Saskatchewan Mustard Development Commission

Optimum Seeding Rates for Hybrid Brown Mustard compared to Standard Recommendations of other Varieties

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ADOPT 2019

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Final Report

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2019 Final Report

Abstract
In 2019 a trial titled “Optimum Seeding Rates for Hybrid Brown Mustard compared to Standard Recommendations of other Varieties” took place at three locations in Saskatchewan, which included Swift Current, Indian Head, and Redvers. This project consisted of a 4-replicate demonstration with increasing seeding rates using an open pollinated brown mustard (Centennial) and a new Hybrid brown mustard variety (AAC Brown 18) to demonstrate to producers the optimum rate at which to seed a hybrid variety compared to a conventional variety to achieve optimum yields. The trial looked at seeding rates of 12, 16, 20, 24, and 28 seeds per square foot in both the hybrid and Centennial brown mustard. Mustard seeding rate calculations are based on a target plant population per m^2. Built into these calculations are thousand kernel weight (TKW) and estimated emergence (which includes percent germination and estimated seed mortality). When developing protocols for this project we determined our seeding rates based on a known TKW and germination, and estimated seed emergence at 50 percent, as emergence rates for mustard generally range from 50-80 percent when soil moisture is not limiting. With the poor spring soil moisture conditions experienced in the province in 2019, we saw emergence rates on average of 21% from the hybrid brown mustard and 34% from the Centennial brown mustard, therefore, we were unable to consistently achieve the desired plant populations designed for this project. With the excessively low plant populations at this site, we were not able reach an optimal seeding rate and no recommendations or economic analysis could be made based on the data from this site. What this trial does demonstrate is the vigor and the impressive elasticity built into the hybrid brown mustard giving it the potential to branch out and compensate for thin plant stands to produce yield.

This trial was brought to the attention of the group on the Annual Field Day on July 18, 2019 and was also promoted on a CKSW radio program called "Walk the Plots" which is broadcasted on a weekly basis throughout the summer. This project was also presented by Lana Shaw of the Southeast Research Farm (SERF) at the Crop Production Show on January 16, 2020 in Saskatoon as a part of the Mustard Days.

Project Objectives

The objective of this project is to demonstrate to producers’ optimum seed rates of the new hybrid brown mustard, compared to the current recommended rate of standard varieties, such as Centennial brown. Producers can benefit financially and environmentally from the increased vigor of hybrid varieties.

Project Rationale

The first hybrid brown mustard was developed from the breeding program of Bifang Cheng, the condiment mustard breeder with Agriculture Canada in Saskatoon. The results of her current projects show more than a 20% increase in yield compared to standard brown mustard varieties. Based on the performance of other hybrid crops, the increased vigor of the hybrid brown mustard should be able to better compete with weeds, be more responsive to inputs, and exhibit improved elasticity to compensate for reduced plant establishment, as shown by scientist Ross McKenzie with Alberta Agriculture, Food and Rural Development.

Hybrid brown mustard has shown average yield increases of 24% compared to the Centennial Brown check variety in Co-op Mustard trials in past years. This is a significant yield increase unlike mustard growers have seen, resulting in a high demand for seed. Mustard 21 Canada Inc. is managing the production and launch of the Hybrid Brown Mustard seed. The plan is to gather on-farm experience across the Prairie mustard growing areas by making 80 acres of seed available to about 25 growers in 2019. In 2020 Mustard 21 hopes for a full launch with commercial availability for 50,000 acres. Using a hybrid developed seed and buying new seed every year, gives Canada a competitive advantage in mustard export. Hybrid seed is slightly smaller than other brown varieties (~2.8 grams per 1000 seeds vs. ~3.1 grams per 1000 seeds), therefore establishing an optimum seed rate for each is important. The traditional, standard seeding rate for Centennial brown mustard was 6 lbs/ac, however this is based on outdated research that needs to be fine tuned. To maximize production, producers need to optimize seeding rates based on seeds per square foot rather than lbs/ac, for both Hybrid and other open pollinated brown mustard. Canada is the dominant exporter of all three mustard types. Kevin Hursh, past executive director with the Saskatchewan Mustard Development Commission says that hybrid mustard production will help to keep Canada competitive in the export market.

