Saskatchewan Mustard Development Commission

Optimum Nitrogen Fertilizer Rates for Hybrid Brown Mustard

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ADOPT 2019

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Final Report

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2019 Final Report

Abstract

In 2019 a trial took place in Swift Current and Indian Head, Saskatchewan titled, “Optimum Nitrogen Fertilizer Rates for Hybrid Brown Mustard.” This project consisted of a 4-replicate demonstration with increasing rates of Nitrogen using an open pollinated brown mustard (Centennial) and a new hybrid brown mustard variety (AAC Brown 18) to demonstrate optimum fertility management practices and dismiss the myth that mustard does not respond to inputs as well as other crops. The fertility trial looked at side banded nitrogen rates as follows: Soil N only, 30, 50, 70, 90, 110, 130 lbs total N (residual plus applied N). A blanket application (40 lbs P2O5 and 25 lbs S) was applied across all treatments and also side banded. Results from 2019 showed that yields in the hybrid brown increased with increasing N up to 90lbs N followed by declining yields at 110 and 130 lbs total N. The Centennial brown was somewhat more variable with yields increasing up to the 70 lbs rate, then declining yields at 90 and 110 lbs, followed by another slight increase at the 130 lb total N rate. At Indian Head, yields increased with increasing N rates in the open pollinated mustard and yields increased with increasing N rates up to 110 lbs/ac N in the hybrid mustard and leveled off at the130 lb rate. Overall average yield of the Centennial brown was 25.9 bus/ac in Swift Current and 27.6 bus/ac in Indian Head. The overall average yield of the hybrid brown was 29.1 bus/ac in Swift Current and 29.2 bus/ac in Indian Head, a 12% increase in the hybrid at Swift Current and a 6% increase in the hybrid at Indian Head. Considering the low establishment rates due to excessively dry growing conditions this spring and the flea beetle damage at Indian Head, particularly in the hybrids, 12% and 6% is a substantial increase. This trial was brought to the attention of the group at the Annual Field Day on July 18, 2019 and was also promoted on a CKSW radio program called "Walk the Plots" which was broadcasted on a weekly basis throughout the summer. This project was also presented by Lana Shaw at the Crop Production Show on January 16, 2020 in Saskatoon in as a part of the Mustard Days.

Project Objectives

The objective of this project is to demonstrate to producers’ optimum fertility management practices in hybrid brown mustard, by varying nitrogen fertilizer rates and to promote the findings of Dr. Ross McKenzie that dismiss the myth that mustard does not respond to inputs as well as other crops[1]. Producers can benefit financially and environmentally from a nitrogen response curve by preventing both under and over applying nutrients.

Project Rationale

Fertilizer recommendations and other agronomic information for mustard production is predominantly based on mid-1970s data and area producers have traditionally thought of mustard as an inexpensive crop to grow, requiring fewer inputs such as nitrogen. However, more recently research scientist Ross McKenzie with Alberta Agriculture, Food and Rural Development

1 Mustard fertilizer management. Grain News. Ross McKenzie. March 23, 2016. https://www.grainews.ca/2016/03/23/mustard-fertilizer-management/

(AAFRD) at Lethbridge has completed a four-year study to update the recommendations for mustard production. The results of his study in southern Alberta show a high response to nitrogen fertilizer and producers can benefit from higher yields by investing in crop inputs. Juncea mustards (brown and oriental) were somewhat more responsive than yellow mustards at most sites. McKenzie says that the optimum N fertilizer rate is a function of stored soil N, stored soil moisture (SSM) at seeding and expected growing season precipitation (GSP). This project is relevant to producers in numerous ways. By preventing both under application or over application of nutrients will benefit producers financially and environmentally. Since the traditional way of thinking suggests a mustard crop requires fewer inputs, there may be a tendency to under apply nutrients resulting in lower yields and less profits. By establishing a nitrogen response curve for mustard crops in SW Saskatchewan, similar to that recently established by Dr. McKenzie in Lethbridge, area producers can benefit by targeting optimal application rates.

