Sunflower Research Trials

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2009 VERMONT SUNFLOWER STUDIES

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In 2009, the University of Vermont Extension Crops and Soils Team conducted several sunflower research projects. A number of agronomic topics were investigated including pest control strategies, nitrogen management, and variety selection. Many farmers are engaged in on-farm fuel production endeavors. In order for on-farm fuel production to be feasible farmers must be able to reliably produce a high yielding crop. Therefore the overall goal of this research is to develop best agronomic practices for sunflower production in New England. In 2009, sunflowers trials were conducted in Alburgh and Newbury, VT and Chazy, NY.

WEATHER DATA

Seasonal precipitation and temperatures recorded at weather stations in close proximity to the 2009 research sites are shown in Table 1. This growing season brought cooler temperatures and higher than normal rainfall, resulting in fewer Growing Degree Days (GDD) than usual. Excess moisture and low soil temperatures resulted in poor germination, loss of plant available nutrients, and a slowed crop dry down prior to harvest. Several fields were also impacted by white mold (*Sclerotinia sclerotium*) a fungi that can be devastating to sunflower fields. White mold prevalence was primarily due to weather conditions (Figure 1).

Figure 1. White mold resulting in shredded head skeleton. Note black sclerotia in the sunflower head. These black rock-like structures are the over-wintering structure of the fungi. These sclerotia will germinate in the spring and release spores.

Table 1. Temperature and precipitation summary – 2009.

Alburgh, VT	April	May	June	July	August	September	October
Average Temperature	44.9	53.9	62.8	65.9	67.7	57.7	44.1
Departure from Normal	+1.4	-2.7	-3.0	-5.2	-1.3	-2.7	-4.7
Precipitation	2.89	6.32	5.19	8.07	3.59	4.01	5.18
Departure from Normal	+0.38	+3.39	+1.98	+4.66	-0.26	+0.55	+0.79
Growing Degree Days	184.4	325.5	565.5	657.5	708.5	428	113
Departure from Normal	+53.9	-65.1	-88.5	-181.1	-66.5	-64.0	-82.3

Based on National Weather Service data from South Hero, VT. Historical averages are for 30 years of data (1971-2000).

Newbury, VT	May	June	July	August	September	October
Average Temperature	51.2	58.8	62.9	64.7	54.6	41.5
Departure from Normal	-1.2	-2.4	-2.9	-1	-0.7	-2.5
Precipitation	5.8	4.5	7.9	5.6	1.8	5.2
Departure from Normal	+2.31	+1.0	+4.09	+1.59	-1.74	+1.83
Growing Degree Days	291	455.5	586	638.5	358.5	94
Departure from Normal	-64.0	-60.5	-165.8	+23.1	-13.5	-104.4

Based on National Weather Service data from Chelsea, VT. Historical averages are for 30 years of data (1971-2000).

Chazy, NY	May	June	July	August	September
Average Temperature	56.6	66.8	66.9	69.0	59.4
Precipitation	3.17	2.49	3.81	2.30	2.20
GDD	426	586	700	735	459

Based on data collected from the Cornell Willsboro weather station.

Sunflower Variety Selection

Variety selection is one of the most important aspects of crop production. Replicated sunflower variety trials were conducted in Alburgh, VT. The experimental design was a randomized complete block with four replications. Ten varieties were trialed with a range of maturity dates. The specific varieties and maturity groupings are listed in Table 2.

Table 2. Varieties trialed, distributors, and days to maturity – Borderview Farm, Alburgh, VT.

Company	Variety	Maturity
Croplan	Croplan 306	87
Croplan	Croplan 369	95
Croplan	Croplan 3080	90
Dekalb	DKC 2930	93
Interstate Seed	Hysun 521	94
Seeds 2000	6946	Early
Seeds 2000	Defender Plus	Early
Seeds 2000	Panther	Early
Seeds 2000	Teton	Early
Seeds 2000	Viper	Medium

The seedbed at each location was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 3). Plots were seeded at a rate of 31,000 seeds per acre with a John Deere 1750 corn planter equipped with sunflower fingers. The plots size was 5' x 40'.

Table 3. Plot management of the sunflower variety trial.

Borderview Farm - Alburgh, VT	
Soil type	Silt loam
Previous crop	Corn
Tillage	Plow and disk
Planting date	5/19/2009
Row width	30 inches
Fertilizer (starter)	200 lbs/acre 10-20-20
Fertilizer (sidedress)	61 lbs N/acre
Herbicide (6/8/2009)	2.5 pts Poast + 2 pts crop oil/acre

In early September, data was collected on sunflower height, head width, population, seed size, and percent bird damage. By September 3, 2009, bird damage was already extensive, and by the time the sunflowers had dried down enough to be harvestable, they were completely decimated. North Dakota State University Extension has developed a formula for inferring yields from seed size, population, head width, and seed set which has allowed us to make a conjecture on yield results from data collected. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant ($P < 0.10$).

