

Participatory Plant Breeding Program: Update

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Introduction

The participatory plant breeding (PPB) program is a partnership between the University of Manitoba, Agriculture and AgriFood Canada and the Bauta Family Initiative on Canadian Seed Security (Seedchange). This report highlights the results of the farmer participatory research and development project focussed on wheat and oats.

There have been three groups or cohorts of farmers selecting wheat and oat lines since 2011 (Table 1). Between 2011 and 2014, we worked with just a few farmers, mostly in our home province of Manitoba. Between 2013 and 2016, we worked with farmers from across Canada, thanks to the financial support of the Bauta Family Initiative on Canadian Seed Security. A new set of farmer selectors started their on-farm selection in 2017 and many of these lines were ready for field testing in 2020. The three farmer cohorts and associated field testing of the farmer developed wheat and oat lines is shown in Table 1.

Table 1. Description of PPB program farmer cohorts, timing of on-farm selection and field testing of each cohort's selections.

Cohort of farmers	Time period for on-farm selection	Field testing farmer selections
1	2011-2014	2015, 2016
2	2013-2016	2017, 2019
3	2017-2019 (ongoing)	2020, 2021

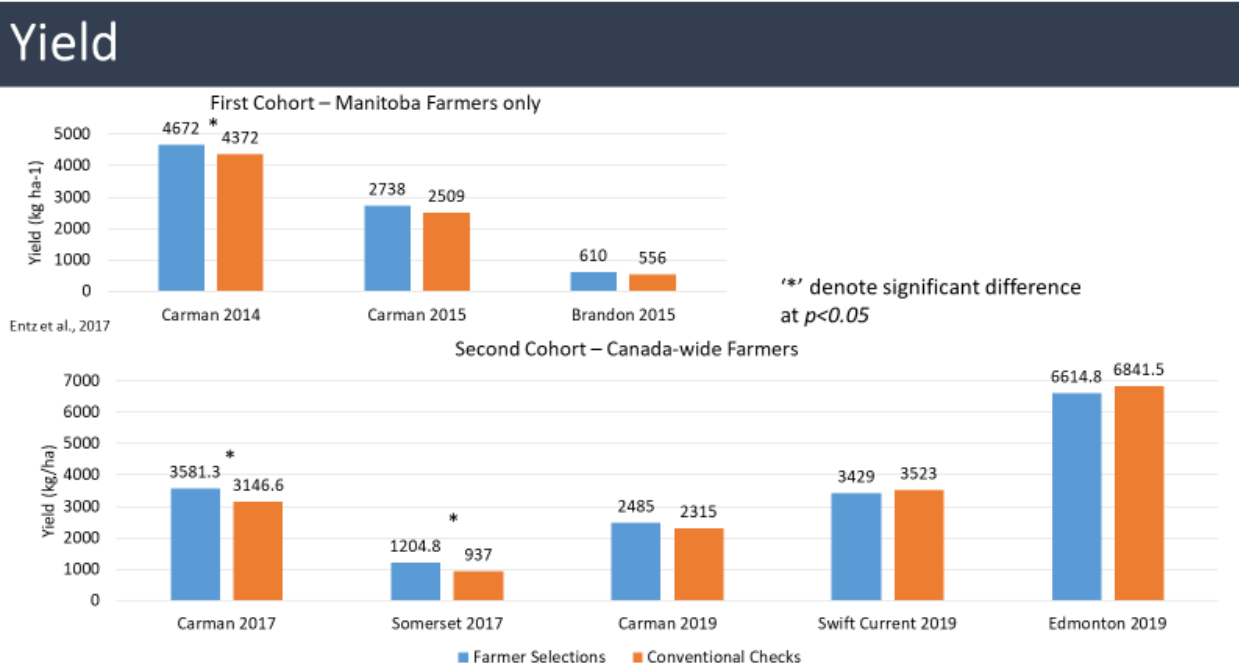
Results and Discussion

Results for the 1st cohort of farmer-selectors

Results for farmer cohort one have been described in a publication (Entz et al. 2018). Highlights indicate that:

- Farmer selections were generally taller, later maturing, more susceptible to lodging
- Farmer selections were higher yielding than the check cultivars at one of three site-years. Yield highlights are shown in Figure 1.
- When selecting from the same population, farmers produced distinctively different lines; differences were observed in disease response, days to maturity, height, lodging, and yield.
- Farmer selections had significantly less Fusarium Head blight infection and severity than check cultivars at the one site where disease pressure was high.

Figure 1. Yield highlights of PPB lines compared with check varieties in the 1st and 2nd cohort of PPB farmers.



Results for the 2nd cohort of farmer-selectors

Field evaluation of the second cohort was conducted in 2017 and 2019 (Figure 1) with sites in both eastern and western Canada. Results are highlighted in the following figures (Figure 2 to 7). Detailed description of the data is presented in Appendix 1.

Figure 2. Oat yields in 2019. Summary of the three western evaluation experiments.

