Sunflower Population and Nitrogen Rate Trial

NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2012 Sunflower Population and Nitrogen Rate Trial

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The UNIVERSITY of VERMONT EXTENSION

2012 SUNFLOWER POPULATION x NITROGEN APPLICATION RATE TRIAL

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Sunflower (*Helianthus annus* L.) is a warm-season crop with the potential to add high value to diversified farms in the Northeast as a rotation crop, an on-farm fuel production source, and an added-value retail crop. Production of high-yielding sunflower crops is highly influenced by plant population and adequate nitrogen (N). Applying excessive N to sunflower can have detrimental effects to the crop and environment as well as decreasing profits for farmers. Sunflower populations can also have a significant impact on yield and quality. In Vermont where a more temperate climate prevails, higher plant populations may be advantageous compared to the more arid sunflower-growing regions in the U.S. Plains. As target populations increase, N application recommendations generally increase as well. With the need for regionally-specific recommendations, the University of Vermont Northwest Crops & Soils Program has initiated a yearly study since 2010 to determine the effects of target population and N application rate on plant stand characteristics, pest damage, and seed and oil yields of sunflower. The following are results from the 2012 study.

MATERIALS AND METHODS

In 2012, UVM Extension conducted an experiment to determine the impact of plant population and N application rate on sunflower yield and quality. The on-farm study was conducted 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. Target population and nitrogen (N) rate treatments.

Population treatments plants acre^{-1}	N application rate treatments lbs acre^{-1}
20,000	0
24,000	60
28,000	90
30,000	120
32,000	

The soil type in this trial was a Swanton fine sandy loam (Table 2). The variety of sunflower planted was Syngenta 3433, with a maturity of 94 days. The experiment was planted on 26-May with a 2-row White 6180 air pressure seeder equipped with a small corn seed disk. Because of planting discrepancies and concerns about early plant development, the field was planted at a high seeding rate (approximately 40,000 seeds ac^{-1}), then thinned by hand at the V-5 stage (13-Jul) to achieve desired populations. Each subplot was 10’ x 20’. On 13-Jul, ammonium sulfate (21-0-0) was applied by hand as a side-dress at 0, 60, 90 and 120 lbs of N ac^{-1}.

Table 2. Cultural practices for the 2012 sunflower population by N rate trial.

Location	Alburgh, VT
Soil type	Swanton fine sandy loam
Previous crop	Silage corn
Tillage operations	Spring disk, harrow, spike-toothed harrow
Plot size (ft.)	10' x 20'
Replicates	4
Variety	Syngenta 3433 (RM 94)
Row width (in.)	30
Planting date	26-May
Starter fertilizer	5 gal ac^{-1} of popup starter, 5-20-5
Additional amendment	1 ton ac^{-1} of wood ash
Harvest dates	17-Oct

Prior to harvest, each plot was evaluated for plant 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 (Figure 1). Bird damage was estimated using guidelines provided by the National Sunflower Association, based on the estimated percentage of bird-pecked or missing seeds on a sampled number of whole sunflower heads.


Figure 1. Sclerotinia stalk rot can cause lodging.

At harvest, actual plant populations were calculated (Table 3). Plots were harvested on 17-Oct 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. Reported seed yields were adjusted to 13% moisture. Seeds were cleaned with a Clipper fanning mill to remove debris and plant material. Oil from each seed sample was extruded on 20-Nov and 21-Nov with a Kern Kraft KK40 oil press and oil content was measured. The average moisture level at the time of pressing seeds was 5.0%, which is lower than recommended. Reported oil yields have been adjusted to a standard 10% pressing moisture.

Table 3. Variations between target and actual population, 2012.

Target population (plants ac^{-1})	Actual average population (plants ac^{-1})
20000	21504
24000	25700
28000	27736
30000	28641
32000	30519

All data were analyzed using a mixed model analysis where replicates were considered random effects and treatments were fixed effects. The LSD procedure was used to separate 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 below, 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

Using data from an on-site Davis Instruments Vantage Pro2 Weather Station at Borderview Research Farm in Alburgh, VT, weather data are summarized for the 2012 sunflower growing season (Table 4). In general, 2012 was warmer and drier than average. Monthly temperatures averaged above normal for every month (May-Oct). In addition, precipitation was below average with the exception of Sep and Oct. For sunflower, Growing Degree Days (GGDs) are calculated with a base temperature of 44°F. There were 3726 accumulated GDDs for the 2012 growing season, 392 more than the 30-year average (1981-2010).

