



# 2019 South Dakota Organic Oat & Spring Wheat Variety Trial Results

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## 2019 Organic Oat Variety Trial - Beresford

Plot size:	12 ft long by 5 ft wide
Row spacing:	7 inches
Previous crop:	Soybean and oat/pea
Seeding Rate:	31 seeds per square ft
Under-seeding:	Medium red clover
Date seeded:	4/29/2019
Date harvested:	8/5/2019

## 2019 Organic Oat Variety On-Farm Trial Results -Madison

Plot size:	12 ft long by 5 ft wide
Row spacing:	7 inches
Previous crop:	Soybean
Seeding Rate:	31 seeds per square ft
Under-seeding:	Alfalfa
Date seeded:	5/16/2019
Date harvested:	8/23/2019

## 2019 South Dakota Organic Spring Wheat Variety Trial Results -Beresford

Plot size:	12 ft long by 5 ft wide
Row spacing:	7 inches
Previous crop:	Soybean
Seeding Rate:	35 seeds per square ft
Date seeded:	4/29/2019
Date harvested:	8/5/2019

The demand for organic small grains has been increasing over the last decade. Small grains, such as oats and spring wheat, work well in rotation with corn and soybean. They help break pest cycles and improve soil health by adding diversity in the rotation. In organic systems, small grains can also help with weed management.

Choosing a variety is likely one of the most important management decisions for growers because the choice of variety has a direct impact on the grain marketability and the revenue per acre. This is especially true for organic production because pesticides cannot be used. The mechanisms of defense against pathogens and pests need to come from the variety itself. For example, some oat varieties have inherent resistance to crown rust while others do not. Crown rust is the most damaging disease of oats in the Midwest. It can severely reduce yield, test weight, and grain quality. In the eastern part of South Dakota where dew points are often high during the growing season, crown rust infections on oats are common. Delayed planting, as was experienced in 2019, can further exacerbate the incidence of the pathogen.

Fusarium head blight (FHB) is a fungal disease that reduces the yield, quality and feeding value of wheat grain. The FHB fungus produces accumulation of mycotoxin in grains, which is a risk to the health of livestock and humans. Breeding for improved resistance to FHB is one of the objectives of the spring wheat breeding program.

In addition, not all varieties exhibit the quality characteristics desired or required by processors and end-users. For example, plump and thin percentages, thousand kernel weight, groat percentage, and protein, beta-glucan and oil contents are important milling and nutritional quality traits for oats. In general, an ideal milling oat cultivar has a high proportion of plumps, high thousand kernel weight, high groat percentage, and high protein and beta-glucan contents with a low proportion of thin kernels.

General Mills Foundation is supporting efforts by the SDSU oat and spring wheat breeding programs to evaluate both oat and spring wheat varieties under organic management systems. The goal of this project is to identify and develop varieties that will help farmers improve profits while improving soil health by incorporating small grains into crop rotations.

## **Oats**

An oat variety trial under organic management was performed at two locations, Beresford, SD and Madison, SD. Agronomic characteristics such as heading date, plant height, lodging, and resistance to diseases were collected during the growing season (Tables 1 and 4). In Beresford, crown rust severity ranged from 8.3% for Sumo to 91.7 % for Rockford. In Madison, crown rust severity ranged from 11.7% for breeding line SD140741 to 61.7 % for Shelby 427. At both locations, varieties susceptible to crown rust (with high crown rust severity ratings) performed poorly. Sumo, Saddle, Warrior, and Leggett are cultivars with good levels of resistance to crown rust (Tables 1 and 4).

Grain yield for oats in Beresford averaged 64.4 bu/acre, ranging from 101.7 bu/acre (SD160067) to 25.5 bu/acre (Souris). Entries in the top yielding group included SD160067, SD140741, MN Pearl, and Sumo. Test weight is an important component of crop quality and is highly variety dependent. Test weight averaged 34.5 lb/bu in Beresford and ranged from 39 lb/bu for Antigo to 26.4 lb/bu for Rockford.

