2011

Sunflower Seeding Rate X Nitrogen Rate Trial

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The UNIVERSITY of VERMONT EXTENSION

2011 Vermont Sunflower Seeding Rate x Nitrogen Rate Trial
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Because the majority of sunflowers in the United States are grown in the Great Plains, recommendations for plant populations and fertilization rates are limited to this specific region and climate. Due to the temperate climate of the northeast, it is likely that optimal seeding rates and nitrogen (N) rates for sunflower production will differ from the Great Plains. A crop's N requirements are often linked to population; this study attempts to evaluate the impact of both seeding rates and N rates on sunflower yield and quality.

MATERIALS AND METHODS

The study was conducted at Borderview Farm in Alburgh, VT. The experimental design was a randomized complete block with a split plot arrangement and four replications. Main plots were comprised of four N application rates; subplots consisted of five seeding rates (Table 1).

Table 1. Seeding and nitrogen rate treatments.

Seeding rates plants acre^{-1}	Nitrogen rates lbs acre^{-1}
20,000	0
24,000	60
28,000	90
30,000	120
32,000	


Figure 1. Emerging sunflower seedling in June.

The soil type was a Benson rocky silt loam. The sunflowers were planted on 15-June with an Allis Chalmers two-row cone planter. Each subplot was 10' x 20'. The pre-plant herbicide Treflan (trifluralin) was applied at 2.5 pints acre^{-1}. The variety of sunflower planted was Croplan 306 (87 RM). A four-row Brillion cultivator was used to control weeds between the rows on 5-July. Plots were thinned by hand on 12-July to meet the treatment population goal. On 28-July, ammonium sulfate (21-0-0) was applied as a topdress at 0, 60, 90, and 120 lbs of N per acre^{-1}. Cultural practices implemented are listed in Table 2.

Table 2. Cultural practices for the 2011 sunflower seeding rate by nitrogen rate trial.

Location	Borderview Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Tillage operations	Spring disk, harrow, spike-toothed harrow
Weed control	24- May, Trifluralin, 2.5 pints/acre 5-July row cultivation
Plot size (ft.)	10 x 20
Replicates	4
Row width (in.)	30
Planting date	15-June
Variety	Croplan 306
Harvest date	12-Oct.
Pressing date	20-Oct

Prior to harvest, each plot was evaluated for height, head width, white mold incidence, lodging, and bird damage. Plants were examined for signs of white mold (*Sclerotinia sclerotiorum*) at three locations: on the sunflower head, along the stalk, and at the base. White mold has been known to contribute to lodging, plant rot, and decreased seed and oil yields in the Northeast. Bird damage was estimated using guidelines provided by North Dakota State University Extension, based on the estimated percentage of bird-pecked or missing seeds on a sampled number of whole sunflower heads.

Figure 2. Kern Kraft KK40 press.

Plots were harvested on 12-October with an Almaco SPC50 plot combine with a 5' head equipped with sunflower pans. 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. Seeds were cleaned with a Clipper fanning mill to remove debris and plant material. Oil from each seed sample was extruded on 20-October with a Kern Kraft KK40 oil press, and oil content was measured (Figure 2). The average moisture level at the time of pressing seeds was 4.8%, which is lower than the recommended level of 6 to 10%.

All data was analyzed using a mixed model analysis where replicates were considered random effects and treatments were fixed effects. The LSD procedure was used to separate cultivar means when the F-test was 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. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table a LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSD's) 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 listed in bold had the top performance in a particular column; treatments that did not perform significantly lower than the top-performer in a particular column are indicated with an asterisk. In the example at right, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 400, which is less than the LSD value of 500. This means that these treatments did not differ in yield. The difference between A and C is equal to 650, which is greater than the LSD value of 500. This means that the yields of these treatments were significantly different from one another.

Variety	**Yield**
A	**1600***
B	1200*
C	950
LSD (0.10)	500

RESULTS

Weather information was collected from a station in close proximity to Borderview Farm in Alburgh, VT, and data is summarized in Table 3. The 2011 growing season was wetter than normal, with very heavy precipitation in the spring and fall. However, the months of June and July were close to average in rainfall, and average temperatures were near normal. There were an accumulated 3,886 Growing Degree Days (GDDs) at a base temperature of 44°F, 544 more GDDs than the 30-year average.

