Increase the Oat Acres in Alberta by Finding a High Yielding Oat Variety that maximizes Producer Income and Meets the Demands of the Millers.

Summary:

This study is a continuous effort to collect data on 11 milling variety oats and 4 feed oat varieties in Central and Northern Alberta. The goal was to determine how variety and growing location will influence the yield and functional property attributes linked to beta-glucan levels of the oats. There was noticeable difference of the location on the varietal yields as well as beta-glucan content.

Background

Oat production in Alberta has been on a relatively steady decline since 2011. Oats has earned the status of major Canadian export crop from a domestic crop status. According to Prairie Oat Grower's Association (POGA), an estimate of 3.1 million acres of oat were seeded in year 2015-16 but there is a decline in Alberta due to lack of markets and non-competitive pricing with other crops. Many major millers will not accept oats from Alberta, or look to Alberta only after Manitoba and Saskatchewan's supply is gone, because the main two oat varieties grown in Alberta, Morgan and Derby contain low amounts of Beta Glucan (β-glucan). A minimum of 4% β-glucan is required for companies to be able to label their products with the Heart Healthy Claim and both Morgan and Derby are consistently below that amount. Therefore, oat producers in Alberta need an oat variety that can consistently beat the yields of Morgan and Derby but has the higher β-glucan amounts that the oat miller desire. To emphasize this fact, in 2015 two millers are helping to fund this variety trial to get it started before outside funding can be located to make oats in Alberta more competitive.

Oats are a valuable part of crop rotation and are therefore beneficial to producers. They provide disease and insect breaks for wheat, barley, and canola. Their rapid establishment and growth provide excellent weed suppression. Oats also work well as a "catch crop" for taking up and storing excess nitrogen, and the straw provides a nutrient source for the following year's crop. The straw also

protects against soil erosion, and contributes to an increase in the soils organic matter content (Campbell et al., 1991). A well-planned management and appropriate selection of variety makes oats a profitable crop due to their low input requirements and favorable effects on succeeding crops in a rotation.

Test weight is the most commonly used indicator of grain quality. High test-weight varieties should be chosen by growers who intend to market oat grain. However, the functional attribute such as β-glucan solubility and viscosity are main criteria for the processing industry. Many studies have shown that oat β-glucan can lower blood cholesterol levels, glucose and insulin response and therefore decrease the risk of cardiovascular diseases and prevention of diabetes (Wang and Ellis, 2014).

Oats are regularly affected by crown rust in other parts of Western Canada but this issue is moving west, towards Alberta. Neither Morgan or Derby varieties have crown rust resistance but selecting a new disease resistance varieties can overcome the problem. The information for producer to choose the newer and higher yielding varieties specific to their region is therefore very important step to stay profitable in the oat production. The β-glucan content in oat may varies with change in growing conditions (Perez Herrera et al., 2016). The current trial will provide the valuable agronomic information for the producers in Alberta to grow oat varieties with higher yield and increased functional properties (β-glucan) attribute.

Objective

- To investigate the impact of genotype and growing condition on the yield and β-glucan content of milling oat varieties in Alberta.

Methodology

Eleven milling oat varieties and four forage oat varieties were tested in 2016 (Table 1). Based on the soil fertility recommendations, fertilizers were added to

maintain the optimal levels growing condition. Seeding rates were calculated based on 1000 kernel weight of each variety with a Seed Counter, desired plant density and germination percentage. A 9-inch spaced 6 row Fabro small plot seeder was used for the seeding. Each plot of a variety occupied 10.96 sq. m. (1.37 m width and 8 m long) and there were three replications. The trial site was maintained weed-free with use of herbicides or hand weeding method (Table 1). The trial was harvested with a Wintersteiger Nursery Mate Elite combine (5 foot header) and grain yield from each plot were measured using Electronic Scales at the site.

