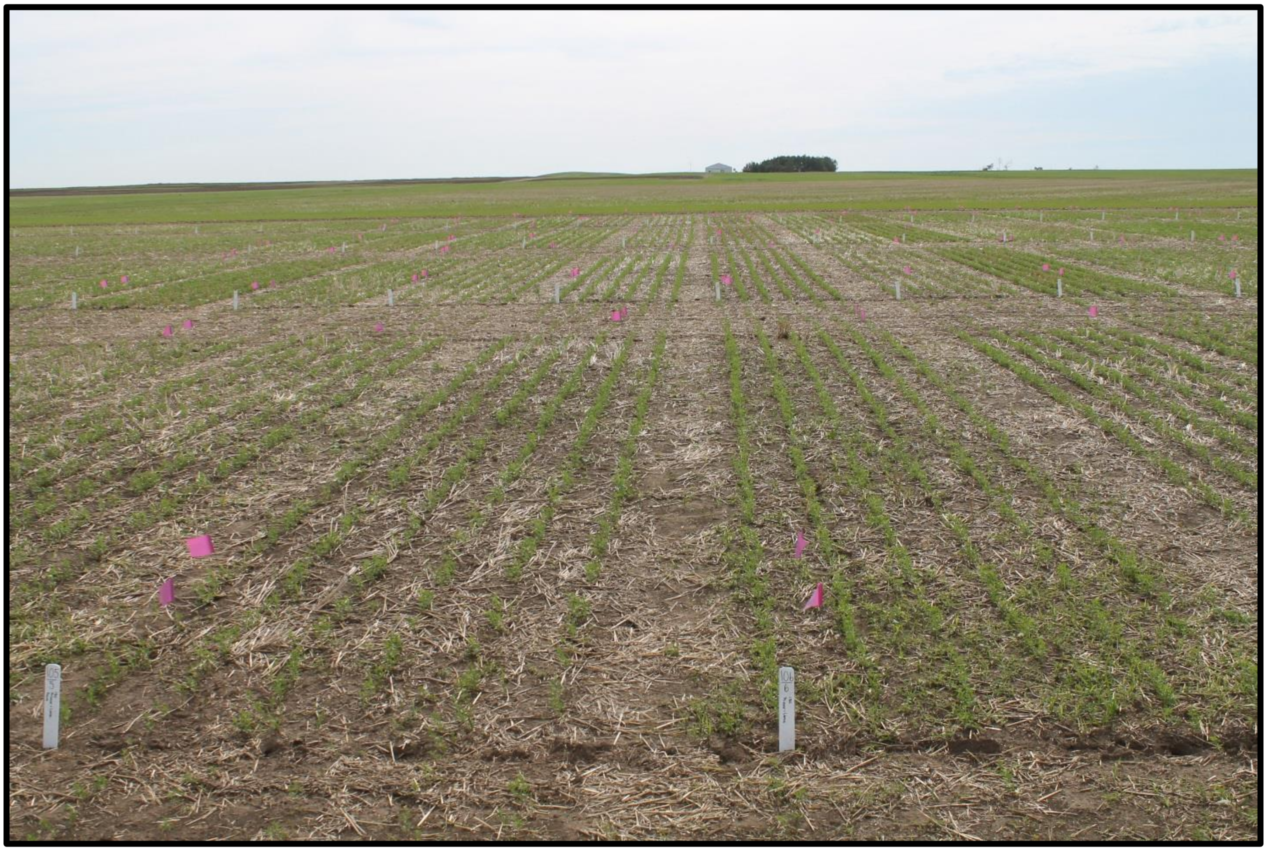
2017 Interim Report

for the

Saskatchewan Ministry of Agriculture (ADF Program), Saskatchewan Pulse Growers (SPG) & Western Grains Research Foundation (WGRF)

Project Title: Lentil Input Study

(Project #20160010)



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1. Project Information

a. **Title:** Lentil Input Study
b. **ADF File Number:** 20160010
c. **Reporting Period:** January 01, 2018 to March 1, 2018

2. Special Project Activities Undertaken During this Reporting Period

Objective 1: To determine which combination of the common agronomic practices produce the greatest lentil yield

Methodology: The study was conducted at five locations in 2017 throughout Saskatchewan: Western Applied Research Corporation at Scott, Indian Head Agriculture Research Foundation at Indian Head, Irrigation Crop Diversification Centre at Outlook, East Central Research Foundation at Yorkton and Wheatland Conservation Area at Swift Current.

The experiment was conducted as a randomized complete block design (RBCD) with four replications. The trial consisted of a 3 x 3 x 2 factorial design with three seeding rates (130, 190 and 260 seeds/m^2), three fungicide treatments (no application, single application, two applications) and two herbicide management practices (pre-seed burn-off vs. pre-seed residual) to result in a total of 18 treatments. While certain aspects of the specific seeding equipment varied (i.e. row spacing, opener type) across locations, all plots were direct-seeded into cereal stubble and all fertilizer was side-banded during seeding. The single fungicide application consisted of Priaxor applied at beginning of flowering, while the dual fungicide application consisted of Priaxor followed by Lance WDG 10 to 14 DAA. The pre-seed burn off consisted of glyphosate and the pre-seed residual included glyphosate and Focus® co-formulated. Focus rates were applied based on soil type. The herbicide applications were applied three to five days prior to seeding. Post-emergent herbicide applications consisted of Ares and Centurion for all treatments. Fertilizer (N-P-K-S) was applied based on soil test recommendations to achieve a 30 bu per acre crop. Nodulator XL SCG pea and lentil inoculant was applied based on row spacing recommendations.

Pertinent agronomic information for each location is provided in Table 1 of the Appendices. Specific management practices and decisions were largely left to individual site managers and tailored to regional practices, available equipment and pests encountered; however, all controllable factors other than seeding rate, herbicides, and fungicides were intended to be non-limiting. Seeding dates ranged from May 9 to May 26. Pre-harvest herbicides or desiccants were applied at or after the latest maturing plots reached physiological maturity if considered necessary or desirable. All plots were combined at maturity and, wherever possible, outside rows were excluded to minimize edge effects.

A composite soil sample (targeted depth intervals of 0-15 cm and 15-60 cm) was collected from each trial location in the early spring and submitted to laboratories of the individual sites choosing. The crop response data collected included crop and weed density, crop and weed biomass, disease ratings, days to flowering, days to maturity, seed yield, thousand kernel weights, and test weight.