At the on-farm site near Madison, the experimental error was high for grain yield. This may be attributed to the delayed planting, weed pressure, and environmental factors. As a result, it is difficult to draw clear conclusions regarding the performance of each cultivar relative to one another at that site.

Oat varieties with high proportion of plump and low thin kernels included Sumo, Betagene, SD120665, and Rushmore. Sumo, SD150012 and SD140741 are cultivars and breeding lines with high thousand kernel weight. The cultivar MN Pearl exhibited high groat percentage, while Leggett and Betagene have high protein and beta-glucan contents, respectively (Tables 2 and 5).

### **Spring wheat**

An organic spring wheat trial was conducted at Beresford, SD. Grain yield for spring wheat averaged 39.4 bu/acre. Entries in the top-yielding group included SD4873, SD4854, Advance, SD4773, SD4849, SD4848, SD4855, SD4843, SD4852, SD4870, SD4878, LCS-Trigger, SD4879, SD4842, SD4840, Surpass and SD4859. It is important to note that varieties with a yield difference of 8 bu/acre may still be statistically similar due to inherent environmental variabilities and the yield testing process. Spring wheat breeding lines that exhibited excellent test weight included SD4842, SD4866, SD4854, SD4855, SD4848, SD4878, and SD4873 (Table 8). Protein content is also highly dependent on the variety and environment and is an important component of the wheat grain end-use value. Boost, SD4707, SD4848, SD4854 and SD4855 are varieties and breeding lines that exhibited high protein content. FHB severity averaged 2 (on a scale of 1 to 5) with breeding lines Boost, SD4814, SD4852, SD4874 and SD4878 showing a good level of resistance.

In summary, the agronomic and grain quality characteristics from the 2019 organic oat and spring wheat variety trials are summarized in Tables 1-8. Variety selection should be based on yield performance over multiple locations and years in the intended production area. This is because the growing conditions in a single season may favor certain varieties, which would give an inaccurate yield potential over time. The support from General Mills Foundation will allow us to conduct spring wheat and oat variety trials again in 2020.

Table 1. Agronomic characteristics and disease ratings for oat varieties and breeding lines evaluated under organic management at Beresford, SD.

Variety	Relative Heading * (Days)	Relative Height ** (inches)	Lodging# (%)	Crown Rust¥ (%)	Stem Rustβ (1-5)
Antigo	1	2	55.0	23.3	1.7
Badger	0	3	65.0	70.0	2.0
Betogene	5	5	33.3	36.7	2.0
Deon	9	7	56.7	38.3	1.7
Excel	8	6	86.7	78.3	1.3
Goliath	9	8	58.3	75.0	1.0
Hayden	8	6	66.7	83.3	1.3
Jerry	7	9	88.3	90.0	1.7
Leggett	10	4	30.0	18.3	1.0
MN Pearl	9	10	31.7	53.3	1.0
Natty	5	6	48.3	71.7	1.0
Newburg	8	7	66.7	86.7	1.0
Reins	1	0	88.3	83.3	1.7
Rockford	10	5	80.0	91.7	1.7
Saber	3	4	23.3	78.3	2.7
Saddle	3	4	16.7	13.3	1.3
SD120665	6	6	40.0	36.7	1.7
SD140741	9	10	45.0	36.7	1.3
SD150012	5	7	30.0	28.3	1.0
SD150081	6	6	36.7	51.7	1.3
SD150112	4	10	26.7	35.0	2.0
SD150270	9	9	43.3	53.3	1.0
Rushmore	6	5	20.0	28.3	1.0
SD160067	6	4	50.0	31.7	1.0
SD160240	8	6	68.3	20.0	2.7
SD160778	9	7	50.0	48.3	1.7
Shelby 427	4	7	58.3	88.3	1.0
Souris	8	5	76.7	86.7	1.0
Sumo	0	6	28.3	8.3	1.0
Warrior	7	5	25.0	13.3	1.0

\*Days to heading compared to Sumo (172 Julian days).

