2015

Sunflower Planting Date Trial

Heather Darby
University of Vermont, heather.darby@uvm.edu

Sara Ziegler
University of Vermont

Lily Calderwood
University of Vermont

Erica Cummings
University of Vermont

Abha Gupta
University of Vermont

See next page for additional authors

Authors
Heather Darby, Sara Ziegler, Lily Calderwood, Erica Cummings, Abha Gupta, and Julian Post

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Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, Lily Calderwood, Erica Cummings, Abha Gupta, and Julian Post
UVM Extension Crops and Soils Technicians
(802) 524-6501

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

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

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 2015.

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 2015 (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 (15-May, 22-May, 29-May, 5-Jun, and 12-Jun). The subplots were two varieties, 'Cobalt II' (early) and 'Torino' (med-full). Both varieties are Nuseed® (formerly Seeds 2000®) hybrids. 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, Alburgh, VT, 2015.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Varieties	Nuseed 'Cobalt II' (Early), Nuseed 'Torino' (Med-Full)
Previous crop	Corn with rye cover crop
Replications	4
Plot size (ft.)	10 x 30
Planting equipment	John Deere 1750 MaxEmerge planter
Sunflower planting rate (seeds ac^{-1})	35,000 seeds per acre
Row width (in.)	30
Thinned (date; plants ac^{-1})	8-Jul; 32,000
Weed control	Cultivated 17-Jun and 7-Jul
Sunflower planting date	15-May, 22-May, 29-May, 5-Jun, and 12-Jun
Starter fertilizer (at planting)	10-20-20 250 lbs ac^{-1}
Sunflower harvest dates	19-Sep, 23-Sep, 29-Sep
Pressing dates	17-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 cereal rye cover crop. 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 John Deere 1750 corn planter fitted with sunflower finger pickups. Each 10'x 30' plot was planted at 35,000 seeds per acre, and 250 lbs ac^{-1} 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 mechanically cultivated to control weeds on 17-Jun and 7-Jul.

'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 in order to more accurately estimate the impact of bird pressure on seed yields and quality (Figure 2).

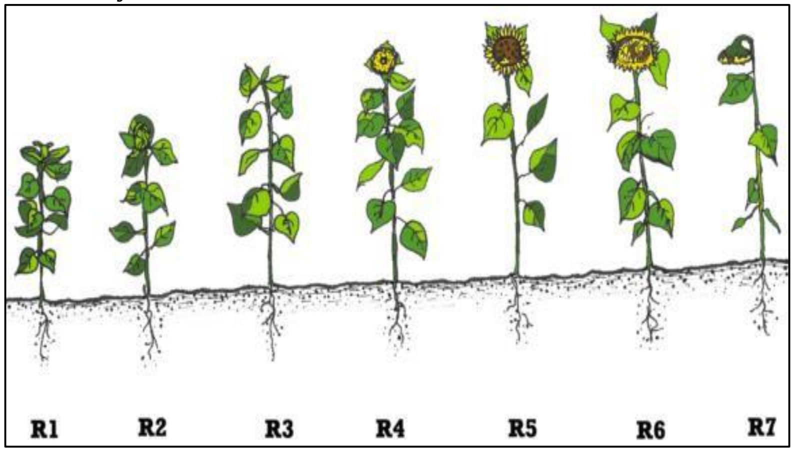

Figure 1. Sunflower reproductive growth stages from R1 to R7.

Plots were also scouted for the disease Phomopsis as symptoms were discovered during routine scouting. The percentage of each plot infected was visually estimated as well as given a severity rating. The severity scale was 0-5 where 0 was no infection present, 1 was minimal infection (1 lesion) and 5 was heavily infected (3+ lesions up covering majority of stem). 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. White mold (*Sclerotinia sclerotiorum*), a fungus which can overwinter in the ground and spread quickly, has proven problematic in the Northeast in the past. Planting dates were harvested according to physiological maturity. Planting dates 15-May and 22-May were harvested on 19-Sep, planting dates 29-May and 5-Jun were harvested on 23-Sep, and planting date 12-Jun was harvested on 29-Sep. 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 boring insects by counting the number of seeds out of 100 randomly selected seeds from each plot that had an insect exit hole present. Oil from a known volume of each seed sample was extruded on 17-Dec with a Kern Kraft Oil Press KK40, and the oil quantity was measured to calculate oil content. Oil yield (lbs ac^{-1} and gallons ac^{-1}) 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 ($p<0.10$).

