2015 Annual Report

for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Phosphorus Fertilization and Fungicide Effects on Faba Bean Establishment and Yield

(Project #20140436)

Principal Applicant: Chris Holzapfel, MSc, PAg

Indian Head Agricultural Research Foundation, Box 156, Indian Head, SK, S0G 2K0

Correspondence:

Project Identification

1. **Project Title:** Phosphorus fertilization and fungicide effects on faba bean establishment and yield.
2. **Project Number:** 20140436
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation
4. **Project Location(s):** Indian Head, Saskatchewan, R.M. #156
5. **Project start and end dates (month & year):** April 2015 to January 2016
6. **Project contact person & contact details:**

Chris Holzapfel, Research Manager

Indian Head Agricultural Research Foundation

P.O. Box 156, Indian Head, SK, S0G 2K0

Phone: 306-695-4200

Email:

Objectives and Rationale

7. **Project objectives:**

The objectives of this project were to demonstrate: 1) the effects of phosphorus rate and placement on faba bean establishment and yield and 2) faba bean yield response to applications of registered foliar fungicides.

8. **Project Rationale:**

Faba beans have been grown in limited acres on the Prairies for decades and have long been considered to be well adapted to the moister, cooler regions of Saskatchewan such the Black soil zone. While acres continue to be small, interest in this crop has been rising due to its high yield potential and ability to withstand prolonged wet periods much better than more traditional pulse crops like field pea and lentil. With the potential for increased uptake, producers need increased exposure to some of the management factors that should be considered when growing this crop. The two factors which were varied in this demonstration are phosphorus (P) fertilizer management practices and foliar fungicide applications.

Sound phosphorus fertility management is important for all crops, both to ensure high productivity in the year of application and also to maintain the fertility of our soils over the long-term. While the response to fertilizer may be variable for this crop, high yielding faba beans remove large amounts of P in the grain. The amount of P exported in the seed ranges from 55-67 lbs P_2O_5 ac^{-1} for a 50 bu ac^{-1} crop while, at this yield, total uptake is in the range 89-108 lbs P_2O_5 ac^{-1}. At Indian Head in 2014, early seeded faba beans yielded approximately 90 bu ac^{-1}, therefore removing extremely large quantities of P from the soil. These high removal rates illustrate just how important adequate P fertilization of this crop is for the long-term health of our soils. For placing P fertilizer in the seed-row, it is not recommended that more than 25 kg/ha P_2O_5 be applied when using narrow openers with faba beans. For side-banding, the rates that can safely be applied are higher; however, some growers question the efficacy of side-banding P and are hesitant to rely on this method.

Faba bean disease issues and options for control is another subject that has been top of mind for many growers in the Black soil zone and southeast Saskatchewan in general. For faba bean, the main diseases that should be monitored include chocolate spot, ascochyta leaf and pod spot, sclerotinia (white mold) and rust. While the impact that these diseases are currently having on faba bean yields in Saskatchewan is uncertain, several fungicide products are now registered for application on this crop and options for control or suppression of all diseases listed are available.

While faba bean P fertility practices and fungicide applications are not expected to be correlated or dependant on one another in any way, these are two major components to the production package that, at the time this project was initiated, were not currently being evaluated in this region. Furthermore, the inclusion of the fungicide component provides the added benefit of increased replication of the P treatments which will enhance our ability to detect potentially subtle treatment effects.

Methodology and Results

9. Methodology:

A field trial with faba beans was established on a clay soil east of Indian Head, Saskatchewan (R.M. #156; -103.560 W 50.554 N). Five fertilizer treatments and two fungicide treatments were arranged in a split plot design with fungicide treatments as the main plots and P fertilizer treatments as the sub-plots. Each treatment was replicated four times. The P treatments were a control (no P fertilizer) and 25 or 50 kg P_2O_5 ha^{-1} (22-45 lb ac^{-1}) either side-banded or placed in the seed-row. The P fertilizer source was mono-ammonium phosphate (11-52-0) and the drill was a SeedMaster plot drill with eight openers (1.6 cm opener width) on 30 cm spacing and a seed-bed utilization of approximately 6%. The targeted seed depth was approximately 3.75-4 cm and, for the side-banded treatments, P fertilizer was placed 1.9 cm (0.75") below and 3.8 cm (1.5") beside the seed-row (www.seedmaster.ca/openers.php). During seeding, plugging as a result of the large seed and rocks in the seed source led to variable establishment and missing rows in many plots.

