2013

Sunflower Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2013 SUNFLOWER 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. The major sunflower production areas are in the northern Great Plains, so seed production and agronomic management guidelines generally come from this region. Identifying varieties of sunflower that will perform well in Vermont's particular climate is essential to viable crop production. With this in mind, UVM Extension's Northwest Crops and Soils Program have been evaluating sunflower varieties for their performance in our microclimate.

MATERIALS AND METHODS

A trial was initiated at Borderview Research Farm in Alburgh, VT in 2013 to assess the yield and quality of 18 commercially-available sunflower varieties of varying relative maturity (Table 1).

Table 1. Characteristics of 18 sunflower varieties, sunflower variety trial, Alburgh, VT, 2013.

Variety	Company	RM	Traits	Treatment	Seed Size
306	Croplan	88	ExpressSun®	Cruiser Maxx®	4
378	Croplan	97	NuSun®, High Oleic	Cruiser Maxx®	2
432E	Croplan	89	NuSun®	Cruiser Maxx®	4
8D310	Mycogen	93	Clearfield®, NuSun®	Cruiser Maxx®	2
8N337	Mycogen	92	NuSun®, DMR	Cruiser Maxx®	2
8N358	Mycogen	94	Clearfield®, NuSun®, DMR	Cruiser Maxx®	2
Camaro II	Seeds 2000	Medium	Clearfield®, NuSun®	Cruiser Maxx®	3
Cobalt II	Seeds 2000	Early	Clearfield®, High Oleic	Cruiser Maxx®	3
Daytona	Seeds 2000	Medium	Clearfield®, High Oleic	Cruiser Maxx®	3
Defender Plus	Seeds 2000	Early	NuSun®, DMR	Cruiser Maxx®	4
Durango	Seeds 2000	Med-Full to Full	NuSun®, ExpressSun®	Cruiser Maxx®	3
Falcon	Seeds 2000	Medium	NuSun®, ExpressSun®	Cruiser Maxx®	3
Torino	Seeds 2000	Med-Full	Clearfield®, NuSun®	Cruiser Maxx®	3
3433	Syngenta	92	NuSun®, DMR, Mid-Oleic	Cruiser Maxx®, Apron XL®, Maxim 4FS®	4
3733	Syngenta	97	NuSun®, DMR, Mid-Oleic	Cruiser Maxx®, Apron XL®, Maxim 4FS®	4
7111	Syngenta	Very Early to Early	Clearfield®, High Oleic, DMR	Cruiser Maxx®	4
7120	Syngenta	95	High Oleic, DMR	Cruiser Maxx®	3
s673	Triumph	Med-Full to Full	NuSun®, short stature	Maxim 4FS®, Apron XL®, CruiserMaxx®, Dynasty®	3

Bred traits: Clearfield® = tolerant of Beyond® ammonium salt of imazamox herbicide; DMR = downy mildew resistant; HO = High Oleic (≥80% oleic acid); MO = Mid-Oleic (approximately 65% oleic acid); NuSun® = 55-75% oleic acid; Short stature = selected for short plant height; ExpressSun® = tolerant of Express® tribenuron methyl herbicide

Seed treatments: Apron XL® = metalaxyl-M and S-isomer; Cruiser Maxx® = thiamethoxam, azoxystrobin, fludioxonil, mefnoxam; Dynasty® = azoxystrobin; Maxim 4FS® = fludioxonil

The experimental design was a randomized complete block with four replications and with 18 varieties as treatments. Short-stature sunflowers (var 's673') were planted on the east and west edges of all four replications, so that their yield and quality data would not be compromised by competition for light and resources.

The soil was a Benson rocky silt loam with a 3-8% slope (Table 2). The previous crop was winter canola, grown conventionally. Each plot was 5' wide (2 rows of sunflowers on 30" rows) and 25' long. The seedbed was prepared with a spring disc, harrow, and spike tooth harrow to finish. The pre-plant herbicide Trust® (trifluralin) was applied on 16-May at a rate of 1.5 pints per acre. Sunflowers were planted at a rate of 34,000 seeds per acre on 31-May with a John Deere 1750 MaxEmerge corn planter fitted with sunflower finger pickups. At planting, a 10-20-20 starter fertilizer was applied at a rate of 200 lbs per acre.