Table 1a: Agronomic details for the POGA Trail 2016

Location:	**Peace region (Dion East)**	**Westlock**
Seeding Date:	May 17th, 2016	May 13th, 2016
Seeding Date:	Sept 16th, 2016	Sept 27th, 2016
Soil Temp:	not indicated	10.4 Celsius
Soil Moisture:	adequate	very poor
Seeding Depth:	1.5 inch	1.5 inch
Tank A (Seed placed)	phos (51.4g/plot)	phos (86 g/plot)
Tank B (Side Banded)	general blend (525.4g/plot)	general blend (285g/plot)
Fert. Nutrients	**130N-30P2O5-25K2O-25S**	**20.4N- 42P2O5- 48K20- 00S**
Cone 1	seed package	seed package
Herbicides applied to trial	Pre-burn Transorb 0.5L/Acre on May 2; 2016 and Express pro 7 gm/Acre on May 2; 2016	Pre-burn Roundup 1L/Acre on May 6; 2016
Herbicides applied to trial	In crop Broad leaf: stellar A (400 ml/ Acre) + stellar B (240 ml/ Acre) on 05 June, 2016	In crop Broad leaf: Buctril M (400 ml/ Acre) on 13 June and Curtail M (600 ml/ Acre) on 22 June
Fungicides applied to trial	Proline (140 ml/Acre) on July 4, 2016	Headline (160 ml/Acre) on July 8, 2016
Rainfall (mm)	406	424
Comment:	Fertilizer applied with a cereal blend that was used in their all cereal trails.	Target yield was 120 bu/acre of Oat and fertilizer applied on based of soil test. High residual N in soil test.

Table 1b: Agronomic details for the POGA Trail 2017

Location	Peace (Falher)	Westlock
Previous Crop	Canola	Canola
Seeding Date	May 29th-2017	May-17th-2017
Row Spacing	11 inch	9 inch
Soil Temp	14.9 Centigrade	11 Centigrade
Soil Moisture	Moderate	Very high
Seeding Depth	1 1/8"	1"
Fertilizer	107N-30P2O5-25K2O-25S (lb/ac)	58 lbs/ac of 11-52-0 seed placed 422 lbs/ac 29-0-19-2 side banded
Precipitation (mm)	207.9	427
Harvesting Date	Oct 02-2017	Oct 1-2017
Chemical application		
Pre-seed	Glyphosate 0.60L/ac on 17-May	Glyphosate 0.60L/ac on 09-May
Herbicide		Curtial M and Axial on june 19
Desiccant	Reglone Ion 0.7 L/acre on 14-Sept	Reglone Ion 0.7 L/acre on 12-Sept

The moisture content was immediately measured using Grain moisture tester. The geographical and climate information throughout the trial were recorded using Davis Instrument weather stations at the trial site. After harvesting, a clean composite sample (500 g) was collected and sent to laboratory analysis for the β-glucan estimation. The growing season of 2017 was little drier compared to 2016 for Peace region location. During the growing season, May to August-2017, sites received 207.6 vs 406 mm precipitation in same time frame in 2016 (Table 1b). For the Westlock Site, we had similar but very high levels of precipitation for both years.

Oat grain dehulling and stabilization

The oat seeds were dehulled with an impact huller (Warner Control Techniques), aspirated to remove most of hulls, and further hand-picked to obtain hull-free groat samples. Heat treatment was applied to dehulled oat groats to inactivate the native enzymes. Oat groats (100 g) were steamed in a kitchen vegetable steamer with a lid by placing the groats on the metal shelf (layered with a cheese cloth) over boiling water for 20 min. After steaming, the samples were dried in a forced air oven at 78 °C for 1h, 63 °C for 30 min and 50 °C for overnight. The oat groats were then ground using the Retsch ZM 200 sample mill (Retsch GmbH, Rheinische Straβe 36, 42781 Haan, Germany) equipped with a 0.5 mm screen into flours.

Analytical methods

Quantitative estimation of moisture was performed by standard AACC (2000) procedures. Beta-glucan content was determined using the mixed-linkage beta-glucan assay kit (Megazyme International Ireland Ltd., Wicklow, Ireland). Thousand-grain and thousand-groat weights were determined by manually counting and weighing 200 grains and 200 groats (before heat treatment), respectively, and multiplying each number by 5. All the determination was done in duplicate and beta-glucan content was reported on dry matter basis.

