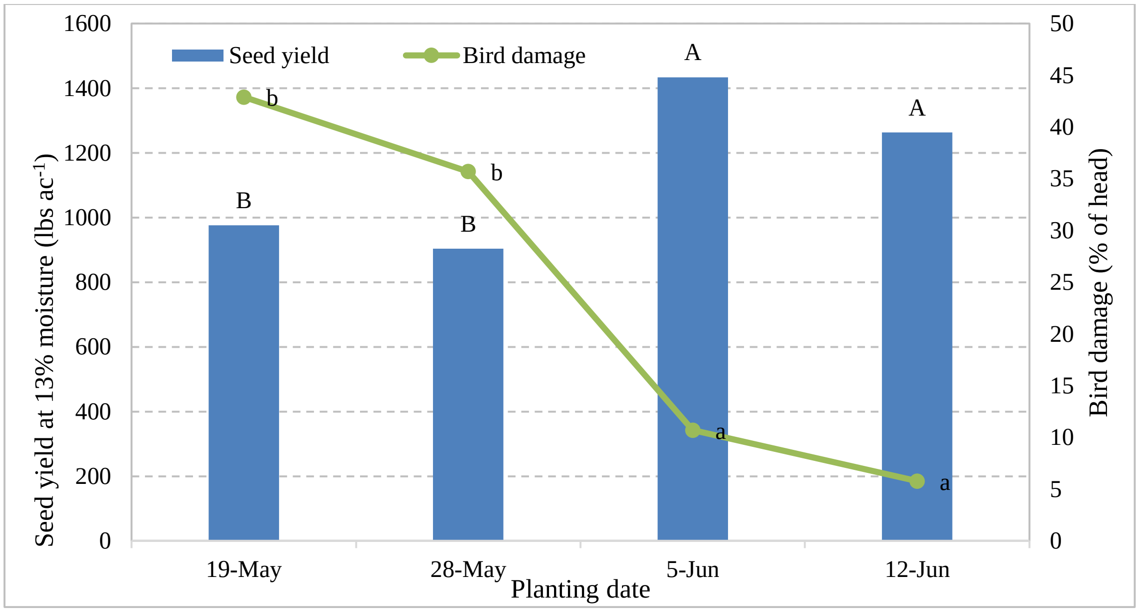

Figure 1. Seed yield and bird damage by planting date, 2017.
Treatments that share letters performed statistically similar to one another.

Impacts of Variety

Varieties also differed significantly in terms of stand characteristics (Table 6). Populations ranged from 21,862 to 26,681 plants ac^{-1}, with no variety reaching the minimum target population of 28,000 plants ac^{-1}. Flowering dates ranged from 69 to 76 days after planting. The variety N5LM307 reached full bloom in the fewest days and Torino required the most days to bloom. This was to be expected as Torino is the latest maturity variety in the trial. Bird damage (Image 2) ranged from 8.72 to 34.0% with the lowest damage observed from variety N5LM307 and Cobalt II (Figure 1). Interestingly, N5LM307 in 2016 had the lowest bird damage regardless of when it was planted. These data suggest that birds do not prefer this variety, however, we will continue to monitor this observed difference. The highest bird damage was observed with Falcon and Camaro II with 34.0 and 32.4% respectively. Disease incidence did not vary statistically across the varieties. Head rot ranged from 0 to 109 plants ac^{-1} with the highest incidence in variety N5LM307 and no infection in Camaro II. Stalk rot (Image 1) ranged from 0 to 54.5 plants ac^{-1} with the lowest infection levels seen in Cobalt II and N5LM307. However, overall disease levels appeared low and did not seem to negatively impact yields.

Image 1 and 2. Sclerotinia stalk rot and bird damage.

Table 6. Stand characteristics by variety, 2017.

Variety	Population	Flowering	Bird damage	Sclerotinia head rot	Sclerotinia stalk rot
	plants ac^{-1}	DAP	% of head	plants ac^{-1}	
Camaro II	24230	73.3	32.4	0.00	27.2
Cobalt II	21862	72.9	17.2*	81.7	0.00
Falcon	26463	75.4	34.0	27.2	54.5
N4HM354	23713	71.6	24.6	54.5	54.5
N5LM307	**26681**	**69.2***	**8.72***	109	**0.00**
Torino	24339	76.1	26.8	**0.00**	27.2
LSD (p= 0.10)	NS	1.43	11.0	NS	NS
Trial mean	24548	73.1	23.9	43.4	27.2

DAP- days after planting.
*Varieties with an asterisk * performed statistically similar to the top performer in **bold**.
NS – No significant difference.

Varieties also varied in harvest characteristics (Table 7). Moistures at harvest ranged from 15.8 to 28.0% with N4HM354 and N5LM307 producing seed of the lowest moisture and Torino with the highest. However, all of the varieties produced seed with moistures above the target of 13% and required additional drying prior to storage. Test weights ranged from 21.6 to 25.5 lbs bu^{-1} with all varieties producing seed with test weights below the industry standard of 28 lbs bu^{-1}. Seed yields ranged from 1068 to 1258 lbs ac^{-1} and did not differ statistically. Oil contents ranged from 23.5% to 28.8% with N5LM307 and Cobalt II producing the lowest levels. These oil content differences did not lead to significant differences in oil yield which averaged just over 41 gal ac^{-1}.

Table 7. Harvest characteristics by variety, 2017.

