2025 Project Report

for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Field Pea Response to Varying Phosphorus Forms and Placement Options

Project #: 20240989 (IHARF) 20240990 (WCA); 20240991 (WARC); 20240992 (NARF)

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Agriculture Demonstration of Practices and Technologies (ADOPT)

Project Final Report

The final project report should be made available electronically (MS Word). Additional data tables and or graphs may be submitted in spreadsheet format. Due to formatting, printing and distribution requirements, final reports will not be accepted as PDF documents. Completed reports must be returned by email to Evaluation.Coordinator@gov.sk.ca.

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Producer Group Sponsoring the Project: Indian Head Agricultural Foundation (IHARF); Northeast Agriculture Research Foundation (NARF); Western Applied Research Corporation (WARC); Wheatland Conservation Area (WCA)

Project Location(s): *Provide the name or number of the rural municipality, nearest town or legal land location if possible. Provide the name of any cooperating landowner(s).* Indian Head (RM #156), Melfort (RM #428), Scott (RM #380), and Swift Current (RM #137)

Project start date *(month & year):* 4/1/2025

Project end date *(month & year):* 3/31/2026

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Abstract *(maximum 200 words)*

Detail key elements from the project objectives, methodology, results and conclusions to provide a short concise summary of the project. List extension activities such as field days or workshops and include the number of people who visited the project.

Phosphorus (P) trials with field pea were established near Indian Head, Melfort, Scott, and Swift Current. In addition to untreated controls, the treatments were a combination of five products (MAP, MAP+AMS, MES15, MAP+MST, and Synchro 50) and two placement options (sideband versus in-furrow). Data collection included emergence, early-season growth, yield, and protein. Side-banded P never affected emergence while in-furrow P effects varied with location and fertilizer form. There was essentially no injury at Indian Head while the most severe damage occurred at Swift Current. The riskiest products for in-furrow placement were MAP+AMS and MES15 and seedling injury (or the lack thereof) was similar for MAP, MAP+MST, and Synchro 50. Phosphorus increased early-season growth quite consistently, but with some inconsistencies across forms and/or placement. The yield response to P was weakest at Indian Head and strongest

at Swift Current, averaging 6% across sites. All P forms and placement options performed similarly on average except in-furrow MAP+AMS produced lower yields than MAP applied alone. The treatments did not affect seed protein at any location except Swift Current where in-furrow P, particularly MES15, reduced protein. In conclusion, all P forms performed similarly overall. MES15 or MAP+MST might be a fit for growers looking for alternative S sources while Synchro 50 or struvite blends might be appropriate for those requiring added safety with in-furrow placement.

Project Objectives

Provide a short statement outlining the project objectives. Identify the key concept this project was designed to demonstrate. For example, you might use a statement such as *"This project was intended to demonstrate and compare the benefits of……" or "The objective of this project was to demonstrate the impact of…."*

The overall project objective was to demonstrate the agronomic response of field pea to various phosphorus (P) fertilizer formulations and placement options. We aimed to explore whether the response to fertilizer forms differs depending on placement option and how the responses differ with environment. Additionally, the treatments allowed us to demonstrate how applying modest rates of ammonium sulfate might impact field pea yield and establishment, particularly when placed in-furrow.

Project Rationale

Briefly describe why this project is of interest to local producers. Why is it important to have this project? What are the potential beneficial outcomes? What is the perceived need?

Due to high fertilizer prices and tightening margins, phosphorus (P) fertilizer management continues to be identified as a top research/demonstration priority by Saskatchewan farmers and agronomists. Recent fertility trials with field peas have demonstrated the importance of P fertilization to consistently achieve high yields. The importance of maintaining long-term soil fertility is also well-accepted. It is estimated that field peas remove ~30 kg P_2O_5/ha in a 3400 kg/ha (50 bu/ac) crop (https://prairienutrientcalculator.info/). In a recent Saskatchewan study exploring the capacity for enhanced fertility to improve field pea yields and protein, Holzapfel et al. (2020) increased seed yields with side-banded monoammonium phosphate (MAP) by 9% (in predominantly low P soils) and the optimal rate was 40 kg P_2O_5/ha (average of 12 location-years). Seed protein increased linearly with P rate, but the response was small. Over a three-year period on low P soils near Outlook, Melfort, and Saskatoon, Henry et al. (1994) increased pea yields by as much as 16% with side-banded MAP at Saskatoon, but the only significant responses at the other locations were yield reductions with high rates of seed-placed P. In 21 field trials using Triple Super Phosphate (0-45-0) as the fertilizer source, Karamanos et al. (2003) found that field peas responded to P when modified Kelowna extractable P was less than 10 ppm and added that the response was greater in loam versus clay soils and with sideband versus in-furrow placement. In high P soils at Melfort, Johnston and Stevenson (2001), increased yields by 4-5% with the addition of 25 kg P_2O_5/ha as side-banded MAP. With 52 field trials through Alberta, rates ranging from 0-60 kg P_2O_5, and two placement methods (pre-seed band versus in-furrow), McKenzie et al. (2001) observed an overall average yield increase of 7% with P fertilization; however, the response was only statistically significant for 37% of the sites when analyzed individually. It was noted that the responses were broadly greater, and similar, for the thin Black, Black, and Grey soil zones but negligible in the Dark Brown and Brown irrigated sites. In Montana, Wen et al. (2008) observed reasonably consistent and substantial increases in field pea forage yield as with P; however, effects on yield were less frequent and smaller.