A two depth (0-15 cm, 15-60 cm) composite soil sample was collected on April 29 and submitted to ALS laboratory group for various analyses. Snowbird faba beans were direct-seeded into heavy harrowed spring wheat stubble at a rate of 45 seeds m^{-2} (175 kg ha^{-1}) on May 1. The seed was inoculated with Nodulator self-adhering peat-based inoculant, monoammonium phosphate (11-52-0) was applied as per protocol and no other fertilizers were applied. Weeds were controlled using pre-emergent applications of 4.4 l Avadex BW ha^{-1} followed by a tank-mix of 890 g glyphosate ha^{-1} and 292 ml Authority 480 ha^{-1} (April 29). In-crop applications include 43 g Odyssey ha^{-1} plus 166 ml Equinox ha^{-1} (June 2) and then 185 ml Centurion ha^{-1} (June 24) to control a late flush of volunteer wheat and wild oats. Insects were somewhat problematic and blister beetles were sprayed on June 29 (82 ml Matador 120) followed by pea aphids on August 1 (423 ml Lagon 480 ha^{-1}). As per protocol, the treated plots received two applications of foliar fungicide due to uncertainty of the optimal timing of application and product selection for this crop. The applications were 0.4 l Headline EC (early bloom – June 28) followed by 0.44 l Priaxor (mid-bloom – July 7). Fungicides were applied using flat fan nozzles and a solution volume of 224 l ha^{-1}. The plots were terminated with 890 g glyphosate ha^{-1} (August 26) but, due to variability caused by the plugging at seeding, could not be mechanically harvested. Instead, 4 random 1 m sections of representative crop row were hand harvested on September 11 and later threshed using a Wintersteiger plot combine. Only rows that were flanked by intact rows on both sides were considered suitable for harvesting.

Various data were collected over the course of the growing season and from the harvested grain samples. Emergence was assessed by counting the number of plants in four separate 1 m sections of crop row (avoided compromised rows) on June first and converting the values to plants m^{-2}. There was no disease noted at the time of fungicide application but ratings from each fungicide treatment were completed for 25 plants from each fungicide treatment on August 24. Seed yields were corrected for dockage and to a uniform moisture content of 16%. Seed size was determined by mechanically counting and weighing approximately 400-500 seeds and converting the values to g 1000 $seeds^{-1}$.

Response data were analysed using the Mixed procedure of SAS 9.3. Individual treatment means were separated using Fisher's protected LSD test and single degree-of-freedom contrasts were used to compare P rates (across fungicide treatments and placement methods) and to compare P placement

methods (across rates and fungicide treatments). All treatment effects and differences between means were considered significant at $P \leq 0.05$.

Results:

Soil test results for the trial site are presented in Table 1. All macronutrients except for K were considered deficient to marginal with strong potential for a yield response to P fertilization. The pH was 8.0 for the 0-15 cm soil profile.

Table 1. Soil test results for the ADOPT faba bean P fertilizer by fungicide demonstration at Indian Head in 2015. Samples were collected on April 29 and submitted to ALS Laboratory Group for analyses.

Soil Depth	Nitrogen (NO_3)	Phosphorus (Olsen-P)	Potassium (K)	Sulphur (SO_4)	--- pH ---
	---------- kg ha^{-1} ----------				—
0-15 cm	12	12	> 605	7	8.0
15-60 cm	15	—	—	18	8.3
Total [z]	27	12	> 605	25	—

[z] 0-60 cm for N and S; 0-15 cm for P and K

Mean monthly temperatures and precipitation amounts for the 2015 growing season at Indian Head are presented relative to the long-term averages in Table 2. Temperatures were slightly above-average overall in May-June, close to normal in July and slightly below average in August. While seed and fertilizer were placed into adequate, but not excessive moisture, the spring as whole was dry with no significant precipitation events until late in the third week of June when the faba beans were already flowering. While moisture conditions dramatically improved from late June onwards, the warm dry start to the season was not ideal for this crop, likely limiting the yield potential early on and generally not conducive to disease development.

Table 2. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) averages for the 2015 growing season at Indian Head, SK.