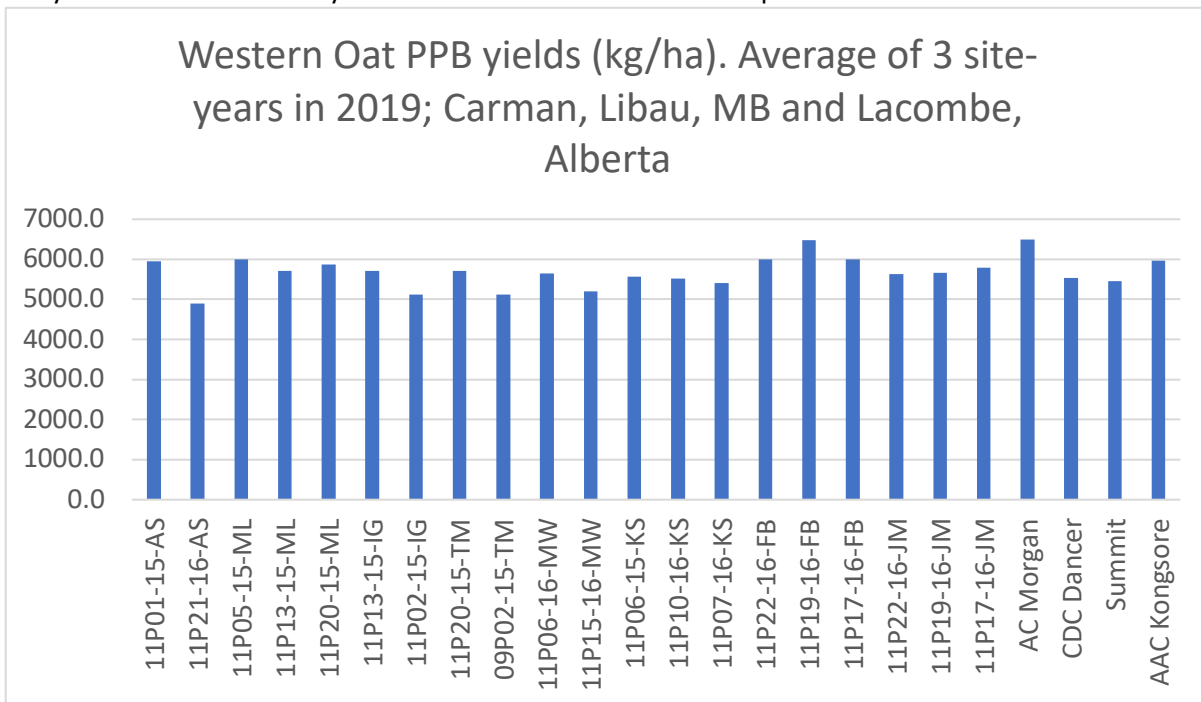


Figure 3. Wheat yields in 2019. Summary of the three western evaluation experiments.

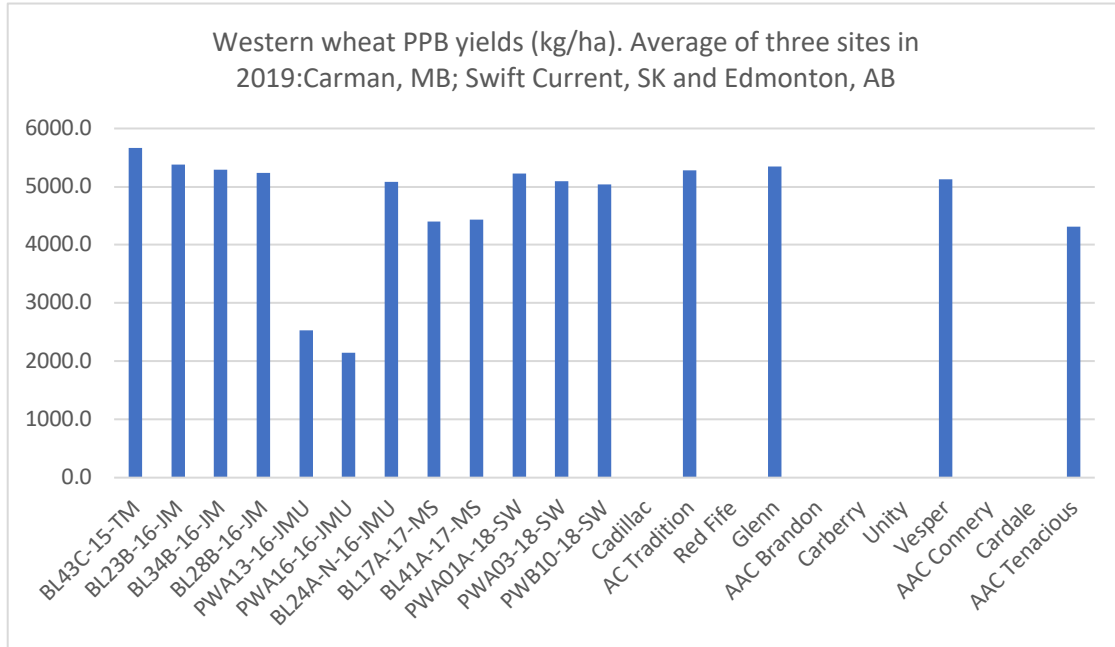


Figure 4. Oat yields at Eastern Canada location 1: Libau, MB in 2019.