Table 2. Agronomic field management of a sunflower variety trial, 2013, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 3-8% slope
Previous crop	Winter canola
Varieties	18
Replications	4
Plot size (ft)	5 x 25
Planting equipment	John Deere 1750 MaxEmerge planter
Sunflower planting rate (seeds ac^{-1})	34,000
Row width (in.)	30
Weed control	1.5 pt ac^{-1} Trust® (trifluralin), 16-May
Sunflower planting date	31-May
Starter fertilizer (at planting)	200 lbs ac^{-1}, 10-20-20
Sunflower emergence	10-Jun
Sunflower harvest date	21-Oct
Pressing dates	7-Nov and 20-Nov

By 10-Jun, sunflowers had emerged. On 29-Aug, plots were covered with tobacco and grape netting to deter birds and minimize damage to seeds. However, strong winds in September led to damage of the net and temporary access to the sunflower stand. Plant stand characteristics including plant population, lodging, disease incidence, bird damage, height, and head width were measured just prior to harvest. Bird damage was visually estimated with a standard protocol from the National Sunflower Association. 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. There was no base rot discovered. Issues with white mold (*Sclerotinia sclerotiorum*), a fungus which can overwinter in the ground and spread quickly, especially in wet seasons, have proven problematic in the Northeast in the past. Plots were harvested on 21-Oct with an Almaco SPC50 plot combine with a 5' head and specialized sunflower pans made to 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. Seed yields were adjusted to 13% moisture before reporting. Subsamples were assessed for seed damage from banded sunflower moth

in the form of round "exit holes" and hollowed-out seed. Oil from a known volume of each seed sample was extruded on 7-Nov and 20-Nov with a Kern Kraft Oil Press KK40 (at 120°F and 40 RPM), and the oil quantity was measured to calculate oil content. Oil yield (in lbs per acre and gallons per acre) was adjusted to 10% pressing moisture and reported. A subsample of sunflower meal from each plot was shipped to Cumberland Valley Analytics in Hagerstown, MD for wet chemistry analysis of crude protein (as a percentage of dry matter content) and fat (as a percentage of dry matter content, calculated with ether extraction).

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 hybrids were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$). Where data were missing, a pair-wise comparison (Tukey-Kramer) was used to determine significant differences between treatments ($p<0.10$).

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 hybrids 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, except where analyzed by pairwise comparison (t-test). 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. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In the example at below, 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	Variable
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 consolidated for the 2013 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, it was colder and wetter than average in the spring of 2013. In June 2013, there were 5.54 more inches of precipitation than normal. After June, however, the summer of 2013 was much drier than normal, with an average of 6.58 fewer inches of rainfall between July and October. Growing degree days are calculated at a base temperature of 44°F for sunflowers. Between the months of planting and harvesting, there were an accumulated 2950 GDDs for sunflowers, 74 more than the 30-year average.

Table 2. Consolidated weather data and GDDs for sunflower, Alburgh, VT, 2013.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	64.0	71.7	67.7	59.3	51.1
Departure from normal	-1.8	1.1	-1.1	-1.3	2.9
Precipitation (inches)	9.23*	1.89	2.41	2.20	2.22*
Departure from normal	5.54	-2.26	-1.50	-1.44	-1.38
Growing Degree Days (base 44°F)	607	863	740	465	275
Departure from normal	-47	37	-27	-33	144

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.

* Jun and Oct 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT.

Varieties varied significantly in bloom dates, which were noted when 75% of the stand was at least in the R5 stage (Table 3). Bloom dates ranged from 6-Aug to 13-Aug and, as expected, longer-season varieties tended to bloom later.

Table 3. Bloom dates for 18 sunflower varieties, Alburgh, VT, 2013.