Methods

This demonstration was set up at two Agri-ARM sites in the province. Preliminary soil samples were taken to determine residual nutrients. The trial was direct seeded with a Fabro built Cone Seeder at Swift Current into durum stubble and a SeedMaster plot drill at Indian Head into canary seed stubble (Table 1). Helix Vibrance was applied as a pre-seed treatment. This project consisted of 7 nitrogen rates in both centennial brown mustard and hybrid brown mustard and included 4 replicates to better demonstrate consistent fertility effects. Fertilizer N was added to the amount of stored soil N to achieve the following rates of total available N.

1) Stored soil N only- Hybrid Brown mustard
2) 30 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
3) 50 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
4) 70 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
5) 90 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
6) 110 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
7) 130 lb/ac total N (Stored soil + Fertilizer N) - Hybrid Brown mustard
8) Stored soil N only- Centennial Brown mustard
9) 30 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard
10) 50 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard
11) 70 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard
12) 90 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard
13) 110 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard
14) 130 lb/ac total N (Stored soil + Fertilizer N) - Centennial Brown mustard

To insure other nutrients were none limiting, all treatments at each site received a balaced side banded application of P, K, and S to maximize mustard production.

The follwing measurements were taken:

- Soil Sample to determine stored soil nitrogen
- Crop Establishment – plants/m^2
- Lodging (1-9 scale where 1 is upright and 9 is flat)
- Crop Height – cm
- Yield – bu/ac
- Pictures to capture visual differences for extension purposes

Table 1. Crop Management notes as follows:

Agronomic Table	WCA	IHARF
Previous crop	Durum	Canaryseed
Seeding date	08-May-19	16-May-19
Row spacing	8.25"	12"
Seeding rate	22 seeds/ft2	220 seeds/m2
Blanket Nutrient (lb/ac)	13-40-0-25	8-40-30-10
Herbicide	Muster / Assure II	Muster / Assure II
Fungicide	none	none
Harvest Date	22-Aug-19	20-Sep-19
Pre-harvest Herbicide	none	RoundUp 5-Sep-19
Desiccant	none	Reglone 15-Sep-19

General Site Conditions

Table 2. 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**
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**

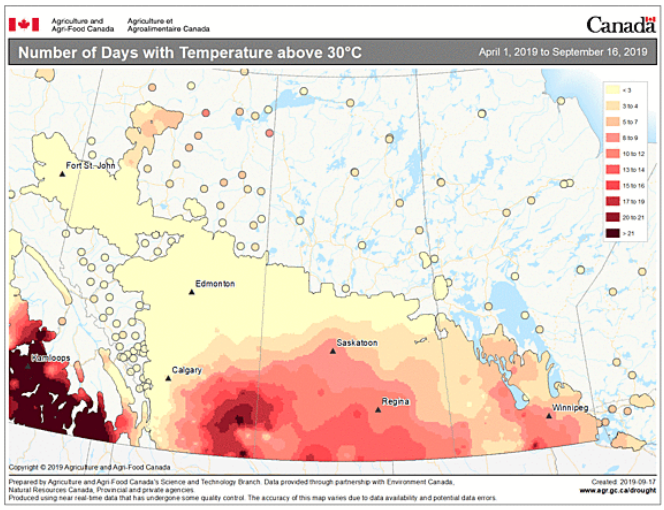
Table 3. Mean monthly precipitation vs long-term (30 year) means for the 2019 growing seasons at Saskatchewan Trial Locations.

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**
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 at both sites, but allowed for seeding to advance fairly quickly (Table 2, Table 3). Crops were slow to emerge due to a lack of moisture and

cool conditions with frost occurring more than once. Following seeding, cool temperatures and strong winds continued to dry fields slowing crop progression that delayed normal stages of development. Many of our small seeded trials were reseeded. Late, but much needed rains began June 14th leading to highly variable crop conditions. Nearly six inches of rainfall was received by the end of June. 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. Strong winds and little precipitation in July in Swift Current caused topsoil moisture to deteriorate further and flea beetle damage at Indian Head, resulted in poor crop development and, for the most part, overall yield penalties.