Plant densities were determined by counting number of emerged plants on 2 x 1-meter row lengths per plot approximately two weeks after emergence (WAE). Weed densities were collected prior to canopy closure in the front and back of each plot using 0.25 m^2 quadrants. Disease ratings were taken prior to the first fungicide application, 7, 14 and 21 days after initial application (DAIA). Plots were rated based on % total disease ranging from zero to ten. Crop biomass was collected from the front and back using 0.25 m^2 quadrants at crop physiological maturity and weed biomass was collected and separated from the crop. Days to flowering was recorded at beginning of flowering and days to maturity were recorded when the bottom third of the pods turned yellow to brown and rattled when shaken. Yields were determined from cleaned harvested grain samples and corrected to 14% moisture content. Thousand kernel weights and test weights were recorded for seed quality. Mean monthly temperatures and precipitation amounts were estimated for each location from the nearest Environment Canada or private weather station.

Data were analysed on an individual and combined basis using the mixed model procedure of SAS software, with replicate, seed rate, fungicide application and herbicide application as random effects; location was considered fixed effect. Treatments were compared using the Tukey test and significance was declared at $P \leq 0.05$. In addition, contrast statements were used to compare the unsprayed check with fungicide treatment means.

Objective-2: To determine which integrated production system in the most economically feasible

Methodology: The economic analysis was conducted by calculating the cost and subsequent return of each agronomic practice. The economic equation took into consideration the yield (kg per hectare) per treatment and price per kilogram to determine gross income ($ per kg) minus the total cost [cost of seed ($ per kg), herbicide ($ per ha), fungicide ($ per ha), labor ($ per hour) and fuel ($ per ha)] to determine net grain ($ per ha).

a. Research accomplishments during the reporting period:

Objectives	Progress
1) To determine which combination of the common agronomic practices had the greatest effect on crop and weed growth, crop seed yield and overall seed quality	Year one of the study conducted at five locations, disease levels were low due to dry weather conditions. Seeding rate had an effect on disease incidence and severity. No effects on disease levels were detected but a trend indicated a reduction. Weed control was poor with low seeding rates and a single pre-seed burndown. Days to maturity were extended for increased seeding rates. A seeding rate of 190 seeds m^{-2} had the best yield.
2) To determine which integrated production system in the most economically feasible	The first year of the study was very dry. Due to dry environmental conditions, the treatments effect on yield were minimal. A seeding rate of 190 seeds m^{-2} had the highest gross profit with both “basic” and “conventional” management strategies.

In 2017, growing season temperatures and especially precipitation amounts were below-average at all 5 sites, therefore the lentils were limited by moisture and thus disease incidence was limited at most sites. Mean monthly temperatures and precipitation amounts are presented in Table 2 and 3 of the Appendices, respectively. The Outlook trial did apply irrigation sparingly with applications of 37.5 mm in June, and 12.5 mm in each of July and August for a total irrigation supplement to rainfall amounts listed of 62.5 mm. Amounts applied were judicial and only applied to relieve severe moisture stress.

Objectives: *To determine which combination of the common agronomic practices had the greatest effect on crop and weed growth, crop seed yield and overall seed quality*

Crop & Weed Densities

Indian Head

Weed density resulted in differences between the herbicide treatments (P= 0.0373), indicating that at this location pre-seed burn-off was more effective than pre-seed residual. No differences among seeding rates (P = 0.5369) were detected but a trend indicated the highest seeding rate had the lowest weed density. Crop density was directly related to seeding rates and resulted in differences among all treatments (P < 0.0001). A seeding rate of 130 seeds m^{-2} had the lowest crop density and as seeding rate was increased the plant density followed similarly.

Outlook

Weed densities were relatively low at this location and no differences were detected between the herbicide treatments (P= 0.3559) or among the seeding rates (P= 0.5485). Differences were minimal and a trend was not observed. Crop densities were not affected by herbicide application (P= 0.2785). Differences among seeding rates were observed (P= 0.050). A direct relationship between seeding rate and plant stand was observed.

Scott

Weed densities at Scott were high and differences between the herbicides treatments were detected (P < 0.001). Pre-seed residual was the most effective treatment and weed density was lower than the treatment that consisted of a pre-seed burn-off. Seeding rates resulted in differences in plant stand for the crop (P< 0.001). A direct relationship between seeding rate and crop density was observed.

Swift Current

Although weed densities were low at this location, herbicide treatment effects resulted in differences (P= 0.0056). Pre-seed residual had a higher weed control than the pre-seed burn-off. Seeding rates resulted in differences in crop densities (P <0.001). A direct relationship between seeding rate and crop density was observed.

Yorkton

No differences were detected for weed densities for herbicide treatments (P= 0.6913) or seeding rates (P= 0.7596). However, there were several trends observed. The lowest seeding rate of 130 seeds m^{-2} resulted in the highest weed density. Weed densities tended to decline as seeding rate increased. Furthermore, weed densities were lower for the treatments sprayed with the pre-seed residual compared to treatments sprayed with the pre-seed burn-off. Seeding rate resulted in crop density differences (P <0.001). These results were similar to all the other locations were the higher seeding rates had the higher plant stands.

All sites combined

When a combined analysis of all the sites was performed no differences were detected for the herbicide treatments (P= 0.5162). However, a trend indicated that the pre-seed residual resulted in better weed control than the pre-seed burn-off. Seeding rate did not have an effect on weed densities and no differences were detected (P= 0.5270). Seeding rate had a significant effect on crop density at all sites and results were consistent. The lower seeding rate had the lower plant density and as the seeding rate was increased the plant density was increased as well.

Crop & Weed Dry Weight

Indian Head

No effects of seeding rate (P=0.4478) and herbicide treatments (P= 0.9067) were detected for weed biomass. However, a trend indicated that with the lowest seeding rate resulted in the highest weed biomass and subsequently declined with increased seeding rates. Differences in crop biomass were detected for seeding rates (P= 0.005). The seeding rate of 260 seeds m^{-2} had the highest crop biomass, followed by 190 seeds m^{-2} with a slight but not significant reduction and the lowest seeding rate had a significant reduction of crop biomass.

Outlook

Weed biomass was very low at this location and no difference between the herbicide treatments (P= 0.8767) or seeding rates (P= 0.7882) were detected. No effects of seeding rate (P= 0.6929) or herbicide treatments were detected for crop biomass. A trend indicated that the highest biomass corresponded to a seeding rate of 190 seeds m^{-2}.

Scott

Weed biomass was severely affected by the herbicide treatments (P= 0.0164) and there were differences between the two treatments used. The pre-seed residual treatment resulted in a weed biomass reduction of 71% compared to the pre-seed burn-off. Crop biomass was not affected by herbicide treatments and no differences were observed (P= 0.5975). Seeding rate had an effect on crop biomass and differences among treatments were detected (P= 0.0286). A seeding rate of 190 seeds m^{-2} resulted in the highest crop biomass and a significant reduction was detected when a seeding rate of 130 seeds m^{-2} was used.

