NORTHWEST CROPS & SOILS PROGRAM

2022 Hulless Oat Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2022 HULLESS OAT VARIETY TRIAL

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Oats (*Avena sativa* L.) have a long history of production in the Northeast. Although most oats grown in the Northeast are planted as a cover crop or forage, oats grown as a culinary grain are a potential revenue source for farmers. According to the 2017 census, about 80 acres of land in Vermont is cultivated for oat grain production, with an average yield of 1956 lbs ac^{-1}. Except for hulless varieties, oats need to be de-hulled before they can be used for human consumption and even further processing is required to make oatmeal, steel cut oats, or oat flour. Since 2009, the University of Vermont Extension Northwest Crops and Soils Program has conducted oat variety trials to provide yield comparisons in Vermont's climate. With the goal of improving processing efficiency and increasing local grain production, this trial focusing on hulless oat (also referred to as "naked" oats) varieties was conducted to identify varieties that may be successfully produced in Vermont. Varietal selection is one of the most important aspects of crop production and significantly influences yield and quality potential. It is important to remember, however, that the data presented are from replicated research trials from only one location in Vermont and represent only one season. The goal of this project was to evaluate yields and protein of eighteen hulless oat varieties.

MATERIALS AND METHODS

In 2022, the hulless oat variety performance trial was conducted at Borderview Research Farm in Alburgh, VT. Twenty-three hulless oat varieties were evaluated for yield and quality (Table 1).

Table 1. Oat varieties planted in Alburgh, VT, 2021.

Variety	Seed Source
AC Gehl	Semican
Buff	Rocky Mountain Seed Alliance
Buff Sylvia	Sylvia Davatz, private breeder
Casino	Semican
Fuego	Semican
ND040341	Cornell University
Navarro	Semican
Nusso	Johnny Seeds
OA1456-2N	Cornell University
Paul	North Dakota State University
Pennuda	
SD110853NO	South Dakota State University
SD111540NO	South Dakota State University
SD120582NO	South Dakota State University
SD120601NO	South Dakota State University
SD120622NO	South Dakota State University
SD120624NO	South Dakota State University
SD160149NO	South Dakota State University

SD160816NO	South Dakota State University
SD171242NO	South Dakota State University
Shelly	
Streaker	Albert Lea Seed House
Terra Hulless	Fedco Seeds

Plots were managed with practices similar to those used by producers in the surrounding area. Agronomic information is displayed in Table 2. The experimental design was a randomized complete block with four replicates. The previous crop was milkweed. The field was disked and spike tooth harrowed prior to planting. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 23-Apr at a seeding rate of 350 live seeds m^{-2}.

Table 2. Agronomic practices for the 2022 hulless oat variety trial, Alburgh, VT.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Covington silty clay loam, 0 to 3 percent slopes
Previous crop	Milkweed
Seeding rate	350 live seeds m^{-2}
Row spacing (in)	6
Replicates	4
Planting date	23-Apr
Harvest date	29-Jul
Harvest area (ft)	5 x 20
Tillage operations	Spring disc & spike tooth harrow

Field season data were collected on all the 23 varieties. Heading date data was collected through the month of June, recorded when 50% of the heads in each plot had fully emerged. The trial was scouted for arthropod pests and plant diseases on 8-Jul. Five plants from each plot were examined. The top two leaves were examined and evaluated for the presence of disease and insect damage. The Clive James, "An Illustrated Series of Assessment Keys for Plant Diseases, Their Preparation and Usage" was used to identify and determine the severity of plant disease infection. Damage recorded as a percent of the leaf surface that was affected by each pest and disease. Heights and lodging were determined on 29-Jul. Heights were measured three times per plot, excluding awns. Lodging was assessed visually as percent lodged, with 0% indicating no lodging and 100% indicating the entire plot was lodged.

Plots were harvested on 29-Jul with an Almaco SPC50 small plot combine. Grain moisture, test weight, and yield were determined at harvest (DICKEY-john Mini GAC moisture and test weight meter, Auburn, IL). Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a one-pound subsample was collected to determine quality characteristics. Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, Vermont). Grains were analyzed for crude protein and starch content using the Perten Inframatic 9500 NIR Grain Analyzer. Samples were then ground using the Perten LM3100 Laboratory Mill. Falling number was measured

(AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. The falling number indicates the level of enzymatic activity in the grain. It is determined by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of a test-tube. Deoxynivalenol (DON), a vomitoxin, was analyzed using Veratox DON 2/3 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. Samples from one replicate were evaluated for DON and all samples tested below the FDA threshold for human consumption (1 ppm) (data not shown).