Table 4. Sunflower Variety Trial results, organized alphabetically by company.

Variety	Maturity	Emergence	Height	Bird damage	Population	Head width	Seed size	Yield	
		%	in	%	plants/acre	in		lbs/ac	bu/ac
Croplan 306	87	61.2	64.4	53.2*	19,000	8.06	**1.06**	**2390**	**85.5**
Croplan 3080	90	**65.0**	64.1	45.1	**19,900**	7.85	0.90	1980	70.9
Croplan 369	95	55.3	63.1	40.7	17,100	8.05	0.94	1910	68.4
DKC 29-30	93	63.2	**67.3**	55.4*	16,500	8.00	0.99	1830	65.5
Hysun 521	94	50.6	67.2	**64.8***	17,200	**8.56**	1.02	2330	83.3
Defender Plus	Early	54.3	64.8	62.0*	18,900	8.34	0.87	2080	74.3
IS6946	Early	58.0	62.5	38.7	18,900	8.01	1.02	2370	84.8
Panther	Early	54.8	66.3	47.7	17,900	8.19	0.92	2010	71.9
Teton	Early	58.7	65.5	47.7	17,500	7.72	0.99	2050	73.4
Viper	Medium	51.7	65.2	40.2	16,700	**8.56**	0.94	2000	71.4
	LSD (0.10)	NS	NS	15.2	NS	NS	NS	NS	NS
	Trial Mean	57.3	65.0	49.5	18,000	8.13	0.96	2100	74.9

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS - None of the treatments were significantly different from one another.

With the exception of bird damage, there were no significant differences among the sunflower varieties. Cool soil temperatures resulted in poor emergence (average 57%). In early September, bird damage was measured by evaluating 10 heads per plot for percent damage, and was greater in plots of earlier maturating sunflower varieties. Interestingly we also observed that late planted sunflowers in other trials seemed to “miss” the annual bird migration. Future studies will evaluate the impact of planting date on bird damage.

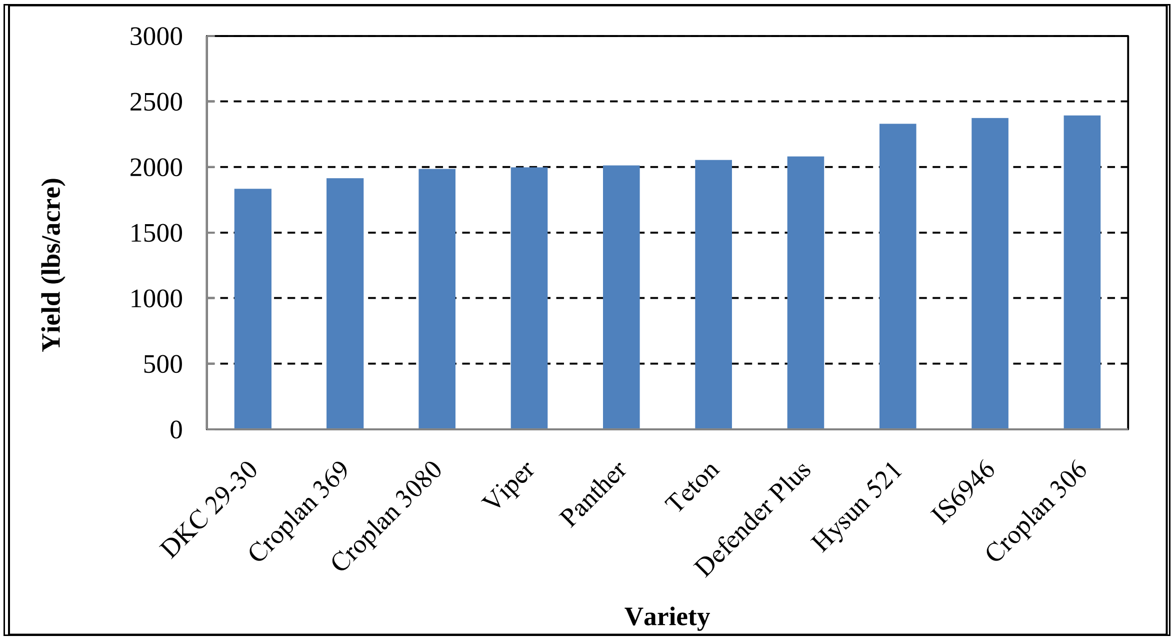

Figure 2. Estimated yields of sunflower varieties. No statistically significant differences between varieties.