Results and Discussion

Using data from an onsite Davis Instruments Vantage Pro2 weather station at our research site, weather data was summarized for the 2016 growing season (Table 1a and 1b). Variety trial results for 2016 and 2017, from Westlock and peace region sites are presented in Table 2a and 2b and Table 3a and 3b respectively. Yields reported are on a 34 lb/bushel basis with moisture adjustments at 13.5%.

At Westlock site, yield were higher in 2017 compared to 2016 for most oat varieties. The reason for increased yield might be higher target yields for fertilizer application in 2016 (table 2a) as compared to 2017 (Table 2b).

Table.2a: POGA OAT trial 2016 (Westlock Site Yield Data).

No.	Variety	Yield (bu/ac)		1000 Kernel Weight		Bushel Wt. lb/bushel		Test weight kg/HL	
1	Morgan	153.81	Ab	48.83	Ab	42.40	Ab	52.32	ab
2	Camden	144.60	B	46.84	a-d	42.10	Ab	51.95	ab
3	Seabiscuit	**174.86**	**ab**	49.12	A	41.18	abc	50.82	abc
4	Triactor	155.93	ab	43.00	Def	42.01	Ab	51.85	ab
5	Ruffian	168.73	ab	46.38	a-e	40.46	abc	49.93	abc
6	Orrin	168.60	ab	48.38	Ab	40.05	Bc	49.42	bc
7	Summit	160.19	ab	40.73	F	40.62	abc	50.12	abc
8	Souris	142.33	B	40.88	F	40.45	abc	49.92	abc
9	Akina	162.21	ab	45.12	b-e	38.82	Cd	47.91	cd
10	Kara	160.32	ab	44.23	c-f	42.72	A	**52.72**	a
11	Minstrel	156.41	ab	45.19	b-e	39.16	cd	48.33	cd
12	CDC SO-1	164.33	ab	47.40	Abc	37.31	D	46.04	d
13	CDC Nasser	177.07	ab	42.70	Ef	37.87	D	46.73	d
14	Mustang	**181.43**	**A**	44.89	b-e	41.16	abc	50.79	abc
15	Baler	168.27	ab	43.98	c-f	41.06	abc	50.68	abc
Standard Deviation		11.874		1.133		0.914		1.127	
CV		7.3		2.51		2.26		2.26	
Treatment Prob(F)		0.0143		0.0001		0.0001		0.0001	

*Varieties that share a letter did not differ significantly from one another (p>0.05).

Table.2b: POGA OAT trial 2017 (Westlock Region Site: Yield Data)

	Plant Height cm		Yield (bu/ac)		1000 Kernel Weight		Bushel Wt. lb/bushal		Test weight kg/HL	
Morgan	111.8	a	**203.0**	**Bcd**	52.6	A	44.2	a	54.5	a
Camden	111.1	a	**225.6**	**Abc**	49.5	B	41.9	abc	51.7	abc
Seabiscuit	118.8	a	**192.3**	**D**	54.2	a	40.6	c	50.1	c
Ruffian	112.4	a	**240.5**	**a**	48.4	b	42.1	abc	52.0	abc
Triactor	114.0	a	**174.2**	**e**	47.4	b	42.2	abc	52.1	abc
Orrin	109.9	a	**214.0**	**abcd**	47.6	b	43.8	ab	54.0	ab
Summit	115.0	a	**224.2**	**abc**	45.8	b	43.5	ab	53.7	abc
Souris	115.3	a	**196.4**	**cd**	40.7	c	42.3	abc	52.2	abc
Akina	115.9	a	**230.3**	**abc**	47.9	b	41.9	abc	51.7	ab
Kara	116.5	a	**218.5**	**bcd**	49.9	b	43.3	ab	53.5	ab
Minstrel	109.6	a	**208.5**	**bcd**	48.2	b	41.2	bc	50.9	ab
Standard Deviation	8.32		13.4		2.56		1.10		1.36	
CV	7.32		6.99		5.26		2.59		2.59	

Treatment Prob(F)	0.0691	0.0001	0.0001	0.2487	0.253

*Varieties that share a letter did not differ significantly from one another ($p>0.05$).