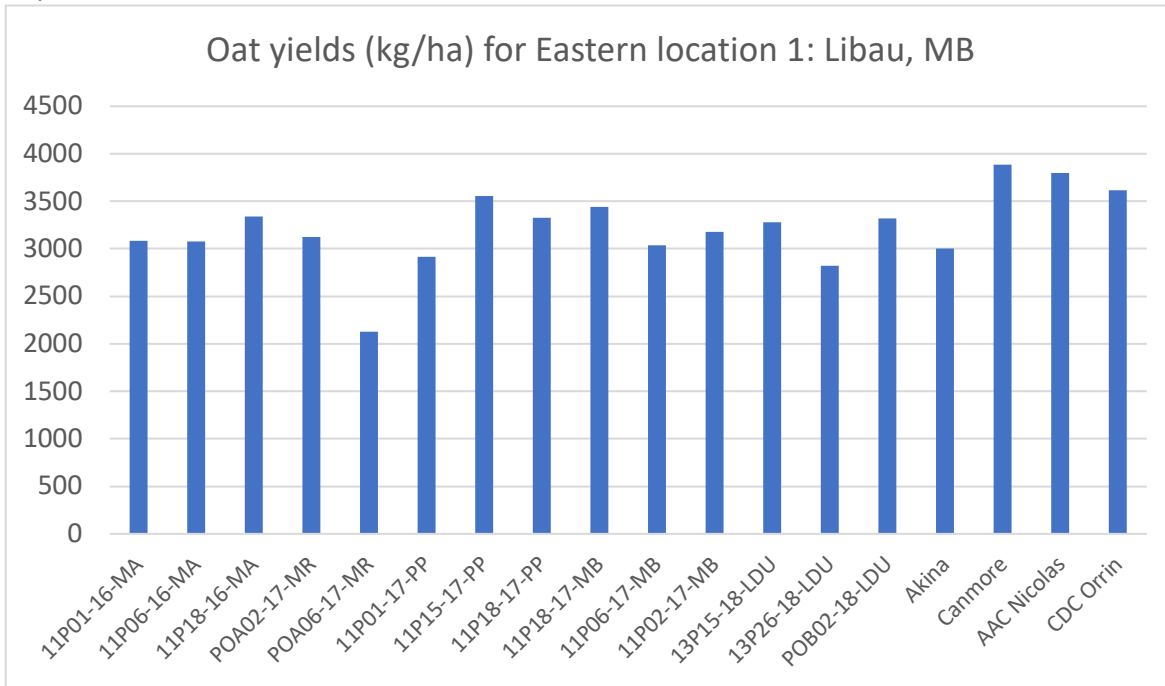


Figure 5. Oat yields at Eastern Canada location 2: Charlottetown, PEI in 2019.

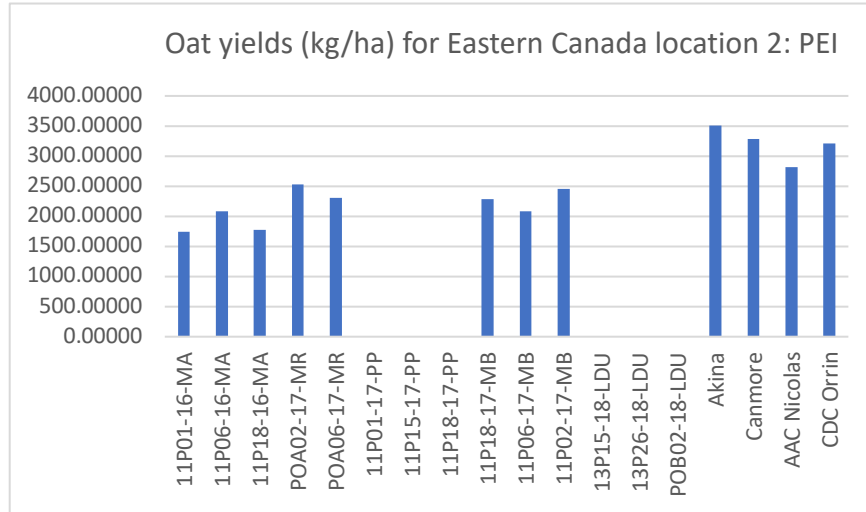


Figure 6. Wheat yields at Eastern Canada location 1: Libau, MB in 2019.

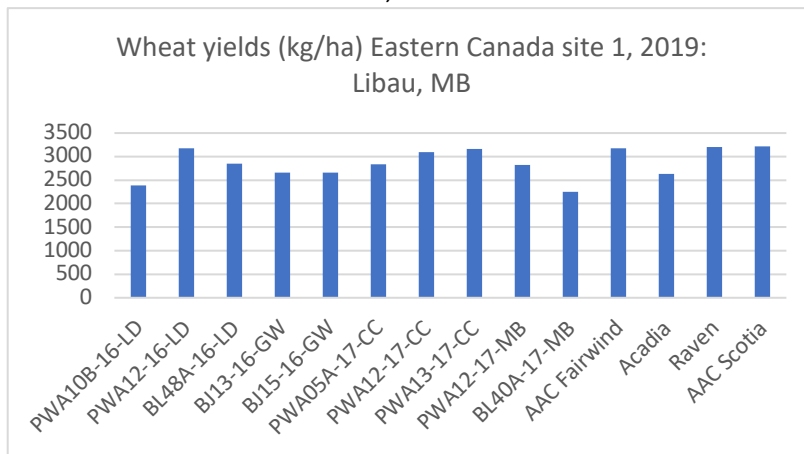
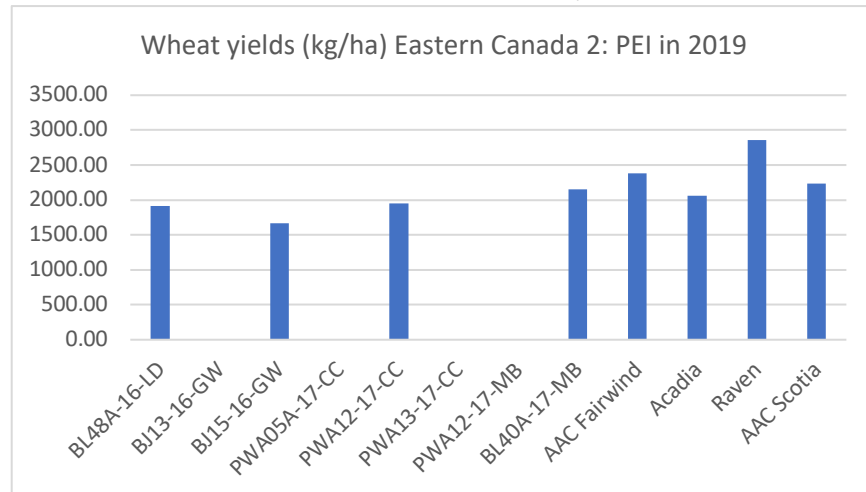