While it is broadly recommended to avoid in-furrow placement of fertilizer with field peas, this is not a practical option for all seeding implements with non-mobile nutrients, and many farmers prefer to place some of their P in-furrow. An estimated 44% of the P applied in wheat and canola is seed-placed compared to only 29% for side-band placement (Stratus Ag Research 2024). That said, field peas are sensitive to seed-placed fertilizer, and, in Saskatchewan, the recommendation is for no more than 15 kg P_2O_5/ha of MAP to be applied in this manner. This number may be conservative for some soils as, in Alberta, the recommended maximum safe rate is 30 kg P_2O_5/ha (Barker 2023). Henry et al. (1994) reported a yield advantage to side-banding MAP over seed-placement at all locations (Saskatoon, Outlook, and Melfort) with the magnitude of the advantage ranging from 227-480 kg/ha or 7-25%. These differences were due to either a positive yield response with side-banding, but not in-furrow P placement, or negative responses with high rates of in-furrow P. For all locations, field pea emergence was unaffected by side-banded MAP but declined with increasing rates of seed-placed MAP. Across P rates, the observed stands with in-furrow placement were 55-57% of those achieved with side-banding (Henry et al., 1994). With triple superphosphate (TSP) and rates as high as 60 kg P_2O_5/ha, McKenzie et al. (2001) did not see any difference between pre-seed banding and in-furrow placement; however, the authors attributed this lack of an effect to the less damaging effects of TSP relative to MAP.

Focusing on formulations, the current project includes MAP (11-52-0) as the industry standard, MicroEssentials® S15 (13-33-0-15), MAP+MST® (9-43-0-16), and Crystal Green® Synchro 50 (9-42.5-0-0 + 7 Mg). While not exclusively a P product, MicroEssentials® S15 is a multi-nutrient fertilizer which has the benefits of improved seed-safety (relative to MAP/AMS blends) and providing slow-release S, consisting of equal parts sulfate and elemental forms. Promotional material for S15 claims significantly higher canola plant populations and a 2.6 bu/ac yield advantage (average of 24 trials over a three-year period) over MAP plus ammonium sulphate (AMS) blends (Mosaic Company 2014). For wheat, when averaged over 39 sites throughout the U.S. and Canada, Mosaic (2019) reported a more modest 1.6 bu/ac advantage over MAP+AMS, equating to a 23% versus 20% yield increase over the control for S15 versus MAP+AMS. University of Manitoba research with canola (Grenkow et al. 2013) showed improved seed safety over MAP+AMS but also warned that MES15 may not be as effective for providing plant available S as sulfate-based products (i.e. MAP+AMS blends). That aside, the claim specific to P is that the combination of nutrients in MES15 creates a more acidic environment which helps retain the P in plant available forms for longer; thus, leading to better uptake. Because it is a relatively new product, publicly available information on crop response to MAP+MST® is limited. The nutrient analysis for this product is 9-43-0-16 and it is essentially MAP with micronized (~15 microns) elemental S particles distributed uniformly throughout each granule (Nutrien Ltd. 2024). While this formulation is primarily marketed as an improved option to deliver elemental S to crops, like MicroEssentials® formulations, the solubility and crop uptake of P with MAP+MST® may be enhanced due to the acidifying effect of the elemental S. While third-party research looking at the relative uptake and yield response to P is scarce for MAP+MST®, preliminary results from the Discovery Research Farm near Langham, Saskatchewan showed favorable crop response to this product and enhanced solubility relative to MAP (i.e., Discovery Farm 2023; Blake Weiseth, personal communication). Crystal Green® Synchro 50 is a struvite/MAP based product where both forms of P are fully homogenized within each granule. Pure struvite has an analysis of 7-33-0-0 + 9 Mg but applying this product alone is generally not recommended due to its high cost and low solubility. Recent work in canola (Holzapfel et al. 2022) showed that occasionally, when applied alone, the solubility of struvite could be too low to meet the needs of the crop; however, in most cases, the yield response was equivalent to MAP or MES15. That said, seed safety of pure struvite was high with essentially no effects on canola stands at any of the 14 sites (across all the major soil zones of Saskatchewan) with application rates as high as 65 kg P_2O_5/ha. While the high cost and low solubility of pure struvite may make using this product on its own prohibitive, utilizing the blend of MAP and struvite largely alleviated these concerns while maintaining a measurable seed-safety advantage over MAP or MES15. We expect Crystal Green® Synchro 50 to perform similarly to a physical blend of MAP and pure struvite, but with the advantage of being fully homogenized and not requiring any further blending. In 2024, MAP accounted for 69% of the P market for canola in western Canada while approximately 14% was MicoEssentials® products and all other formulations accounted for 13%, up from 10% in 2023 (Stratus Ag Research 2024). For wheat, MAP, MicroEssentials®, and other P sources accounted for 75%, 10%, and 9%, respectively, of the P applied in western Canada, with novel sources up from less than 5% in 2023 (Stratus Ag Research 2024).