Table 4. Summarized weather data for sunflower growing season, 2012, Alburgh, VT.

Alburgh, VT	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Average temperature (°F)	60.5	67.0	71.4	71.1	60.8	52.4
Departure from normal	4.1	1.2	0.8	2.3	0.2	4.2
Precipitation (inches)*	3.90	3.22	3.78	2.92	5.36	4.13
Departure from normal	0.45	-0.47	-0.37	-0.99	1.72	0.53
Growing Degree Days (base 44°F)	526	686	849	839	517	309
Departure from normal	142	32	23	72	19	104

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).
* Precipitation data from Jun-Sep 2012 are based on Northeast Regional Climate Center data from an observation station in Burlington, VT.

Population x Nitrogen Rate Interactions

There were no significant interactions between population and N application rate on sunflower plant stand characteristics or yield. This indicates that the effects of population treatments were not significantly different under varying N application conditions. Hence during this year of study, increasing seeding rates did not necessarily indicate that higher rate of N were required to support the crop.

Impact of Population

Sunflower populations significantly impacted plant stand characteristics and pest damage (Table 5). Plant population impacted lodging with lower incidence occurring in the 20,000 and 24,000 plants per acre treatments. There was no significant difference in Sclerotinia head rot by population treatment, and the trial average was 3.63%. There was also no significant difference in Sclerotinia stalk rot by population treatment; the trial average was 2.13%. Bird damage was not impacted statistically by population.

Table 5. Effects of varying population on plant stand characteristics and pest damage of sunflowers, 2012.

Population	Lodging	Sclerotinia		Bird damage	Plant height	Head width	Harvest moisture
		Head rot	Stalk rot				
plants ac^{-1}	%	%	%	%	in.	in.	%
20,000	**4.1***	**3.13**	**1.88**	4.72	68.6	**6.26***	10.7
24,000	6.2*	**3.13**	**1.88**	**2.41**	72.2*	5.91	11.1
28,000	9.8	5.00	**1.88**	4.86	**72.8***	5.80	**11.3**
30,000	7.4	3.75	**1.88**	2.84	71.5*	5.79	11.0
32,000	10.1	**3.13**	3.13	3.63	72.8*	5.67	10.5
LSD (0.10)	2.6	NS	NS	NS	2.3	0.30	NS
Trial mean	7.5	3.63	2.13	3.69	71.6	5.89	10.9

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.

Plant height was significantly impacted by the population treatments (Figure 2). The sunflower population of 20,000 plants per acre were significantly shorter than all other treatments (68.6 inches). Head width was also significantly different among population treatments (Figure 3). Head width was greatest in the lowest population, 20,000 plants per acre (6.26 inches). Harvest moisture did not vary according to population and was 10.9% on average.