Figure 7. Wheat Oat yields at Eastern Canada location 2: Charlottetown, PEI in 2019.

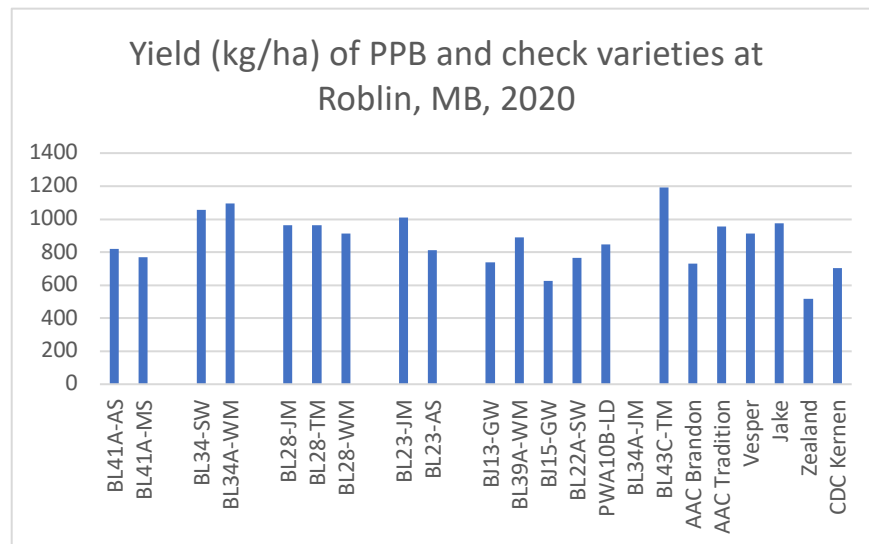


Results for the 3rd cohort of farmer-selectors

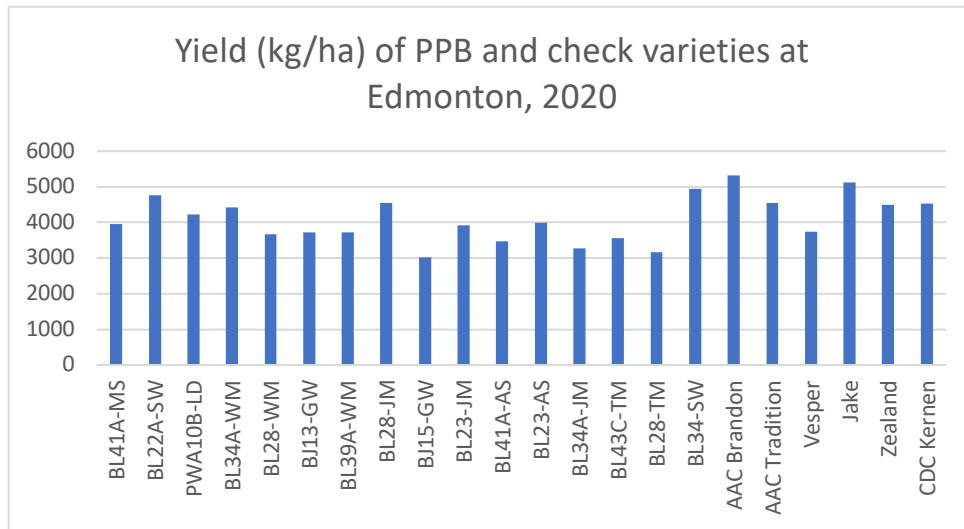
Field experiments for cohort three are being conducted in Quebec, PEI, Manitoba, Saskatchewan and Alberta. The PEI experiments were cancelled in 2020 due to Covid restrictions.

Results from Edmonton, Alberta and Roblin, Manitoba are presented here. Edmonton was a very high yield site, with very high levels of soil nutrients and adequate precipitation. Few weeds were encountered at Edmonton. The Roblin site was weedy, with significant infestations of Canada and Sow Thistle populations. Precipitation at Roblin was below the long-term average. Therefore, Roblin was considered a high stress site.