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 AND DISCUSSION

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 2015 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 2015 was drier than normal, with all months except June having below normal precipitation. June was particularly wet with 6.42 inches of precipitation, 2.73 above normal. Temperatures were slightly above average in May and September. The drier warmer weather in early May allowed for timely field preparation and was favorable to the early planting dates. From May through September, there were an accumulated 3430 GDDs for sunflower (calculated at a base temperature of 44°F), 301 more than the long term norm and 154 more than in 2014.

Table 2. Consolidated weather data and GDDs for sunflowers 2015, Alburgh, VT.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	61.9	63.1	70.0	69.7	65.2
Departure from normal	5.5	-2.7	-0.6	0.9	4.6
Precipitation (inches)	1.94	6.42	1.45	0.00	0.34
Departure from normal	-1.51	2.73	-2.70	-3.91	-3.30
Growing Degree Days (base 44°F)	570	581	815	810	654
Departure from normal	186	-73	-11	43	156

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 for yield. Both varieties exhibited increasing yields with later planting dates (Figure 2). However, the response was much greater for Cobalt II than Torino. For example, there was a 350% increase in yield for Cobalt II and a 150% increase for Torino by delaying planting from the first planting date to the third. Since Cobalt II is a shorter season hybrid, it can maximize yield at later planting dates unlike a full season hybrid such as Torino. Since less bird damage was also seen at later planting dates, the overall trend across both varieties was for higher yields. However, Torino's yields lagged behind Cobalt II likely because it requires a longer growing season. This data suggests that a short season variety should be grown in the region so that later plantings can be utilized to maximize yields and minimize losses from bird pressure.

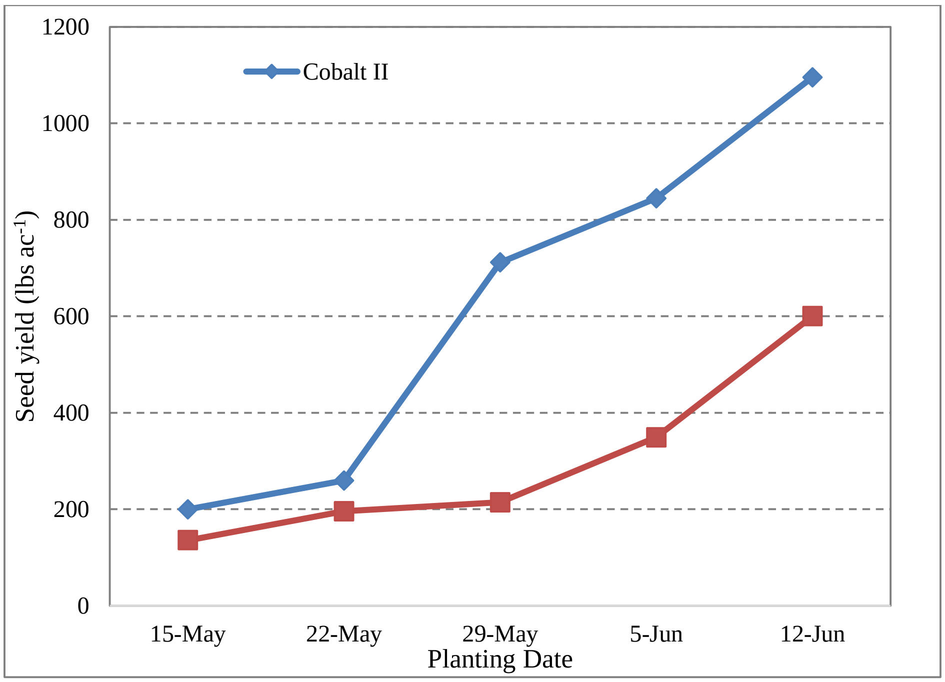

Figure 2. Planting date x variety interactions for yield, 2015.

Impacts of planting date

Plant stand characteristics were impacted by planting date (Table 3). Plant population averaged 25,337 plants per acre at harvest, though the fifth planting date (12-Jun) had statistically higher populations than all other planting dates. Populations this year however, were overall much closer to our target population of 28,000-30,000 plants ac^{-1} than in previous years. The significantly lower populations in the third planting date could potentially have been due to mechanical cultivation at early growth stages. Weed pressure from the increased rainfall required additional weed control in the experimental area.

Table 3. Plant stand characteristics over five planting dates, Alburgh, VT, 2015.