Significance was shown between variety and percent bird damage, with Hysun 521 and Defender being the hardest hit, measuring 65% and 62% bird damage respectively, and IS694, Viper, and Croplan 369 escaping the brunt of the attacks measuring 38.7%, 40.2%, and 40.7% bird damage respectively (Figure 3).

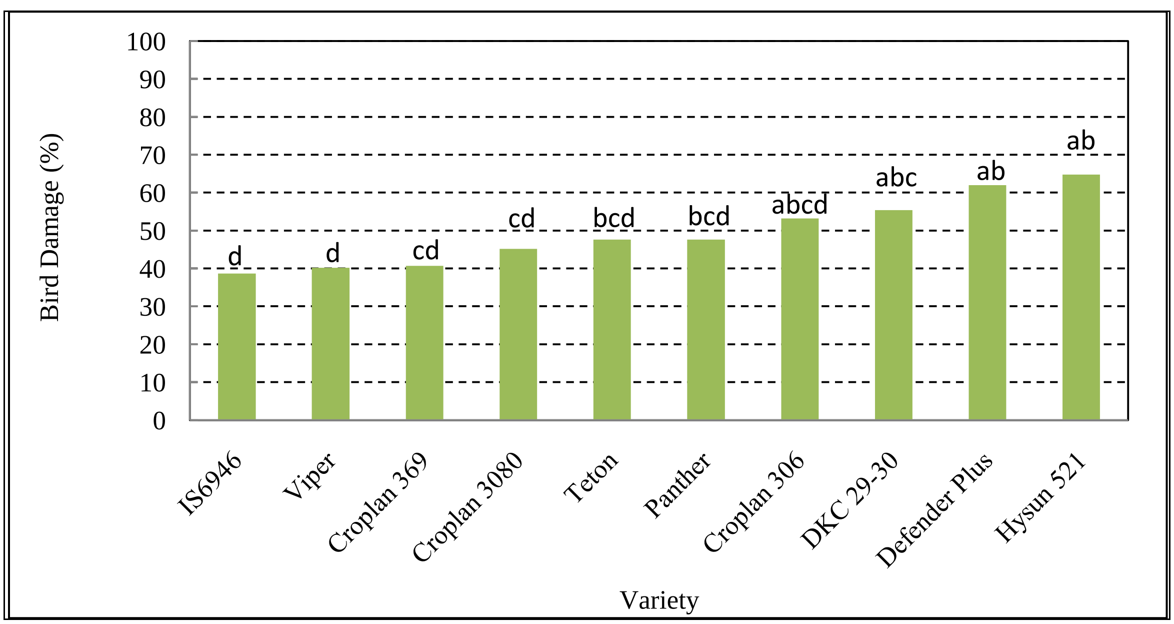

Figure 3. Impact of bird damage on sunflower varieties.

Tineweeding: A Weed Control Strategy for Sunflowers

Figure 4. Tineweeding at Borderview Farm, Alburgh, VT.

As with all annual crops, weeds are a primary pest that farmers must adequately control to produce a satisfactory crop yield. Tineweeding is a type of mechanical cultivation that is implemented early on in the field season. A tineweeder is a low cost and simple piece of equipment (Figure 4). They are designed to disturb the root zones of weed seedlings while they are in the very delicate "white thread root" stage, which often results in seedling desiccation and death. The effectiveness of a tineweeder as a weed control tool in sunflowers was evaluated with replicated plots in Alburgh, VT. The experimental design was a randomized complete block with three replications. Five weed control strategies were tested: tineweeding 6 days after planting (DAP), tineweeding 12 DAP, tineweeding 6 and 12 DAP, herbicide (POAST – sethoxydim), and no weed control.

The seedbed was prepared with conventional tillage methods. Plots were seeded with a John Deere 1750 corn planter equipped with sunflower fingers, and the variety Hysun 521 at a rate of 31,000 seeds per acre. The plots size was 10’ x 30’.

Table 5. Plot management for sunflower weed control trials.