Methods

This demonstration was set up at three Agri-ARM sites in the province. Preliminary soil samples were taken to determine residual nutrients. In Swift Current, the demonstration was seeded with a 9 row Fabro Cone Seeder and similar equipment at the other two AgriARM sites. Four replicates were seeded and treatments were randomized, so reliable results could be demonstrated and extended to producers. The site was maintained for weed, disease, and pests so as not to influence treatment response. All fertilizer applications were side-banded at seeding to avoid any negative effects of in row fertilizer application and seed was treated with Helix Vibrance.

Treatment list: Seed rate as per protocol treated with Helix Vibrance

Trt	Seed Rate	Variety
1	12 seeds/ft2 (3.2 lbs/ac at 2.8 gm TKW)	Hybrid Brown
2	16 seeds/ft2 (4.3 lbs/ac at 2.8 gm TKW)	Hybrid Brown
3	20 seeds/ft2 (5.4 lbs/ac at 2.8 gm TKW)	Hybrid Brown
4	24 seeds/ft2 (6.5 lbs/ac at 2.8 gm TKW)	Hybrid Brown
5	28 seeds/ft2 (7.5 lbs/ac at 2.8 gm TKW)	Hybrid Brown
6	12 seeds/ft2 (3.6 lbs/ac at 3.1 gm TKW)	Centennial Brown
7	16 seeds/ft2 (4.8 lbs/ac at 3.1 gm TKW)	Centennial Brown
8	20 seeds/ft2 (6.0 lbs/ac at 3.1 gm TKW)	Centennial Brown
9	24 seeds/ft2 (7.1 lbs/ac at 3.1 gm TKW)	Centennial Brown
10	28 seeds/ft2 (8.3 lbs/ac at 3.1 gm TKW)	Centennial Brown

The following measurements were taken:

- Spring soil sample to determine soil nutrients
- Plant Emergence (Plts/m2)
- Lodging (1-9 scale where 1 is upright and 9 is flat)
- Plant Height (cm)
- Maturity
- Clean Grain Yield (kg/ha)
- Economic analysis

Crop Management notes as follows:

Agronomic Table	SERF	WCA	IHARF
Previous crop	Barley	Durum	Canaryseed
Seeding date	08-May-19	09-May-19	16-May-19
Row spacing	10”	8.25"	12”
Soil N Available (lb/ac)	46 (0-24")	302 (0-24”)	18 (0-12”)
Applied Fertilizer (lb/ac)	77-20-0-10	73-08-0-13	100-35-26-09
Herbicide	Centurion	Muster / Assure II	Muster / Assure II
Fungicide	none	none	none
Harvest Date	28-Aug-19	22-Aug-19	20-Sep-19
Pre-harvest Herbicide	none	none	RoundUp 5-Sep-19
Desiccant	none	none	Reglone 15-Sep-19

General Site Conditions

Mean monthly temperatures vs long-term (30 year) means for the 2019 growing seasons at Saskatchewan trial locations.