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Methodology

Fully describe how the project was set up and run. You should provide enough information so that any reader can understand what you did, and where and when you did it. From that they can determine if your report has any relevance to their own operation. For example, your description should include all relevant items such as 1) the number and size of any field plots, 2) what was seeded, 3) what treatments were applied to the plots, 4) the schedule or timing of any relevant activities such as seeding, treatment application or harvest, and 5) what was measured to evaluate the success of any treatment. If your project dealt with animals, you should be sure to include 1) the number of animals in each trial group, 2) the treatment or procedure applied to each group, and 3) what was measured to evaluate the success of each treatment.

Replicated small plot demonstrations with field peas (*Pisum sativum*) were established in the spring of 2025 at four Saskatchewan locations; Indian Head (thin-Black soil zone), Melfort (moist Black soil zone), Scott (Dark Brown soil zone), and Swift Current (dry Brown soil zone). The treatments were a combination of P/S fertilizer formulations and placement options along with two control treatments. Where applied, the rate of P was held constant across treatments at 45 kg P_2O_5/ha. Except the 'No Fertilizer' control (Trt 1), N was balanced at 26 kg N/ha which was the amount of N provided by the MAP and AMS in Trt. 4 and 9. Where applicable, the S rate was 17-21 kg S/ha; however, the form of S (elemental versus sulfate) varied. Because Crystal Green Synchro 50 does not include any S, we side-banded 78 kg AMS with this product to eliminate potential biases due to S deficiencies while also preserving any seed-safety benefits. All treatments received a label recommended rate of seed-placed granular *Rhizobium leguminosarum* inoculant. The twelve treatments were arranged in a separate four replicate randomized complete block design (RCBD) at each location and are detailed in Table 1.

Table 1. Phosphorus fertility treatments included in the current demonstration. Supplemental urea in all treatments and ammonium sulfate in treatments 7 and 12 was side-banded.

#	Name / P Form	P Placement	Kg N-P_2O_5-K_2O-S/ha
1	No Fertilizer	n/a	0-0-0-0
2	Nitrogen Only	n/a	26-0-0-0
3	MAP[Z]	Sideband	26-45-0-0
4	MAP + AMS[Y]	Sideband	26-45-0-18.7
5	MES15[X]	Sideband	26-45-0-20.5
6	MAP + MST[W]	Sideband	26-45-0-16.7
7	Crystal Green Synchro 50[V] + AMS[U]	Sideband	26-45-0-18.7
8	MAP[Z]	Seed-Placed	26-45-0-0
9	MAP + AMS[Y]	Seed-Placed	26-45-0-18.7
10	MES15®	Seed-Placed	26-45-0-20.5
11	MAP + MST®	Seed-Placed	26-45-0-16.7
12	Crystal Green Synchro 50[V] + AMS[U]	Seed-Placed	26-45-0-18.7

[Z] MAP: monoammonium phosphate (11-52-0); [Y] AMS: ammonium sulfate (21-0-0-24);
[X] MES15: MicroEssentials® S15 (13-33-0-15); [W] MAP + MST®: Smart Nutrition MAP + MST (9-43-0-16)
[V] Crystal Green Synchro™ 50: (9-42.5-0-0 + 7% Mg); [U] AMS in Trt 7 and 12 is side banded with urea

Pertinent agronomic information is provided in Table 9 of the Appendices. All plots were direct seeded into cereal stubble with seeding dates ranging from May 9-14. Plot size varied by location and the row spacing ranged from 21-31 cm with corresponding seedbed utilization (SBU) of approximately 8-12%. All sites grew the same variety (CDC Spectrum) with seeding rates of 100 seeds/m^2, adjusting for seed size and germination. Weeds were controlled using registered pre-emergent and in-crop herbicides and mandatory, preventative fungicide applications reduced the potential for disease to be a yield limiting factor. Pre-harvest herbicides or desiccants were used at the discretion of individual site managers, and the plots were straight combined after the peas had matured and sufficiently dried.