Table.3a: POGA OAT trial 2016 (Peace Region Site: Yield Data)

No.	Variety	Yield (bu/ac)		1000 Kernel Weight		Bushel Wt. lb/bushal		Test weight kg/HL	
1	**Morgan**	**202.5**	**ab**	43.8	abc	41.1	-	50.7	-
2	Camden	190.3	bc	45.0	ab	41.2	-	50.8	-
3	Seabiscuit	202.8	ab	45.0	ab	39.6	-	48.8	-
4	Triactor	188.5	bc	42.2	a-d	39.9	-	49.2	-
5	**Ruffian**	**217.5**	**A**	43.6	abc	42.0	-	51.8	-
6	Orrin	168.0	C	46.6	a	41.6	-	51.3	-
7	Summit	173.1	C	41.4	bcd	42.3	-	52.2	-
8	Souris	168.6	C	34.4	e	41.5	-	51.2	-
9	Akina	190.4	bc	42.2	a-d	40.1	-	49.4	-
10	Kara	190.2	bc	39.6	cd	41.3	-	51.0	-
11	Minstrel	192.3	bc	42.4	a-d	47.7	-	58.8	-
12	CDC SO-1	192.3	bc	38.5	d	38.3	-	47.2	-
13	CDC Nasser	173.7	C	38.7	d	43.0	-	53.0	-
14	Mustang	194.1	Bc	45.1	ab	40.9	-	50.5	-
15	Baler	183.2	Bc	46.1	ab	38.3	-	47.3	-
Standard Deviation		9.83		1.75		3.35		4.14	
CV		5.22		4.13		8.12		8.14	
Treatment Prob(F)		0.0001		0.0001		0.2487		0.253	

*Varieties that share a letter did not differ significantly from one another (p>0.05).

Table.3b: POGA OAT trial 2017 (Peace Region Site: Yield Data)

	Plant Height cm		Yield (bu/ac)		1000 Kernel Weight		Bushel Wt. lb/bushal		Test weight kg/HL	
Morgan	94.9	a	**220.1**	bc	44.5	a	41.4	a	44.5	a
Camden	92.6	ab	**226.1**	bc	37.6	a	38.8	ab	37.6	a
Seabiscuit	97.0	a	**224.0**	bc	42.7	a	37.5	b	42.6	a
Ruffian	98.2	a	**248.5**	a	41.6	a	40.8	a	41.5	a
Orrin	98.7	a	**227.3**	bc	40.9	a	40.8	a	40.8	a
Summit	88.3	b	**209.7**	cd	37.5	a	40.5	a	37.4	a
Souris	93.4	ab	**190.8**	e	36.4	a	40.8	a	36.4	a
Akina	92.2	ab	**214.2**	cd	42.4	a	38.8	ab	42.3	a
Kara	88.2	b	**225.9**	bc	43.0	a	40.9	a	43.0	a
Minstrel	93.1	ab	**196.4**	de	40.3	a	39.2	ab	40.3	a
Triactor	**97.7**	**a**	**240.3**	**ab**	39.0	a	38.9	ab	39.0	a
Standard Deviation	2.90		9.83		1.75		3.35		4.14	
CV	3.08		5.22		4.13		8.12		8.14	
Treatment Prob(F)	0.0001		0.0001		0.0001		0.2487		0.253	

*Varieties that share a letter did not differ significantly from one another (p>0.05).

At Westlock site, there was no statistical difference between the yields obtained for 11 milling varieties. However, Seabiscuit was numerically highest yielding variety for 2016. In 2017, Seabiscuit didn't do well for yields. As evident from data for plant height (Table 3a), Seabiscuit was tallest oat variety and we noticed issues of lodging that might have resulted in lower yields in 2017 for Seabiscuit at Westlock site.

At Peace region, in year 2016, Ruffian was significantly higher milling oat type than most of the other varieties except Morgan and Sea biscuit. The almost similar trend was noticed for 2017 again with Ruffian top yielding milling oat variety followed by Triactor.

Test weight is the most important indicator of grain milling quality. At Westlock site, the test weight result for Kara and Morgan was higher in both year 2016 and 2017 compared to other milling oat at intermediate levels. However, no statistical difference in either years 2016 or 2017 was observed among the varieties at Peace region.