Variety	Relative maturity	Bloom date
306	88	6-Aug
378	97	8-Aug
3433	92	12-Aug
3733	97	12-Aug
7111	Very Early to Early	6-Aug
7120	95	8-Aug
432E	89	6-Aug
8D310	93	9-Aug
8N337	92	6-Aug
8N358	94	9-Aug
Camaro II	Medium	8-Aug
Cobalt II	Early	8-Aug
Daytona	Medium	11-Aug
Defender Plus	Early	8-Aug
Durango	Med-Full to Full	13-Aug
Falcon	Medium	8-Aug
s673	Med-Full to Full	12-Aug
Torino	Med-Full	12-Aug
Trial mean		9-Aug

Plant populations were measured just prior to harvest, and varied significantly by variety (Table 4). The Mycogen variety ‘8N358’ had the highest population (57,935 plants per acre), though this was not statistically greater than the population of Mycogen ‘8D310’ (48,352 plants per acre). There was a

general trend towards higher plant populations (more successful emergence and stand development) in varieties with seed size 2 (seeds with lower numbers are smaller) (Figure 1).

Table 4. Plant stand characteristics and pest damage on 18 sunflower varieties, Alburgh, VT, 2013.

Variety	Harvest population	Lodging	Sclerotinia incidence		Bird damage	Plant height	Head width
			Head rot	Stalk rot			
	plants ac^{-1}	%	%	%	%	cm	cm
306	23958	17.5	2.50	0.00	3.6	142	12.2
378	38071	10.0	5.00	0.00	1.4	156*	12.0
3433	16814	32.5	2.50	0.00	2.3	127	**16.9***
3733	26833	10.0	5.00	0.00	0.7	141	11.1
7111	25700	30.0	2.50	0.00	45.1	122	12.4
7120	20560	27.5	7.50	0.00	3.8	133	14.5
432E	26920	5.0	**0.00**	0.00	51.1	145	12.2
8D310	48352*	27.5	5.00	0.00	**0.0***	**170***	11.9
8N337	33454	20.0	7.50	0.00	**0.0***	156*	12.7
8N358	**57935***	10.0	2.50	0.00	**0.0***	168*	10.0
Camaro II	27878	12.5	**0.00**	0.00	**0.0***	134	12.4
Cobalt II	23784	17.5	2.50	0.00	7.6	132	11.0
Daytona	22477	17.5	7.50	0.00	5.4	115	13.5
Defender Plus	26746	10.0	2.50	0.00	3.6	134	14.0
Durango	23261	25.0	7.50	0.00	2.1	122	13.2
Falcon	23435	7.5	2.50	2.50	13.9	131	12.8
s673	15856	**0.0**	5.00	2.50	3.4	98	16.6*
Torino	26310	**0.0**	5.00	0.00	3.4	136	12.8
LSD (0.10)	11043	NS	NS	NS	13.8	14	2.3
Trial mean	28241	15.6	4.03	0.28	8.2	137	12.9

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top-performing treatment (p=0.10).