Borderview Farm, Alburgh, VT	
Soil type	Silt loam
Previous crop	Corn
Tillage operations	Plow and disk
Planting date	5/19/2009
Row width	30 inches
Fertilizer (starter)	250 lbs 10-20-20
Fertilizer (sidedress)	61 lbs N/acre
Cultivation (on selected plots)	Tineweeding 6 and/or 12 DAP
Herbicide (6/11/2009)	2.5 pts Poast + 2 pts crop oil/acre

Weed and crop populations were measured at 6 and 12 DAP, and again 5 weeks after planting. Weed identification was performed at each interval. Height was measured at 5 weeks after planting. In early September, sunflower height, head width, population, seed size, percent bird damage, and weed subsamples were collected. By September 4, 2009, bird damage was already extensive, and by the time the sunflowers had dried down enough to be harvestable, they were completely decimated. North Dakota State University Extension has developed a formula for inferring yields from seed size, population, head width, and seed set which has allowed us to make a conjecture on yield results from data collected. Percent survival was calculated by dividing the “harvest” population by the seeding rate. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate treatment means when the F-test was significant (P< 0.10). No significance was found between tineweeding treatments and height as of 5 weeks after plant, harvest population, percent survival, height, head width, seed size, bird damage, calculated yield, or weed biomass (Table 6).

At 6 DAP, sunflowers had not emerged, and so were not affected by tineweeding. Very few weeds were present at that time, and those that were present were in white thread stage. At 12 DAP, sunflowers were still germinating or at the cotyledon stage. Some seedlings were pulled out by the tineweeding, and some were covered up. Height taken 5 weeks after planting showed no significance between treatments, demonstrating that tineweeding, and any associated disturbance the crop received in the rooting zone, did not retard plant growth. By harvest, all tineweeded stands had recovered to such an extent that those few that were buried or uprooted caused no significant difference in percent survival compared with the control or the herbicide plot. Foxtail (*Setaria* spp.), redroot pigweed (*Amaranthus retroflexus* L.), and common lambsquarters (*Chenopodium album* L.) were all removed by the 12 DAP tineweeding treatment.

There were no significant differences among weed control methods. However, there were several trends observed in the data. The herbicide weed control treatment tended to be higher in yield than other treatments. The 6 & 12 DAP tineweeding treatment was very effective at controlling weeds. From the one season of data, it appears that the tineweeder can be an extremely effective weed control tool in a sunflower crop. However, the tineweeder will cause some plant loss. If a farmer adopts this tool, he or she might consider planting at a higher seeding rate to compensate for plant losses.

Table 6. Impact of weed control strategies on sunflower characteristics.

Treatment	Height, 5 weeks AP	Harvest population	Survival	Height	Head width	Bird damage	Sunflower yield		Weed biomass
	in	plants/ acre	%	in	in	%	lbs/ac	bu/ac	lbs/ac
6 Day	10.0	20700	66.9	63.2	7.60	73.6	2180	77.7	1130
12 Day	**11.3**	20400	65.9	65.5	7.53	69.1	2100	75.3	1220
6 & 12 Day	11.0	18800	60.5	65.6	**7.83**	79.4	2080	74.1	505
Control	10.7	21900	70.7	64.6	7.33	54.1	2170	77.5	**1820**
Herbicide	10.2	**22900**	**73.9**	**67.9**	7.70	**79.6**	**2480**	**88.6**	594
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Means	10.6	20900	67.6	65.4	7.60	71.2	2200	78.6	1050

NS - None of the treatments were significantly different from one another.

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Harvest Dates as a Means to Reduce Bird Damage

Bird damage is a well documented restriction on sunflower production in Vermont. This year was no exception with migratory birds arriving in early August. A study was conducted at Borderview Farm in Alburgh, VT to determine if harvest date impacted the level of bird damage in sunflower fields. The experimental design was a randomized complete block with three replications. Sunflower variety Hysun 521 (Interstate Seed) was planted with a John Deere 1750 corn planter, equipped with sunflower fingers, at a rate of 30,000 seeds/acre. Plot size was 10' x 20'. Plot management details are contained in Table 7. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate harvest date means when the F-test was significant (P< 0.10).

Table 7. General plot management for Harvest Date Study.

Borderview Farm - Alburgh, VT	
Soil type	Silt loam
Previous crop	Sunflower, rye cover crop
Tillage	No-till
Planting date	6/8/2009
Row width	30 inches
Fertilizer (starter)	200 lbs 10-20-20
Fertilizer (sidedress)	As per soil test
Herbicide (6/8/2009)	2.5 pts Poast + 2 pts crop oil/acre
Harvest date 1	10/1/2009
Harvest date 2	10/23/2009
Harvest date 3	11/2/2009

Bird damage significantly increased as sunflowers began to dry down. The data indicated that earlier harvest dates would reduce the amount of damage by birds and subsequently increase yields (Table 8).

Table 8. Percent bird damage over three possible harvest dates.