Beta Glucan results: The beta-glucan content of the 11 different milling varieties ranged between 3.8% and 5.0%, with the lowest reported for Ruffian (3.8%) at both sites. Akina at Westlock and Kara at Peace region (5.0%) had the highest beta glucan levels for both the sites in 2016 (Table 4). In 2017, the beta-glucan content of the 11 different milling varieties ranged lower as compared to those levels in 2016. However, the lowest beta glucan levels were still reported for Ruffian at both sites again in 2017. Akina and Moran at Westlock and Souris and Morgan at Peace region (were among with higher beta glucan levels compared to other milling oats varieties tested in 2016 (Table 4 and 5).

Conclusion:

The yield results from a two years suggests that there is potential for the varieties to out compete Morgan. In both, we observed a visible difference of location on

yields that changes among the varieties at that location too. Ruffian was continuously highest yielding variety at Peace region from last two year and Westlock in 2017 too. However, the Ruffian has lowest levels of beta-glucan at both location in year 2016 as well as 2017. Based on year 2016 data, Seabiscuit performed very well at both locations in 2016 with staying in top 3 varieties for yield and average above 4.5% of beta-glucan content. However, in 2017, Ruffian was the top yielding variety at both locations and Seabiscuit had issues with lodging at Westlock site. So it is harder to choose one variety out these two who had shown potential to give strong competition to most popular and with highest acres variety of Alberta, Morgan.

That being said, as environment and disease conditions can fluctuate greatly from year to year, so it is important to consider yields averaged over multiple years. We hope with more data available, we would able to speculate for best suited varieties compared to Morgan for the specific regions of Alberta.

Table 4: The beta-glucan analysis results from the POGA trial 2016.

Location	Variety	Hull %		Flour Moisture (%) (after heat stabilization)		Flour beta-glucan (%, db)	
Westlock	Morgan	23.11	-	4.00	e	3.78	de
Westlock	Camden	24.85	-	3.73	f	4.44	bc
Westlock	Seabiscuit	23.39	-	3.48	g	4.56	b
Westlock	Triactor	30.29	-	5.29	a	4.42	bc
Westlock	Ruffian	22.34	-	4.01	e	3.83	de
Westlock	Orrin	24.92	-	3.08	i	4.37	bc
Westlock	Summit	22.79	-	2.79	j	4.28	bcd
Westlock	**Souris**	**26.01**	**-**	**3.29**	**h**	**4.93**	**a**
Westlock	**Akina**	**21.43**	**-**	**4.23**	**d**	**5.03**	**a**
Westlock	Kara	30.12	-	4.30	d	4.33	bc
Westlock	Minstrel	22.18	-	4.65	bc	3.86	de
Westlock	CDC SO-1	30.62	-	3.72	f	4.01	cde
Westlock	CDC Nasser	26.91	-	4.78	b	3.78	de
Westlock	Mustang	31.19	-	3.12	i	3.62	e
Westlock	Baler	25.19	-	4.53	c	3.80	de

Location	Variety	Hull %		Flour Moisture (%) (after heat stabilization)		Flour beta-glucan (%, db)	
Peace	Morgan	26.45	-	4.60	b	4.20	cd
Peace	Camden	30.58	-	4.25	c	4.62	abc
Peace	Seabiscuit	28.12	-	3.54	ef	4.58	abc
Peace	Triactor	27.41	-	3.48	ef	4.46	bcd
Peace	Ruffian	27.98	-	3.42	f	3.93	d
Peace	Orrin	28.00	-	4.42	bc	3.99	d
Peace	Summit	29.09	-	4.24	c	4.43	bcd
Peace	Souris	28.30	-	3.69	de	4.42	bcd
Peace	Akina	26.94	-	4.54	b	4.92	ab
Peace	**Kara**	**23.53**	**-**	**5.36**	**a**	**5.01**	**a**
Peace	Minstrel	23.75	-	3.79	d	4.27	cd

*Varieties that share a letter did not differ significantly from one another (p>0.05).

Table 5: The beta-glucan analysis results from the POGA trial 2017.