\*\*Height in inches compared to Reins (31 inches).

#Lodging scored as percentage: 0%= no lodging to 100% = plot entirely lodged.

βStem rust severity on a 1-5 scale: 1= most resistant to 5= most susceptible.

¥Crown rust severity scored as percentage: 0%= no pustule to 100%= leaves completely covered with pustules.

Table 2. Grain quality and milling characteristics for oat varieties and breeding lines evaluated under organic management at Beresford, SD.

Variety	Plump %	Mid %	Thin %	1000 Kernel Weight (g)	Groat %	NIR Protein %	NIR Beta-glucan %	NIR Oil %
Antigo	10.5	73.0	16.6	22.7	71.8	19.1	4.7	6.8
Badger	45.5	49.3	5.2	33.9	68.8	16.7	4.2	5.0
Betagene	62.0	33.9	4.2	30.8	69.6	18.1	5.4	5.0
Deon	18.4	70.1	11.6	28.6	72.0	15.2	4.9	5.4
Excel	45.0	39.1	15.9	22.3	59.0	14.7	4.2	5.2
Goliath	13.6	66.2	20.1	23.1	68.9	14.7	4.8	5.4
Hayden	12.7	63.8	23.4	21.1	58.6	13.8	4.8	7.1
Jerry	18.6	60.5	20.9	22.1	60.5	16.8	4.8	5.0
Leggett	47.6	44.2	8.1	30.3	72.8	18.9	5.4	5.0
MN Pearl	49.9	42.5	7.6	29.7	74.6	14.4	4.3	6.1
Natty	28.5	59.1	12.4	25.6	69.0	14.5	4.0	4.2
Newburg	26.4	53.9	19.7	22.0	66.9	14.9	5.2	6.2
Reins	6.1	73.3	20.6	22.4	67.7	15.3	5.0	5.3
Rockford	8.6	57.5	33.9	17.5	61.1	13.2	5.0	7.4
Saber	44.5	48.1	7.3	29.8	74.0	18.2	4.2	4.3
Saddle	36.6	57.8	5.6	26.6	73.9	17.8	4.1	4.1
SD120665	61.6	35.0	3.5	28.7	71.9	17.5	4.3	4.8
SD140741	46.4	50.0	3.6	32.6	73.6	17.7	4.7	4.5
SD150012	53.1	43.3	3.7	31.2	73.4	17.7	4.3	5.8
SD150081	58.4	36.7	5.0	29.4	73.8	14.6	4.4	5.1
SD150112	44.9	50.8	4.3	31.2	75.7	19.4	4.9	5.6
SD150270	57.6	33.8	8.7	27.0	72.0	17.0	4.6	5.3
Rushmore	62.5	33.8	3.7	30.2	74.7	17.9	4.0	4.7
SD160067	58.2	36.8	5.1	32.8	74.3	15.2	4.6	4.8
SD160240	31.8	56.7	11.4	26.4	69.4	16.2	6.0	6.6
SD160778	23.0	60.7	16.3	25.3	70.3	15.6	4.8	5.3
Shelby 427	24.1	61.7	14.3	23.4	69.8	15.9	4.3	5.5
Souris	9.7	59.5	30.8	19.9	65.8	14.9	4.4	5.1
Sumo	66.6	30.2	3.3	31.6	72.5	18.1	4.0	4.3
Warrior	53.5	41.9	4.7	29.9	73.5	17.2	4.3	5.3
<b>Trial Average</b>	37.5	50.8	11.7	26.9	70.0	16.3	4.6	5.3
<b>LSD (0.05) †</b>	12.1	11.5	6.1	3.7	6.0	1.0	0.3	0.5
<b>CV‡</b>	15.7	11.1	25.5	6.7	4.4	3.0	3.1	4.4

† Value to determine if varieties are significantly different from one another.