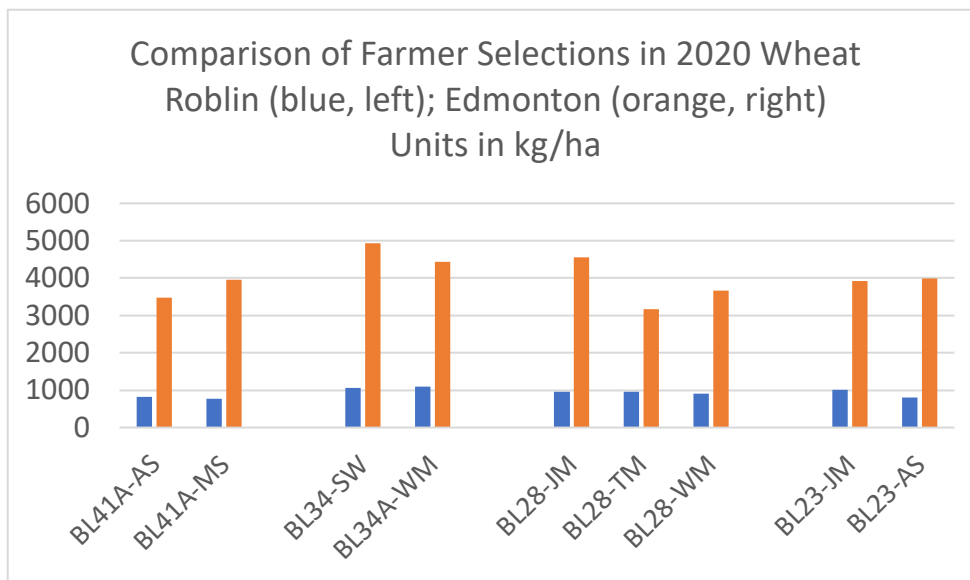
Grain yields at Roblin reflected the high stress growing conditions. Farmer selections performed as well as or better than the check varieties included in the experiment (Figure). The two highest yielding check varieties were Jake and AAC Tradition, both lines developed exclusively under organic production regimes. AAC Brandon, the most popular spring wheat variety on the Prairies in 2020, yielded less; it's low yield was partially attributed to its semidwarf growth habit which reduces competitiveness with weeds. Among the PPB lines, BL43-TM had the highest yield.



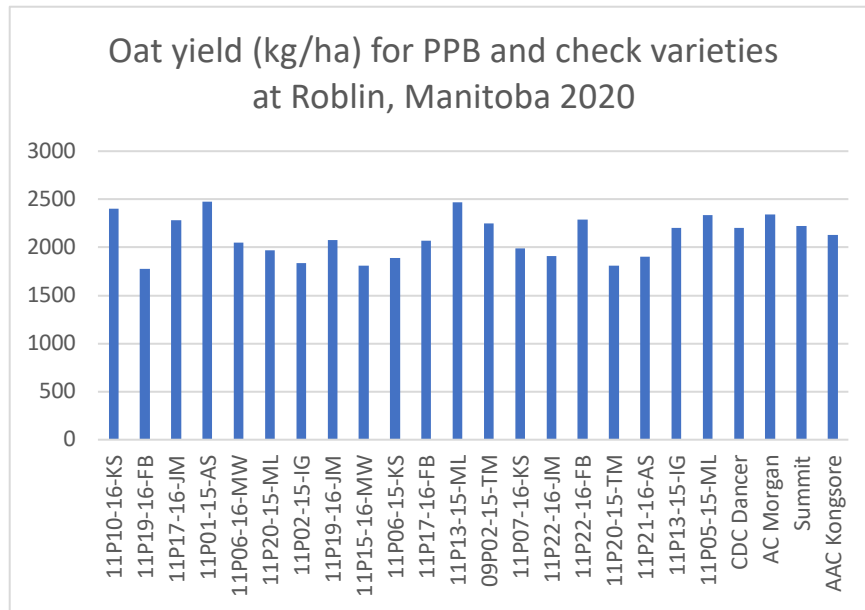
Under optimal growing conditions at Edmonton, the check varieties tended to yield better than the PPB lines. Two farmer-bred lines, BL22-SW and BL28-JM stood out as comparable to the check varieties.



The effect of individual farmer selector on field performance was evaluated for 4 different populations (Figure). Results indicate that the differences between selector was most striking under high yield conditions at Edmonton compared with stress/low yield conditions at Roblin.



The performance of PPB oat lines at Roblin in 2020 ranged from 15% less than check varieties to about 8% above check varieties (Figure). High performing PPB lines were selected in Alberta (11P22-16-FB), Saskatchewan (11P13-15-ML; 11P01-15-AS) and Manitoba (11P10-16-KS).



Appendix 1. Detailed yield and agronomic data from field experiments in 2019.