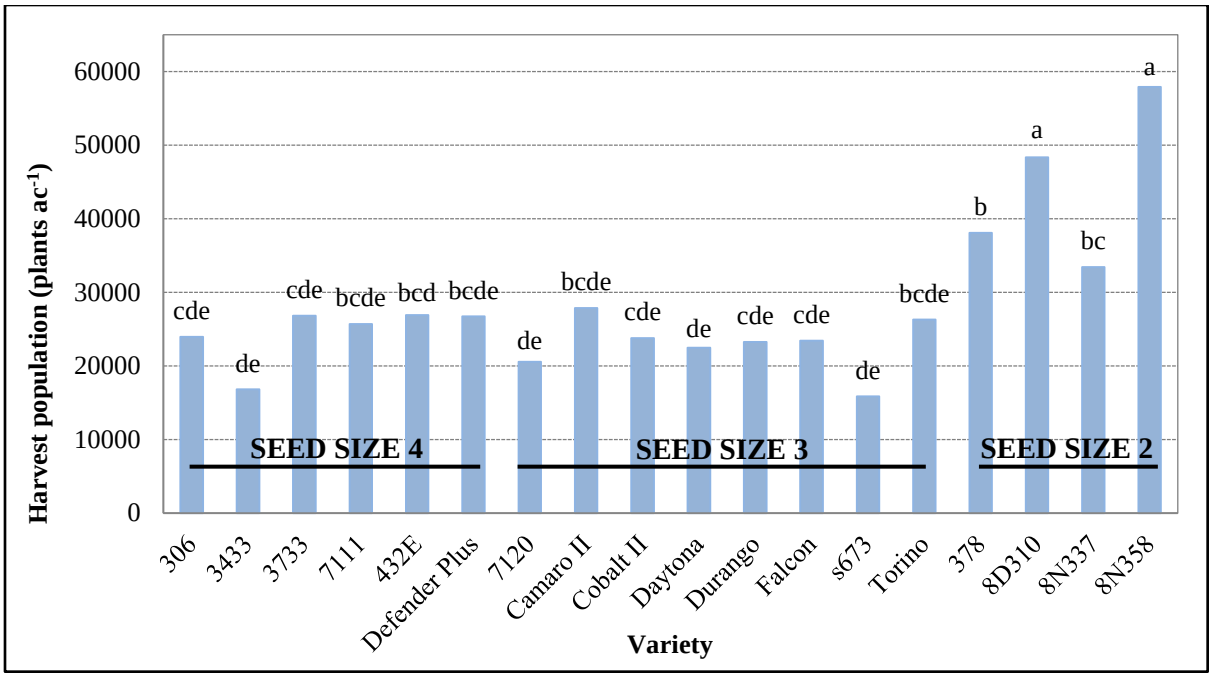

Figure 1. June populations by sunflower variety and seed size, Alburgh, VT, 2013. Treatments that share a letter were not significantly different from one another (p=0.10).

Lodging was not statistically impacted by variety; overall, an average of 15.6% of sunflower plants lodged. Two varieties (Seeds 2000 'Torino' and the short-stature Triumph 's673') had 0% lodging. The incidence of sclerotinia white mold was not statistically different by variety, though two varieties (Croplan '432E' and Seeds 2000 'Camaro II') had 0% sclerotinia head rot. The incidence of stalk rot was 0% for sixteen varieties; only Seeds 2000 'Falcon' and 's673' had any sclerotinia stalk rot (2.50%).

Bird damage varied significantly by variety (Figure 2). Four varieties (8D310, '8N337,' 8N358, and Camaro II) had 0% bird damage, which was significantly different from all other varieties. Overall, the average bird damage was 8.2%, with the greatest damage (51.1%) in the variety 432E. Plant height varied significantly by variety; the tallest plants (170 cm) were of the variety 8D310, but this was not statistically taller than the varieties 8N358, 8N337, or Croplan '378.' Head width was also statistically impacted by variety. Two varieties (Syngenta '3433' and s673) had significantly wider heads than all other varieties.