‡ C.V. is a measure of variability or experimental error.

Table 3. Test weight (lbs/bu) and grain yield (bu/acre) for oat varieties and breeding lines evaluated under organic management at Beresford, SD. Top yielding and varieties with higher test weight of the trial are shaded light blue.

Variety	Test weight (lb/bu)	Yield (bu/acre)
Antigo	39.0	69.4
Badger	35.3	63.5
Betagene	32.8	70.0
Deon	35.1	71.6
Excel	26.6	44.8
Goliath	32.8	63.9
Hayden	30.1	47.5
Jerry	29.3	31.1
Leggett	35.2	70.3
MN Pearl	35.5	88.7
Natty	35.9	57.2
Newburg	30.4	39.9
Reins	34.6	70.6
Rockford	26.4	26.4
Saber	36.9	35.6
Saddle	36.7	72.8
SD120665	38.3	63.9
SD140741	36.6	100.6
SD150012	37.6	83.2
SD150081	36.1	81.0
SD150112	36.9	64.3
SD150270	36.7	57.8
Rushmore	34.9	71.9
SD160067	35.6	101.7
SD160240	35.8	75.8
SD160778	34.2	78.9
Shelby 427	33.3	46.8
Souris	31.3	25.5
Sumo	37.8	85.7
Warrior	36.1	71.4
<b>Trial average</b>	34.5	64.4
<b>LSD (0.05) †</b>	2.91	16.3
<b>C.V.% ‡</b>	5.15	15.5

† Value required to determine if varieties are significantly different from one another.

‡ C.V. is a measure of variability or experimental error.

Table 4. Agronomic characteristics for oat varieties and breeding lines evaluated under organic management at Madison, SD.

Variety	Relative Heading* (Days)	Relative Height** (inches)	Lodging# (%)	Crown Rust‡ (%)
Betogene	4	6	23.3	20.0
Farmer's variety	1	11	21.7	60.0
Deon	9	9	20.0	21.7
Goliath	8	15	20.0	50.0
Hayden	6	6	50.0	55.0
Leggett	8	8	10.0	16.7
MN Pearl	7	9	6.7	50.0
Natty	4	9	11.7	45.0
Reins	1	0	26.7	51.7
Saddle	1	5	15.0	21.7
Rushmore	6	9	8.3	26.7
SD140741	7	12	8.3	11.7
SD150012	3	9	16.7	25.0
SD150081	5	8	11.7	48.3
SD150270	8	13	20.0	30.0
Shelby 427	5	11	30.0	61.7
Sumo	0	8	10.0	33.3
Warrior	5	5	18.3	20.0

\*Days to heading compared to Sumo (183 Julian days).

\*\*Height in inches compared to Reins (25 inches).

#Lodging scored: 0%= no lodging to 100% = completely flat.

‡Crown rust scored as percentage: 0%= most resistant to 100%= most susceptible.

Table 5. Grain quality and milling characteristics for oat varieties and breeding lines evaluated under organic management on farm trial at Madison, SD.