Swift Current

Weed biomass was not affected by seeding rate (P= 0.1882) or herbicide treatments (P= 0.2244). A trend indicated that the lowest seeding rate also had the highest weed biomass. The trend for herbicide treatments indicated that the pre-seed residual was more effective at reducing weed biomass. Crop biomass was similar for all the treatments and no differences were detected for seeding rate (P= 0.7656) or herbicides (P= 0.9513). A trend also indicated a slight biomass reduction for treatments seeded at 260 seeds m^{-2}.

Yorkton

Weed biomass differences were detected for seeding rate (P= 0.0461), as well as an interaction between seeding rate and herbicide treatments were observed (P= 0.0185). The interaction indicated that the highest seeding rates were the most effective at reducing weed biomass. Weed biomass reductions were greater at the highest seeding rates combined with a pre-seed residual application and were of equal efficacy to the highest seeding rate and a pre-seed burn-off. In contrast, pre-seed burn-off treatments combined with the lower seeding rates resulted in the highest weed biomass. Crop biomass did not have any differences in seeding rates (P= 0.7264) or herbicide treatments (P= 0.6670).

All sites combined

No differences in weed biomass were observed for herbicide treatments (P= 0.1674). Seeding rate differences were detected for weed biomass (P= 0.0122). An interaction between herbicides and seeding rates were also observed for weed biomass (P= 0.0022). In general, weed biomass was largely reduced when seeding rates were increased above 130 seeds m^{-2} and a residual herbicide was used (Fig. 1). Weed biomass continuously declined when glyphosate was applied alone at the highest seeding rate.

Disease Prevalence

Indian Head

The first disease ratings indicated a very low presence of disease within the lentil canopy (<3.5%). The disease ratings conducted at 7 DAIA detected a significant difference among seeding rates (P= 0.0318) and fungicide applications (P= 0.0002). The highest seeding rate resulted in the greatest prevalence of disease compared to the lowest seeding rate. The sprayed treatments had a lower disease prevalence compared to the unsprayed check. Disease ratings at 14 and 21 DAIA indicated a significant interaction between seeding rate and fungicide applications (P = 0.018; 0.0026), respectively. The trend indicated that the two highest seed rates (260 seeds m^{-2} > 190 seeds m^{-2}) resulted in the greatest disease prevalence when a fungicide was not applied. Disease pressure tended to decline with seeding rate when fungicides were applied. The lowest seeding rate had the least amount of disease present, particularly when fungicides were applied.

Scott

Disease pressure was very low at Scott due to the dry conditions throughout the growing season. However, a significant effect of seeding rate (P= 0.0014) and fungicide (P=0.0015) at 14 DAIA was detected. The highest seeding rate resulted in the greatest disease pressure and fungicide applications lowered disease prevalence. Although there was a significant difference detected, disease ratings were < 2% for all plots.

Outlook, Swift Current & Yorkton

There were no detectable differences reported at 7, 14, and 21 DAIA.

All sites combined

The ratings conducted prior to fungicide application indicated that disease pressure was very low (<2%) across all sites. At 7 DAIA, there was no significant difference detected, however, the unsprayed checks tended to have a slightly higher disease prevalence compared to sprayed (2.93% vs. 2.27%). At 14 and 21 DAIA, a seeding rate effect was detected (P< 0.0001). Disease pressure tended to decline with seeding rate (130 seeds m^{-2} < 190 seeds m^{-2} < 260 seeds m^{-2}) (Fig. 2). Furthermore, dual fungicide applications tended to have the least amount of disease pressure compared to single applications and unsprayed lentils (Fig. 3).

Maturity (DTF/DTM)

All sites combined

Days to flowering had a 49 day mean for all the sites and no differences were observed for any of the treatments. Days to maturity were 90 days when a seeding rate of 130 and 190 seeds m^{-2} was used and 89 days with a seeding rate of 260 seeds m^{-2}. Although it is a difference of one day, it was statistically significant ($P= 0.001$).

Yield

Indian Head

Seeding rate had a significant effect on yield ($P < 0.0001$). There was no statistical difference detected between the two highest seeding rates, however, the highest seeding rate resulted in the greatest yield. Overall, a yield increase of 12% and 8% occurred for the highest seedings rates of 260 seeds m^{-2} and 190 seeds m^{-2} compared to the lowest seeding rate, respectively.

Scott

Seeding rate had a significant quadratic effect on yield ($P < 0.0001$). A maximum yield of 4980 kg/ha was obtained at 215 seeds m^{-2}. Yield decline when the seeding rate exceeded 215 seeds m^{-2}. Overall, yield increased by 10% when seedings rate exceeds 130 seeds m^{-2} followed by a 2% yield loss once seeding rates exceeded 215 seeds m^{-2}.

Outlook, Swift Current, Yorkton

There were no significant differences detected at all three locations. However, yield tended to increase when seeding rates exceeded 130 seeds m^{-2}.

All sites combined

The combined analysis indicated a significant seeding rate effect ($P=0.0272$). A seeding rate of 130 seeds m^{-2} had the lowest yield with 3355 kg ha^{-1}; a slight but significant yield increase to 3489 kg ha^{-1} was observed when a seeding rate of 190 seeds m^{-2} was used. Subsequently, yield declined slightly to 3423 kg ha^{-1} when a seeding rate of 260 seeds m^{-2} was used. Overall, maximum yield was achieved when seeding rates exceeded 190 seeds m^{-2} (Fig. 4).

Test Weights (TW) and Thousand Kernel Weights (TKW)

Indian Head

No treatment effect was observed for TW as mean TW values for all the treatments were very close and no trends were observed. Seeding rate had an effect on TKW ($P= 0.0001$). The seeding rate of 130 seeds m^{-2} had the highest TKW of 42 g compared to 41 g and 40 g at 190 seeds m^{-2} and 260 seeds m^{-2}, respectively.

Outlook

No treatment effects or trends were observed for TW and TKW.

Scott

No differences were detected for TW and values were almost identical for all the treatments. Differences in TKW were detected among seeding rates (P= 0.0083). As seeding rates increased TKW values decreased. The seeding rate of 130 seeds m^{-2} and 190 seeds m^{-2} had the highest TKW of 37 g compared to 36 g at 260 seeds m^{-2}.