Various data were collected during the growing season and from the harvested grain samples. Two depth (0-15 cm, 15-60 cm) composite soil samples were collected for the trial areas in the early spring and submitted to AgVise Laboratories (https://www.agvise.com) for analyses. For each plot, plant densities were estimated by recording the number of seedings in 4 x 1 m sections of crop, after emergence was complete, and converting the averaged values to plants/m^2. Early-season growth, or 'pop-up' effects were measured by taking two overhead photos from each plot at the late vegetive stages and running the images through Canopeo (https://canopeoapp.com), and calculating percent canopy cover. Yields were estimated from the harvested grain samples and are corrected for dockage and to 16% seed moisture content. Seed protein concentrations were determined by IHARF for all locations by averaging the results from three runs through a FOSS Infratech NIR analyzer (https://www.fossanalytics.com/products/infratec). Monthly precipitation and temperature data were estimated from the nearby ECCC or privately owned weather stations.

All response data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with the effects of site (S), fertilizer treatment (F), and their interaction (S × F) considered fixed and replicate effects (within site) considered random. Heterogeneity amongst variance component estimates (by site) was tested for and permitted when significant and doing so improved model convergence. Predetermined contrasts were used to test for an overall response to P (Trt 2 versus (3-12), to compared the control (2) to either side-banded (3-7) or in-furrow (8-12) P, to compare side-banded (3-7) to in-furrow (8-12) P, and to compare either MAP (3,8) or MAP+AMS (4,9) to MES15 (5,10), MAP+MST (6,11), and Synchro 50 (7,12). Fisher's protected LSD test was used to separate treatment means.

Comparisons of any S × F means were contained within sites and the slicediff statement used to help identify and interpret differences amongst sites. All treatment effects and differences between means were considered significant at $P \leq 0.05$; however, p-values ≤ 0.10 were also considered if trends appeared meaningful and supported by the data.

Results *(you must provide the following information)*

Present and discuss any project results, including any data or measurements taken to evaluate the demonstration. Include things that didn't appear to work. These results are just as important to share. List extension activities such as field days or workshops. List the activity, the date it occurred, and the number of people who attended.

Soil and Weather Conditions

Selected soil test results for the four sites are provided in Table 2 below. The basic physical qualities of the sites varied as expected, with Indian Head and Melfort having higher CEC (37-42 meq/100 g) and organic matter values (6.9-8.1%) compared to Scott and Swift Current (13-16 meq/100 g and 3.0-3.6% OM). From most to least acidic, soil pH was 5.0, 6.0, 6.6, and 7.2 for Scott, Melfort, Swift Current, and Indian Head and the soil at all sites was non-calcareous (0.2-0.5% CCE). Importantly, residual soil P (Olsen) ranged from 13-14 ppm which was considered relatively high. Other nutrients were intended to be non-limiting and were within the expected ranges except for Swift Current where residual N and S were extremely high.

Table 2. Selected soil test results for field pea phosphorus (P) fertility demonstrations conducted at various locations in 2025. Unless otherwise indicated, all measurements are representative of the 0-15 cm soil profile.

Parameter	Indian Head	Melfort	Scott	Swift Current
pH	7.2	6.0	5.0	6.6
Organic Matter (%)	6.9	8.1	3.6	3.0
CEC (meq/100 g)	42.2	36.6	16.0	13.0
CCE (%)	0.2	0.5	0.2	0.2
NO_3-N (kg/ha) [Z]	22	34	25	131
Olsen-P (ppm)	14	14	13	13
K (ppm)	849	409	176	382
kg S/ha (kg/ha) [Z]	83	58	99	>510

[Z] Values for residual NO_3-N and S are for the 0-60 cm soil profile

Mean monthly temperatures and precipitation amounts for the 2025 growing season (May-August) are presented relative to the long-term (1981-2010) averages for each location in Tables 10 and 11 of the Appendices, respectively. Temperature trends varied by location but, in general, May was warmer than average, June-July were cooler than average at Indian Head, Melfort, and Scott and average at Swift Current, and slightly to substantially warmer than average in August. Over the four-month growing season, Swift Current was the hottest location (16.5 °C) while Indian Head and Melfort were more intermediate (15.7-16.0 °C), and Scott was the coolest (15.2 °C). Indian Head was the driest location with only 136 mm (56% of average) of May-August precipitation while the other locations received 209-236 mm, or 92-110% of average. The patterns differed with Indian Head receiving the most rain in May but less in June, July, and August. Melfort and Scott were dry in May and July, but wet in June and August while Swift Current was slightly drier than average in May-June but wet in July-August. In general, the weather conditions were conducive to good field pea establishment and relatively high yield potential.