Line	Year	Carman W. Oat														Libau W. Oat										Lacombe W. Oat (Not statistically analyzed)	All Sites Average
		Early Vigour (strong to weak; 1-5)		% Weed Density		Days to Heading		Height (cm)		Days to Maturity		Yield (kg/ha)		% Plumps		Early Vigour (strong to weak; 1-5)		Height (cm)		Days to Maturity		Yield (kg/ha)		% Plumps		Yield (kg/ha)	
		Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	Letter Group (P<0.05)	Average	
11P01-15-AS	2019	1.75	cd	7.5	abcd	53.8	gh	78.0	ghi	82.3	de	3757.7	bcd	79.7	i	2.5	abc	76.4375	ghi	86	EFG	3070.36	abcd	66.49	l	11028.76	5952.3
11P21-16-AS	2019	3.75	a	6.25	bcd	57.5	ab	83.4	cdefg	85.0	a	3338.0	def	85.8	gh	2.25	abcd	83.4375	cdef	88.75	BCDE	2770.73	bcde	77.39	hi	8557.39	4888.7
11P05-15-ML	2019	2	bcd	5.5	cd	53.3	h	76.5	hi	83.5	abcd	3608.8	bcde	86.4	fgh	2.5	abc	76.125	hi	88	CDE	2955.22	abcde	69.46	k	11422.02	5995.3
11P13-15-ML	2019	2.75	abc	3.5	d	55.0	defg	84.0	cdefg	83.5	abcd	4098.5	abc	92.4	cd	2	abcd	85	bcde	87.5	CDEF	2542.81	e	89.83	bc	10515.20	5718.8
11P20-15-ML	2019	3.25	ab	5.5	cd	56.3	bcd	79.4	fghi	84.5	ab	4043.8	abc	91.9	cd	3	ab	77.6875	ghi	90.75	ABCD	2692.15	cde	87.09	de	10877.13	5871.0
11P13-15-IG	2019	2.5	abc	4.25	cd	56.0	cd	86.8	bcde	83.0	bcd	3957.6	abcd	93.8	cd	2	abcd	83.5625	cdef	90.25	ABCD	2724.75	cde	88.31	cde	10469.96	5717.4
11P02-15-IG	2019	2.5	abc	6.25	bcd	55.0	defg	88.5	bcd	81.3	ef	3455.9	cdef	85.1	gh	2.5	abc	89.0625	ab	87	DEF	2842.42	abcde	73.16	j	9072.30	5123.5
11P20-15-TM	2019	3	abc	5.5	cd	55.8	cd	81.3	efgh	82.5	cde	3963.4	abcd	90.7	de	3	ab	81.625	defg	87.25	CDEF	2889.96	abcde	86.36	e	10270.95	5708.1
09P02-15-TM	2019	2.5	abc	10	abcd	56.3	bcd	84.6	cdef	85.0	a	3545.6	bcde	90.4	de	2.5	abc	88.6875	abc	87.75	CDEF	2962.54	abcde	82.23	f	8843.75	5117.3
11P06-16-MW	2019	3.6851	a	2.7391	d	55.3	cdef	79.9	efghi	83.7	abcd	3979.8	abcd	84.3	gh	3.25	a	79.125	fgh	88.75	BCDE	2697.84	cde	74.00	j	10263.78	5647.1
11P15-16-MW	2019	2.25	bcd	5	cd	55.5	cde	91.6	ab	83.0	bcd	3880.6	abcd	84.4	gh	2.5	abc	91.1875	a	84	FG	2796.36	abcde	79.21	gh	8921.45	5199.5
11P06-15-KS	2019	2.5	abc	6.75	bcd	55.3	def	78.5	fghi	81.0	ef	3735.5	bcd	82.7	hi	2.75	abc	77.6875	ghi	88.25	CDE	2658.25	cde	74.52	j	10318.32	5570.7
11P10-16-KS	2019	0.961	d	5.0408	bcd	53.4	h	80.9	efghi	80.1	f	3587.8	bcde	85.8	gh	2.25	abcd	83.9375	bcdef	84	FG	3274.85	a	75.24	ij	9678.62	5513.8
11P07-16-KS	2019	1	d	11.75	abc	53.3	h	82.0	efgh	80.3	f	3335.7	def	90.4	de	1.5	cd	87.125	abc	86.25	EFG	3026.86	abcde	77.42	hi	9847.87	5403.5
11P22-16-FB	2019	2.5	abc	5	cd	56.3	bcd	89.5	abc	85.0	a	4163.5	ab	90.1	def	2.5	abc	83.75	bcdef	92.75	A	2796.45	abcde	86.06	e	11033.74	5997.9
11P19-16-FB	2019	3	abc	6.25	bcd	56.8	bc	81.1	efghi	84.0	abc	3998.1	abcd	93.4	cd	3	ab	83.3125	cdef	90.25	ABCD	3289.32	a	89.80	bc	12152.27	6479.9
11P17-16-FB	2019	2.0184	bcd	4.4058	cd	55.5	cde	78.4	fghi	80.1	f	3875.8	abcd	87.6	efg	1.75	bcd	88.0625	abc	85	EFG	2984.16	abcde	81.88	f	11157.60	6005.8
11P22-16-JM	2019	1	d	3.75	cd	55.0	defg	78.8	fghi	81.0	ef	3767.6	bcd	90.8	de	2.25	abcd	80.375	efgh	87	DEF	2985.78	abcde	88.08	cde	10119.25	5624.2
11P19-16-JM	2019	2.25	bcd	13.75	ab	56.0	cd	95.8	a	85.0	a	3759.0	bcd	87.5	efg	2.5	abc	91.125	a	91	ABC	2937.81	abcde	82.00	f	10295.45	5664.1
11P17-16-JM	2019	1	d	8.75	abcd	54.0	fgh	78.9	fghi	80.0	f	3777.0	bcd	86.3	fgh	1.75	bcd	86.25	abcd	83	G	2893.68	abcde	80.11	fg	10688.00	5786.2
AC Morgan	2019	2.25	bcd	8.5	abcd	54.0	fgh	84.8	cdef	81.3	ef	4545.8	a	98.3	a	1	d	76.0625	hi	84	FG	3146.92	abc	96.01	a	11776.35	6489.7
CDC Dancer	2019	2.25	bcd	7.5	abcd	54.3	efgh	83.5	cdefg	80.3	f	3634.9	bcde	94.8	abc	1.75	bcd	80.875	defgh	85	EFG	2669.71	cde	91.66	b	10279.12	5527.9
Summit	2019	0.961	d	3.0408	cd	53.4	h	74.4	i	83.1	bcd	2768.0	f	93.9	bcd	1	d	72.625	i	87.75	CDEF	2607.65	de	89.13	bcd	10991.34	5455.7
AAC Kongsore	2019	2.75	abc	15.5	a	58.3	a	83.0	defg	85.0	a	3011.1	ef	97.8	ab	2.75	abc	84.4375	bcdef	92.5	AB	3246.12	ab	90.32	bc	11637.07	5964.8

