2014 Annual Report

for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Fungicide Application and Seeding Rate Effects on Disease Levels and Yield in Field Peas and Lentil

(Project #201300389)

Principal Applicant: Chris Holzapfel, MSc, PAg

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

Correspondence:

Project Identification

1. **Project Title:** Fungicide application and seeding rate effects on disease levels and yield in field peas and lentil
2. **Project Number:** 20130389
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):** September 2012-January 2014
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 objective of this project was to demonstrate the effects of seeding rate and fungicide applications on field pea and lentil production in southeast Saskatchewan. While higher seeding rates have the potential to increase yield and improve the crop's ability to compete with weeds, a denser crop canopy can increase incidence of disease. Consequently, the potential benefits of fungicide applications may vary depending on seeding rates and the subsequent density of the crop canopy.

8. **Project Rationale:**

Diseases such as white mold in lentil and mycosphaerella blight in field pea are frequently associated with reduced yield and quality in southeast Saskatchewan. While there are several registered products on the market, producers may not always see the potential benefits of applying a fungicide. Increased seeding rates in peas and lentils have been promoted as a way to increase yield and decrease weed competition, but dense crop canopies can potentially increase disease incidence and severity. This project was proposed to demonstrate disease incidence and severity in pea and lentil crops with low, medium and high seeding rates along with the potential benefits of applying foliar fungicides at each seeding rate. The intended benefit of the project was to visually demonstrate and provide locally relevant data on the effects of two easily controlled agronomic factors on field pea and lentil production while reinforcing past research on the effects of seeding rates and fungicide applications under field conditions.

Methodology and Results

9. **Methodology:**

Replicated field demonstrations with field pea and lentil were conducted near Indian Head, Saskatchewan in both 2013 (50°34'12" N, 103°38'06" W) and 2014 (50°32'58" N, 103°34'18" W). The treatments evaluated were a factorial combination of two crop types (field pea & lentil), three seeding rates (low, medium, high) and two fungicide treatments (untreated and fungicide applied). In both years, the treatments were replicated four times. In 2013 the treatments were arranged in an

RCBD while in 2014 a split plot design was used with crop type as the main plots. The rationale for the split plot design was to make it easier to apply fungicide treatments and pre-harvest herbicide applications in the event that the two crops matured at different stages. The specific treatments evaluated are provided in Table 1.

Table 1. Treatments evaluated in field pea and lentil demonstration at Indian Head, Saskatchewan in 2013 and 2014.

#	Crop (C)	Seed Rate (R)	Fungicide (F)
1	Lentil	Low (130 seeds m^{-2})	No
2	Lentil	Low (130 seeds m^{-2})	Yes [z]
3	Lentil	Medium (260 seeds m^{-2})	No
4	Lentil	Medium (260 seeds m^{-2})	Yes
5	Lentil	High (520 seeds m^{-2})	No
6	Lentil	High (520 seeds m^{-2})	Yes
7	Field Pea	Low (50 seeds m^{-2})	No
8	Field Pea	Low (50 seeds m^{-2})	Yes
9	Field Pea	Medium (100 seeds m^{-2})	No
10	Field Pea	Medium (100 seeds m^{-2})	Yes
11	Field Pea	High (200 seeds m^{-2})	No
12	Field Pea	High (200 seeds m^{-2})	Yes

[z] 0.4 l ha^{-1} Headline at start of flowering followed by 0.4 l ha^{-1} of Priaxor DS 7-10 days later

The field pea variety CDC Golden and lentil variety CDC Maxim CL were direct seeded into spring wheat stubble in the second week of May of both years (Table 2). The plots were seeded using a Conserva-Pak drill with 14 openers spaced 30 cm apart (4.2 m total seeded width) and a trimmed plot length of 10.5 m. A relatively large plot size was chosen to allow fungicide treatments to be applied with a field sprayer and to reduce potential issues with spray drift and/or disease inoculum spreading from one plot to the next. Seeding rates varied as per protocol, with a targeted seeding depth of 20-25 mm for lentils and 25-30 mm for field pea. Soil conditions at seeding were considered excellent with adequate but not excessive moisture in both years. Fertilizer applications varied from year-to-year (Table 2) but were held constant across treatments and all granular fertilizer products were always side-banded. Nodulator XL pea and lentil inoculant (BASF-Becker Underwood) was seed-placed at 3.7 kg ha^{-1}. Weeds were controlled using recommended herbicide applications including pre-emergent glyphosate and Odyssey (35% imazamox and 35% imazethapyr) and Equinox (200 g l^{-1} tepraloxydim) applied in-crop. To aid with crop dry-down and harvest operations, pre-harvest glyphosate (890 g ha^{-1}) was applied to both crop types in both years. The entire plots were direct-combined as soon as possible after the crops were fit to harvest.