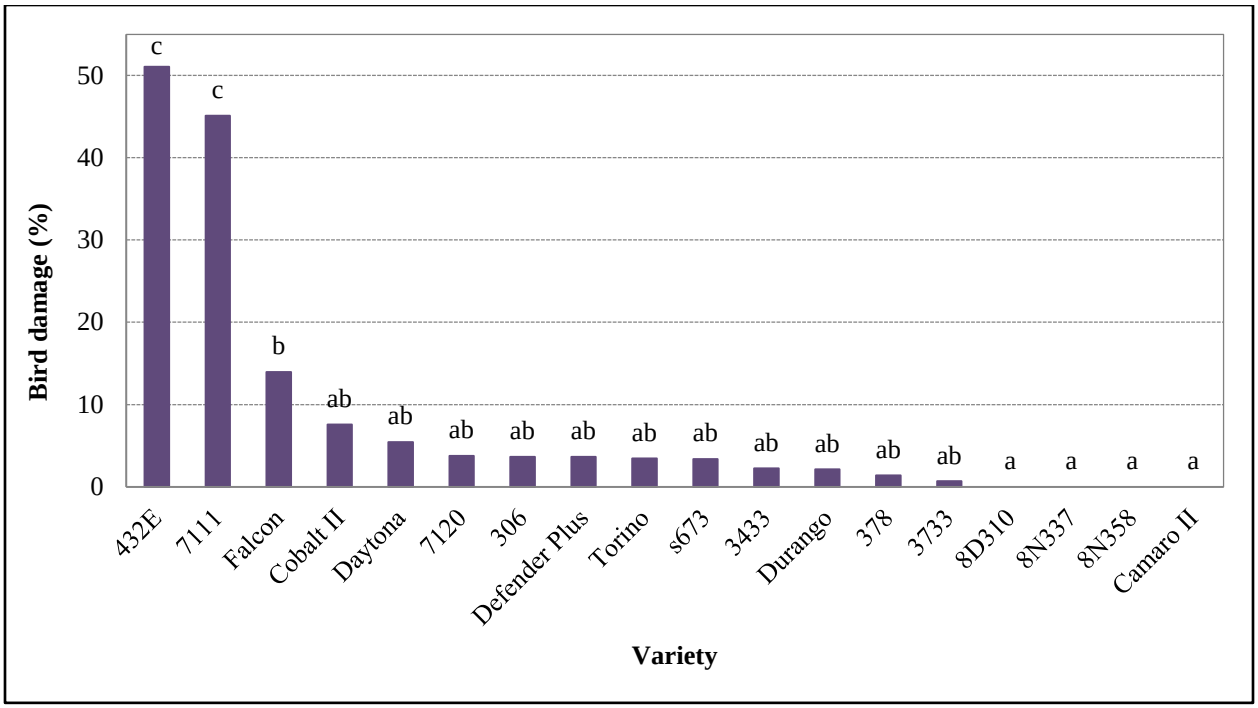

Figure 2. Bird damage by sunflower variety, Alburgh, VT, 2013. Treatments that share a letter were not significantly different from one another (p=0.10).

Harvest moisture differed significantly by variety (Table 5). The trial average was 9.8% moisture at the time of harvest (21-Oct), but one variety (Torino) had a significantly greater moisture content than all other varieties. Test weight varied by variety, with the greatest test weight in Cobalt II and Torino (33.0 lbs per bushel), though this was statistically similar to nine other varieties.

Table 5. Yield and quality of 18 sunflower varieties, Alburgh, VT, 2013.

Variety	Harvest moisture	Test weight	Seed yield at 13% moisture	BSM damage	Pressing moisture	Oil content	Oil yield at 10% moisture	
	%	lbs bu^{-1}	lbs ac^{-1}	%	%	%	lbs ac^{-1}	gal ac^{-1}
306	8.2	30.9	2305	0.63	7.15	40.2*	960*	126*
378	9.5	32.4*	1839	1.13	8.10*	37.6*	715	94
3433	9.0	32.4*	1924	0.50	7.95*	36.1	730	96
3733	7.6	31.9*	2131	0.38	7.78*	38.4*	840	110
7111	10.2	32.9*	2266	1.25	8.78*	34.0	781	102
7120	11.0	30.9	1882	1.25	8.00*	38.1*	728	95
432E	9.9	32.5*	1873	1.00	8.28*	36.4	691	91
8D310	8.3	29.8	2372	1.00	6.98	34.2	824	108
8N337	8.4	31.4	2551	1.75	7.40	39.0*	1025*	134*
8N358	7.7	29.9	2848*	**0.25**	6.68	34.9	1008*	132*
Camaro II	12.2	32.3*	**3538***	1.25	**8.93***	35.5	**1278***	**167***
Cobalt II	8.5	**33.0***	1923	0.88	6.95	37.2	744	97
Daytona	10.9	32.1	2120	1.25	6.80	35.5	787	103
Defender Plus	8.7	32.1*	2839*	0.75	7.18	37.5	1092*	143*
Durango	9.4	32.3*	2103	1.25	7.50*	36.3	784	103
Falcon	10.1	32.6*	2345	0.38	6.70	37.3	898	118
s673	12.2	31.8	2682	1.25	6.85	**40.8***	1132*	148*
Torino	**15.3***	**33.0***	3226*	1.25	8.78*	36.9	1219*	160*
LSD (0.10)	2.3	1.6	856	NS	1.45	3.3	330	43
Trial mean	9.8	31.9	2376	0.97	7.60	37.0	902	118