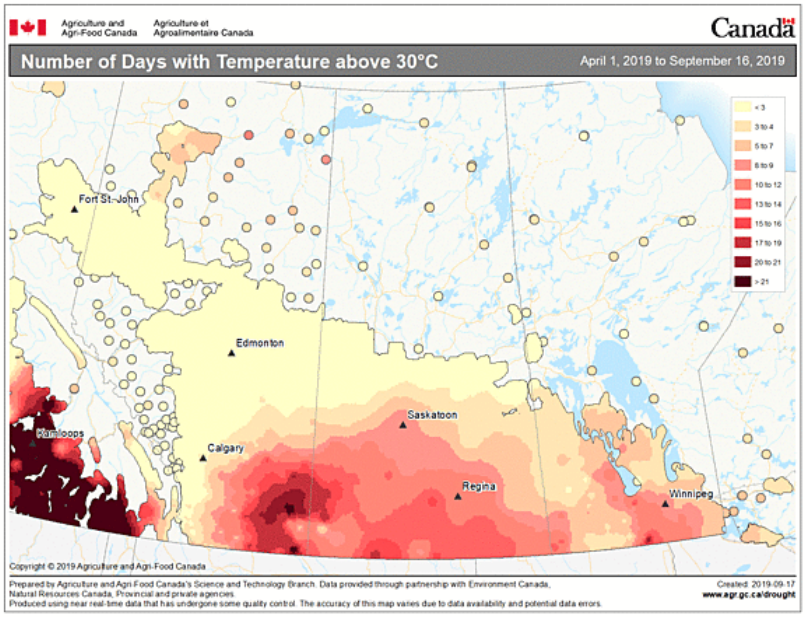
Location	Year	May	June	July	August	Avg. / Total
		----------Mean Temperature (°C) ----------				
Swift Current	2019	9.52	15.78	17.72	16.75	14.9
	Long-term	**10.9**	**15.3**	**18.2**	**17.6**	**15.5**
Redvers	2019	9.5	16.3	18.5	16.6	15.2
	Long-term	**12**	**16**	**19**	**18**	**16.3**
Indian Head	2019	8.9	15.7	17.4	15.8	14.4
	Long-term	**10.8**	**15.8**	**18.2**	**17.4**	**15.6**

Precipitation amounts vs long-term (30 year) means for the 2019 growing seasons at Saskatchewan Trial Locations.

Location	Year	May	June	July	August	Avg. / Total
		---------- *Precipitation (mm)* ----------				
Swift Current	2019	13.3	156	11.1	42.6	223.0
	Long-term	**51.2**	**77.1**	**60.1**	**47.4**	**235.8**
Redvers	2019	18.0	79.0	54.0	88.0	239
	Long-term	**60**	**91**	**78**	**64**	**293**
Indian Head	2019	13.3	50.4	53.1	96.0	212.8
	Long-term	**51.7**	**77.4**	**63.8**	**51.2**	**241.4**

Topsoil moisture was very limited going into spring, but allowed for seeding to advance fairly quickly. Crops were slow to emerge due to a lack of moisture and cool conditions with frost occurring at some sites. Following seeding, cool temperatures and strong winds continued to dry fields slowing crop progression that delayed normal stages of development. Many small seeded crops in the province were reseeded. Late, but much needed rains began in June, leading to highly variable crop conditions and growth stages. Nearly six inches of rainfall was received by the end of June at the Swift Current site. Although still behind normal developmental stages, moisture helped later-seeded crops fill and replenish topsoil moisture, but a variety of growth stages and patchy spring emergence made it difficult to show consistent treatment responses which lead to overall yield penalties.

Temperature maps from the prairie region of Canada in 2019 compared to 2018 growing season (Figure 1) shows the number of days with temperatures above 30 degrees Celsius. In 2019 between April and October, southwest Saskatchewan experienced 12-14 days above 30 degrees Celsius compared to more than 24 days in 2018. The cooler growing conditions in 2019, may have relieved crop stress somewhat compared to 2018, which may have salvaged an average crop yield. Harvest began near the end of August, however, significant rainfall caused delays well into late October creating overall issues with deteriorating grain quality.