Stand characteristics 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. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in project results 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 (e.g. yield). Least Significant Differences (LSD's) at the 10% level 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 that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the previous example, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these treatments were significantly different from one another.

Treatment	**Yield**
A	**2100***
B	1900*
C	1700
LSD	300

RESULTS

Seasonal precipitation and temperature recorded at a weather station at Borderview Research Farm are displayed in Table 3. This growing season was wetter than past years with a total of 20.1 inches, 4.97 inches more than normal. The average temperature of the growing season for spring barley (April to July) was 1.44°F below the 30-year average. From April 2022 to July 2022, there were 3510 Growing Degree Days (GDDs), 35 fewer days than the 30-year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2022.

	2022			
Alburgh, VT	April	May	June	July
Average temperature (°F)	48.1	60.5	65.3	71.9
Departure from normal	-0.81	2.09	-2.18	-0.54

Precipitation (inches)	5.57	3.36	8.19	3.00
Departure from normal	2.50	-0.40	3.93	-1.06
Growing Degree Days (32-95°F)	391	883	1000	1236
Departure from normal	-20	65	-64	-17

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2020) for Burlington, VT.

Table 4. Yield and quality of hulless oat varieties, Alburgh, VT, 2022.

Variety	Yield @ 13.5% moisture	Moisture	Test weight	Crude protein @ 12% moisture	Starch
	lbs ac^{-1}	%	lbs bu^{-1}	%	%
AC Gehl	2274	15.0*	43.6*	11.4*	50.2*
Buff	**3120**	14.8*	41.6*	10.8	51.4*
Buff Sylvia	2551	19.1	36.8	11.6*	**53.1***
Casino	2820	19.0	40.1*	10.9	51.6*
Fuego	3107	13.8*	42.6*	11.7*	50.5*
ND040341	2759	16.8*	40.8*	12.1*	48.1
Navaro	2709	19.3	39.8*	**12.4***	49.7
Nusso	2279	14.3*	40.5*	11.7*	50.4*
OA1456-2N	3025	15.0*	39.6*	11.3*	50.0*
Paul	2767	15.5*	39.4*	11.6*	49.6
Pennuda	3086	18.1	36.6	12.2*	50.7*
SD110853NO	2708	15.9*	**44.0***	10.7	48.6
SD111540NO	3106	18.1	42.0*	11.7*	52.2*
SD120582NO	2865	17.8	37.6	12.2*	48.7
SD120601NO	3002	19.7	39.0*	12.0*	49.3
SD120622NO	2327	16.7*	40.6*	12.3*	49.0
SD120624NO	2318	16.8*	35.1	11.0	50.6*
SD160149NO	2499	17.5	40.4*	12.1*	49.1
SD160816NO	2510	**13.3***	35.8	11.0	48.3
SD171242NO	3068	15.0*	40.1*	11.7*	50.1*
Shelly	2627	17.0*	37.8	11.7*	46.8
Streaker	2604	17.7	37.8	11.4*	49.8
LSD (p=0.10)	§NS	4.08	5.26	1.13	3.08
Trial mean	2733	16.6	39.6	11.6	49.9

‡Treatments with an asterisk (*) are not statistically different from the top performer, shown in **bold**.
§NS indicates that there was no statistical difference between varieties.

Although there were no significant differences in the yields of the varieties tested, there were differences in their heading dates, heights, lodging, test weights, moisture, arthropod damage, foliar diseases, starch, and protein contents (Tables 4 and 5). There were no significant differences in yield between varieties, the average yield was 2733 lbs ac^{-1} (Table 4). Buff was the highest yielding variety at 3120 lbs ac^{-1}, and AC Gehl had the lowest yields at 2274 lbs $ac^{-1.}$ There were significant differences in the other three quality parameters represented in Table 4. 13 varieties had statistically significant levels of moisture at harvest (Figure 1). SD160816NO resulted in the lowest levels of moisture, approximately 3% less compared to the trial mean, 13.3% and 16.6%, respectively (Table 4). In addition to SD160816NO, only one other variety had a harvest moisture below 14% (Fuego, 13.8%) which is the ideal storage moisture for oats. There were significant differences in the test weights between varieties, and the average test weight in this year's trial (39.6 lbs bu^{-1}) was also in line with the trends observed over the several years of hulless oat data (Table 4). The test weight results ranged from 35.1 lbs bu^{-1} (SD120624NO) to 44.0 lbs bu^{-1} (SD110853NO). The average crude protein was 11.6%, which is slightly lower compared to the results observed over the last several years (Table 4). Navaro had the highest levels of protein (12.4%), and SD110853NO the lowest (10.7%) (Figure 1). Although there were statistical differences in protein levels, the protein content in the top performing variety (Navarro) was statistically similar to 15 of the other varieties tested. There were significant differences observed in the levels of starch between the varieties, with an average of 49.9% (Table 4). Buff Sylvia had the highest starch levels at 53.1% and Shelly the lowest at 46.8%.