Line	Year	Carman W. Wheat								Swift Current W. Wheat		Edmonton W. Wheat			Average All Sites
		Early Vigour (strong to weak; 1-5)	% Weed Density	Days to Heading	Height (cm)	Days to Maturity	Yield (kg/ha)	TKW (g)	Test Weight (g/hectalitre)	Height (cm)	Yield (kg/ha)	Height (cm)	Days to Maturity	Yield (kg/ha)	Yield (kg/ha)
PA00-15-JG	2019	1.7def	8.3	54.3a	90.7a	83a	2248.5	34.1abcde	403.7defgh	109.9a	7167.9	112.7	101.3	4727.5	4714.6
BL34A-15-WM	2019	1.5ef	12.5	49fgh	80.9bcdefgh	81.25bc	2692.2	34.5abcd	407.7cde	101.2defgh	7165.9	111.3	106.0	6761.7	5539.9
BL39A-15-WM	2019	1.5ef	11.3	48.5h	78.6efghij	81bc	2544.2	34.7abcd	409.1bcde	99.8efgh	7124.2	106.7	102.7	6735.5	5468.0
BL28A-15-WM	2019	1.7def	8.8	50defgh	83.3bcde	80.75bc	3089.6	35.4abc	409.7bc	105.1abcd	7019.5	108.0	102.3	6024.9	5378.0
BK66A-16-IC	2019	2.2cdef	13.3	50.5bcdef	72.5j	81bc	2274	33.2cdefg	405.6cdef	103.4bcdef	6974	116.0	102.7	6861.0	5369.7
BK95A-15-IC	2019	2.2cdef	15	49fgh	79.5cdefghi	81bc	2371.4	33.1cdefg	408.8bcde	101.9bcdefg	6867.2	108.0	100.0	6280.9	5173.2
BK94A-16-IC	2019	3bc	12.5	51.5bcd	75.7ghij	81.5bc	2355	34.2abcde	403.7efgh	99.5efgh	6850	107.3	102.7	6722.8	5309.3
BL23A-15-AS	2019	1.2f	8.8	49.3efgh	76.4fghij	80.5c	2725.6	32.3defgh	407.73cde	98.2fgh	6777.1	100.7	106.3	6886.3	5463.0
BL41A-15-AS	2019	1.5ef	83	48.8gh	80.3cdefgh	80.5c	2793.6	31.6efgh	407.3cde	99.7efgh	6720.1	106.0	103.0	6641.1	5384.9
BL26A-15-AS	2019	2.2cdef	11.3	49.8efgh	78.3efghij	80.8bc	2586.5	34.2abcde	406.23cdef	103.3bcdef	6705.3	108.0	105.5	7432.4	5574.7
BL30A-15-SW	2019	1.5ef	11.3	50.8bcde	82.8bcdef	80.8bc	2732.1	33.2cdefg	399.6gh	99.1fgh	6658.8	107.3	100.3	6936.9	5442.6
BL22A-15-SW	2019	2.7bcd	13.3	49.5efgh	78.8defghij	81bc	2281.4	34.6abcd	413.9ab	96.9gh	6651.6	108.0	98.7	6561.2	5164.7
BL34A-15-SW	2019	3bc	10.8	50defgh	81.5bcdefgh	81bc	2222.8	33.6cdef	407.3cde	107.2ab	6587.6	106.7	102.0	7022.6	5277.7
BL28A-15-TM	2019	2.5cde	9.3	50defgh	78.6defghij	81.5bc	2015.8	33.8bcdef	409.1bcde	106.6abc	6560.7	110.7	99.3	7046.0	5207.5
BL36A-15-TM	2019	1.7def	9.5	48.8gh	76.5efghij	81.3bc	2409.3	31.3fgh	404.8cdefg	103bcdef	6542.9	110.0	102.0	6740.3	5230.8
BL43C-15-TM	2019	2.2cdef	12.5	50.5bcdef	78.5efghij	81.3bc	2500.2	33.4cdefg	399.7gh	99.2fgh	6521	107.3	108.7	7969.7	5663.6
BL23B-16-JM	2019	2cdef	15	52b	78.5efghij	80.8bc	2821.2	33.1cdefg	407cde	99fgh	6511.8	104.0	98.7	6802.6	5378.5
BL34B-16-JM	2019	1.5ef	12.5	50.8bcde	87.5ab	80.8bc	2376.3	33.4cdefg	404.3cdefg	103.2bcdef	6509.8	113.3	104.7	6988.5	5291.5
BL28B-16-JM	2019	2cdef	10	50.8bcde	85.5abcd	82ab	2790.9	36.4ab	409.8bc	106.1abcd	6509.5	112.0	105.3	6407.5	5236.0
PWA13-16-JMU	2019	2.3cdef	11.8	49fgh	81.3bcdefgh	81bc	2533.9	35.6abc	406.9cdef	-	-	-	-	-	2533.9
PWA16-16-JMU	2019	2.5cde	11.3	52b	81.4bcdefgh	82ab	2151.3	31.7efgh	398.6h	-	-	-	-	-	2151.3
BL24A-N-16-JMU	2019	2.5cde	11.3	48.5h	81.6bcdefg	80.8bc	2345.1	33cdefg	409.5bc	101.6cdefg	6506.8	105.3	101.0	6386.0	5079.3
BL17A-17-MS	2019	2.2cdef	11.8	50.3cdefg	80.1cdefgh	80.5c	2232.2	33.2cdefg	408.3bcde	-	-	111.3	103.3	6566.1	4399.2
BL41A-17-MS	2019	3bc	7	49.5efgh	78.1efghij	81bc	2390.8	30.7gh	405.4cdef	101.4cdefg	6485.1	-	-	-	4438.0
PWA01A-18-SW	2019	2.7bcd	10	50.5bcdef	80.1cdefgh	80.8bc	2409.7	33.9bcdef	401.4fgh	101.5cdefg	6432.2	113.3	106.7	6824.0	5222.0
PWA03-18-SW	2019	3.7b	13.8	50.3cdefg	81.6bcdefg	82ab	2871.3	33.6cdef	409.4bcd	101.4cdefg	6419	112.7	102.0	6006.4	5098.9
PWB10-18-SW	2019	1.7def	10.5	49.3efgh	86.3abc	80.8bc	2330.3	33.7bcdef	403.7efgh	99.4fgh	6376	108.7	106.3	6395.8	5034.0
Cadillac	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AC Tradition	2019	1.7def	10.8	51.8bc	72j	82ab	2696.4	36.8a	419.5a	87.7j	6348	102.0	108.3	6800.7	5281.7
Red Fife	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glenn	2019	3bc	15	49.3efgh	74.8hij	81.5bc	2127.8	29.9h	419.8a	91.3ij	6330	100.7	100.3	7583.2	5347.0
AAC Brandon	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carberry	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unity	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vesper	2019	2.2cdef	11.3	49.3efgh	72.8ij	80.8bc	2768.6	33.8bcdef	409.1bcde	96hi	6293.1	106.0	100.0	6322.8	5128.2
AAC Connery	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardale	2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AAC Tenacious	2019	5a	23.8	53.8a	81.5bcdefgh	83a	2050	33.2cdefg	398.2h	104.8abcde	6136.4	109.3	101.0	4746.0	4310.8