Summer data collection activities included spring plant density measurements (2 x 1 m rows) along with disease ratings prior to the first fungicide application and again prior to physiological maturity. Field pea disease was rated on a scale of 0-9 (according to percent leaf and stem area affected by disease) while lentils were rated on a scale of 0-100 (according to percent total plot area affected). Grain yields were determined by cleaning and weighing the entire harvest sample and are expressed

as kg ha^{-1} of clean seed corrected to uniform moisture contents of 13% for lentils and 16% for field peas. Seed size was determined by mechanically counting and weighing approximately 1000 seeds and converting the values to g 1000 $seeds^{-1}$. Growing season weather data were based on data from the nearest Environment Canada weather station located within approximately 5 km of the plots.

Response data were analyzed using the mixed procedure of SAS 9.3 with the effects of crop, seeding rate and fungicide considered fixed and the effect of replicate random. Heterogeneity of variance estimates were allowed amongst the two crop types; however the more complex model was only used when doing so improved the model fit according to the Akaike information criterion (AICC) values. Fisher's protected LSD test was used to separate individual treatment means and orthogonal contrasts were used to describe the responses to seeding rate with and without fungicides for each crop type. All treatment effects and differences between means were declared significant at $P \leq 0.05$.

Table 2. Selected agronomic information for seeding rate and fungicide demonstration for field pea and lentil at Indian Head, Saskatchewan in 2013 and 2014.

Factor / operation	Indian Head (2013)	Indian Head (2014)
Previous Crop	CWRS Wheat	2-Row Barley
Pre-emergent herbicide	590 g glyphosate ha^{-1} (May-17-2013)	890 g glyphosate ha^{-1} (May-18-2014)
Seeding Date	May-13-2013	May-10-2014
Granular Inoculant	3.7 kg Nodulator XL ha^{-1}	3.7 kg Nodulator XL ha^{-1}
Row spacing	30.5 cm	30.5 cm
Plant Density	Jun-3-2013	Jun-6-2014
kg N-P_2O_5-K_2O-S ha^{-1}	21-30-15-15	7-33-0-0
In-crop herbicide 1	42.7 g Odyssey ha^{-1} + 166 ml Equinox ha^{-1} + 0.5% Merge (Jun-7-2013)	42.7 g Odyssey ha^{-1} + 166 ml Equinox ha^{-1} + 0.5% Merge (Jun-8-2014)
In-crop herbicide 2	0.185 l Equinox ha^{-1} + 0.5% Merge (Jun-29-2013)	0.47 l Poast Ultra ha^{-1} + 0.5% Merge (Jul-7-2014)
Fungicide T1	0.4 l Headline EC ha^{-1} (Jul-4-2013)	0.4 l Headline EC ha^{-1} (Jul-8-2014)
Fungicide T2	0.4 l Priaxor DS ha^{-1} (Jul-11-2013)	0.4 l Priaxor DS ha^{-1} (Jul-16-2014)
Disease ratings T1	Jul-3-2013	Jul-8-2014
Disease ratings T2	Aug-7-2013	Aug-6-2014
Pre-harvest herbicide	890 g glyphosate ha^{-1} (Aug-20-2013)	890 g glyphosate ha^{-1} (Aug-14-2014)
Field Pea harvest date	Aug-30-2013	Sep-1-2014
Lentil harvest date	Sep-3-2013	Sep-2-2014

10. Results:

Mean monthly average temperatures and precipitation totals for the 2013 and 2014 growing seasons are provided in Table 3. While spring arrived late both years with snow persisting into the first week in May, drier than normal weather in May allowed for seeding to progress reasonably well in both 2013 and 2014. June was wetter than normal both years with precipitation levels that were 134% and 258% of the long-term average in 2013 and 2014, respectively (Table 3). Precipitation in July was 79% of the long-term average in 2013 and only 12% of average in 2014. While August was extremely dry with only 6.1 mm of rain in 2013, this month was wet in 2014 with 278% of the long term average amounts. It is well recognized that field peas and lentils are sensitive to prolonged wet conditions, especially on clay soils. While the crops recovered quite well from the excess moisture in June 2013 and yields were remarkably high, 2014 was much wetter and, despite the plots being located on a relatively well drained site, significant crop damage and yield loss occurred.

