2020 Annual Report

for the

Saskatchewan Ministry of Agriculture's

Agricultural Demonstration of Practices & Technologies (ADOPT) Program

Project Title: Dry Bean Response to Nitrogen Fertilizer Rate in Dryland, Solid-Seeded Production

(Project #20190433)

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Project Identification

1. **Project Title:** Dry bean response to nitrogen fertilizer rate in dryland, solid-seeded production
2. **Project Number:** 20190433
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation
4. **Project Location(s):** Field trials were located at Indian Head (#156), Melfort (#428), Redvers (#61), and Yorkton (#244), Saskatchewan
5. **Project start and end dates(s):** April-2020 to February-2021
6. **Project contact person & contact details:**

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Objectives and Rationale

7. **Project Objectives:**
The objective of the proposed project was to demonstrate the response of dryland, solid-seeded black beans to varying rates of nitrogen (N) fertilizer across a range of environments in Saskatchewan.

8. **Project Rationale:**
Dry beans are a relatively high value human food crop that may have potential to add diversity to regions that usually produce peas or soybeans as the sole pulse crop options. For many regions of Saskatchewan, pea production has been hindered by Aphanomyces root rot problems and one of the strategies for coping with this disease is to grow non-host pulses like dry beans in a crop rotation. Soybeans have seen increased uptake in Saskatchewan as a result of production issues with pea and lentil; however, production and acres of this crop have declined recently due to drier conditions and subsequently poor yields. CDC Blackstrap (Bett 2015) is arguably the first commercially acceptable dry bean variety adapted to dryland, narrow-row production systems in Saskatchewan. These black beans can be seeded using no-till drills and straight-cut using a combine with a flex-header. The seeds are about half the weight of CDC Pintium, the variety dryland producers were encouraged to grow in the early 2000's. CDC Pintium seed was highly susceptible to damage in the air seeder due to its large and fragile seeds. There has been very little commercial dry bean production in dryland areas prior to the introduction of CDC Blackstrap; however, black bean production can be profitable in the regions of Saskatchewan that receive sufficient August rainfall.

Dry beans, although they are a legume, are poor at fixing atmospheric nitrogen and production of effective inoculant products has been problematic for a variety of reasons (personal communication – Garry Hnatowich). Most commercial dry bean production does not utilize inoculant but, instead, relies on N fertilizer and soil N to meet the needs of the crop. Shirtliffe and Painchaud (2000) conducted some Saskatchewan dryland N fertility trials in 1999-2000 using CDC Camino and CDC

Expresso. There was a response to N fertilizer applications, but overall productivity was low. In Maine, Liebman et al. (1995) found that dry bean yields increased linearly with N rates up to 135 kg N/ha for both no-till and conventional systems. There is some uncertainty regarding both the overall yield potential and optimal N rates for black beans under dryland production in Saskatchewan. This project was initiated to provide useful N fertility information to producers who want to grow black beans so that they can improve their chances of success. It was also intended to demonstrate the broader yield potential for dryland dry bean production throughout the Black soil zone of Saskatchewan which is of considerable interest to growers and agronomists seeking alternatives to field peas in these regions.

Literature Cited

Bett, Kirstin. 2015. Black Bean: CDC Blackstrap Variety Description. https://saskpulse.com/files/technical_documents/190328_CDC_Blackstrap_Variety_description.pdf

Liebman, M., Corson, S., Row, R. J., and W. A. Halterman. 1995. Dry bean responses to nitrogen fertilizer in two tillage and residue management systems. Agron. J. **87:** 538-546.

Shirtliffe, S and J. Painchaud. 2000. The effect of nitrogen fertilizer on the yield of dry beans in Saskatchewan. Reports of Bean Improvement Cooperative and National Dry Bean Council Research Conference. Pg. 120-121.