Variety	Plump %	Mid %	Thin %	1000 Kernel Weight (g)	Groat %	NIR Protein %	NIR Beta-glucan %	NIR Oil %
Betogene	53.3	46.5	4.7	30.3	69.3	15.6	5.4	5.4
Farmer's variety	18.7	53.9	27.3	21.0	58.9	15.3	5.8	7.5
Deon	7.2	75.3	17.6	25.7	70.3	14.5	4.7	6.1
Goliath	10.2	67.5	22.3	21.6	64.4	12.0	4.4	6.1
Hayden	12.5	53.4	34.0	19.7	45.7	12.5	4.8	7.3
Leggett	42.1	51.7	6.2	30.4	71.5	17.7	4.8	5.9
MN Pearl	35.6	59.0	5.4	29.0	72.9	12.9	4.1	6.9
Natty	6.5	78.7	14.8	22.9	68.8	13.0	3.9	4.5
Reins	4.9	77.0	18.1	23.2	68.6	14.3	4.9	5.7
Saddle	22.8	72.7	4.5	27.7	68.7	16.9	4.5	4.7
SD140515	32.8	56.5	6.7	28.9	70.8	15.8	4.2	5.4
SD140741	17.6	75.8	6.6	30.1	70.5	17.0	4.8	5.2
SD150012	16.5	78.5	4.9	30.6	70.7	15.8	4.3	6.6
SD150081	12.8	76.2	11.0	25.2	69.4	11.9	4.4	5.7
SD150270	32.8	58.3	8.8	26.0	67.7	15.0	4.8	6.4
Shelby 427	5.0	64.4	30.5	19.5	63.0	12.4	4.1	6.9
Sumo	55.6	40.8	3.6	31.4	72.8	17.4	4.1	4.9
Warrior	17.6	77.8	4.5	29.5	71.7	16.2	4.7	5.7
<b>Trial Average</b>	22.4	64.6	12.8	26.2	67.5	14.8	4.6	5.9
<b>LSD (0.05) †</b>	7.3	6.8	3.5	2.7	3.6	1.0	0.3	0.4
<b>CV‡</b>	15.5	5.0	13.0	4.9	2.5	3.4	2.8	3.2

† Value required ( $\geq$ LSD) to determine if varieties are significantly different from one another.

‡ C.V. is a measure of variability or experimental error.



Table 6. Test weight and grain yield for oat varieties and breeding lines evaluated under organic management on farm trial at Madison, SD. Top yielding and varieties with higher test weight of the trial are shaded light blue.

Variety	Test Weight (lb/bu)	Yield (bu/ac)
Betagene	29.4	34.8
Farmer's variety	27.4	27.9
Deon	29.4	44.7
Goliath	27.3	27.6
Hayden	21.1	18.7
Leggett	30.0	20.9
MN Pearl	30.7	39.1
Natty	30.0	28.1
Reins	29.9	19.8
Saddle	30.9	30.4
SD140515	33.1	30.5
SD140741	31.4	41.0
SD150012	32.6	52.1
SD150081	30.3	36.7
SD150270	30.2	29.4
Shelby 427	27.1	15.5
Sumo	33.3	23.2
Warrior	32.0	41.0
<b>Trial Average</b>	29.8	31.2
<b>LSD (0.05) †</b>	1.9	12.1
<b>CV ‡</b>	3.8	23.3

† Value required ( $\geq$ LSD) to determine if varieties are significantly different from one another.

‡ C.V. is a measure of variability or experimental error.

Table 7. Agronomic characteristics for spring wheat variety and breeding lines evaluated under organic management at Beresford, SD.

Variety	Relative Heading* (Days)	Relative Height* (inches)	FHB <sup>α</sup> (1-5)
Advance	3	-2	2.3
Boost	6	0	1.3
Brick	0	0	2.7
Briggs	2	1	3.3
Faller	5	0	2.0
Focus	0	3	3.0
Forefront	1	1	3.0
LCS-Trigger	8	-2	1.0
Oxen	4	-2	2.7
Prevail	3	-1	2.3
SD4625	3	-2	1.7
SD4707	2	-2	3.0
SD4708	2	1	2.0
SD4765	0	-1	2.0
SD4771	0	-4	3.0
SD4772	0	-3	2.3
SD4773	4	-2	1.7
SD4775	5	-1	1.7
SD4814	4	-3	2.0
SD4816	4	-2	1.3
SD4840	0	1	2.7
SD4842	3	0	1.7
SD4843	5	0	1.7
SD4844	4	0	1.7
SD4846	0	-1	3.3
SD4848	5	-3	1.0
SD4849	2	-2	2.7
SD4852	1	-1	2.3
SD4854	4	0	2.0
SD4855	4	0	1.3
SD4859	2	-1	2.7
SD4866	6	-1	1.7
SD4868	5	-2	1.3
SD4869	3	-3	2.3
SD4870	5	1	1.0
SD4871	3	-1	1.3
SD4873	5	2	1.3
SD4874	5	-2	1.0
SD4876	2	-2	2.3
SD4878	5	-2	1.3
SD4879	6	1	1.3
SD4881	4	0	2.0
SD4885	2	1	2.0
SD4891	2	0	2.3
Select	0	0	3.3
Surpass	1	1	2.7
SY-Valda	4	-1	1.0
Traverse	4	0	2.0