Year	May	June	July	August	Avg. / Total
	---------- Mean Temperature (°C) ----------				
2015	10.3	16.2	18.1	17.0	15.4
Long-term	10.8	15.8	18.2	17.4	15.6
	---------- Precipitation (mm) ----------				
2015	15.6	38.3	94.6	58.8	207
Long-term	51.8	77.4	63.8	51.2	244

Faba bean emergence was not affected by phosphorus treatment ($P = 0.117$) indicating that the rates evaluated in this study were safe for seed-row placement under the specific soil and weather conditions encountered. Overall emergence was excellent with an average of 39 plants m^{-2} or approximately an 87% survival rate. Phosphorus treatment effects on yield and seed size were somewhat variable however there did appear to be a P response with a tendency for higher yields at the 50 kg P_2O_5 ha^{-1} rate,

particularly with seed-placement. According to the contrasts, yields and seed size were significantly higher with 50 kg ha^{-1} relative to both the control and the 25 kg P_2O_5 ha^{-1} rate but the yield difference between side-banding and seed-placement was not significant. Again, due to high variability and the small harvest areas our ability to detect treatment effects on yield was limited.

While the mean ratings at maturity were 3.25 for the control and 1.74 for the faba beans which received foliar fungicide, the mean yields did not significantly differ between the sprayed (3247 kg ha^{-1} or 48 bu ac^{-1}) and unsprayed (3012 kg ha^{-1} or 45 bu ac^{-1}) plots. Seed size with fungicide was increased by approximately 5% relative to the control which was similar to the actual observed difference in actual mean yields. Overall, disease appeared relatively late in the season, after significant pod-filling had occurred, and therefore was unlikely to have a large impact on yield.

Table 3. Tests of fixed effects and main effect means for fungicide and phosphorus fertilization effects on faba bean establishment, yield and seed size at Indian Head (2015).

	Plant Density	Seed Yield	Seed Size
Effect	---------- p-value ----------		
Fungicide (F)	0.330	0.195	0.022
Phosphorus (P)	0.117	0.001	< 0.001
F x P	0.696	0.927	0.839
Treatment	--------- plants m^{-2} ---------	---------- kg ha^{-1} ----------	------ g 1000 $seeds^{-1}$ ------
No Fungicide	40.3 a	3012 a	397.5 b
Fungicide Applied	38.3 a	3247 a	416.0 a
S.E.M.	1.26	135.6	3.99
Control (0 P)	41.8	2897 b	401.7 bc
25 kg P_2O_5 ha^{-1} (SR^Z)	39.6	2760 b	392.6 c
50 kg P_2O_5 ha^{-1} (SR)	40.3	3774 a	427.4 a
25 kg P_2O_5 ha^{-1} (SB^Z)	37.7	3015 b	405.2 bc
50 kg P_2O_5 ha^{-1} (SB)	37.0	3204 b	406.9 b
S.E.M.	1.50	182.6	5.24

[Z] SR – seed-row placement; SB – side-band placement

Table 4. Predetermined contrast comparisons results for phosphorus fertilization effects on faba bean establishment, yield and seed size at Indian Head (2015).

Contrast Comparison	Plant Density	Seed Yield	Seed Size
	--------- plants m^{-2} ---------	---------- kg ha^{-1} ----------	------ g 1000 $seeds^{-1}$ ------
Control (0P) vs.	41.8 a	2896 a	401.7 a
Fertilized	38.6 b	3188 a	408.0 a
Pr > F (p-value)	0.047	0.110	0.221
Control (0P) vs.	41.8 a	2896 a	401.7 a
25 kg P_2O_5	38.7 a	2888 a	398.9 a
Pr > F (p-value)	0.069	0.968	0.608
Control (0P) vs.	41.8 a	2896 b	401.7 b
50 kg P_2O_5	38.6 a	3489 a	417.2 a
Pr > F (p-value)	0.067	0.005	0.010
25 kg P_2O_5 vs.	38.7 a	2888 b	398.9 b
50 kg P_2O_5	38.6 a	3489 a	417.2 a
Pr > F (p-value)	0.989	< 0.001	0.000
Seed-Row vs.	39.9 a	3267 a	410.0 a
Side-Band	37.4 a	3110 a	406.1 a
Pr > F (p-value)	0.071	0.327	0.392

Extension and Acknowledgement

This demonstration was a formal stop during the 2015 IHARF Crop Management Field held on July 21. The tour was attended by over 200 registered guests and signs were in place to acknowledge the support of the Agricultural Demonstrations of Technologies and Practices (ADOPT) program. Sherilynn Phelps (Saskatchewan Pulse Growers) led the discussion during this segment of the field day with the assistance of Chris Holzapfel (IHARF). Results from this project will be made available in the 2015 IHARF Annual Report (available online) and also through a variety of other media (i.e. oral presentations, popular agriculture press, fact sheets, etc.) as opportunities arise.