Table 3. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) averages for the 2013 and 2014 growing seasons at Indian Head, Saskatchewan.

Year	May	June	July	August	Avg. / Total
	---------- Mean Temperature (°C) ----------				
2014	10.2	14.4	17.3	17.4	14.8
2013	11.9	15.3	16.3	17.1	15.2
Long-term	10.8	15.8	18.2	17.4	15.6
	---------- Precipitation (mm) ----------				
2014	36.0	199.2	7.8	142.2	385
2013	17.1	103.8	50.4	6.1	177
Long-term	51.8	77.4	63.8	51.2	244

Results of the mixed analyses and tests of fixed effects are presented in Table 4. Heterogeneous variance estimates improved the model fit for plant density and seed size in both 2013 and 2014 but not for seed yield in either year.

Plant densities were affected by crop type ($P < 0.001$-0.007) and seeding rate ($P < 0.001$) with significant crop by seeding rate (C × R) interactions in both years ($P < 0.001$). A crop by fungicide (C × F) interaction was detected in 2013 ($P = 0.048$) but not in 2014 ($P = 0.411$); however the observed effect in 2013 is attributed to random variability since no fungicide treatments had been applied yet at this time these measurements were completed. On average, seed yields were similar for field pea and lentil ($P = 0.082$) in 2013 but were much lower for lentil than field pea in 2014 ($P < 0.001$) when conditions were substantially wetter, especially in June. The overall effect of seeding rate on seed yield was significant in 2013 ($P = 0.035$) and 2014 ($P < 0.001$) while fungicide affected yields in 2013 ($P < 0.001$) but not 2014 ($P = 0.823$). The only significant two-factor interaction for seed yield was C × F in 2013 ($P = 0.010$). In both years, seed size differed between crop types ($P < 0.001$) and fungicide treatments ($P < 0.001$). Seed size was also affected by seeding rate in 2014 ($P = 0.013$) but not 2013 ($P = 0.694$). The C × F interaction was significant for seed size in both years ($P < 0.001$) and in 2014 the C × R interaction was also significant for seed size ($P = 0.036$). Three way interactions between crop type, seeding rate and fungicide treatment were not detected for any

variables in either 2013 (P = 0.317-0.942) or 2014 (P = 0.072-0.984).

Table 4. Tests of fixed effects for crop type, seeding rate and fungicide effects on plant populations, seed yield and seed size of lentil and field pea at Indian Head, Saskatchewan in 2013 and 2014.

	Plant Density		Seed Yield		Seed Size	
	2013	2014	2013	2014	2013	2014
Source	---------- p-value ----------					
Crop (C)	< 0.001	0.007	0.082	0.021	<0.001	<0.001
Rate (R)	< 0.001	<0.001	0.035	<0.001	0.694	0.013
Fungicide (F)	0.384	0.546	< 0.001	0.823	<0.001	<0.001
C x R	<0.001	<0.001	0.899	<0.001	0.504	0.036
C x F	0.047	0.411	0.010	0.434	<0.001	<0.001
R x F	0.759	0.849	0.501	0.798	0.836	0.723
C x R x F	0.317	0.430	0.942	0.072	0.784	0.984
AICC[1]	343.4	222.0	**564.1**	**355.6**	249.9	356.4
AICC[2]	**334.0**	**209.2**	564.2	358.4	**206.7**	**108.9**

AICC – Akaike information criterion (lower is better) [1]equal variance [2]heterogeneous variance

Least squares means for main effects are presented for the each of the two years in Table 5, while means for the two-way interactions are provided in Table 6. Means for the three-way interactions, which were not significant in any cases, are reserved for the appendices (Table 8) along with orthogonal contrasts describing the seeding rate response for various crop and fungicide treatment combinations (Table 9).