Date of harvest	**Bird damage (%)**
Oct 1, 2009	2.90
Oct 23, 2009	36.0
Nov 2, 2009	**68.8**
LSD (0.10)	8.01

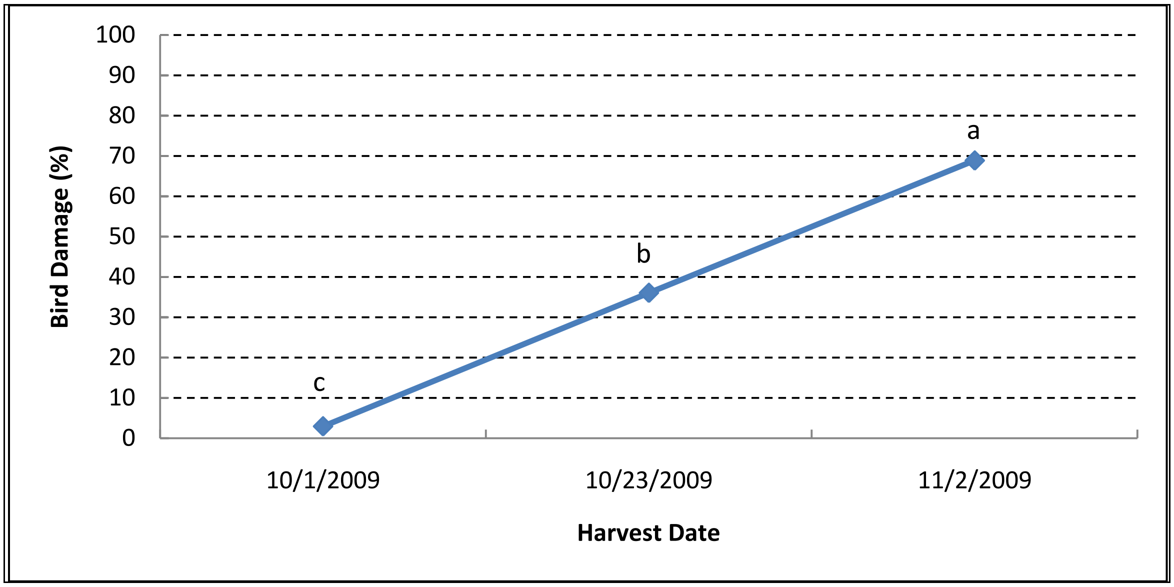

Figure 5. Harvest Date Trial, percent bird damage over time.

On October 1, the sunflowers reached physiological maturity (35% moisture). At this stage the sunflowers could theoretically be harvested, however, the moisture content would prohibit the use of a combine. It may make sense for a farmer to apply a dessicant at this stage of growth especially if it has the potential to significantly increase yield by 60-70%. The benefits of a greater yield must be weighed against the price of the desiccant and the increased fuel, time, and compaction resulting from the extra passes with a tractor. If Roundup (or any other desiccant) takes about 12 minutes to apply per acre, uses about a half gallon of gas per acre, and is applied at 2 qts/acre, and you were to calculate a salary of $15/hr, and $2.50/gallon for fuel, then it would cost an additional $22.56/acre to apply a desiccant, at current desiccant prices. However, if this were to save 60-70% of your crop from bird predation, this would be an economically justified decision.

Alternatively, if the combine can handle a wetter sunflower head, the crop could be harvested at higher moisture contents, but then drying cost must be considered and weighed against early harvesting (Table 9).

Table 9. Drying with 47˚F air with a relative humidity of 65% to dry oilseed sunflowers.

Sunflower seed moisture	Airflow required for drying (cfm/bu)	Drying time required	
		Hours	Days
17%	1.00	648	27
15%	1.00	480	20
	0.75	720	30
	0.50	960	40
13%	1.00	336	14
	0.75	504	21
	0.50	672	28

Texas Cooperative Extension, The Texas A&M University System. http://sanangelo.tamu.edu/agronomy/sunflowr/index.htm

Seeding Rate x Nitrogen Application Study

Seeding rates in oilseed producing areas tend to be low due to limited moisture. Higher sunflower seeding rates under New England high moisture conditions could increase yields and oil quantity per acre. Nitrogen recommendations generally increase with increased plant populations. A seeding rate x nitrogen rate study was conducted to determine optimal rates for sunflower crops in New England.

Replicated trials were conducted at the Cornell Research Facility located in Chazy, NY. Five seeding rates and 4 nitrogen rates were evaluated. The experimental design was a randomized complete block in a split plot arrangement with four replications. Main plots consisted of nitrogen rates and subplots consisted of seeding rates. Main plots consisted of the seeding rates of 24,000; 28,000; 30,000; 32,000; and 34,000 seeds per acre planted with an Allis Chalmers two row cone planter. The variety was Mycogen 8N358CL. Subplots consisted of nitrogen rates of 0; 60; 90; or 120 lbs N/acre which were applied on July 9, 2009. Each subplot was 10' x 20'. The seedbed was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas.