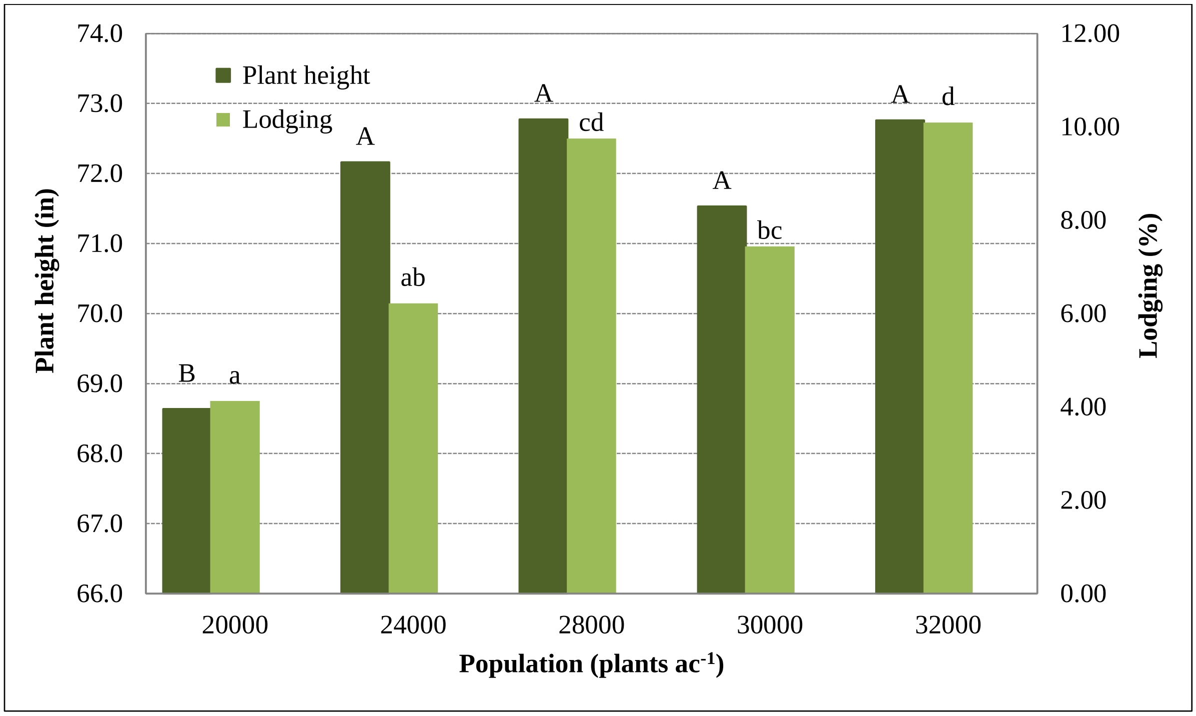

Figure 2. Impacts of population rate on plant height and lodging. Treatments that share a letter were not signficantly different from one another (p=0.10; compare capital letters for plant height and lower-case letters for lodging).

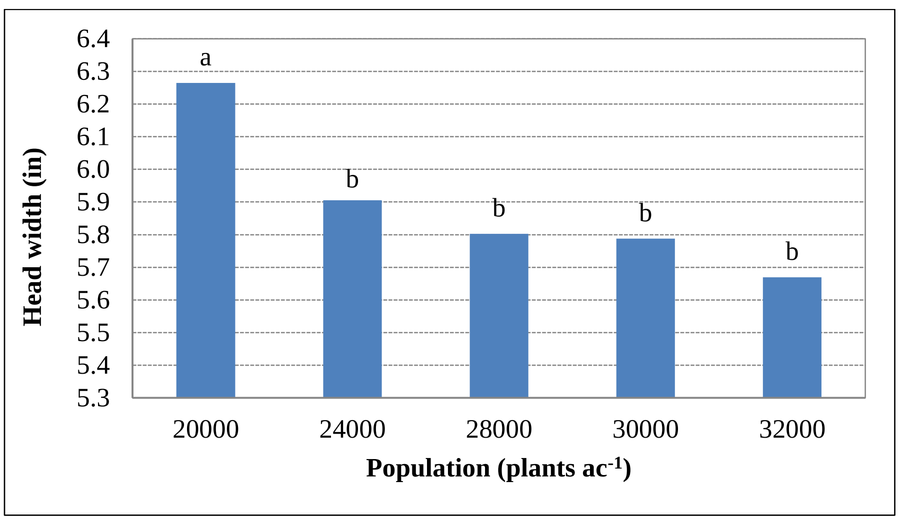

Figure 3. Impacts of population rate on sunflower head width. Treatments that share a letter were not signficantly different from one another (p=0.10).

Sunflower population significantly impacted seed yield and test weight but not oil yields (Table 6). The highest seed yield was observed at the plant population of 20,000 plants per acre (5203 lbs per acre). This was not statistically greater than the yield for treatments of 30,000 and 24,000 plants per acre (Figure 4). Test weight was highest in the most densely-populated sunflowers at 32,000 plants per acre (30.6 lbs per bushel). This was not statistically greater than the test weight of sunflowers with population of 28,000 plants per acre (30.2 lbs per bushel).