10. Conclusions and Recommendations

This project demonstrated the high P requirements of faba bean and did not show any impact of seed-placed P on emergence at the 25-50 kg P_2O_5 ha^{-1} rates evaluated. Current recommendations with narrow openers are to avoid seed-placing rates beyond 25 kg P_2O_5 ha^{-1}; however, this was a relatively fine textured soil and seed and fertilizer was placed into good soil moisture which may have mitigated the risks of crop injury. Despite variable yields due to establishment issues, there was some evidence of a yield response to P fertilization, particularly at the higher application rate. While the overall comparison between side-banding and seed-placement effects on yield was not statistically significant, actual yields tended to favour seed-placement. In any case, faba beans are large users of P and, even with modest

yields due to the hot dry spring, this crop removed approximately 51-63 kg P_2O_5 ha^{-1} in the seed and would have required in the range of 82-96 kg P_2O_5 ha^{-1} in total.

Focussing on fungicide and disease, while there was reduced disease and significantly larger seeds with fungicide application, the observed yield benefits were not statistically significant. However, variability was high (limiting our ability to detect treatment effects) and, for the most part, the disease symptoms that were observed did not appear until relatively late in the season when substantial pod-filling had already occurred. As with most crops, the diseases that affect faba beans tend to be more severe under warm, wet conditions and early onset of disease generally has the largest impact on yield and potential benefits to foliar fungicide applications.

Supporting Information

11. Acknowledgements:

This project was financially supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Acknowledgement of the Saskatchewan Ministry of Agriculture's support for this demonstration will be included as part of all written reports and oral presentations that arise from this work. Crop protection products used in this demonstration were provided in-kind by FMC, BASF and Bayer Cropscience. The support and contributions of Christiane Catellier, Dan Walker, Carly Miller and Danny Petty are greatly appreciated.

12. Appendices

Table 5. Individual treatment means for fungicide and phosphorus fertilization effects on faba bean establishment, yield and seed size at Indian Head (2015).

	Treatment Means		
Treatment	plants m^{-2}	kg ha^{-1}	g 1000 $seeds^{-1}$
No fungicide – 0 P Control	43.9 a	2733 bc	391.7 ef
No fungicide – 25[Z] P SR[Y]	39.2 a	2632 c	379.5 f
No fungicide – 50 P SR	41.0 a	3785 a	421.8 ab
No fungicide – 25 P SB[Y]	38.6 a	2874 bc	396.3 def
No fungicide – 50 P SB	39.0 a	3038 bc	398.2 cde
Fungicide – 0 P Control	39.8 a	3058 bc	411.8 bcd
Fungicide [X] – 25 P SR	40.0 a	2889 bc	405.6 b-e
Fungicide – 50 P SR	39.6 a	3763 a	433.0 a
Fungicide – 25 P SB	36.9 a	3156 abc	414.1 bcd
Fungicide – 50 P SB	35.0 a	3370 ab	415.7 abc
S.E.M.	2.13	241.3	6.93

Abstract

13. Abstract/Summary:

A faba bean field trial was initiated to demonstrate the response to phosphorus fertilization and foliar fungicide applications. The P treatments were a control plus two rates (25-50 kg P_2O_5 ha^{-1}) of monoammonium-phosphate (11-52-0) either side-banded or seed-placed. One set of treatments was not sprayed for disease while the other was sprayed twice (early bloom and mid-bloom). Phosphorus treatment did not affect plant density, despite having evaluated seed-row P rates approximately 2x the maximum recommended amounts. Phosphorus fertilization did result in higher yields and larger seeds, particularly at the higher rate and, to a lesser extent, with seed-placement. Foliar fungicide reduced visible disease symptoms and resulted in larger seeds, but did not provide a statistically significant yield benefit. While this was not necessarily unexpected due to the relatively late onset of disease, our overall ability to detect subtle treatment differences in yield was also limited by high variability high due to establishment issues and small harvest areas.