Planting date	Harvest population	Plant height	Head width	Head rot incidence	Bird damage	Lodged plants	Phomopsis incidence	Phomopsis severity
	plants ac^{-1}	cm	cm	%	%	%	%	0-5 scale
5-May	25955b	154b	10.8ab	0.25b	62.6c	6.90	50.0c	1.60c
22-May	25156b	162b	9.80b	0.63c	56.4bc	6.90	33.8b	1.00b
29-May	20909c	153b	**11.3a**	0.13b	49.6b	**3.80**	21.9b	0.60b
5-Jun	26136b	166ab	11.2a	**0.00a**	**47.8a**	3.80	1.30a	0.10a
12-Jun	**28532a**	**201a**	10.6ab	0.00a	51.5bc	5.60	**0.00a**	**0.00a**
LSD (0.10)	2129	37.3	1.10	0.30	12.9	NS	12.4	0.45
Trial mean	25337	167	10.7	0.20	53.6	5.40	21.4	0.70

Values in **bold** indicate the top performer of that characteristic.
Planting dates that share letters do not statistically differ from each other.
NS – showed no significant difference.

Plant height and head width also varied significantly across planting dates with the tallest plants in the fifth planting date but the largest heads in the third. A relationship between plant population and height can be seen where the tallest plants are associated with higher plant populations (Figure 3). Although this is to be expected, we can see from these data that our target population may be influencing the height and head width of the plants. Another potential consequence of taller plants is a higher proportion of lodged stems. However, we saw little lodging in this trial this year and did not see this relationship. Very little sclerotinia head rot was also observed (trial average 0.2%). However, while scouting the trial area for insects symptoms of another disease, Phomopsis, were seen. These symptoms included wilting and chlorosis of leaves, large brown stem lesions at the petiole, and some lodging at these lesions. Although we did not plan on assessing this trial for Phomopsis, since some of the plots seemed heavily diseased, we estimated the percentage of each plot that was infected and developed a rating system for the severity. Pictures of the symptoms and their assigned severity can be seen in Figures 4-6.

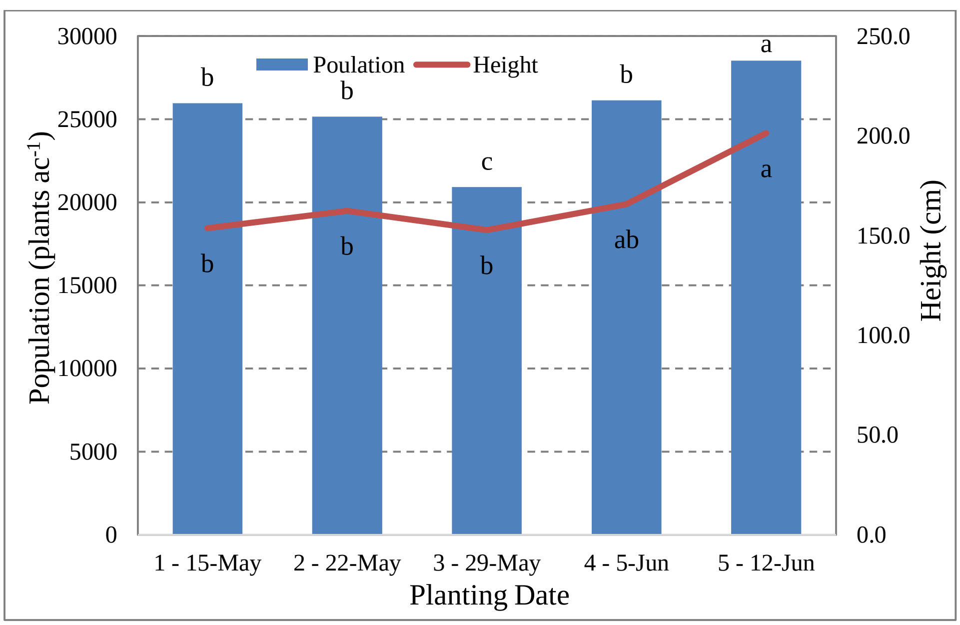

Figure 3. Plant population and height across five planting dates, 2015.

Figures 4-6 (left to right). Phomopsis symptoms rated 1-3 for severity and extent of lesions on stem.

Planting date had a statistically significant impact on seed and oil yields, oil content and seed damage (Table 4). Seed yield was highest is the fifth planting date with 848 lbs ac^{-1} which, with an oil content of 22.2%, translated into 26 gallons of oil ac^{-1}. The fourth planting date had a slightly lower seed yield of 597 lbs ac^{-1} but had a higher oil content of 25.3% and yielded 21 gallons of oil ac^{-1}.