Swift Current

Seeding rate had a significant effect on TW (P= 0.0387). The seeding rate of 130 seeds m^{-2} had the highest TW and as the seeding rates increased TW decreased. TKW values were almost identical for all the treatments and no differences were detected.

Yorkton

No treatment effects were observed for TW and TKW A trend indicated that quality parameters are better with a lower seeding rate and tended to decrease as the seeding rate increased.

All sites combined

Statistical analysis indicated an interaction between herbicide and seeding rate for TW, however, differences among the treatments were negligible (<0.5%). No treatment effects were detected for TKW, however, TKW tended to decrease as seeding rates increased. Consequentially, maximum TKW were achieved at a seeding rate of 130 seeds m^{-2}. In general, for all locations, a trend indicated that the best quality parameters resulted from a seeding rate range from 130 seeds m^{-2} to 190 seeds m^{-2}.

Objective 2: *To determine which integrated production system in the most economically feasible*

As there were no significant differences between herbicide treatments on seed yield, the cost of a pre-seed burn-off was used to determine the cost of production. The economic analysis was done with two market price scenarios. The low price was based on the market drop caused by the import tariff recently imposed by India and a high price that corresponds to the average market price.

Basic management

This management includes no fungicide application. With the basic management strategy, average yield for a seeding rate of 130 seeds m^{-2} was 2556 kg ha^{-1}; 190 seeds m^{-2} was 2757 kg ha^{-1}; 260 seeds m^{-2} was 2690 kg ha^{-1}. The yield increases attributed to the highest seedings rates returned a greater net profit than the lowest seeding rates. However, the highest seeding rate was not the most profitable. A seeding rate of 190 seeds m^{-2} was the most balanced and returned the greatest gross profit with \$124 ha^{-1} with a low market price scenario and \$234 ha^{-1} with a high market price (Table 4).

Conventional management

This management included a single fungicide application. With this management strategy average yield for a seeding rate of 130 seeds m^{-2} was 2623 kg ha^{-1}; 190 seeds m^{-2} was 2825 kg ha^{-1}; 260 seeds m^{-2} 2757 kg ha^{-1}. For conventional management, a seeding rate of 190 seeds m^{-2} proved to be the most balanced and had the greatest gross profit of \$230 per ha (Table 5). Gross profit was lower for conventional management compared to basic management at 190 seeds m^{-2}. However, if disease was prevalent, the conventional management strategy would be preferred.

Enhanced management

This management included a dual fungicide application. With this management strategy average yield for a seeding rate of 130 seeds m^{-2} was 2556 kg ha^{-1}; 190 seeds m^{-2} was 2825 kg ha^{-1}; 260 seeds m^{-2} 2757 kg ha^{-1}. At a seeding rate of 130 seeds m^{-2}, yield was similar to the basic management strategy. In contrast, the seeding rates of 190 and 260 seeds m^{-2} resulted in a yield that was similar to the conventional management. These results indicated that the gross profits are lower for the enhanced management compared to basic and conventional due to the extra costs. As with the other management strategies, a seeding rate of 190 seeds m^{-2} returned the highest gross profits with \$117 ha^{-1} for the low market price and \$219 ha^{-1} (Table 6).

b. Discussion:

The preliminary results indicated a relatively inconsistent response to the pre-seed residual application. Herbicide treatments had an effect in three locations and in one of those locations the pre-seed burn-off had more effective weed control. These results could be attributed to the drier than normal environmental conditions, which inhibited the activation of the soil-applied herbicide. Furthermore, patches of thistle were present at Indian Head and the products were not registered for perennial thistle control. Although results were inconsistent among locations, overall the pre-seed residual application was beneficial as it provided long-term weed control. This was apparent as weed biomass tended to decline with applications that included the soil-applied herbicide.

Seeding rate also played a role in reducing crop-weed competition as weed densities tended to decline with higher seeding rates. Increased seeding rates are an effective weed management strategy because it allows the crop to occupy the available space earlier in the growing season, which will reduce nutrient, space and light availability required for weed growth (Redlick 2015). These results coincide with previous studies (Baird et al. 2009; Redlick et al. 2017) in which increased seeding rate resulted in reduced weed biomass and improved crop competitive ability. In this study, enhanced crop competitive ability was apparent in the early growing season as weed biomass declined by 27% when seeding rates exceeded 130 seeds m^{-2}. Weed biomass was further hindered when an integrated management strategy was implemented.

An integrated weed management strategy of increased seeding rate (>130 seeds m^{-2}) combined with a pre-seed residual herbicide was highly effective in controlling early emerging weeds. Weed biomass continuously declined when a pre-seed burn-off was used at the highest seeding rate. Weed biomass further declined when high seeding rates and a pre-seed residual herbicide was used. These results indicated that seeding rate played a very large role in overall weed growth. Furthermore, these results indicated that a single pre-seed burn-off was not as effective as a residual herbicide at various seeding rates. The preliminary results coincide with several studies (Paolini et al. 2003; Blackshaw et al. 2005; Redlick et al. 2017) that indicated that an integrated approach including increased seeding rates combined with herbicides have proved to be the most effective approach in reducing crop-weed competition.

Increased seeding rates are an effective tool to manage crop-weed competition, however, it can also influence disease pressure within the canopy. A higher seeding rate results in a thicker canopy that is more prone to disease pressure (Davidson and Kimber 2007.) In contrast, lower plant densities typically result in lower disease pressure as there is less contact between plants and a lower moisture content within the canopy. Similarly, disease levels increased by 24% and 36% with seeding rates of 190 seeds m^{-2} and 260 seeds m^{-2} compared to 130 seeds m^{-2}, respectively (Fig. 2). To reduce disease pressure and improve overall plant health and seed yield, fungicides can be used preventatively and curatively throughout flowering. Fungicide treatments were effective in reducing disease levels, particularly when dual applications were used (Fig. 3). However, yield responses to fungicides were limited due to the dry environmental conditions that limited disease development (< 2%). As a result, single and dual fungicide applications resulted in a net loss of -$ 9.50 and -$ 42 compared to unsprayed across all seeding rates, respectively. In years where moisture is not a limiting factor, disease levels for seeding rates that exceed 130 seeds m^{-2} are expected to have exponentially higher disease levels and a greater response to fungicide applications. Therefore, under high disease pressure conditions, management strategies including fungicide applications are expected to return the highest profit. Fungicide applications should be considered as an insurance against yield losses caused by disease problems.