Table 10. Plot management for seeding rate x nitrogen application study.

Chazy, NY	
Soil type	Silt loam
Previous crop	Corn
Tillage	Plow and disk, spring tooth harrow
Planting date	5/22/2009
Row width	30 inches
Fertilizer (starter)	None
Herbicide (5/20/2009)	2 pints/acre Trust (trifluralin)

A squawk box (Bird Gard PRO Bird Repeller, Gempler's, Madison, WI) was erected to minimize bird damage. Height, head size, bird damage, and lodging were recorded in late September. A major wind storm caused severe lodging at the site before yields could be recorded, or even calculated (Figure 6). The data collected was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate treatment means when the F-test was significant (P< 0.10).

Figure 6. Lodged sunflower experiment, Chazy, NY.

There was no significant nitrogen rate x seeding rate interactions observed in this experiment. This data suggests that nitrogen rates impacted sunflower production similarly across seeding rates. Most variation in the experiment was attributed to the main effects of nitrogen rates and seeding rates. With few exceptions, seeding rate did not statistically impact sunflower growth characteristics (Table 11; Figure 7). Height of the sunflowers was significantly impacted by seeding rate. The higher the seeding rate the taller the sunflower. Although not statistically significant, lodging was slightly increased when sunflowers were grown at higher seeding rates. Although more research needs to be conducted, it appears that the lower seeding rate would result in a higher percentage of harvestable plants.

Table 11. Impact of seeding rate on sunflower characteristics.

Population	**Lodging**	**Bird damage**	**Height**	**Head width**
plants/acre	**%**	**%**	**in**	**in**
24000	23.2	24.1	72.5	**5.91**
28000	27.9	22.5	75.1	5.69
30000	26.7	24.3	76.3*	5.58
32000	26.2	24.1	75.8*	5.59
34000	**29.9**	**26.9**	**77.7***	5.60
LSD (0.10)	NS	NS	2.19	NS
Means	26.8	24.4	75.5	5.67

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS - None of the treatments were significantly different from one another.

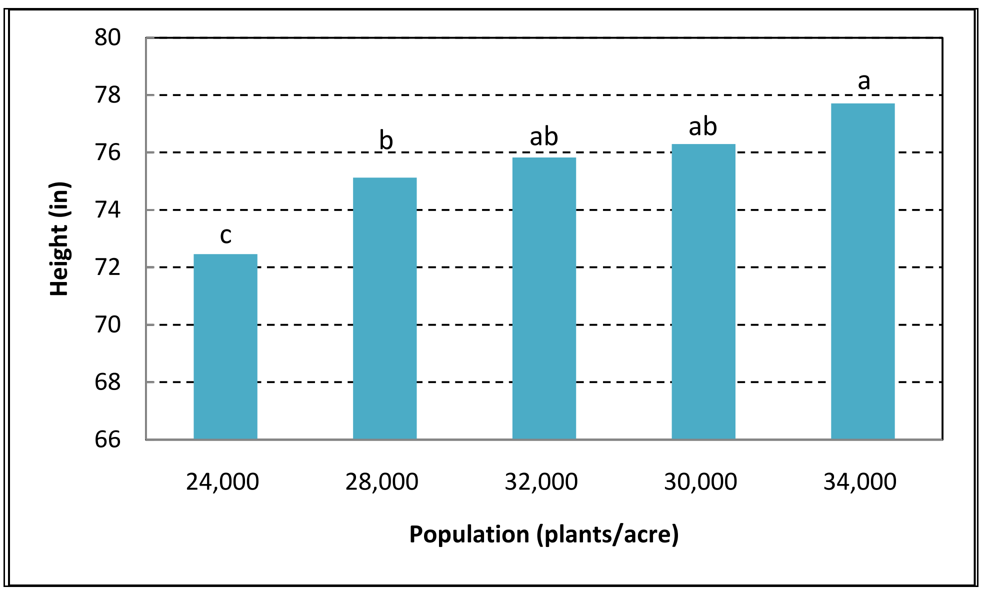

Figure 7. Affects of seeding rate on sunflower height.