Methodology and Results

9. Methodology:

Field demonstrations with CDC Blackstrap dry bean were initiated near Indian Head, Melfort, Redvers, and Yorkton in 2020. All these locations are within the Black soil zone of Saskatchewan which is also the climatic zone where dry bean production is most likely to be successful in the absence of irrigation. The treatments were simply six N rates which included an unfertilized control, 45, 75, 105, 135, and 165 kg N/ha (soil residual plus fertilizer) with side-banded urea as the primary N source. For the control, the only N available to the crop was provided by the soil and any monoammonium phosphate (11-52-0) that was applied.

Selected agronomic information is provided in Table A-1 of the Appendices. Certified seed from the same seed source was utilized by all locations and all used a target rate of 40 viable seeds/m^2. The seed was placed at least 3 cm deep but seeding equipment varied across locations. The plots were rolled after seeding to break up any soil lumps and push any stones down so that they would not interfere with combining. Weeds were controlled using registered pre-emergent and in-crop herbicides with supplemental hand weeding where required. Fungicides were applied to suppress sclerotinia and other leaf diseases at the discretion of individual site managers. Pre-harvest herbicides were utilized as required to assist with crop drydown and provide late-season weed control. The centre rows of each plot were straight-combined when it was fit to do so.

Various data were collected during the growing season and from the harvested seed. Residual nutrient levels were estimated from composite soil samples collected in the early spring for three depths, 0-15 cm, 15-30 cm, and 15-60 cm. The results from the soil samples were used to adjust the target N rates. Spring plant densities were determined by counting seedlings in a minimum of 2 x 1 m sections of crop row after emergence was complete and calculating plants/m^2. Mean plant height was estimated by measuring 4-8 plants per plot to the nearest 1 cm. If present, disease (sclerotinia and/or bacterial blight) were rated on a scale of 0-10. The maturity date, when 60% of the pods had reached the buckskin stage (beans turned yellow but pods still flexible), was recorded for each plot. Grain yields were determined from the harvested grain samples and are corrected for dockage and to 16% seed moisture content. Seed weight was determined by counting and weighing a minimum of approximately 500 seeds and calculating g/1000 seeds. Daily temperatures and precipitation amounts were recorded from the nearest Environment and Climate Change Canada weather station for each location.

Response data were analyzed using the Mixed procedure of SAS with the effects of N rate considered fixed and replicate effects treated as random. Orthogonal contrasts were used to test whether responses to N rate were linear, quadratic (curvilinear), or not significant. For the orthogonal contrasts, residual soil N and N provided by monoammonium phosphate (MAP) were accounted for in the control treatments. The response data were not combined across locations due to differences in number of viable treatments between locations. Fisher's protected LSD test was used to separate individual treatment means and all treatment effects and differences between means were considered significant at $P \leq 0.05$.

10. Results:

Growing season weather and residual soil nutrients

Mean temperatures and total precipitation amounts for May through August at each location are presented with the long-term averages in Tables 1 and 2 below. Overall growing season temperatures were near average at Indian Head and Melfort, but above average at Redvers and Yorkton (Table 1). All locations were drier than average over the four-month growing period (Table 2). Indian Head was the driest location with only 113 mm of precipitation from May through August, or 46% of the 30-year average. Melfort was the wettest (and coolest) location with a total of 201 mm of precipitation, 89% of the long-term average. The total amount of precipitation received at Redvers and Yorkton was 180-181 mm, 66-68% of their long-term averages. With respect to weather, dry beans are highly sensitive to spring or fall frost and moisture stress (i.e., drought) during flowering and pod formation. They also have poor tolerance to saturated soils early in the season. For all the locations, the overall weather was not ideal for dryland bean production.

Table 1. Mean monthly temperatures with long-term (1981-2010) averages for the 2020 growing season at Indian Head (IH), Melfort (ME), Redvers (RV), and Yorkton (YK), Saskatchewan.