Mean plant densities were 145-151 plants m^{-2} for lentil and 67-79 plants m^{-2} for field pea. Averaged across crops, plant populations increased from 62-167 plants m^{-2} from the lowest to the highest seeding rates in 2013 and from 57-178 plants m^{-2} in 2014 (Table 5). As expected, plant densities increased linearly with seeding rate for both crops and in both years of the study (Table 9), from 87-234 plants m^{-2} for lentils in 2013 and from 78-233 in 2014. For field peas, the plant populations achieved at the different seeding rates ranged from 37-100 in 2013 and 37-125 in 2014 (Table 6). The Saskatchewan Ministry of Agriculture recommends targeting plant populations of 75-85 plants m^{-2} for field pea and 130 plants m^{-2} for lentil. Plant populations at the 'normal' seeding rate were 63 and 132 plants m^{-2} field pea and lentil in 2013 and 79 and 124 plants m^{-2} in 2014. Overall, these populations were considered adequate given that adequate weed control was achieved and crop growth or yields were never limited by lack of moisture.

Table 5. Least squares means of main effects crop type, seeding rate and fungicide treatments for lentil and field pea plant density, yield and seed size at Indian Head, Saskatchewan in 2013 and 2014. Standard errors are enclosed in parentheses

Main Effect	Plant Density		Seed Yield		1000 Seed Weight	
	2013	2014	2013	2014	2013	2014
Crop Type	---------- plants m^{-2} ---------		---------- kg ha^{-1} ----------		------- g 1000 $seeds^{-2}$ -------	
Lentil	151a (5.8)	145a (5.4)	4148a (355)	441b (174)	37.1 b (0.9)	37.5b (0.4)
Field Pea	67b (2.5)	79b (1.7)	3887a (354)	2065a (174)	222.1 a (1.9)	222.8a (0.8)
Seeding Rate						
Low [Z]	62c (5.5)	57c (4.9)	3733b (364)	723c (135)	129.5 (1.7)	128.8b (0.8)
Normal	98b (5.5)	100b (4.9)	4134ab (362)	1160b (135)	130.6 (1.7)	129.8b (0.8)
High	167a (5.5)	178a (4.9)	4185a (362)	1876a (135)	128.8 (1.7)	131.8a (0.8)
Fungicide						
No	112a (4.5)	110a (4.0)	3735 b (354)	1261a (130)	124.6b (1.5)	126.7b (0.7)
Yes [Y]	106a (4.5)	114a (4.0)	4300 a (355)	1245a (130)	134.7a (1.5)	133.5a (0.7)

[Z] Seeding rates were 130, 260 and 520 seeds m^{-2} for lentil and 50, 100 and 200 seeds m^{-2} for field pea
[Y] Treated plots received 0.39 l ha^{-1} Headline at start of flowering and 0.39 l ha^{-1} Priaxor DS 7-10 days later

At 4148 and 3887 kg ha^{-1} respectively, average seed yields were above-average and similar for field pea and lentil in 2013. In 2014 however, mean lentil yields were much lower at only 441 kg ha^{-1} while field pea yields were significantly higher at 2065 kg ha^{-1} but still much lower than in 2013. In 2013, while yields for both crops tended to increase with seeding rate, the linear response was only significant when averaged across both crops and when fungicide was applied ($P = 0.028$). In 2014 however, under lower yielding conditions, seeding rate had a stronger impact on yields which increased linearly with seeding rate for both crops with and without a fungicide ($P < 0.001$-0.077). These results suggest that under higher yielding conditions, higher than recommended plant populations were less beneficial and, even under high yielding conditions, diseases needed to be controlled for higher than normal seeding rates to be advantageous. However when yields are limited by factors other than disease, such as in 2014, higher than recommended plant populations were required to achieve maximum yields (particularly for field pea) regardless of whether fungicides were applied. In 2014, although the fields dried off in July and the crops had time to recover, the field pea plants remained very small and were unable to compensate for the extra space at lower populations. It is also plausible that a substantial number of plants died during the extended wet period in June (after the measurements were completed) and therefore the actual plant populations at harvest in 2014 may have been substantially lower than those recorded in the spring.