Nitrogen rates significantly impacted sunflower growth characteristics (Table 12). Higher rates of N application resulted in greater lodging, although ultimately, all plots lodged completely (Figure 8). High levels of soil nitrogen have been shown to increase risk of lodging in other grain crops. Nitrogen application rate of 120 lbs/acre produced the shortest sunflowers, with all other application rates producing equally tall sunflowers (Figure 9). It is extremely important for our group to continue investigating appropriate nitrogen rates for sunflowers in our region.

Table 12. Impact of nitrogen rate on sunflower characteristics.

N application lbs N/acre	Lodging %	Bird damage %	Height in	Head width in
0	14.3	23.4	75.3*	5.70*
60	31.6*	23.0	76.5*	**5.84***
90	26.5	**26.0**	**76.8***	5.43
120	**34.6***	25.0	73.3	5.73*
LSD (0.10)	5.97	NS	1.96	0.29
Means	26.8	24.4	75.5	5.67

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS - None of the treatments were significantly different from one another.

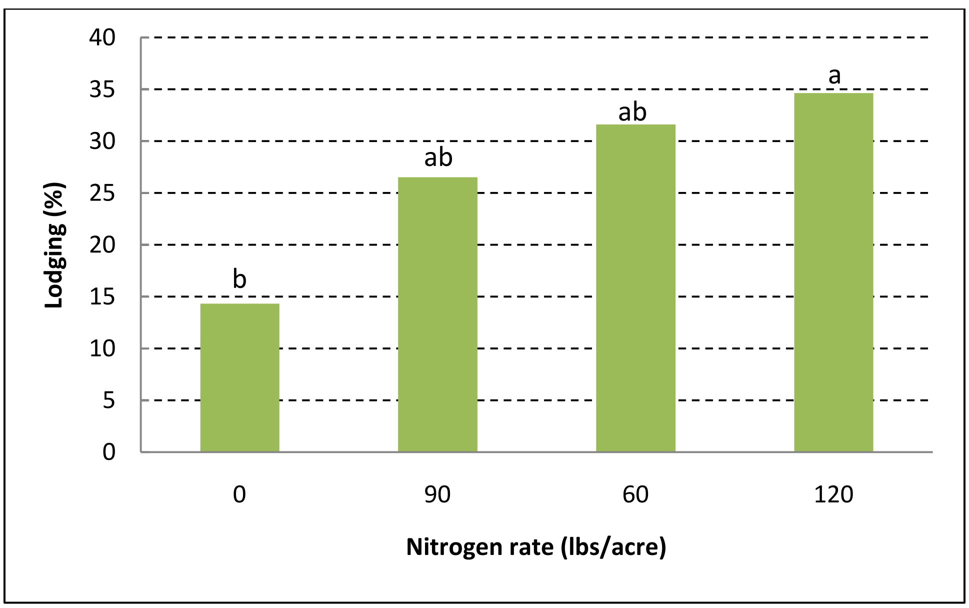

Figure 8. Impact of nitrogen application rate on percent lodging.

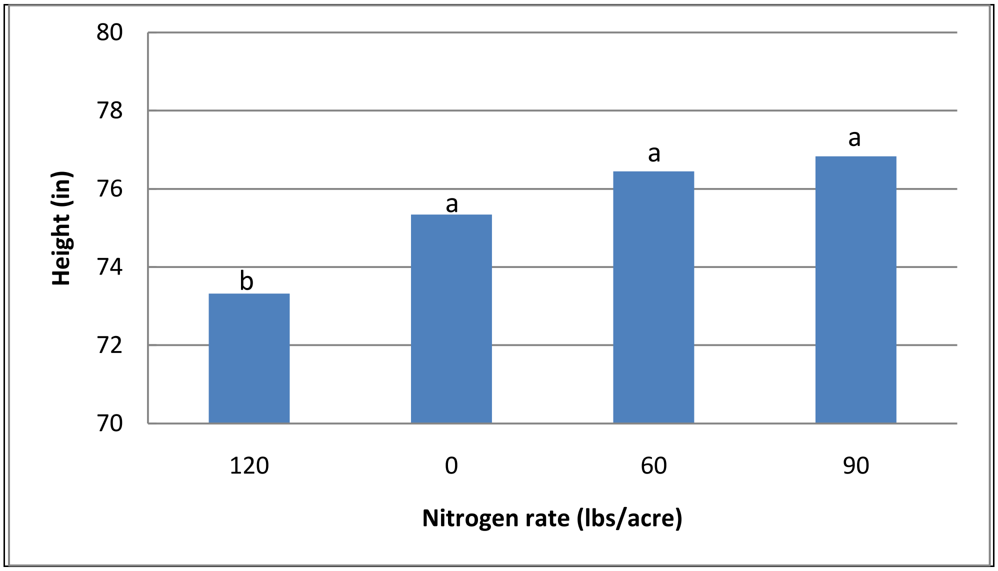

Figure 9. Impact of nitrogen rates on sunflower height.