Year	May	June	July	August	May-Aug
	-------------	-------------	Mean Temperature (°C)	-------------	-------------
IH-20	10.7	15.6	18.4	17.9	15.7 (101%)
IH-LT	10.8	15.8	18.2	17.4	15.6
ME-20	10.1	14.3	18.2	17.6	15.1 (99%)
ME-LT	10.7	15.9	17.5	16.8	15.2
RV-20	11.2	18.2	20.1	19.0	17.1 (107%)
RV-LT	11.1	16.2	18.7	18.0	16.0
YK-20	10.5	16.4	19.9	18.3	16.3 (107%)
YK-LT	10.4	15.5	17.9	17.1	15.2

Table 2. Monthly total precipitation amounts with long-term (1981-2010) averages for the 2020 growing season at Indian Head (IH), Melfort (ME), Redvers (RV), and Yorkton (YK), Saskatchewan.

Year	May	June	July	August	May-Aug
	------ Total Precipitation (mm) ------				
IH-20	27.3	23.5	37.7	24.9	113 (46%)
IH-LT	51.8	77.4	63.8	51.2	244
ME-20	26.7	103.7	52.4	18.5	201 (89%)
ME-LT	42.9	54.3	76.7	52.4	226
RV-20	20.4	63.2	62.4	34.5	181 (68%)
RV-LT	60.0	95.2	65.5	46.6	267
YK-20	16.7	33.6	80.1	49.3	180 (66%)
YK-LT	51.3	80.1	78.2	62.2	272

Soil test results for each location are provided in Table 3. At Indian Head and Yorkton, the sampling depths were 0-15 cm, 15-30 cm, and 30-60 cm. The 30-60 cm depth was not collected at Melfort while, at Redvers, the increments were 0-15 cm and 15-60 cm. Indian Head, Redvers, and Yorkton had intermediate organic matter levels of 3.6-4.8% while the organic matter at Melfort was much higher, but typical for the region at 10.3%. All N application rates, except for the control, were to be adjusted for residual NO_3-N in the 0-30 cm soil profile; however, at Redvers residual NO_3-N from 0-60 cm was accounted for in the application rates. For both Melfort and Redvers, residual NO_3-N levels plus the N provided by MAP totalled 50 kg/ha. Therefore, no urea N was required to achieve the 45 kg N/ha target and this treatment was omitted. All nutrients other than N were intended to be non-limiting. Residual P was generally low, and MAP was applied to supply 15-35 kg P_2O_5/ha, depending on the location. Potassium and sulfur were unlikely to be limiting and neither were applied as fertilizer at any locations.

Table 3. Soil test results for dry bean nitrogen response demonstrations at Indian Head (IH), Melfort (ME), Redvers (RV), and Yorkton (YK), Saskatchewan.

Location / Depth	pH	SOM (%)	NO_3-N (kg/ha)	Olsen-P (ppm)	K (ppm)	S (kg/ha)
IH (0-15)	8.0	4.8	11	4	563	11
IH (15-30)	–	–	7	–	–	11
IH (30-60)	–	–	9	–	–	–
ME (0-15)	6.1	10.3	26	10	540	27
ME (15-30)	–	–	19 [Z]	–	–	29
RV (0-15)	7.9	3.6	19	7	249	20
RV (15-60)	–	–	21 [Y]	–	–	–
YK (0-15)	7.7	4.3	11	7	161	13
YK (15-30)	–	–	11	–	–	20
YK (30-60)	–	–	13	–	–	–

[Z] Soil only sampled 30 cm at Melfort; [Y] 15-30 cm depth was not sampled separately at Redvers – target N rates were adjusted for 0-60 cm residual NO_3-N at that location

Dry Bean Responses to Nitrogen Rates

Results for spring plant densities, or emergence, are provided in Table 4 below. Plant populations were lower than targeted at Indian Head and, to a lesser extent, Melfort. At the other two locations, overall establishment was excellent with essentially no observed mortality. The lower plant populations and Indian Head and Melfort may have been largely due to the cooler, clay soils at these locations. Nitrogen rate did not affect emergence at Indian Head, Melfort, or Yorkton according to both the overall F-tests (P = 0.513-0.933) and the orthogonal contrasts (P = 0.205-0.997). At Redvers, there was some variation across treatments and the quadratic contrast was significant (P = 0.003). At this location, the highest plant densities occurred at 165 kg N/ha with intermediate densities in the control and the lowest values with 75-135 kg N/ha. This response is difficult to explain and likely primarily due to random variability.