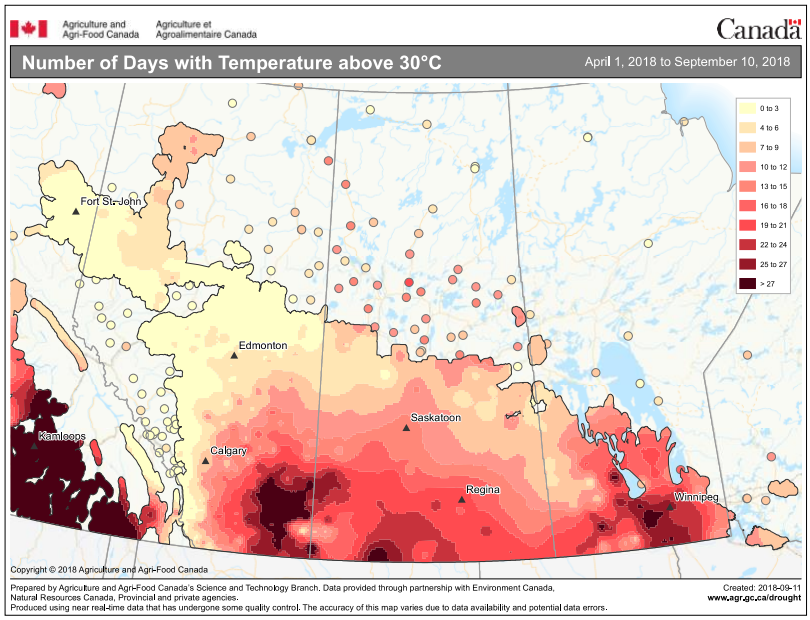


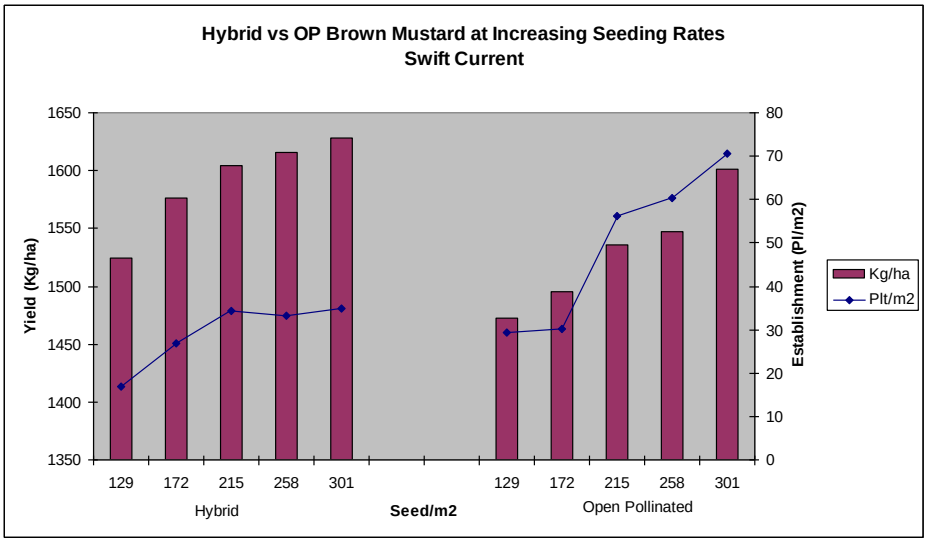
Figure 1. Temperature map of the prairie region of Canada, showing April – September 2019 and 2018 provided by Agriculture and Agri-food Canada.