Table 3. Summarized weather data for 2011 – Alburgh, VT.

South Hero, VT (Alburgh)	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	104	-26.3	98.6	242

± Average temperature for August-October 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).

Seeding Rate x Nitrogen Rate Interactions

There was a significant interaction between seeding rate and nitrogen rate for sunflower head width, lodging, and bird damage in this experiment. These interactions indicate that sunflower seeding rate responds differently across nitrogen rates for these measurements. However, the interaction between seeding rate and nitrogen rate was difficult to interpret from a biological perspective. More data would need to be collected to help further identify if this interaction is agriculturally meaningful to farmers and sunflower production. It does appear that at low N rates and seeding rates there is less bird damage, less lodging, and larger head widths. As N rate and seeding rates increase, the data becomes less clear and it is difficult to interpret the impact that these rates have on sunflower growth characteristics.

Impact of Seeding Rate

The impact of seeding rate on plant stand characteristics was evaluated immediately prior to harvest (Table 4). There was no significant difference among seeding rates in plant height. Head width did vary by seeding rate, with the widest seed heads (5.9 inches) observed at the lowest seeding rate (20,000 plants acre^{-1}). The smallest head width (4.5 inches) was in the most densely-seeded plots (32,000 plants acre^{-1}). Figure 4 shows the impact of seeding rate on head width. The incidence of white mold, which ranged from an average 1.6% (in the form of base rot) to 4.5% (in the form of stalk rot), did not vary significantly by seeding rate.

Table 4. Impact of seeding rate on plant and yield characteristics.

Seeding rate	Height	Head width	White mold incidence			Lodging	Bird damage	Seed yield	Harvest moisture	Test weight	Oil content	Oil yield	
			Head rot %	Stalk rot %	Base rot %								
plants ac^{-1}	inches	inches				%	%	lbs ac^{-1}	%	lbs bu^{-1}	%	lbs ac^{-1}	gal ac^{-1}
20000	52.7	**5.9***	3.1	3.8	2.5	**3.1**	**1.4***	**3666***	16.5	27.6	29.3	1065	140
24000	53.3	5.3	**2.5**	5.6	2.5	8.1	2.7*	3080	**17.1**	**28.0**	30.9	936	123
28000	54.7	4.9	4.4	5.0	**0.6**	8.1	3.8	3362*	15.1	27.3	**33.0**	**1098**	**144**
30000	**55.9**	5.0	3.8	**3.1**	1.3	9.4	4.1	3341*	15.5	27.8	29.5	966	127
32000	54.8	4.5	4.4	5.0	1.3	10.0	4.8	3014	14.6	27.8	31.2	952	125
LSD (0.10)	NS	0.3	NS	NS	NS	NS	2.1	386	NS	NS	NS	NS	NS
Trial Mean	54.3	21.4	3.6	4.5	1.6	7.8	3.3	3293	15.7	27.7	30.8	1003	131

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.