Fungicide applications resulted in an overall yield increase of 15% (averaged across crop types and seeding rates) in 2013 but had no overall effect on yield in 2014 (Table 5). In 2013, the significant C × F interaction was due to the field peas responding favorably to fungicide applications (28% yield increase on average) while the comparatively small 4% yield increase observed with fungicides in lentil was not significant (Table 6). In 2014, there was no significant yield increase with foliar fungicide applications for either lentils or field peas. Disease ratings completed prior to fungicide application in 2013 (Table 7) showed that initial disease levels were higher for field pea than for lentil which was consistent with the observed effects of fungicide application on yield. The lack of

lentil disease in 2013 may have been partly explained by crop rotation since this field had a history of frequent field peas in rotation but, to the best of our knowledge, had never previously been seeded to lentils. In 2014, similar initial disease levels were noted for field pea; however, for lentils the average ratings were higher than for the previous season. Due to the prolonged wet conditions in June and early July, the plots were in much poorer overall condition in 2014, particularly for lentils. For the final disease ratings, the untreated field peas received a mean rating of 5.7 (50-65% of leaf and stem area affected by disease) in 2013 and fungicides reduced this value to 3.0 (25-35% leaf and stem area affected). In 2014, the mean ratings were 6.2 and 5.2 for untreated and treated field peas, respectively. According to the final ratings for unsprayed lentils in 2013, an average of 4% of the plot area was affected by disease and symptoms did not appear until quite late in the season when pods were already turning and most of the yield potential had been realized. With fungicides, the final lentil rating in 2013 was 0.8%. In 2014, lentils received a final rating of 10.2% without fungicide and 4.8% when fungicides were applied; however, the lentils did not recover from the wet conditions earlier in the season and the condition of this crop was poor regardless of fungicide.

Table 6. Least squares means for two way interactions between crop type, seeding rate and fungicide treatments for selected field pea and lentil response variables at Indian Head, Saskatchewan in 2013 and 2014. Standard errors are enclosed in parentheses.

Interaction	Plant Density		Seed Yield		1000 Seed Weight	
	2013	2014	2013	2014	2013	2014
Crop x Rate	---------- plants m^{-2} --------		---------- kg ha^{-1} ----------		------ g 1000 $seeds^{-2}$ ------	
Lentil – Low [Z]	87cd (10.1)	78c (9.4)	3877 (390)	228d (188)	36.3 (0.9)	37.2c (0.4)
Lentil – Normal	132b (10.1)	124b (9.4)	4297 (382)	405d (188)	37.4 (0.9)	37.5c (0.4)
Lentil – High	234a (10.1)	233a (9.4)	4269 (382)	754d (188)	37.8 (0.9)	37.7c (0.4)
Pea – Low	37e (4.3)	37d (3.0)	3589 (382)	1213c (188)	223 (3.1)	220b (1.4)
Pea – Normal	63d (4.3)	79c (3.0)	3971 (382)	1911b (188)	224 (3.1)	222ab (1.4)
Pea – High	100bc (4.3)	125b (3.0)	4100 (382)	2996a (188)	220 (3.1)	226a (1.4)
Crop x Fungicide						
Lentil – No Fung	160a (8.3)	141 (7.7)	4066a (372)	421 (181)	37.1c (0.9)	37.3c (0.4)
Lentil – Fung [Y]	141a (8.3)	149 (7.7)	4229a (369)	461 (181)	37.2c (0.9)	37.6c (0.4)
Pea – No Fung	63b (3.5)	80 (2.5)	3403b (369)	2102 (181)	212b (2.6)	216b (1.1)
Pea – Fung	71b (3.5)	78 (2.5)	4371a (369)	2029 (181)	232a (2.6)	229a (1.1)
Rate x Fungicide						
Low – No Fung	62 (7.8)	57 (7.0)	3575 (390)	722 (148)	125.2 (2.3)	125.5 (1.0)
Low – Fung	62 (7.8)	57 (7.0)	3892 (382)	723 (148)	133.9 (2.6)	132.0 (1.0)
Normal – No Fung	101 (7.8)	98 (7.0)	3792 (382)	1201 (148)	125.2 (2.6)	126.7 (1.0)
Normal – Fung	94 (7.8)	101 (7.0)	4477 (382)	1120 (148)	136.1 (2.6)	133.0 (1.0)
High – No Fung	172 (7.8)	175 (7.0)	3837 (382)	1860 (148)	123.3 (2.6)	128.0 (1.0)
High – Fung	162 (7.8)	183 (7.0)	4532 (382)	1892 (148)	134.3 (2.6)	135.6 (1.0)

[Z] Seeding rates were 130, 260 and 520 seeds m^{-2} for lentil and 50, 100 and 200 seeds m^{-2} for field pea
[Y] Treated plots received 0.39 l ha^{-1} Headline at start of flowering and 0.39 l ha^{-1} Priaxor DS 7-10 days later

Table 7. Average disease ratings before and after fungicide application for lentil and field pea at Indian Head, Saskatchewan in 2013 and 2014.