Variety	Harvest moisture	Test weight	Seed yield at 13% moisture	Oil Content	Oil yield at 10% moisture	
	%	lbs bu^{-1}	lbs ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
Camaro II	23.9	24.9*	1144	26.7*	288	37.7
Cobalt II	21.3	23.4	1078	26.0	289	37.9
Falcon	22.3	**25.5***	1098	**28.8***	**341**	44.7
N4HM354	**15.8***	24.7*	1068	28.6*	312	40.8
N5LM307	16.7*	21.6	1208	23.5	295	38.7
Torino	28.0	24.9*	**1258**	27.8*	353	46.2
LSD (p= 0.10)	3.83	1.00	NS	2.20	NS	NS
Trial mean	21.4	24.2	1143	26.9	313	41.0

*Varieties with an asterisk * performed statistically similar to the top performer in **bold**.
NS – No significant difference.

Planting date x variety interactions

There were statistically significant planting date x variety interactions for bird damage, head rot, and test weight. These interactions indicate that the varieties responded differently to planting date (Figure 2). In terms of bird damage, most varieties tended to show decreased damage with delayed planting dates, however, Falcon and N4HM354 showed higher damage levels in the second planting date than the first. Also, similar to the observations made in 2016, N5LM307 tended to have minimal bird damage across the planting dates with the highest level being just over 20% in the first planting date. This interaction suggests that shifting planting dates to avoid bird damage may produce variable results depending on the planting date and the variety selected.

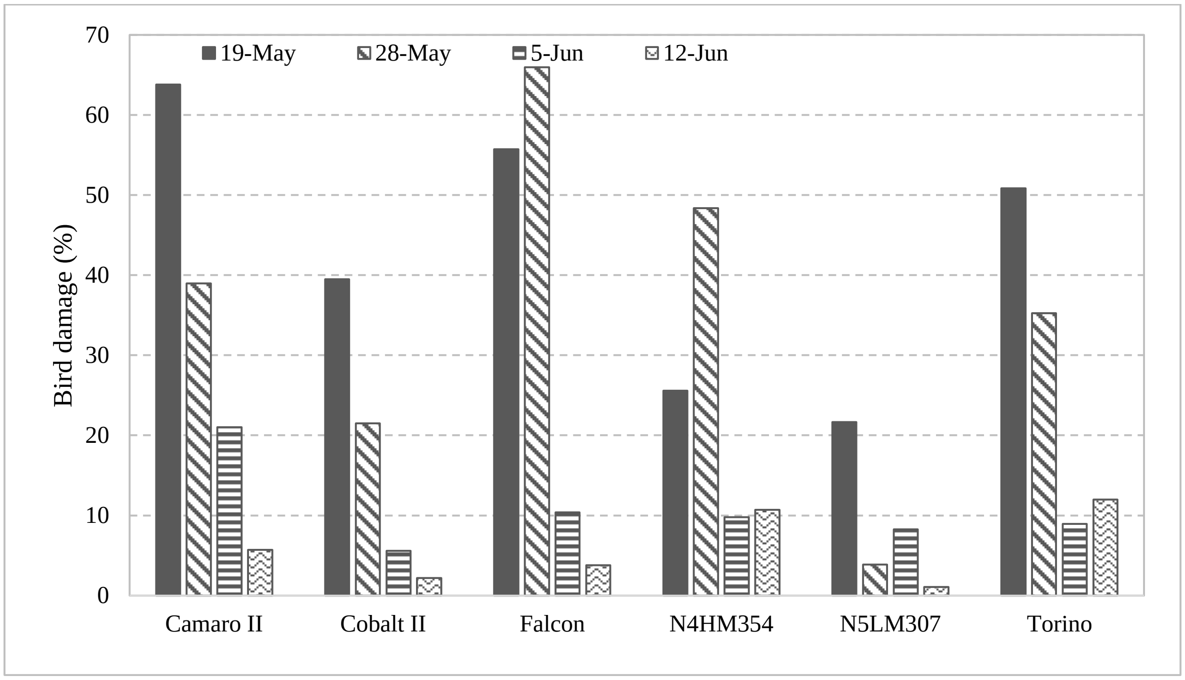

Figure 2. Interaction between planting date and variety for bird damage, 2017.

DISCUSSION

Despite poor weather conditions throughout much of the season, sunflower yields were approximately average for this region. Nationally, much of the sunflower growing region experienced severe drought. However, sunflower yields still averaged 1613 lbs ac^{-1}; yields were 18% lower than in 2016 but was the third highest on record (NSA newsletter, 1/22/2018). These record yields, even under suboptimal conditions, demonstrate sunflower flexibility and resilience showing promise for this region's challenging weather and short growing season. This trial continues to suggest that delaying planting of sunflowers by a few weeks can significantly decrease bird damage, thereby increasing seed yields. Even in the very wet weather of 2017, losses due to disease was minimal. However, had the weather in the fall continued the wet and cool trend of the spring and summer, more significant losses to disease and harvest complications may have been observed. Therefore, it is important to select a moderate to early maturing variety if planting dates will be delayed in this region to ensure adequate time to reach maturity and harvest prior to inclement weather. As seen in 2016, the variety N5LM307 appears to show minimal bird damage regardless of planting date, suggesting that birds do not prefer this variety for some reason. We will continue to investigate this trend and its potential causes in 2018.

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