Table 4. Nitrogen fertilizer rate effects on dry bean emergence at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	---------- *Emergence (plants/m^2)* ----------			
Control	22.6 a	31.6 a	54.2 ab	42.5 a
45 kg N/ha	23.0 a	–	–	39.8 a
75 kg N/ha	24.0 a	30.8 a	43.3 b	44.3 a
105 kg N/ha	21.7 a	24.6 a	43.3 b	40.5 a
135 kg N/ha	24.8 a	28.3 a	40.9 b	36.3 a
165 kg N/ha	23.6 a	24.6 a	63.5 a	38.8 a
S.E.M.	2.18	4.21	4.66	6.39
	---------- Pr > F (p-values) ----------			
Overall F-test	0.933	0.634	0.023	0.513
N Rate – linear	0.655	0.229	0.256	0.205
N Rate - quadratic	0.997	0.757	0.003	0.770

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton

[Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

The results for plant height are presented in Table 5. On average, the plants were quite short at all locations and significantly affected by N rate at Melfort and Yorkton, but not Indian Head or Redvers. At Indian Head, there was a trend for height to increase linearly with N rate, but the effect was not quite significant at the desired probability level (P = 0.064). At Melfort, the response was linear (P < 0.001) with heights ranging from 22 cm in the control to nearly 30 cm at 135-165 kg/ha. At Yorkton, the height response to N rate was more quadratic with the tallest plants observed at 105 kg N/ha and values levelling off or even declining slightly with further increases in N rate.

Maturity ranged widely across locations (Table 6), declared as early as 82-83 days after seeding at Redvers to as late as nearly 109 days at Melfort. Maturity was affected by the N rates at Indian Head and, to a much lesser extent, Redvers, but not at Melfort or Yorkton. At Indian Head, maturity was delayed by nearly five days at 165 kg N/ha relative to the control and the response was linear (P < 0.001). At Redvers, the overall F-test was not significant (P = 0.102), but the linear orthogonal contrast was (P = 0.012); however, the observed range of only 0.7 days was too small to be of much practical importance.

Table 5. Nitrogen fertilizer rate effects on dry bean plant height at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	Plant Height (cm)			
Control	32.0 a	22.4 c	29.5 a	25.7 c
45 kg N/ha	31.0 a	–	–	26.2 bc
75 kg N/ha	32.6 a	24.5 bc	30.4 a	29.5 abc
105 kg N/ha	31.5 a	26.8 ab	30.7 a	32.8 a
135 kg N/ha	34.1 a	29.7 a	33.9 a	29.5 abc
165 kg N/ha	33.2 a	29.6 a	31.8 a	29.7 ab
S.E.M.	0.89	1.40	2.13	1.42
	Pr > F (p-values)			
Overall F-test	0.181	0.012	0.602	0.017
N Rate – linear	0.064	<0.001	0.231	0.009
N Rate - quadratic	0.700	0.398	0.620	0.020

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton
[Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

Table 6. Nitrogen fertilizer rate effects on dry bean maturity at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	Maturity (days from seeding)			
Control	98.5 b	108.5 a	82.3 a	99.0 a
45 kg N/ha	99.0 b	–	–	97.8 a
75 kg N/ha	99.8 b	108.5 a	82.3 a	98.0 a
105 kg N/ha	101.8 a	108.5 a	82.8 a	99.3 a
135 kg N/ha	102.5 a	108.5 a	82.8 a	97.0 a
165 kg N/ha	103.3 a	108.5 a	83.0 a	98.5 a
S.E.M.	0.69	0.62	0.29	1.41
	Pr > F (p-values)			
Overall F-test	<0.001	1.000	0.102	0.510
N Rate – linear	<0.001	1.000	0.012	0.677
N Rate - quadratic	0.839	1.000	0.900	0.710