Temperature maps from the Prairie Region of Canada in 2019 compared to the 2018 growing season (Figure 1) shows the number of days with temperatures above 30 degrees Celsius. 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 issues with deteriorating grain quality.



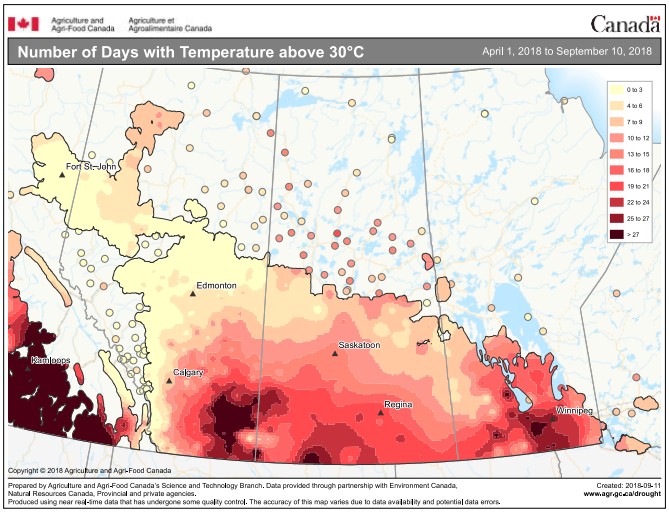


Figure 1. Temperature map of the prairie region of Canada, showing April – September, 2019 (top) and 2018 (bottom) provided by Agriculture and Agri-food Canada.

Results

The lack of early spring moisture, cool temperatures, flea beetle damage, and late spring frosts affected crop emergence, which negatively impacted crop production in 2019. The recommended minimum target plant stand for mustard is 70 plants/m2. Plant establishment in this trial, when averaged across all treatments for each crop was poor (Figure 2). At Swift Current we recorded 26 pl/m2 for the hybrid brown and 47 pl/m2 for the centennial brown mustard. Indian Head recorded 32 pl/m2 for the hybrid brown and 64 pl/m2 for the centennial brown mustard. Establishment was well below the recommended target plant density, and clearly demonstrated the negative effects of the extreme dry soil moisture conditions. The hybrid brown taking 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).