Effect	Field Pea				Lentil			
	2013		2014		2013		2014	
	T1[Z]	T2[Y]	T1	T2	T1	T2	T1	T2
Seeding Rate	---------- (0-9) ----------				---------- (0-100) ----------			
Low	4.3	4.1	4.3	5.3	0.8	1.0	5.1	7.7
Normal	3.4	4.4	4.2	5.7	0.4	2.1	4.5	6.0
High	3.1	4.5	4.5	6.1	0.2	4.8	4.6	8.8
Fungicide								
No	3.8	5.7	4.2	6.2	0.4	4.3	4.6	10.2
Yes	3.5	3.0	4.4	5.2	0.5	0.9	4.9	4.8
Rate x Fungicide								
Low – No	4.4	4.9	4.0	5.5	0.8	1.8	5.0	10.3
Low – Yes	4.1	3.3	4.5	5.0	0.8	0.3	5.2	5.0
Normal – No	3.6	6.1	4.0	6.2	0.4	3.8	4.3	8.7
Normal - Yes	3.3	2.6	4.3	5.2	0.5	0.5	4.7	3.3
High – No	3.3	6.0	4.5	6.8	0.1	7.5	4.3	11.7
High - Yes	3.0	3.0	4.5	5.3	0.3	2.0	4.8	6.0

[Z] Prior to first fungicide application
[Y] After the 2nd application and prior to physiological maturity

In 2013, average seed size was 37 g 1000 seeds^{-1} for lentil and 222 g 1000 seeds^{-1} for field pea (Table 5). Seed size was not affected by seeding rate for either crop ($P = 0.504$). In 2014, mean seed sizes were similar, 37.5 and 223 g 1000 seeds^{-1} for lentil and field pea, respectively. There was no effect of seeding rate on seed size in 2013, either combined across crops or for individual crops and regardless of fungicide application. In 2014, there was an overall increase in seed size with increasing seeding rates attributed to the observed effect on field peas but lentil seed size was unaffected by seeding rate. While the overall effect of fungicide was significant in both years ($P < 0.001$), in both cases this was solely due to the significant 5-6% increase observed in field peas while lentil seed size was always unaffected by fungicide application (Table 6). While the increase in seed size certainly contributed to the observed field pea yield increase with fungicides in 2013, the magnitude of the yield increase was much greater than for seed size suggesting that fungicides also resulted in more seeds per pod and/or more pods per plant. Despite the observed increase in field pea seed size, fungicide applications did not significantly increase pea yields in 2014.

The lack of any interactions between seeding rates and fungicides, combined across crops or with crop as a factor, suggested that the benefits of fungicide applications (or lack thereof) were consistent across the range of plant populations evaluated for both crops. Focussing on the visual disease ratings, there tended to be higher ratings with higher seeding rates; however, in all cases where

disease occurred it was present across seeding rates and any observed fungicide effects were consistent across rates.

Extension and Acknowledgement

In 2013, this field demonstration was shown to an estimated 194 attendees at the IHARF Crop Management Field Day on July 23 and field signs were in place to acknowledge the support of the ADOPT program for the tour. In addition to the annual field day which is geared towards Saskatchewan producers and agronomists, groups of producers from Germany, Kazakhstan and Australia also had formal tours and we estimate that roughly 350-400 producers and agronomists visited over the 2013 growing season. In 2014, the plots were again shown at the annual Crop Management Field Day which was held on July 21 and attended by over 200 producers and industry representatives. Results from this project will be made available in the 2014 IHARF Annual Report (available online) and through a variety of other media as opportunities arise (i.e. oral presentations, popular agriculture press, fact sheets, etc.).