Results from the overall tests of fixed effects are presented in Table 3 which will be referred to as we discuss the fertility responses for each variable. All variables were affected by site, and these overall averages are presented in Table 4 for interest and added context.

Table 3. Overall tests of fixed effects for selected response variables in field pea phosphorus (P) trials conducted in 2025 at Indian Head (IH-25), Melfort (ME-25), Scott (SC-25) and Swift Current (SW-25). Data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with site (S), fertility (F), and S × F considered fixed and replicate effects (within site) considered random.

Source	Plant Density	Canopy Cover	Seed Yield	Seed Protein
	---------- Pr > *F* (p-values) ----------			
Site (S)	<0.001	<0.001	<0.001	<0.001
Fert (F)	<0.001	<0.001	<0.001	0.042
S × F	0.007	<0.001	0.026	0.090[Z]
Effect Slices				
IH-25	0.213	<0.001	0.365	0.999
ME-25	<0.001	0.214	0.004	0.830
SC-25	0.003	<0.001	<0.001	0.979
SW-25	<0.001	0.015	0.001	<0.001

[Z] Because the S x F interaction for seed protein was not significant at the desired level, effect slices for individual sites should be interpreted with some caution; however, results were presented because the value was significant at $P \leq 0.10$ and results from Swift Current appeared to differ from the other sites.

Table 4. Main effect means for site effects on field pea emergence, canopy cover, seed yield, and seed protein concentration. The locations were Indian Head (IH), Melfort (ME), Scott (SC), and Swift Current (SW). Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD, *P* < 0.05) and values in parentheses are the standard error of the treatment means.

Site	Plant Density	Canopy Cover	Seed Yield	Seed Protein
	------ plants/m^2 ------	----------- % -----------	-------- kg/ha --------	----------- % -----------
IH-25	82.8 A (1.60)	22.3 B (0.99)	5765 A (88.0)	18.7 D (0.19)
ME-25	73.8 B (1.60)	34.0 A (0.81)	5125 B (88.0)	20.1 C (0.19)
SC-25	58.7 C (1.60)	36.2 A (0.79)	4226 C (88.0)	21.9 A (0.19)
SW-25	81.9 A (1.60)	33.9 A (3.59)	3002 D (88.0)	20.7 B (0.19)

Plant Densities

Field pea plant densities were affected by site (S; *P* < 0.001) with the lowest overall mortality at Indian Head and Swift Current (82-83 plants/m^2), the highest at Scott (58 plants/m^2), and intermediate values at Melfort (74 plants/m^2) (Table 4). The overall fertilizer (F) treatment effects were also significant (*P* < 0.001); however, a significant S × F interaction (*P* = 0.007) indicated that the fertilizer effects varied across locations. The effect slices showed that P fertilizer form and placement had no effect on emergence at Indian Head (*P* = 0.213), but treatment differences occurred at the remaining three locations (*P* < 0.001-0.003). Treatment means for plant densities at individual sites and across sites are in Table 5. At Indian Head, overall mortality averaged 17% with individual treatments ranging from 78-88 plants/m^2. Furthermore, none of the pre-determined contrasts for plant density were significant at this location (Table 12). Additionally, plant densities with side-banded P never significantly differed from the control at Melfort, Scott, or Swift Current indicating that side-banding consistently provided sufficient separation from seedrow to mollify the risk of fertilizer injury. With in-furrow placement at individual sites, we detected significant stand reductions relative to the N only control with MAP, MAP+MST, and Synchro 50 in 1/4 cases (Swift Current only for all), MAP+AMS in 3/4 cases (all except Indian Head), MES15 in 2/4 cases (Scott and Swift Current). When averaged across the four locations, all products/blends significantly reduced stands relative to the N only control (79 plants/m^2) with MAP, MAP+MST, and Synchro 50 all resulting in similar stands (72-73 plants/m^2) and greatest injury occurring with MAP+AMS and MES15. Looking at the contrast comparisons (Table 12; Appendices), the 0P versus sideband (SB) comparison was marginally significant at Swift Current (*P* = 0.054), but no other locations (*P* = 0.234-0.718) or on average (*P* = 0.404). The 0P versus in-furrow (IF) comparison was not significant at Indian Head (*P* = 0.896) or Melfort (*P* = 0.127) but was at Scott and Swift Current and when averaged across locations (P < 0.001-0.003). The more powerful SB versus IF comparison for plant density were significant at all Melfort (P < 0.001; reduced by 12% with IF relative to SB), Scott (P = 0.002; reduced by 11%), Swift Current (P < 0.001; reduced by 13%) and on average (P < 0.001; reduced by 9%) but, again, not at Indian Head (P = 0.395; numerically reduced by 2%).