The current seeding rate recommendations of 130 seeds m^{-2} should be revalued based on our preliminary results. Yield tended to increase at a seeding rate of 190 seeds m^{-2} compared to the current recommendations. Yield advantages were attributed to an enhanced crop competitive ability as a result of improved canopy closure, reduced weed biomass, and relatively low disease pressure. The preliminary results correspond with a similar study lead by Dr. Shirtliffe which indicated that the seeding rate of extra small and small red lentil should be doubled to 260 seeds m^{-2} (Barker, 2017). Although the current study found that 190 seeds m^{-2} was more beneficial than 260 seeds $m^{-2,}$ both studies indicate that a seeding rate exceeding 130 seeds m^{-2} is critical to enhance yields and reduce crop-weed competition.

Seeding rates had a consistent, positive effect on yield that resulted in profitable gross gains. A seeding rate of 190 seeds m^{-2} also proved to be the most economically feasible, regardless of management strategy. The increase in seed costs associated with a seeding rate of 190 seeds m^{-2} were offset by the yield advantage; making this management strategy the most profitable. In contrast, the seed cost associated with a seeding rate of 260 seeds m^{-2} was unable to offset the input costs, making the highest seeding rate less profitable. Overall, preliminary results indicate that a seeding rate of 190 seeds m^{-2} could be utilized to limit disease pressure while simultaneously improving crop competitive ability to ensure a yield benefit.

c. Interim Conclusions:

During the first year of the study conditions were very dry. The pre-seed residual treatment required soil moisture to be activated and thus responses were inconsistent among locations. Disease pressure was low and fungicide treatment effects were limited and differences between the unsprayed checks and the treatments were minimal. A seeding rate of 190 seeds m^{-2} resulted in the highest yield and also provided enough canopy closure to compete with weeds. The seeding rate of 260 seeds m^{-2} did not substantially increase yield and resulted in higher input costs. Seed size had a slight, but not significant, reduction when seeding rates exceeded 130 seeds m^{-2}.

The economic analysis demonstrated that the best management practice is the conventional strategy with a seeding rate of 190 seeds m^{-2}. A high price market scenario indicated a minimal gross profit decrease for the conventional management compared to the basic management. The high input costs associated with the enhanced management could be justified if a severe high disease pressure is present.

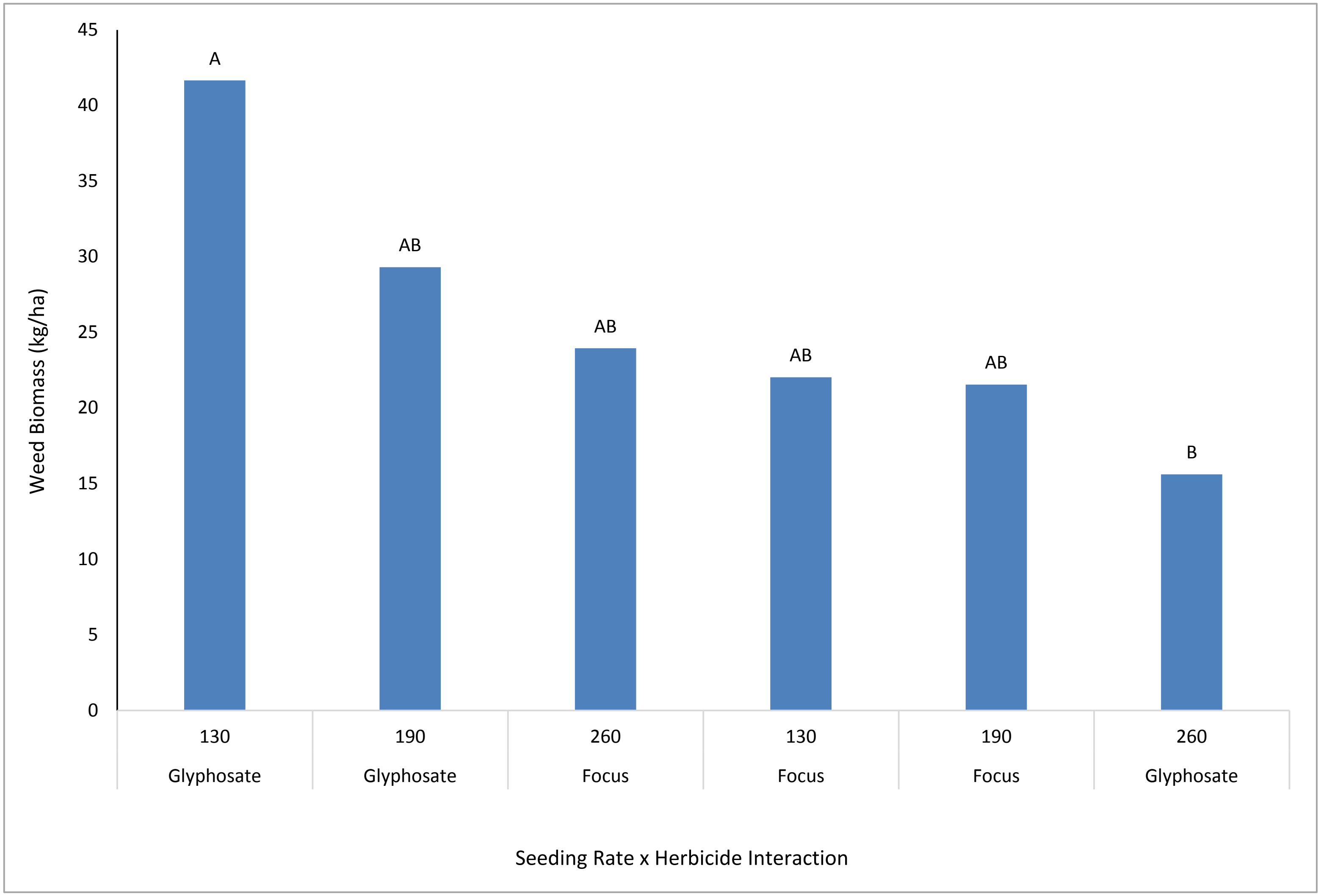

Figure 1. Weed biomass (kg/ha) response to lentil seeding rates and herbicide treatments of pre-seed burn-off and pre-seed residual herbicides at five locations (2017).