11. Conclusions and Recommendations

With yields ranging from extremely low to well above average and moderately high disease pressure in both years, conditions in 2013 and 2014 at Indian Head, Saskatchewan provided a good opportunity to evaluate field and lentil response to fungicide over a range of plant populations. A wide range of plant populations was achieved with chosen seeding rates and the populations were consistent between the two years. In general terms, plant densities were considered below optimal at the low seeding rate, close to optimal at the normal rate and above optimal at the high seeding rate. Increasing seeding rates tended to be more beneficial with field peas than with lentils but, in all cases (both crop types in either year), yields declined when plant populations were below optimal. In 2014, with significant crop injury early in the season, plant populations above those normally recommended did provide significant yield benefits for both crop types but this was not the case in 2013 under more desirable growing conditions. While significant interactions between seeding rate and fungicide were not detected, the orthogonal contrasts suggested that the greatest benefit to higher than normal seeding rates under high yielding conditions was achieved when fungicides were also applied; however, this was only the case when a response to fungicide was observed (Table 9). While the potential economic benefits to fungicide application to lentil were questionable at Indian Head in 2013 and with both crops in 2014, the yield advantage observed with field pea in 2013 was more than adequate to cover the costs of this application, even at low grain prices. Overall, these results suggest that fungicide recommendations should not necessarily be changed based on plant populations. However, scouting for disease remains critical since applying a fungicide, while frequently beneficial in southeast Saskatchewan, will not necessarily provide a return on investment when disease pressure is low or other factors are more limiting to yield.

Supporting Information

12. Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 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. In-crop herbicide products and the fungicides used in the demonstration were provided in-kind by BASF.

13. Appendices

Table 8. Least squares means for three-way interactions between crop type, seeding rate and fungicide treatments for selected field pea and lentil response variables at Indian Head, Saskatchewan in 2013 and 2014. Standard errors are enclosed in parentheses.

Interaction	Plant Density		Seed Yield		Seed Size	
	2013	2014	2013	2014	2013	2014
Crop x Rate x Fungicide	-------- plants m^{-2} --------		---------- kg ha^{-1} ---------		----- g 1000 $seeds^{-2}$ -----	
Lentil – Low – Check	90 (14.3)	78 (13.3)	3908 (447)	216 (207)	36.1 (1.0)	37.3 (0.5)
Lentil – Low – Fungicide	83 (14.3)	78 (13.3)	3846 (421)	218 (207)	36.5 (1.0)	37.1 (0.5)
Lentil – Normal – Check	138 (14.3)	123 (13.3)	4190 (421)	281 (207)	37.5 (1.0)	37.5 (0.5)
Lentil – Normal – Fung	126 (14.3)	125 (13.3)	4404 (421)	491 (207)	37.2 (1.0)	37.5 (0.5)
Lentil – High – Check	252 (14.3)	222 (13.3)	4100 (421)	765 (207)	37.5 (1.0)	37.2 (0.5)
Lentil – High – Fung	215 (14.3)	245 (13.3)	4438 (421)	674 (207)	38.0 (1.0)	38.2 (0.5)
Pea – Low – Check	33 (6.1)	37 (4.3)	3241 (421)	1228 (207)	214.2 (4.3)	213.8 (1.9)
Pea – Low – Fung	41 (6.1)	36 (4.3)	3937 (421)	1228 (207)	231.2 (4.3)	226.8 (1.9)
Pea – Normal – Check	64 (6.1)	74 (4.3)	3393 (421)	2121 (207)	212.8 (4.3)	215.8 (1.9)
Pea – Normal – Fung	62 (6.1)	78 (4.3)	4549 (421)	1748 (207)	234.9 (4.3)	228.4 (1.9)
Pea – High – Check	92 (6.1)	129 (4.3)	3574 (421)	2956 (207)	209.1 (4.3)	218.9 (1.9)
Pea – High – Fung	109 (6.1)	121 (4.3)	4626 (421)	3111 (207)	230.5 (4.3)	233.1 (1.9)

[Z] Seeding rates were 130, 260 and 520 seeds m^{-2} for lentil and 50, 100 and 200 seeds m^{-2} for field pea
[Y] Treated plots received 0.39 l ha^{-1} Headline at start of flowering and 0.39 l ha^{-1} Priaxor DS 7-10 days later

Table 9. Orthogonal contrasts describing field pea and lentil responses to seeding rate for selected response variables at Indian Head, Saskatchewan in 2013 and 2014.