Table 5. Hulless oat varieties agronomic characteristics in Alburgh, VT, 2022.

Variety	Heading date†	Arthropod damage % foliar surface affected	Disease damage % foliar surface affected	Height cm	Lodging†† %
AC Gehl	15-Jun	4.93	9.73	113	26.3
Buff	17-Jun	4.27*	10.5	113	27.5
Buff Sylvia	16-Jun	5.60	3.93*	113	45.0
Casino	16-Jun	4.27*	4.27*	114*	33.8
Fuego	17-Jun	**3.33***	7.93*	113	32.5
ND040341	17-Jun	5.33	8.87*	**115***	43.8
Navaro	18-Jun	5.67	**1.80***	114*	47.5
Nusso	16-Jun	3.87*	8.00*	114*	47.5
OA1456-2N	15-Jun	5.33	9.60	113	27.5
Paul	15-Jun	3.93*	8.27*	113	**3.8***
Pennuda	16-Jun	4.93	6.33*	114*	38.8
SD110853NO	15-Jun	4.00*	5.00*	113	38.8
SD111540NO	17-Jun	4.00*	8.20*	114	45.0
SD120582NO	16-Jun	3.80*	10.2	114*	43.8
SD120601NO	15-Jun	5.00	6.07*	114*	50.0
SD120622NO	16-Jun	6.27	6.40*	114*	61.3
SD120624NO	19-Jun	4.60*	7.00*	114*	5.0*
SD160149NO	16-Jun	3.87*	11.3	113	47.5

SD160816NO	18-Jun	5.27	7.73*	113	27.5
SD171242NO	16-Jun	4.20*	6.53*	114*	70
Shelly	17-Jun	4.13*	3.80*	114*	57.5
Streaker	16-Jun	4.47*	11.1	114*	35.0
LSD (p=0.10)	NS§	1.50	7.60	1.14	46.8
Trial mean	18-Jun	4.59	7.38	114	38.9

† No optimal value or range has been determined for heading date.
‡Treatments with an asterisk (*) are not statistically different from the top performer, shown in **bold**.
§NS indicates that there was no statistical difference between varieties.
††Lodging with 0% indicates no lodging and a rating of 100% indicates that the entire plot was lodged.

Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased plant typically exhibits reduced vigor, growth, and seed fill. Earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. Each plot was evaluated for the presence of several individual diseases and disease symptoms. These individual disease ratings were combined into a single foliar disease rating for statistical analysis. The most problematic diseases noted in the hulless oat variety trial this year were symptoms characteristic of powdery mildew, mosaic virus, rust, and two unknown foliar diseases – one producing yellow stripes, the other had brown spots on the leaves (Table 5). Navarro was the least affected by disease pressure with only 1.8% of the leaf surface showing disease symptoms, and SD160149NO was the most impacted by disease at 11.3%. All but one variety (Navarro) had statistically similar amounts of disease symptoms with an average of 7.38% leaf surface damaged by disease. The damage caused by arthropods produced symptoms characteristically caused by mites, thrips, and cereal leaf beetles. On average 4.59% of the leaf surface was damaged by arthropods this year (Table 5), with the variety Fuego displayed the least (3.33%) and SD120622NO the most (6.27%).

This year all varieties of hulless oats headed between June 15 and June 18. The varieties ranged between 113 cm and 115 cm at the time of harvest. ND040341 reaching 115 cm. SD120624NO and Paul had the least amount of lodging (3.8% and 5.0%, respectively) at the time of harvest (Table 5). The overwhelming majority had significantly more lodging, with an average of 38.9% lodged plants.