Table 4. Seed and oil yield by planting date, Alburgh, VT, 2015.

Planting date	Test weight	Pressing moisture	Seed damage	Seed yield	Oil content	Oil yield	
	lbs bu^{-1}	%	%	lbs ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
15-May	26.0	4.20b	14.8b	168c	21.0c	29d	4d
22-May	24.0	4.20b	13.1ab	228c	23.7ab	41d	5d
29-May	28.7	5.10a	13.1ab	463b	23.2ab	108c	14c
5-Jun	27.8	**5.40a**	**8.10a**	597b	**25.3a**	157b	21b
12-Jun	25.1	4.40b	20.4c	**848a**	22.2bc	**201a**	**26a**
LSD (0.10)	N/A	0.40	5.40	134	2.20	21.0	4.1
Trial Mean	26.6	4.60	13.9	461	23.1	107	14

Treatments in **bold** were top performers for the given variable.
Treatments that share letters do not statistically differ from one another.
Statistical analysis was not performed for test weight.

Through our research, we have found that sunflowers can reliably produce seed yields of 1200 lbs ac^{-1}. These low yields could be due to the fact that shortly after they were planted, we had excessive rainfall through the month of June followed by below average rainfall the rest of the season. The excessive rainfall may have slowed sunflower growth early in the season leading to lower yield potential once the rain stopped. The lower yields can also be explained by the high levels of bird damage and incidence of Phomopsis observed in the earliest planting dates (Figure 7).

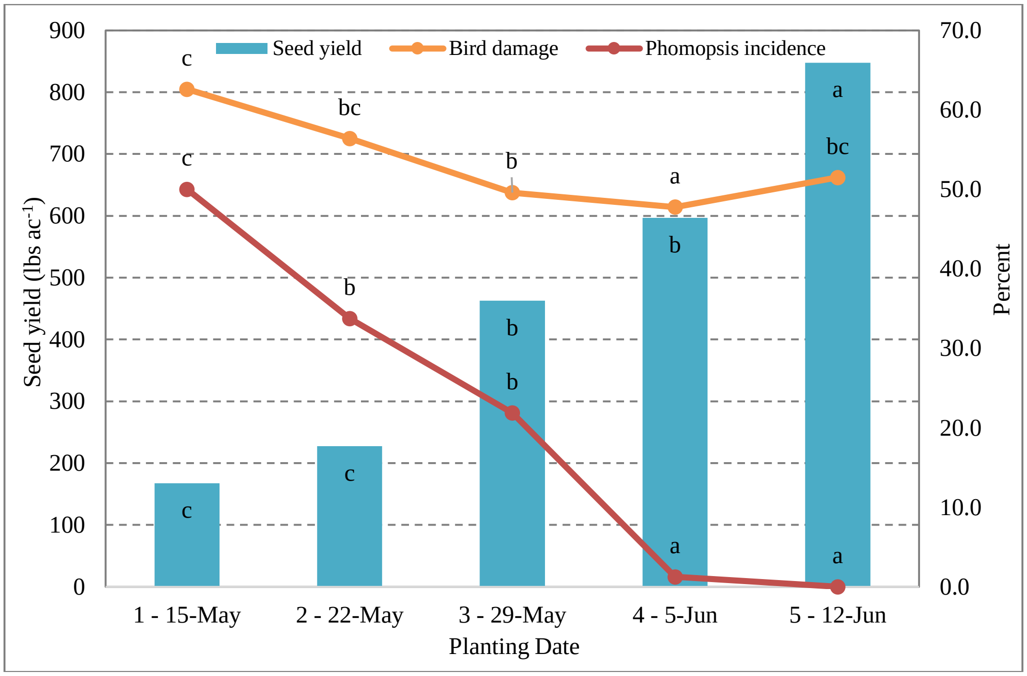

Figure 7. Seed yield, Phomopsis incidence, and bird damage, 2015.
Treatments that share letters do not statistically differ from one another.

Low oil yields can also be explained partially by the low pressing moistures of the seeds. At the time of harvest, the seeds were extremely wet and needed to be dried. Unfortunately, due to the nature of our sample size and drying equipment, the seeds were dried well below the target pressing moisture. Pressing sunflower seed at such low moistures can cause plugging and extra wear on equipment making the oil extraction process more difficult. It is possible that the dry seed plugged the press more and did not allow for extraction of all the oil contained in the seed.