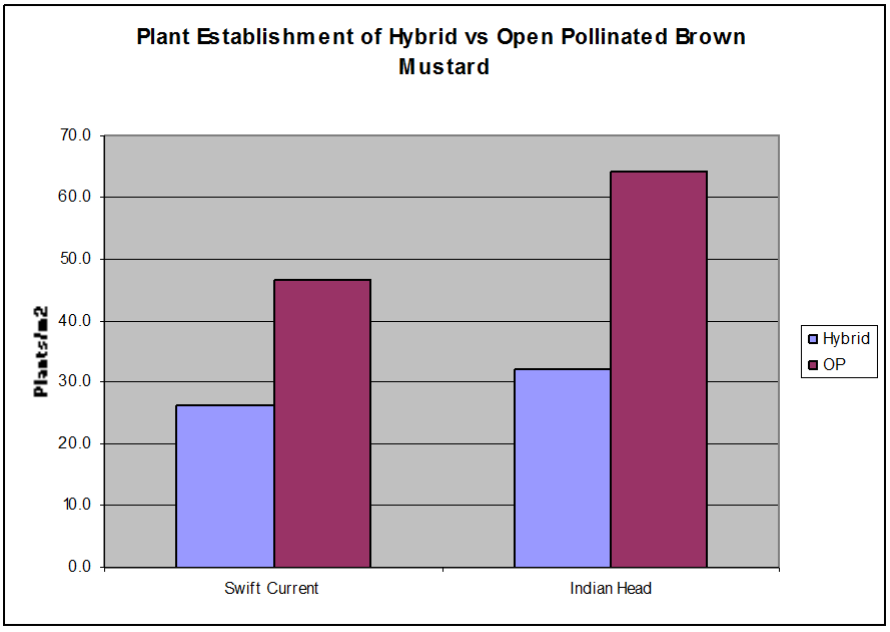
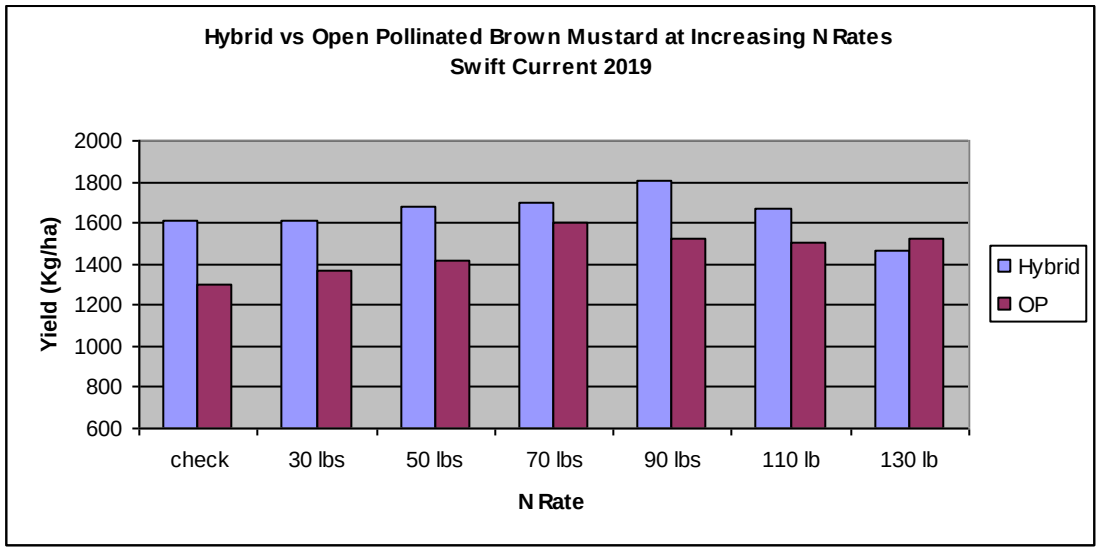


Figure 2. Plant establishment of Hybrid Brown and Centennial Brown Mustard (Swift Current and Indian Head) in plants/m2.

Results from 2019 in Swift Current showed that yields in the hybrid brown increased with increasing N up to 90 lbs N followed by declining yields at 110 and 130 lbs total N (Figure 3, top) The Centennial brown was somewhat more variable with yields increasing up to the 70 lbs rate, then declining yields at 90 and 110 lbs, followed by another slight increase at the 130 lb total N rate. At Indian Head, yields increased with increasing N rates in the open pollinated mustard and yields increased with increasing N rates up to 110 lbs/ac N in the hybrid mustard and leveled off at the130 lb rate (Figure 3, bottom). Overall average yield of the Centennial brown was 25.9 bus/ac in Swift Current and 27.6 bus/ac in Indian Head (Table 4). The overall average yield of the hybrid brown was 29.1 bus/ac in Swift Current and 29.2 bus/ac in Indian Head, a 12% increase in the hybrid at Swift Current and a 6% increase in the hybrid at Indian Head. Considering crop establishment rates, well below the recommended rates, particularly in the hybrids, 12% and 6% is a substantial yield increase.

Mid-season rains at both sites promoted branching, flowering and pod development producing average yields. The vigorous nature of the hybrid mustard appears to better utilize higher rates of N to promote branching, pod development, and higher yields, even though plant stands started off very thin compared to the Centennial brown mustard.