Sunflower Nitrogen Application Study

Since sunflowers are a new crop to New England, nutrient recommendations have not been developed for the area. This experiment was a step towards developing a nitrogen recommendation for sunflowers. A replicated on-farm trial was conducted in Newbury to evaluate the impact of nitrogen application rates on sunflower yield and oil quantity. The experimental design was a randomized complete block with four replicates. Plots were 10' x 10'. The seedbed was prepared by conventional tillage methods. Plots were seeded with Defender Plus (Seeds 2000) with a Cyclone International 400 at a rate of 30,000 seeds per acre. On July 20, 2009, nitrogen rates of 0; 60; 90; or 120 lbs per acre were applied to all plots. Plots were harvested by hand on October 19, 2009, and run through an Almaco SP50 plot combine. Moisture at harvest was collected, as was height, population, and head width. Seeds were pressed with a Kern Kraft Oil Press KK40, and oil and meal measured. LSD procedure was used to separate treatment means when the F-test was significant ($P < 0.10$).

Table 13. Plot management for Sunflower Nitrogen Application Study.

Riverside Emus - Newbury, VT	
Soil type	Silt loam
Previous crop	Soybeans
Tillage	Plow & harrow
Planting date	5/22/2009
Row width	30 inches
Fertilizer	300 lbs 10-20-20
Herbicide (5/25/2009)	Prowl (1 qt/acre)
Harvest date	10-19-2009

White mold was found present in all plots, resulting in a lower harvest population due to lodging. The prevalence of white mold is most likely due to the fact that the field is in a flood plain, and that the sunflowers were preceded by soybeans. Proper rotation is very important to being successful when trying to cultivate sunflowers in an economically sustainable fashion. Nitrogen rates showed a significant difference in yield and oil quantity (Table 14). Nitrogen rates of 90 lbs/acre produced the highest seed (1,980 lbs/acre) and oil (69.5 gal/acre) yields (Figure 10). Overall, the level of oil extraction was low for sunflower seeds, as we would normally expect between 39-49% oil extrusions. Our low oil percentage is most likely due to the sunflower seeds being very dry (~2% moisture) when attempting to extrude oil. No significance was found between N application rate and head width or plant height.

Table 14. Impact of nitrogen rate on sunflower characteristics.

N application	Yield		Height	Head width	Oil	
lbs/acre	lbs/acre	bu/acre	in	in	%	gal/acre
0	1520	62.3	71.6	7.33	**28.0***	56.0*
60	1530	62.9	70.9	**7.66**	21.1	43.0
90	**1980**	**81.3**	70.7	7.05	26.6*	**69.5***
120	1440	59.2	**74.3**	7.10	27.7*	47.3
LSD (0.10)	330	13.5	NS	NS	4.01	16.3
Mean	1620	66.4	71.8	7.28	25.8	54.0

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS - None of the treatments were significantly different from one another.

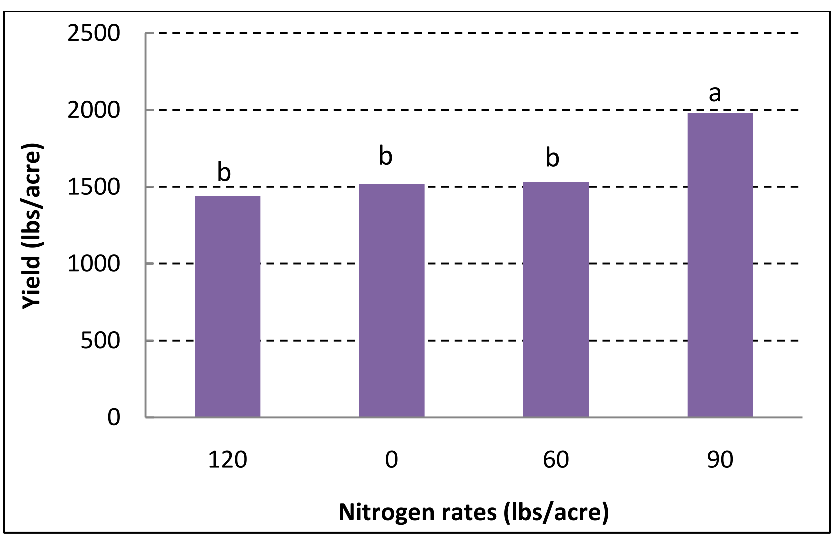

Figure 10. Impact of nitrogen rate on sunflower yields.

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