The percent of damaged seed reported in Table 4 refers to seed damaged by seed boring insects. Through past years' research we have found that, although we regularly scout our sunflower trials for insects we often do not observe many pests as they may be in a larval stage inside the seed head or in an adult stage in field margins during scouting. Therefore, to get a more accurate representation of insect pressure on sunflowers, we visually inspected 100 seeds from each plot after harvest for insect larvae exit holes (Figure 8). The average seed damaged by insects was 13.9% with the lowest damage observed in the fourth planting date and the highest in the fifth planting date. These levels of damage also explain some of the decrease in test weights observed in this trial which are largely below the industry standard of 28 lbs bu^{-1}. However, test weights could have also been impacted by the drought conditions during the majority of the summer, especially during seed fill.

Figure 8. Sunflower seed damage.
Photo credit: sunflowernsa.com

Impacts of Variety

Plant stand characteristics were statistically impacted by variety (Table 5). Although the variety Cobalt II had lower populations and shorter plants than the variety Torino, Cobalt II was the top performer in terms of all other plant stand characteristics. Most notable were the differences in bird damage and Phomopsis incidence. Cobalt II is an early maturing, short stature sunflower variety while Torino is a medium-full maturing, drought resistant variety. The flower heads of Cobalt II were much larger than Torino and tended to face downward. This may explain why they experienced less bird damage as they were face down and closer to the ground than the Torino heads. Overall there was little sclerotinia head rot found, however, there was some significant Phomopsis infection found in the Torino plots (34.5%). Torino plots also exhibited more lodging, probably due to the taller heights, although lodging was still quite low overall.

Table 5. Stand characteristics by variety, 2015.

Variety	Harvest population plants ac^{-1}	Plant height cm	Head width cm	Head rot incidence %	Bird damage %	Lodging %	Phomopsis incidence %	Phomopsis severity 0-5 scale
Cobalt II	18528	157	**12.8**	**0.15**	**36.2**	**0.50**	**8.30**	**0**
Torino	**32147**	**177**	8.70	0.25	70.9	10.3	34.5	1
LSD (0.10)	1346	23.6	0.70	0.19	8.16	3.26	7.85	0.29
Trial mean	25337	167	10.7	0.20	53.6	5.40	21.4	0.70

Treatments in **bold** were top performers for the given variable.
Treatments that share letters do not statistically differ from one another.

Seed and oil yield characteristics were also statistically impacted by variety (Table 6). As described previously, pressing moistures were extremely low and may have influenced oil yields. Seed yield was significantly higher for Cobalt II, probably due to lower bird damage and larger head size. Although Cobalt II had a lower oil content than Torino, the increased seed yield, and perhaps to some extent the pressing moisture, translated into a much higher oil yield at 19 gallons ac^{-1}. As previously stated, this is half of what has previously been observed as typical sunflower yields in our region and was likely due to adverse weather conditions.

Table 6. Seed and oil yield, 2015.

Variety	Test weight	Pressing moisture	Seed damage	Seed yield	Oil content	Oil yield	
	lbs bu^{-1}	%	%	lbs ac^{-1}	%	lbs ac^{-1}	gal ac^{-1}
Cobalt II	26.8	**5.00**	14.8	**622**	21.9	**148**	**19.0**
Torino	26.3	4.30	**13.0**	299	**24.3**	67.0	9.00
LSD (0.10)	N/A	0.30	3.4	84.9	1.40	19.6	2.60
Trial Mean	26.6	4.60	13.9	461	23.1	107	14.0

Treatments in **bold** were top performers for the given variable.
Treatments that share letters do not statistically differ from one another.
Statistical analysis was not performed for test weight.

Overall, we observed that later planted sunflowers experienced less bird damage, fewer symptoms of Phomopsis, and consequently had higher yields. In terms of insect pressure, we saw a less consistent pattern as insect damage was lowest in the fourth planting date, but highest in the fifth planting date. These general trends, however, are consistent with our previous findings, that planting sunflowers in early June can increase yields through avoidance of bird pressure although this may come at the expense of slightly higher insect pressure. In general, we saw better performance from the early maturing variety Cobalt II likely due to lower bird damage associated with larger downward facing heads. When augmenting planting dates to avoid pest pressure, it is important to remember that pushing planting dates back too far while selecting a full maturing variety, in this region with a short growing season, could lead to the crop not fully reaching maturity or not drying down properly. This can cause losses to underdeveloped seed, harvesting losses, and higher expenses in drying seed. Therefore, it is important to pay close attention to varietal selection while attempting to augment planting dates to fully realize the benefits. 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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