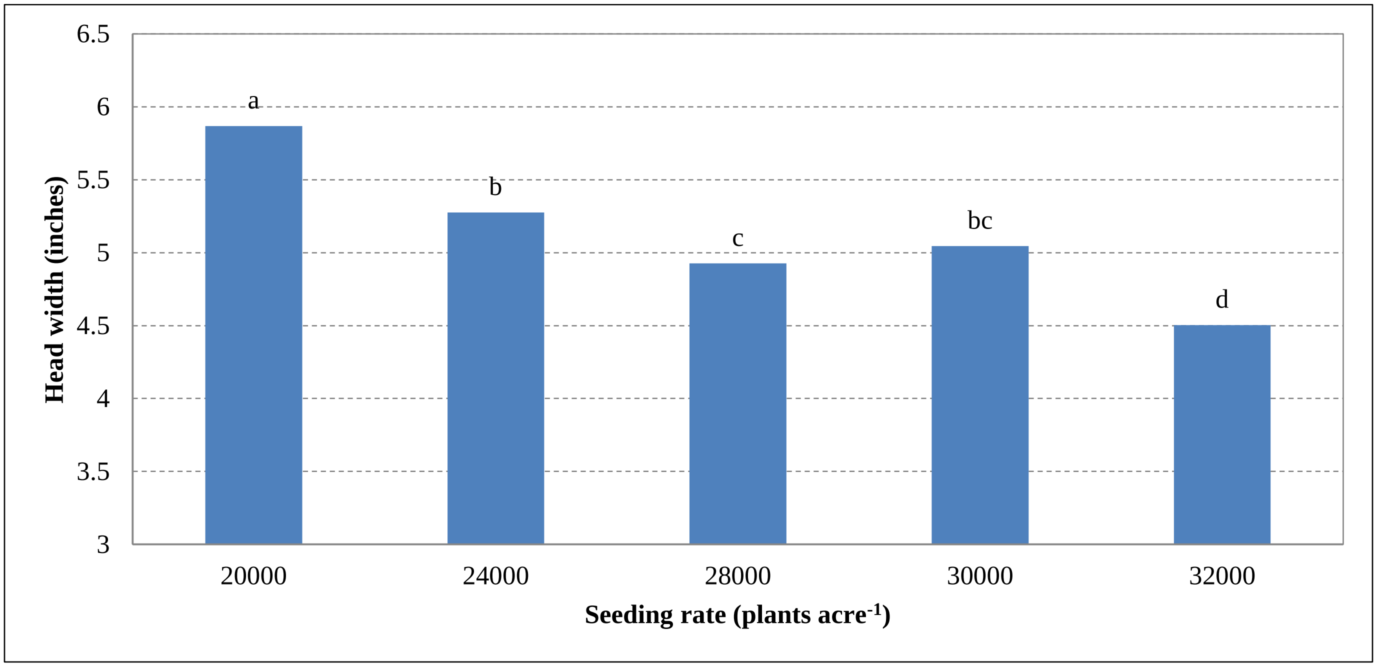

Figure 4. Impact of seeding rate on head width of sunflowers. ***Treatments with the same letter did not differ significantly from one another (p=0.10).***

There was no significant difference among seeding rates for the percentage of lodged plants. The estimated amount of bird damage to the sunflower crop was significantly different by seeding rate. The lowest amount of damage (1.4%) was observed at the 20,000 plants $acre^{-1}$ seeding rate, though this was not significantly lower than the bird damage in 24,000 plants $acre^{-1}$. The greatest amount of damage (4.8%) was in the treatment with 32,000 plants $acre^{-1}$ (Figure. 5).