Line	Year	Libau E. Oat		PEI E. Oat	All Sites
		Yield (kg/ha)		Yield (kg/ha)	Yield (kg/ha)
		Average	Letter Group (P<0.05)	Average	Average
11P01-16-MA	2019	3085.19	cde	1743.84	2414.51
11P06-16-MA	2019	3075.39	cde	2088.27	2581.83
11P18-16-MA	2019	3340.22	abcde	1774.62	2557.42
POA02-17-MR	2019	3121.88	cde	2528.10	2824.99
POA06-17-MR	2019	2126.71	f	2310.16	2218.44
11P01-17-PP	2019	2917.51	e		2917.51
11P15-17-PP	2019	3553.3	abcd		3553.30
11P18-17-PP	2019	3325.03	abcde		3325.03
11P18-17-MB	2019	3443.83	abcde	2283.61	2863.72
11P06-17-MB	2019	3035.53	cde	2086.15	2560.84
11P02-17-MB	2019	3178.9	bcde	2456.42	2817.66
13P15-18-LDU	2019	3278.99	bcde		3278.99
13P26-18-LDU	2019	2819.93	e		2819.93
POB02-18-LDU	2019	3317.43	abcde		3317.43
Akina	2019	3006.26	de	3502.88	3254.57
Canmore	2019	3885.31	a	3285.71	3585.51
AAC Nicolas	2019	3801.21	ab	2817.21	3309.21
CDC Orrin	2019	3613.91	abc	3205.64	3409.78

Line	Year	Libau E. Wheat		PEI E. Wheat	All Sites
		Yield (kg/ha)		Yield (kg/ha)	Yield (kg/ha)
		Average	Letter Group (P<0.05)	Average	Average
PWA10B-16-LD	2019	2393.21	CD	.	2393.21
PWA12-16-LD	2019	3175.21	A	.	3175.21
BL48A-16-LD	2019	2845.02	ABC	1917.30	2381.158575
BJ13-16-GW	2019	2655.14	BCD	.	2655.14
BJ15-16-GW	2019	2665.2	BCD	1666.78	2165.988158
PWA05A-17-CC	2019	2841.43	ABC	.	2841.43
PWA12-17-CC	2019	3100.97	AB	1950.21	2525.589167
PWA13-17-CC	2019	3161.73	A	.	3161.73
PWA12-17-MB	2019	2816.67	ABC	.	2816.67
BL40A-17-MB	2019	2257.87	D	2154.44	2206.152654
AAC Fairwind	2019	3182.22	A	2378.07	2780.145088
Acadia	2019	2635.4	CD	2056.51	2345.956579
Raven	2019	3209.5	A	2859.14	3034.322368
AAC Scotia	2019	3217	A	2236.91	2726.956689