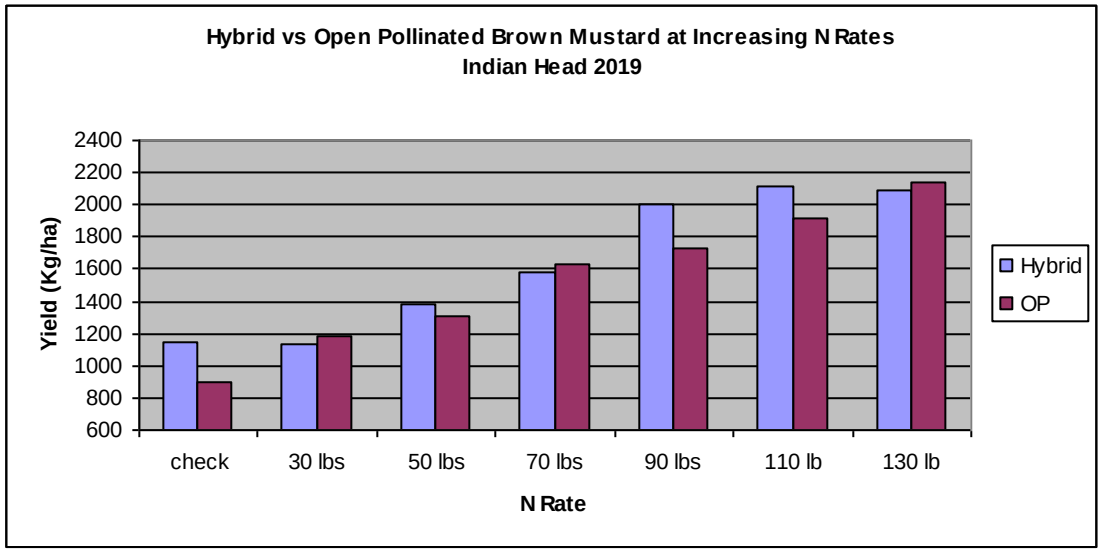


Figure 3. Yield of Hybrid Brown Mustard vs. Centennial Brown Mustard with increasing nitrogen rate at each individual site (Swift Current, top, and Indian Head, bottom) in kg/ha.

Table 4. Plant establishment, height, and yield comparing Hybrid brown and Centennial brown mustard 2019.

		Swift Current					Indian Head			
		Lodge	Establ	Height	Yield		Lodge	Establ	Height	Yield
TRT #	Mustard	(1up-9)	Pl/m2	cm	Kg/ha		(1up-9)	Pl/m2	cm	Kg/ha
1	Hybrid check	2.50	25.0	97	1615		4.75	29.7	106	1149
2	Hybrid 30 lb N	2.50	25.5	98	1615		5.75	22.6	109	1138
3	Hybrid 50 lb N	1.63	38.5	98	1675		6.00	32.2	111	1384
4	Hybrid 70 lb N	1.75	31.0	96	1694		6.38	34.2	115	1582
5	Hybrid 90 lb N	2.00	22.0	104	1810		7.50	43.3	112	2007
6	Hybrid 110 lb N	2.25	27.8	104	1674		7.88	33.2	113	2110
7	Hybrid 130 lb N	1.50	19.0	96	1465		7.00	29.5	111	2091
8	OP check	1.63	49.5	102	1305		4.75	90.2	107	894
9	OP 30 lb N	1.38	50.3	103	1373		5.75	63.6	107	1187
10	OP 50 lb N	1.63	44.3	105	1414		5.75	56.2	107	1308
11	OP 70 lb N	1.50	58.0	101	1602		6.13	53.1	105	1630
12	OP 90 lb N	1.63	43.9	110	1528		7.00	77.3	106	1731
13	OP 110 lb N	1.13	43.9	112	1500		7.13	49.2	111	1922
14	OP 130 lb N	1.38	39.8	115	1528		7.50	59.5	110	2139
1&8	check	2.06	37.3	99	1455		4.75	60.0	107	1022
2&9	30 lbs	1.94	37.0	95	1485		5.75	43.1	108	1163
3&10	50 lbs	1.63	41.4	101	1532		5.88	44.2	109	1346
4&11	70 lbs	1.63	44.5	99	1609		6.25	43.7	110	1606
5&12	90 lbs	1.81	29.0	104	1652		7.25	60.3	109	1869
6&13	110 lb	1.69	34.9	100	1579		7.50	41.2	112	2016
7&14	130 lb	1.44	31.4	102	1484		7.25	44.5	111	2115
1-7	Hybrid	2.02	26.1	95	1631		6.46	32.1	111	1637
8-14	OP	1.46	46.8	105	1454		6.29	64.2	108	1545