Table 6. Impact of population rate on yield and quality of sunflowers, 2012.

Population	Seed yield	Test weight	Oil content	Oil yield	
plants ac^{-1}	lbs ac^{-1}	lbs bu^{-1}	%	lbs ac^{-1}	gal ac^{-1}
20,000	**5203***	29.7	41.6	2287	300
24,000	4886*	29.7	43.0	2222	291
28,000	4398	30.2*	43.2	2000	262
30,000	4926*	29.3	44.1	**2301**	**301**
32,000	4469	**30.6***	**44.2**	2093	274
LSD (0.10)	520	0.7	NS	NS	NS
Trial mean	4776	29.9	43.2	2181	286

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.

Oil content was not statistically impacted by population treatments, though treatments with greater populations tended to have higher oil content. The average oil content was 43.2%. Oil yields were adjusted to a standard 10% pressing moisture and reported. Oil yields were not significantly different according to population (Figure 4). The trial average was 2181 lbs or 286 gallons of oil per acre.

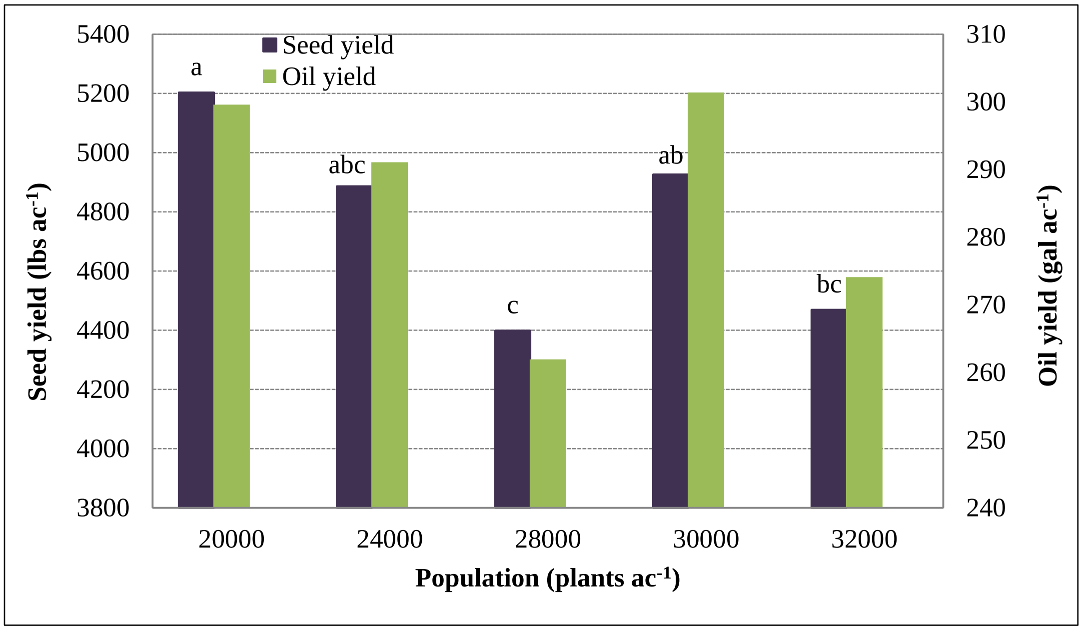

Figure 4. Impacts of population rate on seed and oil yields. Treatments that share a letter were not signficantly different from one another in seed yield; there was no significant difference in oil yield by population (p=0.10).

Impact of Nitrogen Rate

There were few significant differences in plant stand characteristics by N application rate (Table 7). Lodging incidence was lowest in plots that were not side-dressed (3.2%). There was no statistical difference in disease or bird damage by N rate.

Table 7. Impact of N application rate on plant characteristics and pest damage in sunflower, 2012.