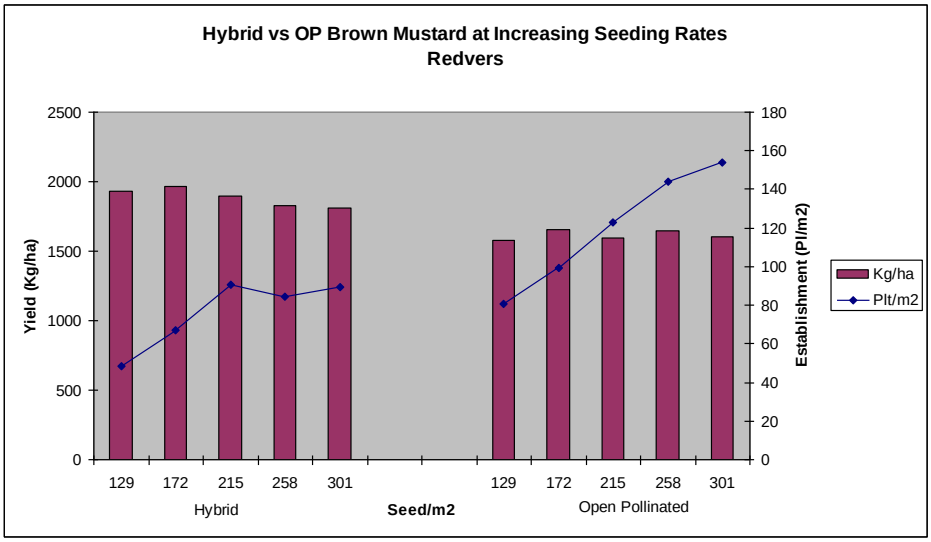
Results

The lack of early spring moisture, cool temperatures, and late spring frosts affected crop emergence, which negatively impacted crop production in 2019 and limited any treatment effects studied in this trial. There were no significant treatment effects on yield, height, lodging, or days to maturity at all sites (Table 1). When looking at the hybrid mustard compared to the open pollinated mustard averaged over all seeding rates, we can pick out positively higher yields in the hybrid mustard at Redvers and Indian Head, and lower establishment rates in the hybrid mustard at all three sites. The current recommended target plant stand for mustard is 70-120 plants/m^2. Plant establishment in this trial was well below this recommended target window at Swift Current and Indian Head, and clearly demonstrated the negative effects of the extreme dry soil moisture conditions. The hybrid brown took the biggest hit in 2019, which may be due to the smaller seed size of the hybrid (TKW=2.8grams) compared to the Centennial (TKW= 3.1 grams). In fact, the only treatment that reached the minimum target plant stand at Swift Current and Indian Head was the highest seeding rate of Centennial brown mustard. Hybrid mustard yields were higher at all three sites even though establishment rates were much lower. This demonstrates the vigorous elasticity of the hybrid and its ability to branch out and compensate for thin plant stands to produce yield when moisture conditions improve. In 2019, despite poor establishment of the hybrid brown mustard, mid-season rains promoted branching, flowering and pod development producing higher yields than the corresponding Centennial brown mustard at each seeding rate treatment.

Table 1. Individual treatment means for plant establishment, height, and yield comparing Hybrid brown and Centennial brown mustard at all trial locations in 2019.

		Swift Current					Redvers					Indian Head				
		Yield	Pl Est.	Height	Lodging	DTM	Yield	Pl Est.	Height	Lodging	DTM	Yield	Pl Est.	Height	Lodging	DTM
Tmt #	Seed Rate	Kg/ha	Pl/m2	cm	(1up-9)	days	Kg/ha	Pl/m2	cm	(1up-9)	days	Kg/ha	Pl/m2	cm	(1up-9)	days
1	129 seeds/m2,HYBRID	1525	16.8	109	2.8	94.5	1930	48.4	124	2.3	87.8	2059	22.1	105	7.3	
6	129 seeds/m2,OP	1473	29.3	105	1.5	90.5	1582	80.8	118	2.3	87.3	1841	32.2	102	7.5	
2	172 seeds/m2,HYBRID	1576	26.8	105	1.6	91.0	1964	66.8	129	3.0	86.5	2152	24.2	107	7.6	
7	172 seeds/m2,OP	1496	30.3	105	1.4	89.8	1658	99.2	118	2.5	87.0	1907	25.6	100	7.3	
3	215 seeds/m2,HYBRID	1604	34.3	107	1.9	89.5	1897	90.4	128	3.0	85.5	2136	29.3	105	7.6	
8	215 seeds/m2,OP	1536	56.3	109	1.6	89.5	1595	123.2	115	2.7	88.2	1965	49.6	102	7.1	
4	258 seeds/m2,HYBRID	1616	33.3	109	1.6	89.8	1827	84.5	120	2.8	86.3	2181	31.0	106	7.9	
9	258 seeds/m2,OP	1547	60.3	108	1.3	89.5	1645	143.9	115	2.3	86.3	1852	60.1	108	7.8	
5	301 seeds/m2,HYBRID	1628	35.0	105	1.5	89.5	1812	89.4	121	2.5	85.8	2111	43.5	102	7.8	
10	301 seeds/m2,OP	1601	70.5	108	1.4	89.0	1600	153.8	119	3.0	88.3	1842	80.0	102	7.8	
	HYBRID	1590	**29.2**	107	**1.9**	90.9	**1886**	**75.9**	124	2.7	86.4	**2128**	**30.0**	105	7.6	
	OP	1531	**49.3**	107	**1.4**	89.7	**1616**	**120.2**	117	2.5	87.4	**1882**	**49.5**	103	7.5	
	129 seeds/m2	1499	**23.0**	107	2.1	92.5	1756	**64.6**	121	2.3	87.5	1950	**27.2**	103	7.4	
	172 seeds/m2	1536	**28.5**	105	1.5	90.4	1811	**83.0**	124	2.8	86.8	2030	**24.9**	103	7.4	
	215 seeds/m2	1570	**45.3**	108	1.8	89.5	1746	**106.8**	122	2.9	86.8	2051	**39.5**	104	7.4	
	258 seeds/m2	1582	**46.8**	108	1.4	89.6	1736	**114.2**	117	2.5	86.3	2017	**45.5**	107	7.8	
	301 seeds/m2	1615	**52.8**	106	1.4	89.3	1706	**121.6**	120	2.8	87.0	1976	**61.7**	102	7.8	