As seasonal moisture increases, the need for nitrogen fertilizer also tends to increase. Even though the spring of 2019 was dry and emergence was less than ideal, we did see a positive fertilizer response at Swift Current. Indian Head saw a much greater response to N likely due to wetter conditions during flowering and seed set. This reiterates the fact that mustard has a good response to nitrogen fertilizer inputs and producers can use the optimum rate for maximum yield increases that will benefit them financially and environmentally. 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 N fertilizer rates, which will demonstrate the elasticity of the hybrid variety and develop an optimum nitrogen rate for future hybrid varieties.

Another notable agronomic difference aside from yield was height. All seven nitrogen treatments of centennial brown mustard were taller than all the hybrid brown mustard treatments in Swift Current. When averaged across all treatments, the average height of the centennial was 105 cm compared to the average of the hybrid brown at 95 cm. At Indian Head, the heights were fairly similar. Lodging was more of an issue at Indian Head for both the hybrid and the centennial brown mustard, with the hybrid brown having a slightly higher lodging rating than the centennial. 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 in Swift Current was about 1.9 of 9 where the centennial rated about 1.4 of 9. The average lodging rating for the hybrid mustard at Indian Head was 6.5 of 9 where the centennial rated 6.3 of 9.

This information compliments of the research of Bifeng Chang 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 Hybrid Brown Mustard available, 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 the Executive Director for the Saskatchewan Mustard Growers 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 Show 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 be posted on our website at www.wheatlandconservation.ca.

Conclusions and Recommendations

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. In the past growers have traditionally thought of mustard as an inexpensive crop to grow, requiring fewer inputs resulting in lower yields. As AAC Brown 18 is now available, it is important for growers to have a nitrogen response curve developed to avoid under, or over applying nutrients so as to maximize return and achieve the yield hybrid seed is capable of. The first developed condiment hybrid brown mustard launched commercially in 2020. 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.

This project demonstrated that mustard is responsive to nitrogen fertilizer inputs, which is the most influential agronomic factor controlling mustard yield and quality. Despite dry spring conditions and less than ideal emergence, this trial demonstrated the elastic properties of the hybrid mustard by promoting branching and pod development. Results from 2019 in Swift Current showed that yields in the hybrid brown increased with increasing N up to 90 lbs N followed by declining yields at 110 and 130 lbs total N. The Centennial brown was somewhat more variable with yields

increasing up to the 70 lbs rate, then declining yields at 90 and 110 lbs, followed by another slight increase at the 130 lb total N rate. At Indian Head, yields increased with increasing N rates in the open pollinated mustard and yields increased with increasing N rates up to 110 lbs/ac N in the hybrid mustard and leveled off at the130 lb rate. Considering crop establishment rates, well below the recommended rates, the vigorous nature of the hybrids appeared to better utilize higher rates of N to promote branching, pod development, and higher yields even though plant stands started off very thin compared to the Centennial brown mustard. As nitrogen uptake is directly correlated with stored soil nitrogen and moisture, nitrogen applications may have appeared more effective in a greater precipitation year and yield margins may have been greater.

As other hybrid mustards such as oriental and synthetic yellow become available in the coming years other important traits like oil and protein content can be selected for to ensure Canada's place in mustard export for the future. More research will be done in 2020 at all three sites under the Strategic Field Program looking at an expanded list of N fertilizer rates, which will demonstrate the elasticity of the hybrid variety and develop a newly updated nitrogen response curve, as well as an optimum seed rate to further demonstrate differences between centennial brown and the new hybrid mustard.

Acknowledgements

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