N rate	Lodging	Sclerotinia		Bird damage	Plant height	Head width	Harvest moisture
		Head rot	Stalk rot				
lbs ac^{-1}	%	%	%	%	in.	in.	%
0	**3.2***	4.00	**0.50**	**2.89**	70.3	5.75	10.9
60	7.5	**3.50**	2.50	3.76	71.9*	5.82	11.1
90	10.3	**3.50**	2.50	4.91	**73.7***	**6.00**	**11.4**
120	9.2	**3.50**	3.00	3.20	70.3	5.98	10.3
LSD (0.10)	2.4	NS	NS	NS	2.1	NS	NS
Trial mean	7.5	3.63	2.13	3.69	71.6	5.89	10.9

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.

Nitrogen rate significantly impacted plant height, with the tallest plants side-dressed with 60 or 90 lbs N per acre (Figure 5). There was no statistical difference in head width or harvest moisture by N rate.

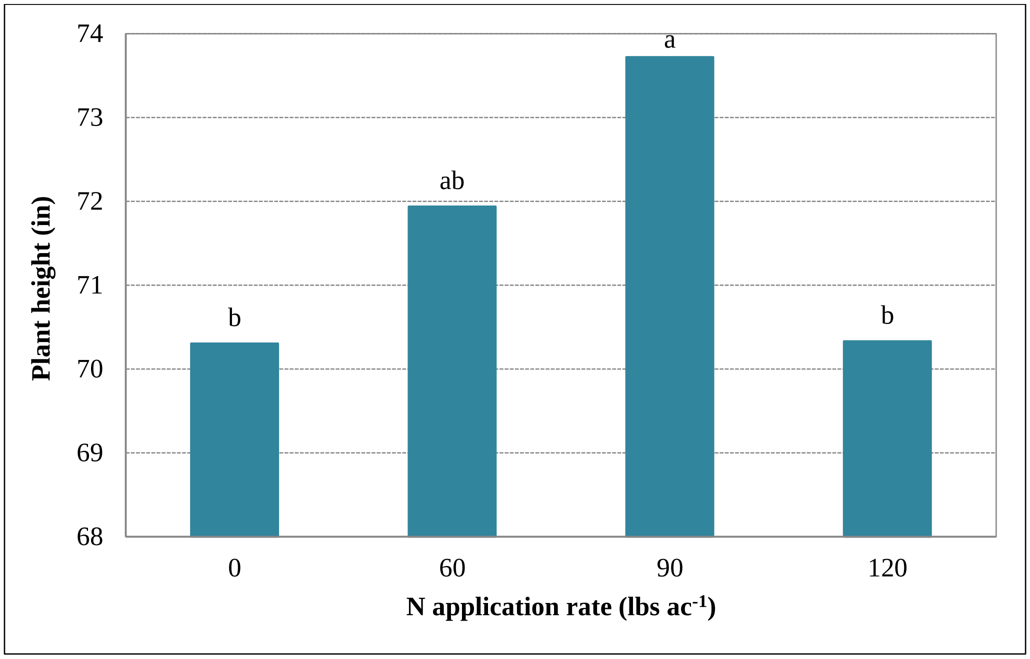

Figure 5. Effects of N rate on sunflower plant height. Treatments that share a letter were not statistically different from one another (p=0.10).

Seed and oil yields were impacted by N application rate (Table 8). The greatest seed yields were in plots without side-dress applications (5533 lbs per acre). This was a significantly greater seed yield than all side-dressed plots (Figure 6). Test weight did not vary significantly by N rate.

Table 8. Quality and yield by N application rate treatment in sunflower, 2012.

N rate	Seed yield	Test weight	Oil content	Oil yield	
lbs ac^{-1}	lbs ac^{-1}	lbs bu^{-1}	%	lbs ac^{-1}	gal ac^{-1}
0	**5533***	30.1	**45.1***	**2635***	**345***
60	4869	29.7	42.9	2207	289
90	4164	29.8	43.1	1897	248
120	4539	**30.1**	41.7	1983	260
LSD (0.10)	465	NS	1.7	228	30
Trial mean	4776	29.9	43.2	2181	286

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.