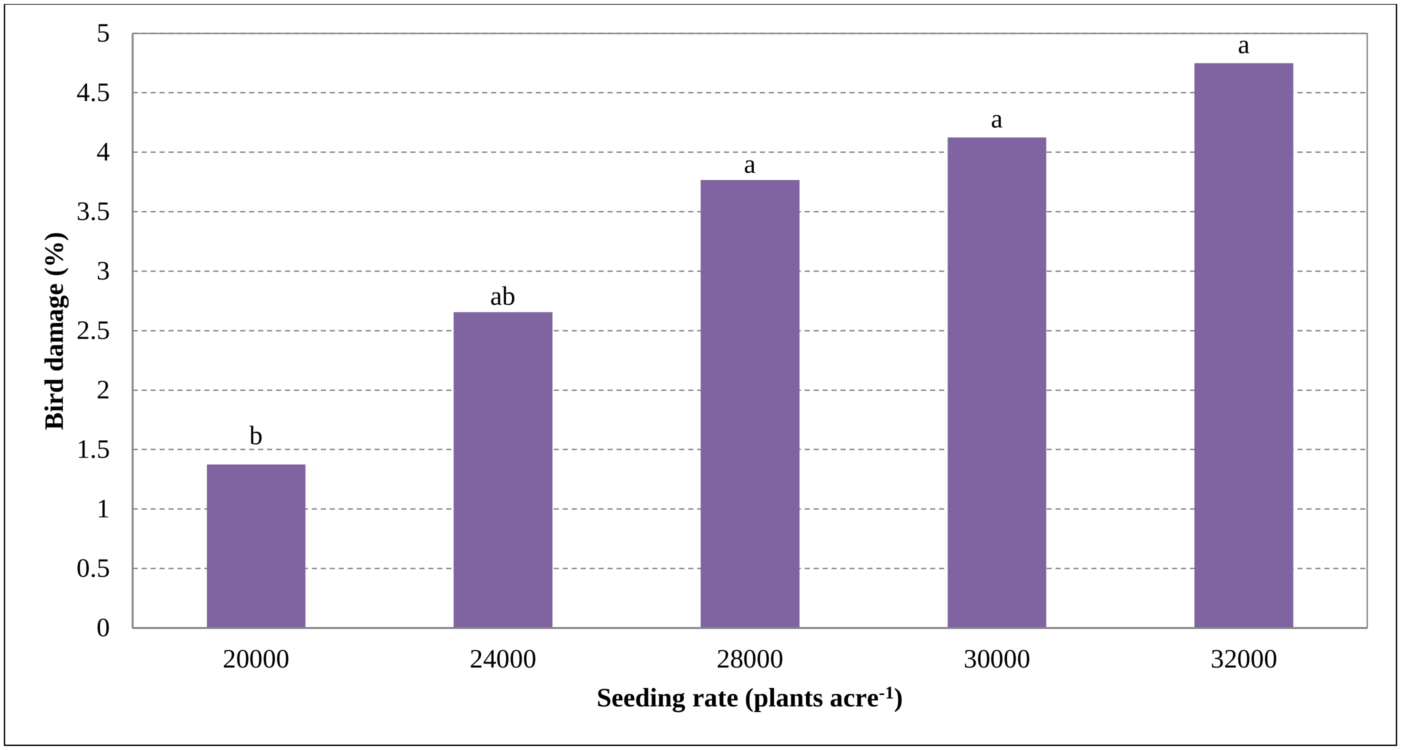

Figure 5. Impact of seeding rate on bird damage in sunflowers. ***Treatments with the same letter did not differ significantly (p=0.10).***

Seed yield differed by seeding rate, with the highest yield (3,666 lbs acre^{-1}) in the 20,000 plants acre^{-1} treatment (Table 4; Figure. 6). This was not significantly higher than yields from the 28,000 or 30,000 plants per acre treatments. Average seed yield for the study was 3,293 lbs acre^{-1}. Oil yields did not differ significantly by seeding rate. The average oil yield for the study was 131 gals acre^{-1} (Table 4). Oil content did not vary significantly by seeding rate (trial average, 30.8%).