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton
[Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

Results for seed yield are presented in Table 7. Regardless of the N rate, yields were below 1000 kg/ha at Indian Head, Melfort, and Yorkton but higher at Redvers. The overall F-test for the effect of N rate was highly significant at Indian Head, Melfort, and Yorkton ($P < 0.001$-0.007), but only marginally significant at Redvers ($P = 0.099$). The linear orthogonal contrasts were significant at Melfort, Redvers, and Yorkton ($P < 0.001$-0.009); however, at Indian Head, the response was primarily quadratic ($P < 0.001$). Focussing on Indian Head, yields were lowest in the control (408 kg/ha) and peaked at 712 kg/ha at a modest N rate of 75 kg N/ha. As we continued to increase the N rate, yields gradually declined and were significantly less at the highest, 165 kg N/ha rate. For all other locations, yields continued to climb up to the highest N rate, but individual treatment means did not always significantly differ.

Table 7. Nitrogen fertilizer rate effects on dry bean seed yield at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	------------------ *Seed Yield (kg/ha)* ------------------			
Control	408.0 d	347.4 b	1046.6 a	400.0 d
45 kg N/ha	513.0 cd	–	–	330.5 d
75 kg N/ha	711.6 a	513.3 b	1170.4 a	548.4 c
105 kg N/ha	637.6 ab	651.0 ab	1277.5 a	647.6 b
135 kg N/ha	672.6 ab	872.6 a	1507.1 a	660.5 b
165 kg N/ha	576.3 bc	945.7 a	1615.4 a	810.2 a
S.E.M.	43.05	117.01	159.4	28.6
	------------------ Pr > *F* (p-values) ------------------			
Overall F-test	<0.001	0.007	0.099	<0.001
N Rate – linear	0.003	<0.001	0.009	<0.001
N Rate - quadratic	<0.001	0.685	0.945	0.958

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton

[Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

Dry bean seed weight, reported as g/1000 seeds, was affected by N rate at all locations (Table 8; $P < 0.001$). At Indian Head, the response was primarily quadratic ($P < 0.001$), increasing from 161 g/1000 seeds in the control to 187 g/1000 seeds at 105 kg N/ha. At this point, seed size largely levelled off with only small, non-significant increases observed with further additions of N fertilizer. At Melfort, the response differed in that seed weight was statistically similar for the lowest three N rates but increased at the highest levels. According to the orthogonal contrasts, N rate effects on seed weight at Melfort were largely linear ($P < 0.001$) but the lesser impact at low N rates resulted in the quadratic contrast also being marginally significant ($P = 0.074$). At Redvers, the seed weight response to N rate was also primarily quadratic ($P = 0.008$) and similar in shape to that observed at Indian Head. Seed weight at Redvers was lowest in the control (157 g/1000 seeds) and increased with N rates up to 135 kg N/ha (182 g/1000 seeds) where increases were no longer observed with further increases in N rate. At Yorkton, the seed weight response to increasing N rates was linear ($P < 0.001$), increasing from 188 g/1000 seeds in the control to 219 g/1000 seeds at 165 kg N/ha. Despite the lack of a significant quadratic response at Yorkton, there was relatively little effect on seed weight at the lower N rates with the greatest gains observed at 105 kg N/ha and beyond.