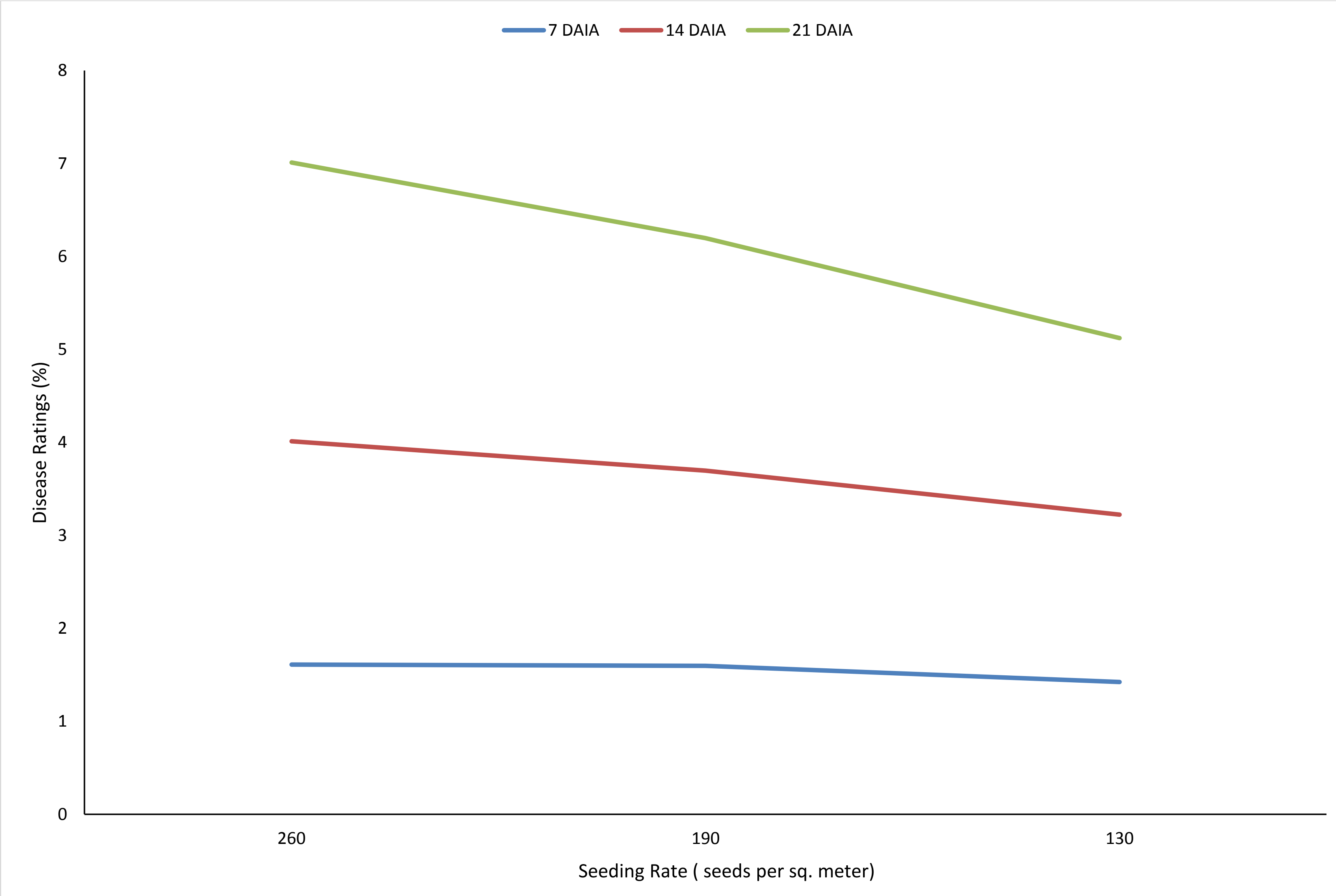

Figure 2. Disease response ratings at 7 DAA, 14 DAA, 21 DAA to lentil seeding rates at five locations across Saskatchewan, Canada (2017).

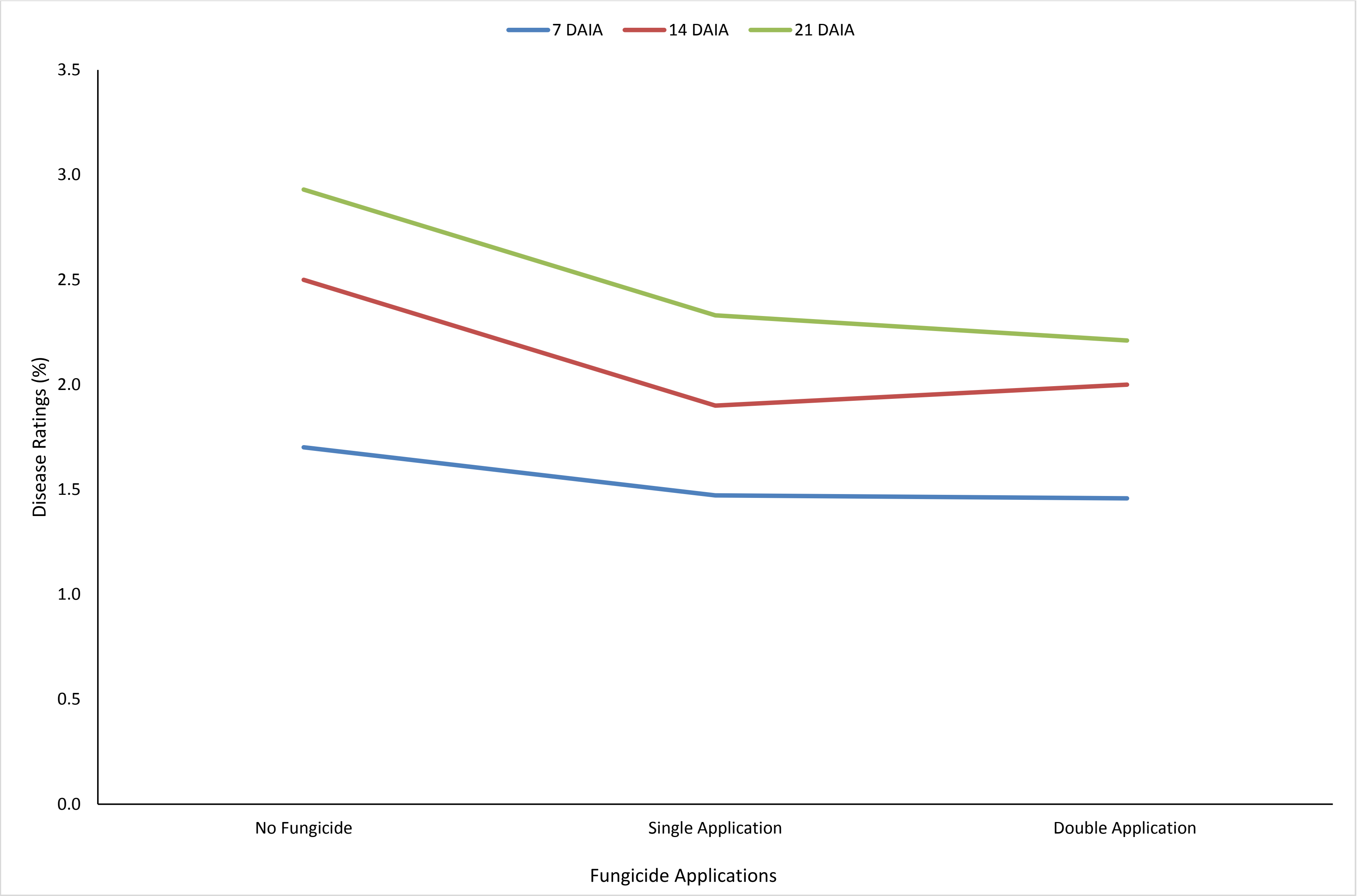

Figure 3. Disease response ratings at 7 DAA, 14 DAA, and 21 DAA to fungicide applications at five locations across Saskatchewan, Canada (2017).