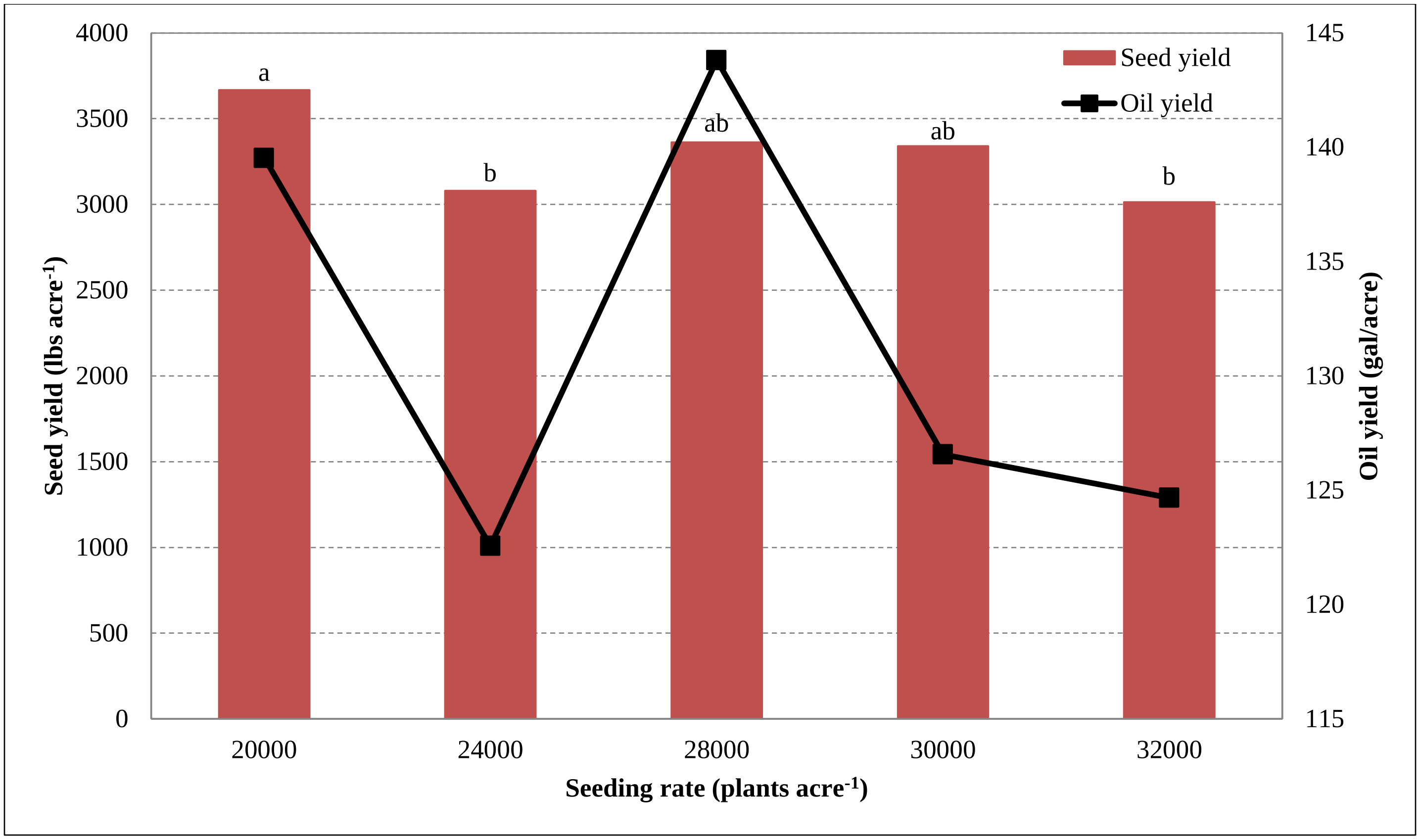

Figure 6. Impact of seeding rate on seed and oil yields. ***Treatments with the same letter did not differ significantly in seed yield (p=0.10). Oil yield did not vary significantly by treatment.***

Impact of Nitrogen Fertilizer Rate

Nitrogen application rate did not significantly impact height and head width of sunflower plants (Table 5). White mold incidence on sunflower heads or stalks did not vary by N rate. However, there was a significant difference by N rate in the incidence of base rot. The least amount of white mold base rot was observed in the 90 or 120 lbs N acre^{-1} treatment. Lodging varied by N rate and was lowest in plots receiving 0 lb N acre^{-1}. Bird damage was also significantly lowest in the treatment with 0 lbs N acre^{-1} (Figure. 6).

Table 5. Impact of nitrogen rate on selected plant and yield characteristics.

Nitrogen rate	Height	Head width	White mold incidence			Lodging	Bird damage	Seed yield	Harvest moisture	Test weight	Oil content	Oil yield	
			Head rot %	Stalk rot %	Base rot %								
lbs ac^{-1}	inches	inches				%	%	lbs ac^{-1}	%	lbs bu^{-1}	%	lbs ac^{-1}	gal ac^{-1}
0	52.8	5.1	3.5	4.5	3.0	**2.0***	**1.8***	3105	**18.0***	**28.3***	**33.0**	1006	132
60	**55.0**	5.1	5.0	**4.0**	2.0	10.5	4.9	3195	14.1	27.0	30.2	950	124
90	54.6	**5.2**	**3.0**	4.5	1.5*	7.0	3.6*	3322	16.0	28.0*	29.7	1009	132
120	54.7	5.1	**3.0**	5.0	**0.0***	11.5	3.1*	**3549**	14.9	27.5*	30.2	**1048**	**137**
LSD (0.10)	NS	NS	NS	NS	2.0	4.3	1.9	NS	1.6	0.7	NS	NS	NS
Trial Mean	54.3	21.4	3.6	4.5	1.6	7.8	3.3	3293	15.7	27.7	30.8	1003	131