Table 8. Nitrogen fertilizer rate effects on dry bean seed weight at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, *P* ≤ 0.05).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	---------- *Seed Weight (g/1000 seeds)* ----------			
Control	160.9 d	179.3 c	156.8 d	188.4 b
45 kg N/ha	170.2 c	–	–	179.1 b
75 kg N/ha	180.2 b	179.3 c	166.2 c	186.0 b
105 kg N/ha	186.7 a	181.4 c	173.9 b	206.8 a
135 kg N/ha	187.8 a	186.1 b	182.2 a	212.4 a
165 kg N/ha	191.1 a	190.6 a	182.1 a	218.8 a
S.E.M.	1.73	2.29	1.90	5.10
	---------- Pr > *F* (p-values) ----------			
Overall F-test	<0.001	<0.001	<0.001	<0.001
N Rate – linear	<0.001	<0.001	<0.001	<0.001
N Rate - quadratic	<0.001	0.074	0.008	0.253

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton
[Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

Extension Activities

Due to COVID-19 restrictions, we were not able to show the field trials on any summer field tours or workshops during the 2020 season at Indian Head; however, highlights of this work will be shared where feasible going forward. Technical reports and extension materials will be available online through IHARF and/or Agri-ARM websites. Extension activities for the other locations are reported in separate individual site reports.

11. Conclusions and Recommendations

This project has demonstrated both dry bean responses to N fertilizer rate and the overall yield potential of this crop under dryland, solid-seeded production in Saskatchewan. The responses were replicated across a range of soil and weather conditions; however, all locations were drier than average which was neither ideal for dry bean production nor likely to represent the potential at these locations over the longer term. Looking at crop establishment, we saw the poorest emergence at Indian Head and Melfort, the locations with the heaviest soil texture and highest organic matter. This is consistent with past experiences with this crop which have indicated that dry beans can struggle to establish in finer textured soils, despite the potential advantages of greater water holding capacity relative to coarser soils. Plant heights were similar across locations but increased with N rate in 2/4 possible cases. It appeared that the slow emergence and low plant populations at Indian Head and Melfort also led to delays in maturity whereby maturity at these locations was later than for the other sites, especially Redvers. Melfort had a killing frost on September 7, prior to declaring all plots mature, but no other locations reported any concerns in this regard. One of the potential problems with higher N rates in dry bean production is increased severity of disease. Although we monitored for sclerotinia and bacterial blight, disease levels were always extremely low and not affected by the treatments in any cases (data not reported). In terms of overall productivity, yields at all locations were below what would likely be considered average; however, long-term averages have not been established since most of the collaborators and producers within their respective regions have minimal experience with this crop. Focussing on dry bean yield response to N rates, the results of this demonstration clearly showed the need for relatively large quantities of N to optimize yields, despite the low productivity observed in 2020. Most of the locations showed linear responses with yields increasing right up to the highest rates of N fertilizer. The exception to this was Indian Head where yields peaked at a modest N rate of 75 kg N/ha. Indian Head was also the driest and lowest yielding of the locations. We did not attempt to measure all the individual yield components (i.e., pods per plant, beans per pod, etc.), but the observed yield benefits were at least partly due to larger seeds. When the objective is to maximize profits, the optimum N rate will vary depending on the relative prices of both the fertilizer and the harvested commodity. Reporting the marginal economic returns for the different N rates is beyond the scope of this project; however, this is important to keep in mind. More data from a broader range of conditions, particularly where drought is less of a limiting factor, are required to make more confident recommendations for optimizing N rates in non-irrigated, solid-seeded dry bean production in Saskatchewan.

Supporting Information

12. Acknowledgements:

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership bi-lateral agreement between the federal government and the Saskatchewan Ministry of Agriculture. Crop protection products used at Indian Head were provided in-kind by BASF and Bayer CropScience. Seed was provided in-kind by Jeff Ewan. IHARF provided the land, equipment, and infrastructure required to complete this project at Indian Head and IHARF also has a strong working relationship and memorandum of understanding with Agriculture & Agri-Food Canada which helps to make work like this a possibility.

Figure 1. Strong visual response of dry bean to nitrogen fertilizer at Yorkton in 2020. The plot on the left received 165 kg N/ha while the plot on the right received 45 kg N/ha (soil plus fertilizer).