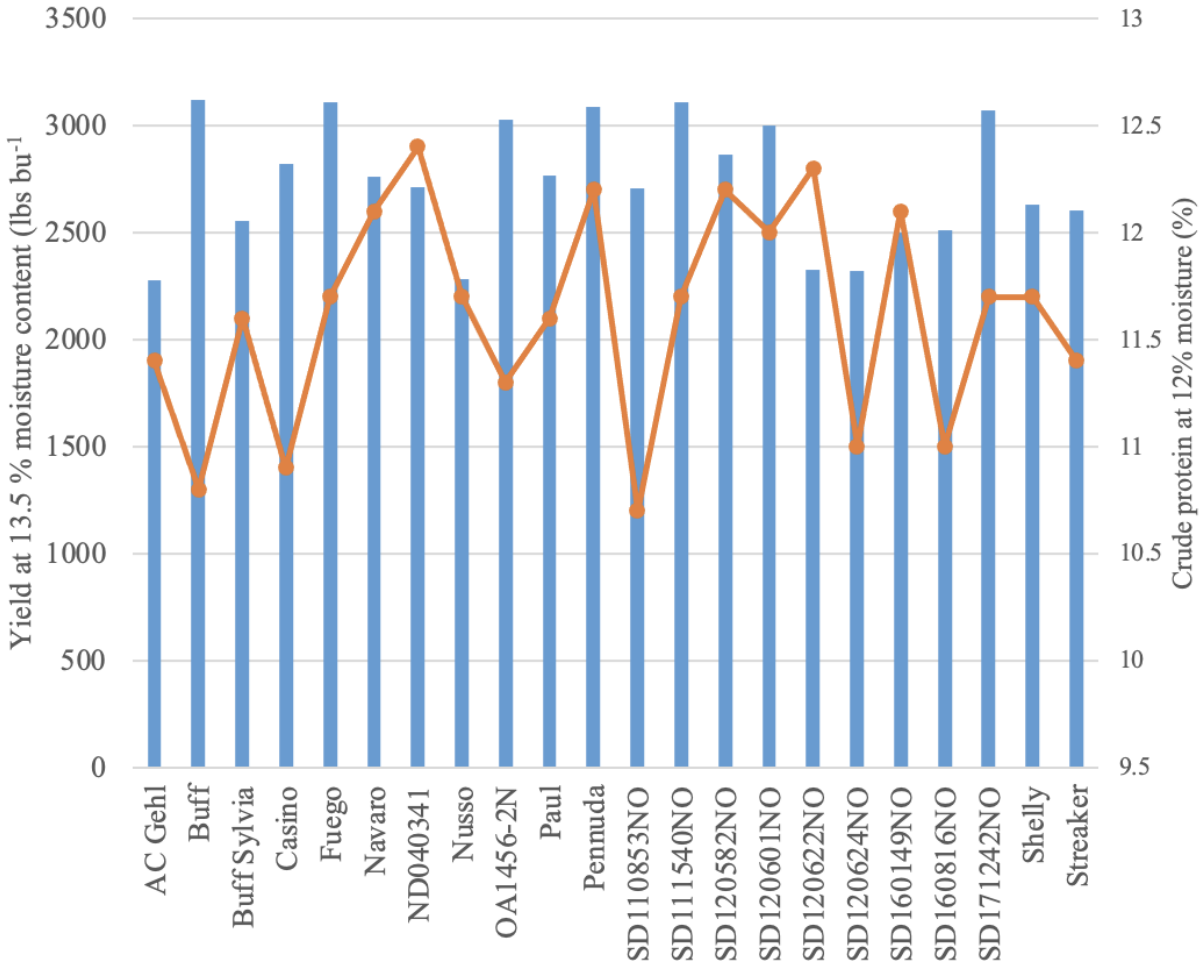

Figure 1. Yield and crude protein of hulless oat varieties evaluated in Alburgh, VT, 2022.

DISCUSSION

The 2022 growing season had temperatures that aligned with the season averages over the last 30 years. However, there were fewer Growing Degree Days in 2022 than the norm. The amount of precipitation in this year's growing season varied when compared to historical trends of the region, April and June had slightly higher amounts of rainfall and May and July had less. Overall, the varieties in 2022 performed relatively similarly to one another in the characteristics measured in this study. All varieties headed within three days of one another, there were no significant differences in yield between varieties (average yield was 2733 lbs ac^{-1}), and although there were some parameters in which there were statistically significance differences, however there were few outliers in the data and most varieties shared similar trends.

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