Table 5. Mean field pea plant densities for phosphorus (P) treatments within individual sites and averaged across sites. Importantly, the significant S x F interaction indicates that effects varied by site; therefore, the averaged (across sites) values should be interpreted with caution. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD, P < 0.05).

Fertility Treatment		Indian Head	Melfort	Scott	Swift Current	Average
		------------------------------------ Plant Density (plants/m^2) ------------------------------------				
1	No Fert	85.5 a	83.5 a	58.6 abc	87.9 ab	78.9 A
2	N Only	82.2 a	73.6 b-e	65.5 ab	92.7 a	78.5 A
3	SB-MAP	87.8 a	81.2 ab	58.6 abc	87.0 abc	78.6 A
4	SB-MAP+AMS	82.0 a	76.7 a-d	62.8 ab	82.0 bc	75.9 AB
5	SB-MES15	85.7 a	75.3 a-e	67.7 a	87.3 abc	79.0 A
6	SB-MAP+MST	84.1 a	74.6 a-e	59.8 abc	84.1 abc	75.6 AB
7	SB-Sync50	77.9 a	79.6 abc	57.6 bc	89.1 ab	76.0 AB
8	IF-MAP	82.0 a	66.6 ef	60.5 abc	78.7 c	72.0 B
9	IF-MAP+AMS	86.1 a	64.4 f	48.0 d	68.5 d	66.7 C
10	IF-MES15	75.1 a	68.1 def	52.2 cd	65.5 d	65.2 C
11	IF-MAP+MST	85.3 a	70.1 c-f	56.1 bcd	78.7 c	72.7 B
12	IF-Sync50	80.4 a	70.1 c-f	56.9 bcd	82.0 bc	72.5 B
	S.E.M	3.46	3.46	3.46	3.46	1.73

Early-Season Vegetative Growth

Percent canopy cover at the late vegetative growth stages was lower at Indian Head (22%) than the other three locations (34-36%; Table 4); however, this discrepancy was mainly attributed to timing of the measurements and row spacing. The effect slices showed that the fertilizer effect was significant at all locations individually (P < 0.001-0.015) except Melfort (P = 0.214) for this variable. At Indian Head, all individual treatments where P was applied showed more vigorous growth relative to the control treatments except for side-banded Synchro 50 which was like the control (Table 6). The reason for the lack of response with this treatment is uncertain but may be due to the lower solubility of Synchro 50 combined with the fact that it was side banded with supplemental urea and AMS; thus, making it less available to the crop early in the season. The predetermined contrasts (Table 13; Appendices) at Indian Head showed positive with both SB and IF placement (P < 0.001) and no difference between placement methods (P = 0.892) when averaged across forms, but did reinforce the reduced response with Synchro 50, particularly when compared to MAP+AMS (P = 0.002) but with a similar, not quite significant, trend relative to MAP (P = 0.079). No other differences between forms were detected. Despite the lack of significant effect slice at Melfort, the contrasts did show an overall trend for enhanced early-season growth with P relative to the control (P = 0.083), particularly with in-furrow placement (36% versus 31%; P = 0.032). At Scott, there was a strong P response for this variable with 26% canopy cover in the absence of P and an overall average of 38% with P (P < 0.001). Despite the differences in establishment, there were no significant differences amongst the individual treatments that received P at Scott (35-42%) and the SB versus IF comparison was not significant (P = 0.432). Effects of P on early season growth at Swift Current were less consistent with only a marginally significant increase relative to the control with side-banded P (P = 0.095) but not in-furrow P (P = 0.421). Early season growth was significantly enhanced with side-banded P (37%) relative to in-furrow P (31%; P < 0.001); however, the overall variability at this site was high and significant differences amongst individual treatments were rare. The trend for a better pop-up response with side-banded P was opposite to what occurred at Melfort;

presumably due to the greater toxicity and impacts on emergence with in-furrow placement at Swift Current with the coarser soil and lower organic matter. When averaged across sites, we see a substantial overall response with P, regardless of placement ($P < 0.001$), and no difference between placement options when averaged across forms ($P = 0.327$). The only form effect on early-season growth, when averaged across sites and placement, was for a slight advantage ($P = 0.045$) to MAP (33%) over Synchro 50 (31%); however, this was mostly due to the observed response at Indian Head , specifically with side-band placement.

Table 6. Mean field pea canopy cover (late vegetative stage) for phosphorus (P) fertilizer treatments within individual sites and averaged across sites. Importantly, the significant S x F interaction indicates that effects varied by site; therefore, the averaged (across sites) values should be interpreted with caution. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD, *P* < 0.05).