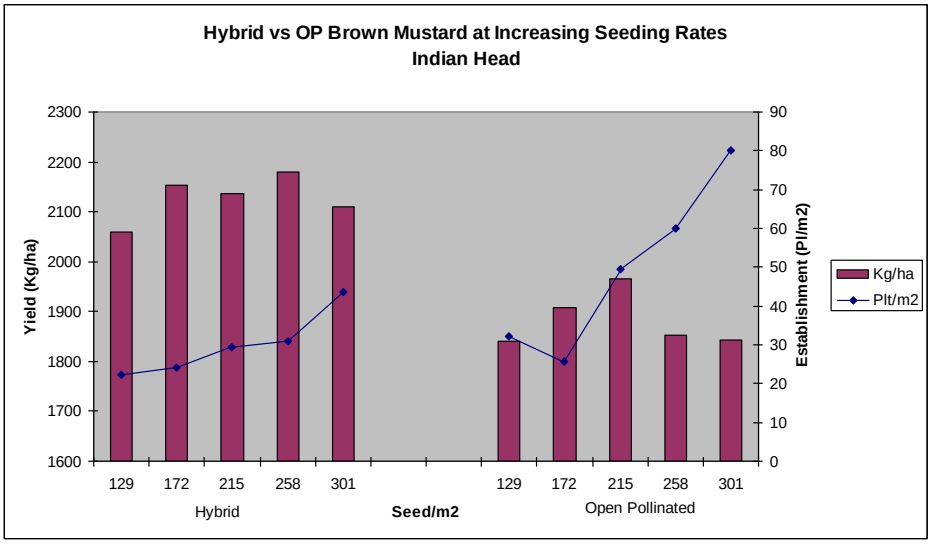


Figure 2. Establishment and yield of Hybrid Brown Mustard vs. Centennial Brown Mustard with increased seeding rate for each individual site (Swift Current, Redvers, and Indian Head) in kg/ha.

Mustard seeding rate calculations are based on a target plant population per m^2. Built into these calculations are thousand kernel weight (TKW) and estimated emergence (which includes percent germination and estimated seed mortality). When developing protocols for this project we determined seeding rates based on a known TKW and germination, and estimated seed emergence at 50%. Emergence rates for mustard generally range from 50-80% when soil moisture is not limiting. With the poor spring soil moisture conditions experienced in the province in 2019, we saw emergence rates on average of 21% from the hybrid brown mustard and 34% from the Centennial brown mustard, therefore, we were unable to consistently achieve the desired plant populations designed for this project (Table 1). With the excessively low plant populations at this site, we were not able reach an optimal seeding rate and no recommendations or economic analysis could be made based on the data from this site. What this trial does demonstrate is the vigor and the impressive elasticity built into the hybrid brown mustard giving it the potential to branch out and compensate for thin plant stands to produce yield.