\*Days to heading and height compared to Brick (172 Julian days and 30 inches respectively).

<sup>α</sup>FHB: 1 = most resistant to 5 = most susceptible.

Table 8. Performance of spring wheat variety and breeding lines evaluated under organic management at Beresford, SD. Top yielding and varieties with higher test weight of the trial are shaded light blue.

Variety	Test Weight (lb/bu)	Protein %	Yield (bu/ac)
Advance	60.5	14.3	<b>46.0</b>
Boost	60.2	16.2	33.5
Brick	59.3	14.2	36.4
Briggs	58.6	15.1	38.8
Faller	54.6	13.0	30.9
Focus	59.2	15.2	36.5
Forefront	60.0	15.0	40.7
LCS-Trigger	59.9	12.8	<b>43.0</b>
Oxen	54.4	14.7	28.6
Prevail	59.0	14.2	40.6
SD4625	60.8	14.5	40.7
SD4707	57.3	16.0	29.7
SD4708	60.3	14.8	40.1
SD4765	59.1	14.9	39.0
SD4771	56.6	14.5	34.8
SD4772	58.5	14.6	39.7
SD4773	60.2	14.5	<b>45.9</b>
SD4775	59.4	14.3	40.1
SD4814	58.4	14.5	37.4
SD4816	58.3	15.0	35.5
SD4840	59.3	14.1	<b>42.1</b>
SD4842	<b>62.3</b>	14.5	<b>42.1</b>
SD4843	60.6	14.4	<b>43.9</b>
SD4844	60.5	15.1	38.5
SD4846	57.5	14.1	35.5
SD4848	<b>61.5</b>	15.9	<b>44.1</b>
SD4849	60.5	15.0	<b>45.7</b>
SD4852	60.8	15.1	<b>43.9</b>
SD4854	<b>61.6</b>	15.6	<b>47.6</b>
SD4855	<b>61.6</b>	15.5	<b>44.0</b>
SD4859	58.0	14.6	<b>41.8</b>
SD4866	<b>61.7</b>	15.3	41.0
SD4868	58.2	14.6	31.7
SD4869	57.3	14.7	38.3
SD4870	60.3	14.5	<b>43.6</b>
SD4871	60.9	14.8	39.5
SD4873	<b>61.1</b>	14.2	<b>50.0</b>
SD4874	59.8	14.9	36.7
SD4876	58.6	13.7	37.1
SD4878	<b>61.5</b>	14.3	<b>43.1</b>
SD4879	60.6	15.0	<b>42.3</b>
SD4881	59.2	14.6	40.9
SD4885	60.9	14.8	37.3
SD4891	59.6	14.5	33.4
Select	59.6	14.7	35.8
Surpass	59.2	14.5	<b>41.8</b>
SY-Valda	60.5	14.7	39.6
Traverse	56.4	13.6	34.4
<b>Trial Average</b>	59.4	14.7	39.4
<b>LSD (0.05) †</b>	1.2	0.7	8.3
<b>CV ‡</b>	1.4	3.1	13.2

† Value to determine if varieties are significantly different from one another.

‡ C.V. is a measure of variability or experimental error.