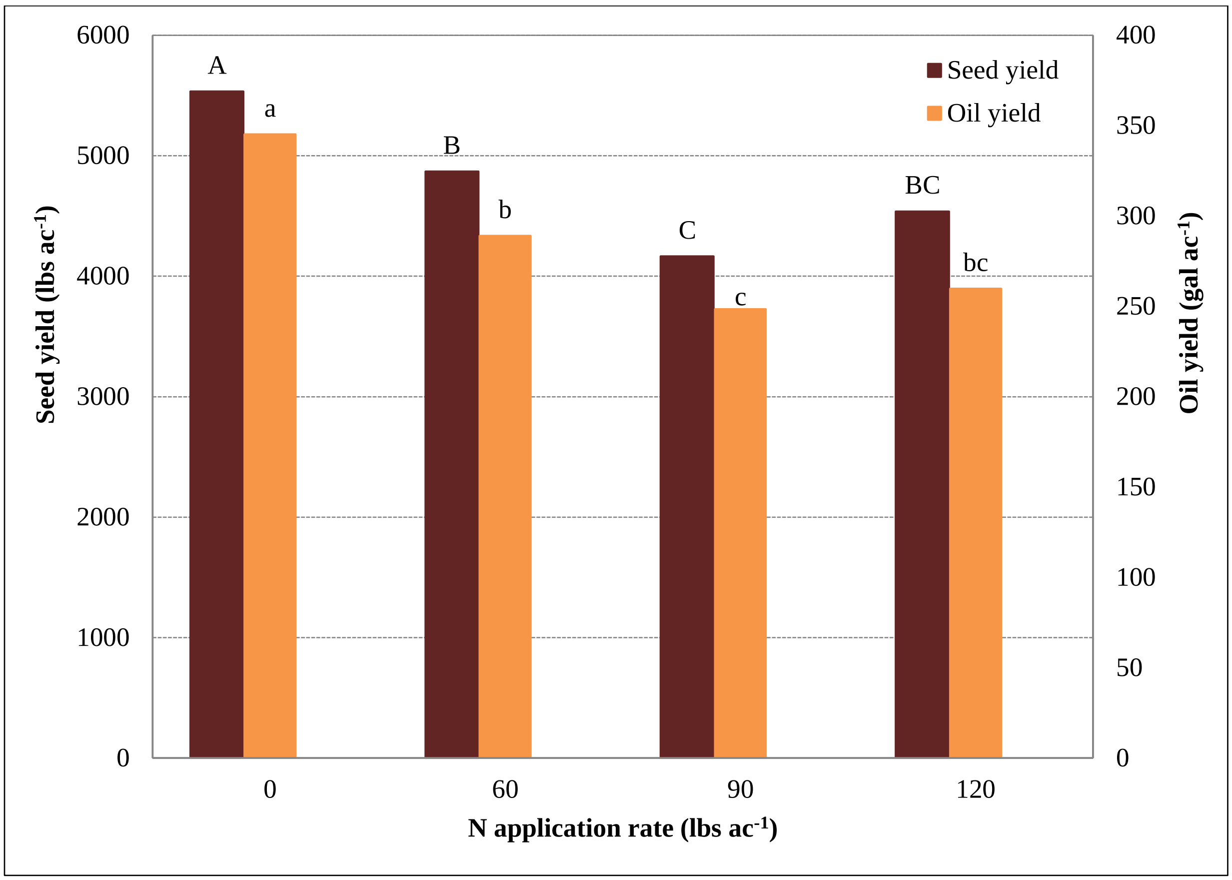

Figure 6. Effects of N application rate on sunflower seed and oil yield. Treatments that share a letter were not statistically different from one another (p=0.10; compare capital letters for seed yield and lower-case letters for oil yield).

Oil content was significantly greatest without side-dress application (Figure 7). Oil yields were statistically greatest in sunflowers with 0 lbs N applied per acre (2635 lbs or 345 gallons of oil per acre). This was statistically greater than sunflowers fertilized at all other N application rates.