Orthogonal Contrast	Plant Density		Seed Yield		1000 Seed Weight	
	2013	2014	2013	2014	2013	2014
	---------- p-value ----------					
All (linear)	< 0.001	<0.001	0.030	<0.001	0.636	0.004
All (quadratic)	0.937	0.740	0.121	0.495	0.480	0.977
Crop Type						
Lentil (linear)	< 0.001	<0.001	0.200	<0.001	0.009	0.213
Lentil (quadratic)	0.763	0.627	0.207	0.991	0.173	0.587
Pea (linear)	< 0.001	<0.001	0.066	<0.001	0.429	0.006
Pea (quadratic)	0.368	0.016	0.342	0.343	0.580	0.942
Fungicide Treatment						
Check (linear)	< 0.001	<0.001	0.359	<0.001	0.511	0.080
Check (quadratic)	0.785	0.843	0.569	0.368	0.816	0.814
Fungicide (linear)	< 0.001	<0.001	0.028	<0.001	0.991	0.011
Fungicide (quadratic)	0.872	0.786	0.100	0.951	0.443	0.846
Crop x Fungicide						
Lentil – Check (linear)	< 0.001	<0.001	0.695	0.003	0.762	0.796
Lentil – Check (quadratic)	0.642	0.867	0.507	0.448	0.788	0.520
Lentil – Fungicide (linear)	< 0.001	<0.001	0.146	0.020	0.735	0.050
Lentil – Fungicide (quadratic)	0.929	0.600	0.254	0.439	0.950	0.900
Pea – Check (linear)	< 0.001	<0.001	0.356	<0.001	0.235	0.068
Pea – Check (quadratic)	0.397	0.257	0.897	0.051	0.939	0.906
Pea – Fungicide (linear)	< 0.001	<0.001	0.089	<0.001	0.723	0.023
Pea – Fungicide (quadratic)	0.890	0.019	0.226	0.491	0.317	0.825

Abstract

14. Abstract/Summary

Field trials were conducted near Indian Head during 2013 and 2014 growing seasons to demonstrate seeding rate and fungicide application effects on lentil and field pea performance in southeast Saskatchewan. The treatments were a factorial combination of the two crop types (lentil and field pea), three seeding rates (low, normal and high) and two fungicide treatments (untreated and treated). Data collection included spring plant density measurements, visual disease ratings before and after fungicide application, seed yield and seed size. Overall, crop conditions and yields were excellent for both crops in 2013, slightly below average for field pea in 2014 and poor for lentil in 2014. Plant densities increased linearly with increasing seeding rate and, at the normal rate, were considered adequate for optimal yields in both years. Field pea yields were increased by almost 30% with fungicide in 2013 but fungicide applications did not significantly increase field pea yields in 2014 or lentil yields in either of the two years. The field pea yield increase with fungicide in 2013 was partly, but not entirely attributed to, a significant increase in seed size. Despite the lack of a yield benefit in 2014, field pea seed size was again increased with fungicides. Lentil seed size was not affected by fungicide or seeding rate in either of the two years. There was no significant interaction between seeding rate and fungicide application for any of the variables measured with either crop, indicating similar benefits to fungicide regardless of plant populations. However, close inspection of the orthogonal contrasts suggested that the linear response of field pea / lentil yield to increasing seeding rates were only significant when a fungicide was applied in 2013. This was not the case in 2014 where there was an overall lack of a fungicide response. These results suggest that, under high yielding conditions when disease is limiting, higher than normal seeding rates for these crops were only beneficial when disease was also controlled. Under lower yielding conditions such as 2014, there was a greater overall response to higher seeding rates. Alternatively, when disease was a yield limiting factor (i.e. field peas in 2013) fungicides were beneficial at all seeding rates, even though there appeared to be a slight tendency for higher disease pressure at the higher seeding rates. This demonstration was shown at the IHARF Crop Management Field Days in both 2013 and 2014 in addition to several smaller tours. It is estimated that 600-650 producers and agronomists visited the site over the course of the two growing seasons. The results from this project will be presented at winter meetings and other written reports/popular press when there are opportunities to do so and will be summarized in the 2014 IHARF Annual Report.

Figure 1. Overview of the field demonstration site in 2013 at Indian Head, Saskatchewan.

Figure 2. Overview of the field demonstration site in 2014 at Indian Head, Saskatchewan.