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

Seed yields varied significantly by variety, with the greatest yield in Camaro II (3538 lbs per acre). This was not statistically greater than Torino, 8N358, or Seeds 2000's 'Defender Plus' (Figure 3). The lowest yields were statistically similar among fourteen varieties. There were no significant differences in the amount of banded sunflower moth (BSM) damage to seed. The trial average was only 0.97% damage. Pressing moisture in November varied by variety but averaged 7.60%.

Oil content, averaging 37.0%, was highest in s673 (40.8%). This was not statistically greater than the oil content in the five varieties Croplan '306,' 8N337, Syngenta '3733,' Syngenta '7120,' or 378. Oil yield, a calculation based on both seed yields and oil content, was statistically significant by variety. Oil yield averaged 902 lbs, or 118 gallons, per acre. Oil yields were highest in Camaro II, though not statistically greater than the varieties Torino, s673, Defender Plus, 8N337, 8N358, or 306.

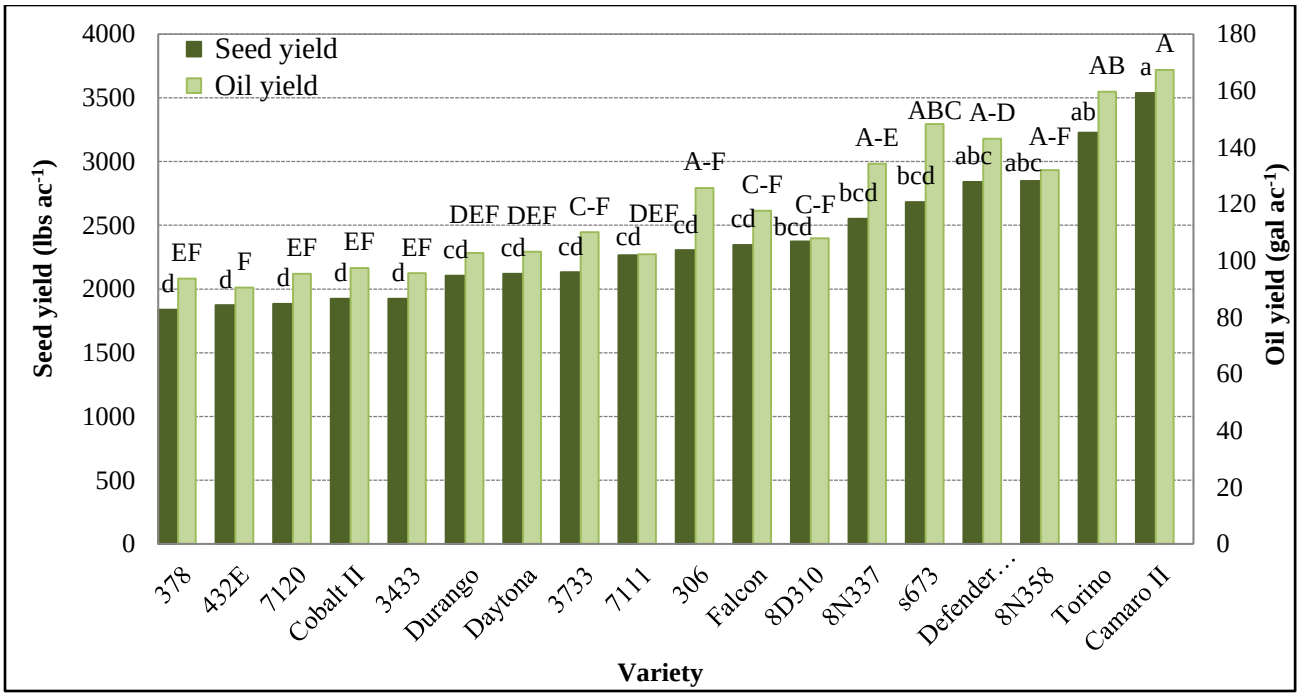

Figure 3. Seed and oil yields of 18 commercially-available sunflower varieties, Alburgh, VT, 2013. Treatments that share a letter were not significantly different from one another (p=0.10); compare lower-case letters for seed yield and capital letters for oil yield.

After oil extraction, subsamples of meal were shipped to a lab for analysis of crude protein and fat content (Table 6). Crude protein varied significantly by variety, with the greatest content in the variety Falcon (32.3% of dry matter). There were 11 other varieties that performed similarly to Falcon (Figure 4). Fat content in the meal was not statistically impacted by variety, and averaged 16.9% of dry matter.

Table 6. Meal quality by sunflower variety.

Variety	Crude protein	Fat
	% of DM	% of DM
306	25.8	16.8
378	25.1	16.4
3433	27.1*	**18.7**
3733	26.3	16.9
7111	29.7*	17.1
7120	26.9*	15.7
432E	27.8*	15.4
8D310	26.1	16.8
8N337	27.9*	16.6
8N358	25.3	17.2
Camaro II	28.6*	17.4
Cobalt II	28.4*	17.7
Daytona	30.1*	16.5
Defender Plus	25.4	17.3
Durango	29.4*	17.2
Falcon	**32.2***	14.9
s673	30.3*	17.5
Torino	29.2*	18.4
Trial mean	27.9	16.9
P-value	0.0019	0.4162

Treatments in **bold** were top performers for the given variable.
P-values are given to indicate statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