Fertility Treatment		Indian Head	Melfort	Scott	Swift Current	Average
		-- Canopy Cover (%)			--	
1	No Fert	16.5 bc	30.4 a	24.5 b	34.8 abc	26.5 D
2	N Only	15.7 c	31.0 a	26.3 b	33.0 abc	26.5 D
3	SB-MAP	22.3 a	37.2 a	39.6 a	35.6 abc	33.6 AB
4	SB-MAP+AMS	26.0 a	33.3 a	34.9 a	36.6 ab	32.7 BC
5	SB-MES15	27.2 a	32.9 a	40.7 a	41.6 a	35.6 A
6	SB-MAP+MST	26.2 a	34.1 a	37.9 a	33.9 abc	33.0 AB
7	SB-Sync50	15.8 c	31.5 a	36.3 a	36.0 abc	29.9 C
8	IF-MAP	22.7 a	34.7 a	40.9 a	31.9 bc	32.5 BC
9	IF-MAP+AMS	24.5 a	36.3 a	35.4 a	30.8 c	31.7 BC
10	IF-MES15	25.1 a	35.3 a	35.4 a	29.2 c	31.2 BC
11	IF-MAP+MST	24.0 a	37.7 a	42.1 a	32.0 bc	33.9 AB
12	IF-Sync50	22.0 ab	34.2 a	40.7 a	31.9 bc	32.2 BC
	S.E.M	2.19	2.11	2.10	4.08	1.38

Seed Yield

For seed yield, the overall site ($P < 0.001$), fertilizer treatment ($P < 0.001$), and S × F interactions were significant (Table 3). The site effects (Table 4) were such that yields were highest at Indian Head (5765 kg/ha), followed by Melfort (5125 kg/ha), Scott (4226 kg/ha), and then Swift Current (3002 kg/ha). Despite a trend for higher yields with P (3% overall relative to the N only control; Table 7), neither the overall F-test ($P = 0.365$; Table 3) nor any contrasts ($P = 0.118$-0.838; Table 14) were significant at Indian Head. This lack of response was not necessarily unexpected given the moderately high soil test P levels and previous experience with field peas; however, yield increases were detected at the other sites. At Melfort, we saw an overall 5% yield increase with P fertilizer ($P = 0.047$) that was generally stronger with side-band placement; however, inconsistencies amongst forms were observed. Differences amongst individual treatments that received P were rare at Melfort; however, a key exception was the MAP+AMS blend yielding significantly lower with in-furrow versus side-band placement (4875 vs 5265 kg/ha). At Scott, we saw a 7% overall yield increase with P fertilizer ($P = 0.017$), regardless of placement method ($P = 0.014$-0.018) and with no difference between placement method when averaged across forms. Like Melfort, side-banded MAP+AMS yielded significantly (10%) higher than in-furrow MAP+AMS at Scott. At Swift Current, we saw a relatively strong 10% overall yield increase with P fertilizer ($P = 0.018$) but no difference between placement methods ($P = 0.195$). Significant differences amongst individual forms were relatively rare; however, when averaged across placement methods there was an advantage to MAP and MAP+AMS over MES15 ($P = 0.019$-0.036). The reason for this difference was unclear and may have been somewhat random. When averaged across sites we see an overall 6% yield increase with P fertilizer ($P < 0.001$) and similar yields regardless of placement when averaged across forms ($P = 0.195$). Individual treatments that received P did not significantly differ except for the highest yielding treatment, side-banded MAP (4658 kg/ha) yielding 4% higher than in-furrow MAP+AMS

(4472 kg/ha); presumably a result of the higher potential for seedling injury with this blend when placed in the seed-row. Overall, and from a practical perspective, these results suggest that MAP was equally effective relative to the other forms for supplying P to field peas, and there did not appear to be any cases where the crop responded to S. The lack of S response was consistent with past research work with this crop; however, positive responses to this nutrient could in some soils.

Table 7. Mean field pea seed yields for phosphorus (P) fertilizer treatments within individual sites and averaged across sites. Importantly, the significant S x F interaction indicates that effects varied by site; therefore, the averaged (across sites) values should be interpreted with caution. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD, *P* < 0.05).

Fertility Treatment		Indian Head	Melfort	Scott	Swift Current	Average
		---------- Seed Yield (kg/ha) ----------				
1	No Fert	5503 a	4846 d	3922 f	2670 e	4235 D
2	N Only	5626 a	4942 cd	3988 def	2783 de	4335 CD
3	SB-MAP	5744 a	5441 a	4241 a-e	3206 a	4658 A
4	SB-MAP+AMS	5812 a	5265 abc	4331 abc	3034 a-d	4611 AB
5	SB-MES15	5898 a	5066 bcd	4372 ab	3003 a-d	4585 AB
6	SB-MAP+MST	5736 a	5089 bcd	4439 ab	3112 abc	4594 AB
7	SB-Sync50	5840 a	5194 abc	4045 c-f	3152 abc	4557 AB
8	IF-MAP	5762 a	5184 abc	4532 a	3170 abc	4662 A
9	IF-MAP+AMS	5783 a	4875 d	3943 ef	3289 a	4472 BC
10	IF-MES15	5908 a	5279 abc	4226 b-f	2858 cde	4567 AB
11	IF-MAP+MST	5726 a	5264 abc	4403ab	2881 b-e	4568 AB
12	IF-Sync50	5845 a	5052 bcd	4274 a-d	2869 b-e	4510 AB
	S.E.M	136.5	136.5	136.5	136.5	68.3