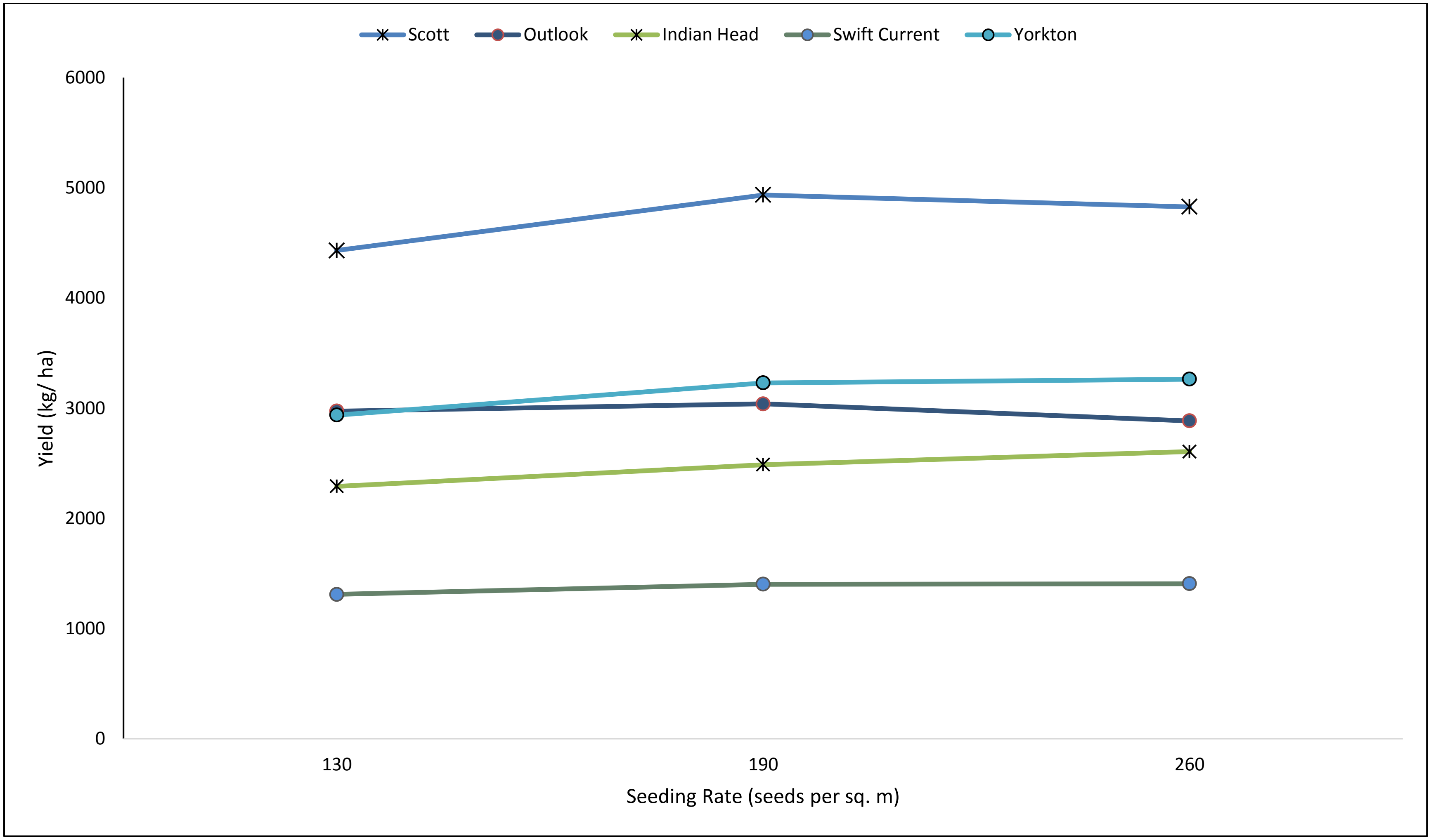

Figure 4. Lentil seed yield response to seeding rate (seeds per sq. m) at five locations across Saskatchewan, Canada (2017).

3. Technology Transfer Activities in Relation to the Project

Weber, Jessica. An economic approach to lentil production. Crop Opportunity, North Battleford. March 13th, 2018. Approx. 100 farmers and agronomists in attendance.

WARC Field Day Tour, July 12th, 2017, Scott, SK. Presentation on management strategies for lentil production. Approx. 130 farmers and agronomists in attendance.

Farmer Writers of Saskatchewan Field Tour. June 3rd, 2017, Scott, SK. Presentation on management strategies for lentil production. 6 reporters in attendance.

FMC Agronomy Tour. July 19th, 2017, Scott, SK. Presentation on management strategies for lentil production. 10 agronomists in attendance.

Indian Head Richardson- Pioneer Agronomy Tour. July 21th, 2017. presentation on fungicide efficacy and the influence of seeding rates in lentils. in durum and stripe rust in winter wheat. Approx. 40 agronomists in attendance.

ECRF Field Day Tour, July 13th, 2017, Scott, SK. Presentation on management strategies for lentil production. Approx. 73 farmers and agronomists in attendance.

ICDC Field Day Tour, July 13th, 2017, Scott, SK. Presentation on management strategies for lentil production. Approx. 150 farmers and agronomists in attendance.

4. Changes Expected to Industry Contributions, In-Kind Support, Collaborations, Etc.

No changes to industry contributions or in-kind support occurred and none are expected going into the second year of the study. With regard to collaboration, the original site proposed at Yorkton (East Central Research Foundation) was dropped due to location restrictions and replaced with a site at Saskatoon under the supervision of Steve Shirtliffe. This revision is not expected to have any impacts on budget or the deliverables of the project.