Figure 4. Crude protein by sunflower variety, Alburgh, VT, 2013. Treatments that share a letter were not significantly different from one another (p=0.10).

DISCUSSION

The eighteen varieties evaluated in the 2013 sunflower variety trial were statistically different from one another in many yield and quality indicators. Bloom dates varied, and ranged from 6-Aug (70 days after planting) to 13-Aug (77 days after planting). Plant populations varied widely, and smaller-seeded varieties (size 2, specifically) had higher establishment rates. The greatest populations actually exceeded seeding rates, indicating that the planter needs to be better calibrated as seed size changes from variety to variety. Plant stand characteristics such as height and head width varied significantly by variety. There were no significant differences in lodging or sclerotinia head rot or stalk rot incidence. Bird damage varied significantly, and was lowest (0%) in the four varieties 8D310, 8N337, 8N358, and Camaro II. Interestingly, taller varieties were not more prone to bird damage. Banded sunflower moth damage to seed was not statistically impacted by variety and only averaged 0.97%. Actual seed damage may have been greater; however, as assessments were made after seed was combined and cleaned.

Harvest moisture and test weight were significantly different according to variety. Interestingly, Torino sunflowers had a higher moisture content at harvest (15.3%) than all other varieties. Overall, seed yields were high, averaging over a ton (2376 lbs) per acre. The greatest seed yield was in the variety Camaro II (3538 lbs per acre), though this was not statistically greater than Torino, 8N358, or Defender Plus. Oil content averaged 37.0%, which is within the average for sunflower oil (35-40%). The short-stature variety s673 performed best in oil content (40.8%), though this was statistically similar to five other varieties. Oil yield, a measurement of both seed yield and oil content, was greatest in the varieties Camaro II, Torino, s673, Defender Plus, 8N337, 8N358, and 306. All varieties performed well in this trial, with the lowest seed yields over 1800 lbs per acre. This indicates strong potential for successful crop production in the region.

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