Plant heights and lodging were similar in this study in 2019 for both the hybrid or the centennial brown mustard, even though the hybrid brown had a slightly higher lodging rating than the centennial at Swift Current (Table 1). This is likely a result of increased branching and pod development on the thin stand exhibited by the hybrid variety. On a scale of 1-9 (1 being totally upright and 9 being totally flat), the average lodging rating for the hybrid mustard was about 1.9 of 9 where the centennial rated about 1.4 of 9 at the Swift Current site. The other two sites had higher lodging ratings, however, there was little difference between the hybrid and the open pollinated variety.

This information compliments the research done by Bifang Cheng at AAFC in Saskatoon, as the mustard hybrid technology can outperform the centennial brown by double digit yield increases to stay competitive with domestic crops and global export over the next decade. AAC Brown 18 is the first Brown Hybrid Mustard available in 2020, providing higher yields, greater weed competition and a higher quality of seed in comparison to the centennial brown check. After breeding superior yield into hybrid seed technology is accomplished, we can begin to select for other lines with key traits like oil content, protein content and resistance to diseases such as blackleg and white rust.

This trial was brought to the attention of the group on the Annual Field Day held July 18, 2019 (120 participants) by Kevin Hursh, past Executive Director for the Saskatchewan Mustard Development Commission and Matthew Bernard from the Saskatchewan Ministry of Agriculture. The project was also promoted on a CKSW radio program called "Walk the Plots" that is broadcasted on a weekly basis throughout the summer. Results of this trial were presented at winter meetings and workshops including Crop Production Week in Saskatoon on January 16, 2020 by Lana Shaw of SERF at the Mustard Meetings. Results will be also shared locally at Cropportunities 2020 on March 11th in Swift Current (200+ expected participants). A summary will also be posted on our website at www.wheatlandconservation.ca.

Conclusions and Recommendations

Mustard seeding rate calculations are based on a target plant population per m^2. Built into these calculations are thousand kernel weight (TKW) and estimated emergence (which includes percent germination and estimated seed mortality). When developing protocols for this project we determined our seeding rates based on a known TKW and germination, and estimated seed emergence at 50%. Emergence rates for mustard generally range from 50-80% when soil moisture is not limiting. With the poor spring soil moisture conditions experienced in the province in 2019, we saw emergence rates on average of 21% from the hybrid brown mustard and 34% emergence from the Centennial brown mustard, therefore, we were unable to consistently achieve the desired plant populations designed for this project. With the excessively low plant populations at this site, we were not able reach an optimal seeding rate and no recommendations or economic analysis could be made based on the data from this site. What this trial does demonstrate is the vigor and the impressive elasticity built into the hybrid brown mustard giving it the potential to branch out and compensate for thin plant stands to produce yield. Knowing this, future studies can be developed around these findings. A similar study will be done in 2020 at all three sites under the Strategic Field Program looking at an expanded list of seeding rates, which will demonstrate the elasticity of the hybrid variety and develop an optimum seeding rate for future hybrid varieties.

Many growers in the province are opting out of growing mustard acres as it has not kept up with technological advances driving the competitiveness of other Canadian crops. Double digit increases to yield can keep mustard competitive with domestic crops and global export by remaining a valuable business option as a rotational crop for our mustard growers. As AAC Brown 18 becomes available, it is important for growers to optimize seeding rates to maximize yield potential. Since the first developed condiment hybrid brown mustard has launched commercially in 2020, more research is required to develop an optimum seeding rate and to further explore the vigor and elasticity of hybrid mustards and their ability to compensate for a reduced plant stand to produce yield. Mustard has not kept up technologically in previous years compared to other Canadian crops due to the huge financial commitment of research and development for such a small acreage crop making a significant increase in yield a main strategic priority for Mustard 21.

Acknowledgements

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