13. Appendices:

Table A-1. Selected agronomic information and dates of operations from dry bean nitrogen response demonstrations completed at Indian Head, Melfort, Redvers, and Yorkton, Saskatchewan in 2020.

Factor / Operation	Indian Head	Melfort	Redvers	Yorkton
Previous Crop	Canaryseed	Canola	Flax	Oat
Pre-emergent herbicide	1.66 l/ha Roundup Transorb HC (May 14)	1.5 l/ha Roundup Transorb HC (May 24)	1.66 l/ha Roundup Transorb HC (May 25)	None
Seeding Date	May 17	May 23	May 22	May 19
Residual NO_3-N (0-30 cm)	18 kg/ha	45 kg/ha	45 kg/ha [Z]	22 kg/ha
kg N-P_2O-K_2O-S applied (excluding urea)	7-35-0-0	5-22-0-0	5-22-0-0	3-15-0-0
Plant Density	July 7	June 22	N/A	June 2
In-crop Herbicide	1 l/ha Viper ADV + 2 l/ha UAN + 0.36 l/ha Basagran Forte (June 29)	1 l/ha Viper ADV + 2 l/ha UAN (July 10)	1 l/ha Viper ADV + 2 l/ha UAN (June 22)	1 l/ha Viper ADV + 2 l/ha UAN + 185 ml/ha Centurion
Foliar Fungicide	0.4 l/ha Delaro (July 16)	865 ml/ha Acapela (July 30)	None	None
Disease Ratings	August 10 (none noted)	August 12	N/A	July 31
Plant Height	August 10	August 12	N/A	August 4
Pre-harvest herbicide	1.66 l/ha Roundup Transorb HC + 146 ml/ha Heat LQ (September 4)	1.66 l/ha Roundup Transorb HC (September 10)	None	None
Harvest date	September 22	September 24	August 23	September 10

NA – Information not available; [Z] Residual NO_3-N are for the 0-60 cm depth compared to 0-30 cm for the other location

Abstract

14. Abstract/Summary

Field trials were conducted at four Saskatchewan locations in 2020 to demonstrate dry bean response to nitrogen (N) fertilizer along with the overall adaptation of this crop under dryland solid-seeded production. All the locations were within the Black soil zone and included Indian Head, Melfort, Redvers, and Yorkton. The variety was CDC Blackstrap which is one of the most drought tolerant, early maturing dry bean varieties available and relatively well-suited for straight combining. The treatments were six N fertilizer rates which included a control (where the only N was that provided by the soil and monoammonium phosphate), 45, 75, 105, 135, and 165 kg N/ha. At Melfort and Redvers, soil NO_3-N plus that provided by the MAP exceeded 45 kg N/ha; therefore, the lowest N rate was dropped at those locations. Emergence tended to be poorer at Indian Head and Melfort compared to Redvers and Yorkton. This may have been partly attributable to the higher clay content and finer soil texture. Maturity also tended to be later at these locations and, although maturity varied widely with location only Indian Head and, to a lesser extent, Redvers, observed any delays with increasing N fertilizer rates. Plant height increased with N rate at two of four locations, but the average height was consistent. Seed yields were extremely low at Indian Head, Melfort, and Yorkton but higher at Redvers. All locations saw strong yield increases with N fertilizer rate, but the specific responses varied. At Indian Head, yields peaked at a modest rate of 75 kg N/ha before levelling off and even declining slightly at the highest N rate. For all other locations, the response was linear with yields increasing right up to 165 kg N/ha. This was somewhat unexpected considering the low yields, especially at Melfort and Yorkton. Although we did not measure all the yield components (i.e., pods per plant, seeds per pod, etc.), the observed yield increases were at least partly due to increasing seed size as more N was applied. To improve our understanding of dry bean response to N rate and adaption to dryland, solid-seeded production in Saskatchewan, it would be beneficial to repeat these trials under a wider range of conditions.