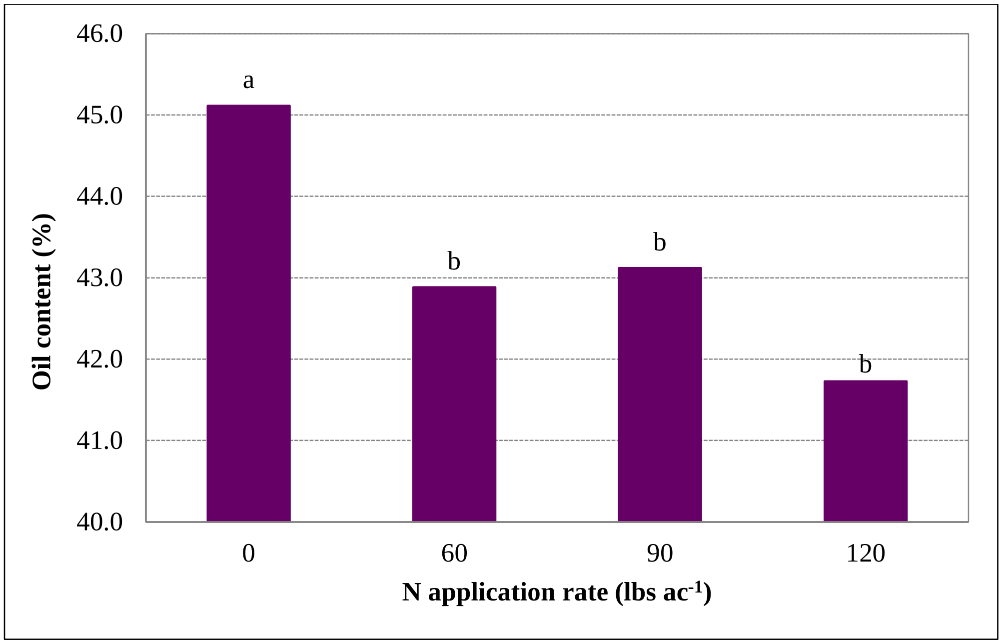

Figure 7. Effects of N application rate on oil content of sunflower across population treatments. Treatments that share a letter were not statistically different from one another (p=0.10).

DISCUSSION

The lack of significant interactions between population treatments and N application rates signifies that the effect of both variables was consistent. Hence during this year of study, increasing seeding rates did not necessarily indicate that higher rates of N were required to support the crop.

Population impacted lodging, plant height and head width. As plant population increased, so did plant height and the incidence of lodging. Sunflowers grew taller to compete with their neighboring plants in densely-populated plots, and as their stalks weakened, they were more likely to lodge. Lower populations allowed for shorter plants with wider heads. Seed yields were greatest in low populations (5203 lbs per acre when thinned to a target population of 20,000 plants per acre), though this was not statistically different than the seed yield of sunflowers thinned to 30,000 or 24,000 plants per acre. Oil yields were not significantly impacted by population treatments.

N application rate impacted plant height and lodging significantly; Plants were tallest when fertilized with 90 and 60 lbs N per acre. Lodging was lowest (3.2%) in unfertilized plots. The greatest seed yields were in plots that were not side-dressed (5533 lbs of seed per acre). Oil yields, similarly, were greatest in plots with 0 lbs N per acre (2635 lbs or 345 gallons of oil per acre). Results from this study show that N application rates did not significantly boost yields. This shows the importance of sunflower fertility management that takes into account the variable needs of the crop. The development of an adaptive test similar to a PSNT (Pre Side-dress Nitrate Test) for corn would greatly improve the ability to make nutrient recommendations for a crop like sunflower. Growers have the opportunity to save money and energy by applying only what is needed by the crop to yield well under specific conditions.

Interestingly, neither population nor N application rate had any significant impact in pest pressures (disease and bird damage incidence). Overall, sunflower seed yields were very impressive; the trial average for seed yield was 4776 lbs, or 2.38 tons. Oil content was, on average, 43.2%, which is above the goal of 40% oil for sunflowers. Sunflower can be a productive and valuable crop in the Northeast, and developing recommendations for regionally-appropriate management practices will help to produce a more viable crop.

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