Location	Variety	Hull %	Flour Moisture (%) (after heat stabilization)	Flour beta-glucan (%, db)
Westlock	Morgan	22.42	3.80	3.88
Westlock	Camden	22.32	3.55	3.70
Westlock	Seabiscuit	19.76	3.47	3.73
Westlock	Triactor	21.92	3.79	3.49
Westlock	Ruffian	16.84	3.94	2.66
Westlock	Orrin	25.67	3.11	3.22
Westlock	Summit	20.05	2.84	3.57
Westlock	Souris	23.60	3.88	3.64
Westlock	Akina	20.98	3.42	3.81
Westlock	Kara	23.84	3.74	3.59
Westlock	Minstrel	20.72	3.68	2.92

Location	Variety	Hull %	Flour Moisture (%) (after heat stabilization)	Flour beta-glucan (%, db)
Peace	**Morgan**	**22.58**	**3.08**	**4.08**
Peace	Camden	19.87	3.02	3.86
Peace	Seabiscuit	17.04	3.81	3.74
Peace	Ruffian	21.19	3.56	3.28
Peace	Orrin	21.82	3.00	3.67
Peace	Summit	12.40	2.84	3.67
Peace	**Souris**	**20.39**	**2.66**	**4.41**
Peace	Akina	18.31	2.82	3.69
Peace	Cara	21.62	3.01	3.68
Peace	Minstrel	20.96	4.03	3.50
Peace	Triactor	23.53	3.04	3.71

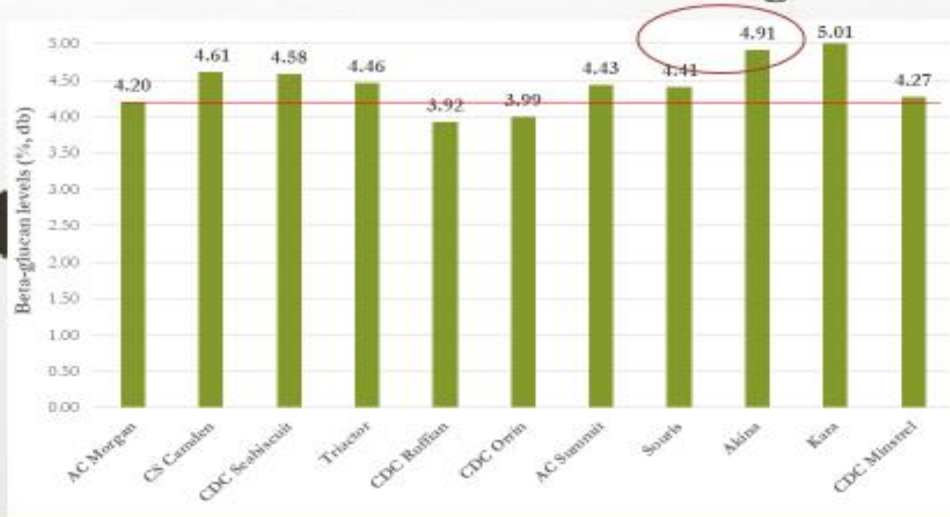
*Statistical analysis not done).


Beta-Glucan 2017 – Westlock
Beta-glucan levels (%, db)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.88
3.70
3.73
3.49
2.66
3.22
3.57
3.64
3.81
3.59
AC Morgan
CS Camden
CDC Seabiscuit
Triactor
CDC Ruffian
CDC Orrin
AC Sunnnit
Souris
Akina
Kara


Beta-Glucan 2016 – Westlock
Beta-glucan levels (%, db)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.78
4.44
4.56
3.83
4.37
4.27
4.93
5.03
4.32
3.86
4.42
AC Morgan
CS Camden
CDC Seabiscuit
CDC Ruffian
CDC Orrin
AC Sunnnit
Souris
Akina
Kara
CDC Minstrel
Triactor

Beta-Glucan 2017– Peace Region

Beta-Glucan 2016– Peace Region



ACKNOWLEDGEMENTS: We would like to thank **Prairie Oat Growers Association (POGA)** for their full financial assistance and FP Genetics for their contribution in lab analysis for this trial. We would also like to thank Jubilee Farms, Canterra seeds, Canada Seed depot, and FP Genetics for their generous seed donation with this trial. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any variety/product mentioned, nor criticism of unnamed variety/products is implied.

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