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

Seed yields did not differ significantly by N rate, but the highest yield was in the heaviest-fertilized treatment, 120 lbs N acre^{-1} (3549 lbs seed acre^{-1}) (Table 5). The moisture at harvest was significantly higher in the treatment with 0 lbs N acre^{-1}. Test weight was significantly different by N rate, and the greatest test weight was in the treatment without N fertilizer (28.3 lbs per bushel). This was not significantly higher than the test weights for treatments fertilized with 90 or 120 lbs N acre^{-1}. Oil content and yield was not significantly different according to N rate.

DISCUSSION

Overall, seed yields were higher in this trial than in other 2011 sunflower trials at the same location. The trial average was 3,293 lbs per acre, almost three times greater than the average yield from UVM Extension's 2011 Sunflower Variety Trial. This increased yield could have been due to the later planting date and adequate soil conditions at the time of germination. Because of the late planting date of this trial, the sunflowers reached physiological maturity later than the peak bird migration season; therefore plots in this trial were not covered with tobacco and grape netting as they had been in previous seasons. Further research to document optimal sunflower planting dates for the region are necessary to understand bird predation. While seed and oil yields were high, the average oil content of harvested seeds (30.8%) was relatively low, perhaps because of low moisture contents (4.8% average) at the time of pressing seed samples.

Seeding rates had little impact on the crop stand characteristics of the trial, though head width decreased significantly as seeding rates increased. Plant height did not differ significantly by seeding rate. This was unexpected since most crops tend to grow taller in height as seeding rates are elevated. Bird damage was most severe (4.8%) in the highest seeding rate treatments (32,000 plants acre^{-1}), suggesting perhaps that birds congregated in plots with higher populations, where they might find more readily available food. The seed yield was also significantly impacted by seeding rates, with highest yields of 3,666 lbs acre^{-1} in the lowest seeding rate treatment of 20,000 plants acre^{-1}. This suggests that higher seeding rates do not necessarily yield greater amounts of sunflower seed. This has obvious implications on seed costs and can have an impact on overall farm viability.

Nitrogen rates had a slightly different impact on overall characteristics and yields of sunflowers in this study. The only significant differences in crop stand characteristics by nitrogen rate were in white mold base rot (lowest in the treatment fertilized with 120 lbs N per acre), lodging (lowest in the unfertilized treatment), and bird damage (lowest in the unfertilized treatment). There were no significant differences in seed yield, oil yield, or oil content by nitrogen rate, though yields were higher in treatments fertilized with 120 lbs N per acre. Other studies have linked high N rates with increase white mold incidence in sunflowers and other susceptible crops. High rates of N can also weaken crop stems and cause lodging. It is unclear why bird damage would increase with higher N rates. Although not significant, plant heights tended to be taller with higher N rates. Birds may be more drawn to taller plants and hence cause greater damage. Overall, it does appear that residual soil N rates need to be determined for sunflower fields. This is important so that N applications are reasonable and over-application does not occur, resulting in higher disease, lodging, and bird damage.

Results of this study show that seeding rates and nitrogen rates can have an impact on the quality and yield of a sunflower crop. In 2011, in contrast to years past, low seeding rates and high fertilization rates tended to produce the highest seed yields. However, there was no significant impact on oil yields by either population or fertilization, and only a significant difference in seed yield by seeding rate. There are many other factors that contribute to overall seed and oil yields. It is important to remember that, though interesting and indicative of agronomic patterns, the data presented here is from one season and one location only. More research should be reviewed before making decisions about sunflower production.

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