5. Appendices

a. Resources / Literature Cited

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Table 1. Selected agronomic information for the lentil input study at 5 locations in western Canada (2017).

	Location (2017)				
Factor / Field Operation	Indian Head	Scott	Swift Current	Outlook	Yorkton
Previous Crop	Barley	Wheat	Wheat	Barley	Wheat
Variety	CDC Maxim	CDC Maxim	CDC Maxim	CDC Maxim	CDC Maxim
Pre-emergent Herbicide	May 14- 15th	May-16th	May 16th	May 23rd	May 12th May 16th
Seeding Date	May 9th	May 19th	May 19th	May 26th	May 15th
Seeding Rate	-	-	-	-	-
Row spacing	30 cm	25 cm	23 cm	25 cm	25 cm
In-crop Herbicide	June 9th	June 15th June 23rd	Jun-27	June 23rd	June 12th
Fungicide	July 4th July 18th	July 8th July 17th	July 10th July 20th	July 10th July 27th	July 17th July 27th
Insecticide	n/a	n/a	n/a	n/a	July 27th
Pre-harvest herbicide	Aug 3rd	Aug 25th	Aug 16th	Aug 29th	Sept 7th
Harvest date	Aug 16th	Sept 1	Aug 23rd	Sept 5th	Sept 17th

Table 2. Mean monthly temperatures for the 2017 growing season relative to the long-term averages (1981-2010) at 5 locations in western Canada.

Location	Year	Mean Monthly Temperature				
		May	**June**	**July**	**August**	**Average**
		---------- ºC ----------				
Indian Head	2017	11.6	15.5	18.4	16.7	15.5
	LT	10.8	15.8	18.2	17.4	15.6
Scott	2017	11.5	15.1	18.3	16.6	15.4
	LT	10.8	15.3	17.1	16.5	14.9
Swift Current	2017	12.3	15.7	20.6	18.3	16.7
	LT	10.9	15.4	18.5	18.2	15.8
Yorkton	2017	11.1	15.5	19	17.4	15.8
	LT	10.4	15.5	17.9	17.1	15.2
Outlook	2017	12.2	16.1	19.7	19.1	16.8
	LT	11.4	16.6	19.2	18.2	16.4

[z] LT- Long-Term average (1981-2010)

Table 3. Monthly precipitation amounts for the 2017 growing season relative to the long-term averages (1981-2010) at 5 locations in western Canada.

Location	Year	Total Monthly Precipitation				
		May	**June**	**July**	**August**	**Total**
		---------- ºC ----------				
Indian Head	2017	10.4	65.6	15.4	25.20	116.6
	LT [z]	51.8	77.4	63.8	51.2	244
Scott	2017	69.0	34.3	22.4	53	178.7
	LT	38.9	69.7	69.4	48.7	227
Swift Current	2017	21.0	35.3	11.0	28.0	95.3
	LT	48.5	72.8	52.6	41.5	215
Yorkton	2017	74.9	62.8	141.7	59.1	338.5
	LT	51.3	80.1	78.2	62.2	272
Outlook	2017	32.0	29.0	60.4	7.4	128.8
	LT	56.5	79.6	68.2	65.5	270

[z] LT- Long-Term average (1981-2010)

Table 4. Economic analysis of a "basic" management strategy with three seeding rates with two market prices of CDC Maxim lentil at five locations in Saskatchewan (2017).

Seeding Rate (seeds m^{-2})	Yield (kg per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)
130	2556	0.44	124.00	0.66	216.30
190	2757	0.44	134.45	0.66	234.00
260	2690	0.44	124.78	0.66	221.90

Table 5. Economic analysis of a "conventional" management strategy with three seeding rates with two market prices of CDC Maxim lentil at five locations in Saskatchewan (2017).

Seeding Rate (seeds m^{-2})	Yield (kg per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)
130	2623	0.44	117.73	0.66	212.47
190	2825	0.44	128.18	0.66	230.20
260	2757	0.44	118.30	0.66	218.09

Table 5. Economic analysis of a "enhanced" management strategy with three seeding rates with two market prices of CDC Maxim lentil at five locations in Saskatchewan (2017).

Seeding Rate (seeds m^{-2})	Yield (kg per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)	Market Price ($ per kg)	Gross Profit ($ per ha)
130	2556	0.44	102.02	0.66	194.34
190	2825	0.44	117.33	0.66	219.36
260	2757	0.44	107.65	0.66	207.24

Table 6. Cost of CDC Maxim seed for economic analysis production costs

Seeding Rate (seeds /m^2)	Seeding Rate (lb/ac)	Cost of CDC Maxim ($ / lb)	Total of CDC Maxim
130	43.5	0.51	$22.19
190	63.5	0.51	$32.39
260	86.9	0.51	$44.32

Table 7. Input costs for the economic analysis based on management strategies and seeding rates 2017 growing season

	@ 130 seeds per sq. meter			@ 190 seeds per sq. meter			@ 260 seeds per sq. meter		
	Basic	Conventional	Enhanced	Basic	Conventional	Enhanced	Basic	Conventional	Enhanced
Seed ($/ac)	22.2	22.2	22.2	32.4	32.4	32.4	44.3	44.3	44.3
Fertilizer ($/ac)[Z]	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Herbicide ($/ac)[Y]	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Inoculants ($/ac)[X]	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
Fungicides ($/ac)[W]	0.0	23.5	46.3	0.0	23.5	46.3	0.0	23.5	46.3
Labour ($/hr)[V]	18.0	22.0	26.0	18.0	22.0	26.0	18.0	22.0	26.0
Insurance [Z]	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2
Miscellaneous [Z]	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Interest [Z]	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Fuel ($/ac) [Z]	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
Total Cost ($/ac)	149.7	177.2	204.0	159.9	187.4	214.2	171.8	199.3	226.1

[Z] Fertilizer, Insurance, Miscellaneous, Interest and Fuel costs were based on the average costs of fertilizer from the Crop Planning Guide, 2018

[Y] Herbicide costs were based on glyphosate, Ares, and Centurion. As there was no significant difference of herbicide on yield, the cost of Focus was excluded for the economic analysis

[X] Inoculant costs were based on granular product for the 2017 growing season

[W] Fungicide costs we based on the product cost for Priaxor sprayed at 180 ml/ac and Lance WDG at 170 g/ ac for the 2017 growing season

[V] Labour costs were based on the provided values from the Crop Planning Guide, 2018. Incremental costs were included for cost of spraying based on a 60% cost of a custom sprayer fee of $6.50 (customer sprayer cost averaged from 3 independent quotes)