Seed Protein Concentrations

For field pea seed protein concentrations, the overall site (*P* < 0.001) and fertilizer treatments (*P* = 0.042) effects were significant (Table 3). The site effects were such that protein was highest as Scott (21.9%), followed by Swift Current (20.7%), Melfort (20.1%), and Indian Head (18.7%), trends which were essentially the inverse of what was observed for yield (Table 4). While the S × F interaction was only marginally significant (*P* = 0.090), inspection of the effect slices suggest that any overall fertility effects were primarily due to the response at Swift Current (*P* < 0.001) with no effect at any of the remaining sites (*P* = 0.830-0.999). This observation is supported by the lack of any individual treatment differences (Table 8) or contrast comparisons (Table 15) at Indian Head, Melfort, or Scott. At Swift Current, we see an overall reduction in protein with in-furrow placement (*P* = 0.015). While this was most apparent with in-furrow MES15, protein was also significantly reduced with in-furrow relative to side-band placement for MAP+MST and Synchro 50 with a similar trend for MAP+AMS. The unique response at this location may have been due to the greater seedling toxicity with in-furrow fertilizer application relative to the other sites and/or the extremely high residual soil N. We did not look at treatment effects on nodulation; however, it is possible that this was affected by these factors at Swift Current and poor nodulation could have an impact on field pea seed protein concentrations. When we looked at the overall average treatment effects on protein, the only individual treatment that differed was in-furrow MES15 (19.5% versus 20.2-20.8%) the sideband versus in-furrow comparison was also significant (*P* = 0.003). However, as previously indicated, these responses appeared to be exclusively due to the observed effects at Swift Current and, as such, should be interpreted cautiously.

Table 8. Mean field pea seed protein concentrations for phosphorus (P) fertilizer treatments within individual sites and averaged across sites. A marginally significant S x F interaction indicates that effects varied by site; therefore, the averaged (across sites) values should be interpreted with caution. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD, *P* < 0.05).

Fertility Treatment		Indian Head	Melfort	Scott	Swift Current	Average
		------ Seed Protein (%) ------				
1	No Fert	18.3 a	20.6 a	22.1 a	20.2 cd	20.3 A
2	N Only	18.9 a	19.9 a	21.8 a	21.3 a-d	20.5 A
3	SB-MAP	18.8 a	20.2 a	22.5 a	20.6 bcd	20.5 A
4	SB-MAP+AMS	18.9 a	19.7 a	21.5 a	21.4 abc	20.3 A
5	SB-MES15	18.9 a	20.3 a	21.8 a	21.2 a-d	20.5 A
6	SB-MAP+MST	18.8 a	19.8 a	22.0 a	22.5 a	20.8 A
7	SB-Sync50	18.8 a	20.5 a	21.7 a	21.6 ab	20.7 A
8	IF-MAP	18.8 a	19.6 a	22.1 a	20.6 bcd	20.6 A
9	IF-MAP+AMS	18.9 a	20.3 a	21.7 a	20.8 bcd	20.5 A
10	IF-MES15	18.7 a	19.6 a	21.6 a	18.1 e	19.5 B
11	IF-MAP+MST	18.4 a	19.8 a	22.1 a	20.4 bcd	20.2 A
12	IF-Sync50	18.5 a	20.4 a	21.8 a	20.0 d	20.2 A
	S.E.M	0.49	0.49	0.49	0.49	0.24

Extension Activities

This project could not be featured during the annual Indian Head Crop Management Field Day but was shown throughout the tour during various private/individual tours. At Melfort, the trial was not a formal stop but was outfitted with treatment and sponsor signs and acknowledged during NARF/AAFC Joint Annual Field Day (July 23, 2025; 126 attendees) and the NARF/AAFC Minor/Niche Crops Field Day (July 24, 2025; 36 attendees). On July 21, 2025, Amber Wall and Glenda Lee Allan featured the project in the 'Walk the Plots' radio show which aired throughout the summer on CKSW 570, Magic 97.1, and Country 94.1. Chris Holzapfel presented highlights multiple times throughout the winter months including the Manitoba Agronomists Conference in Winnipeg, MB (Dec. 10, 2025; 410 attendees), the IHARF Winter Seminar and AGM (Feb. 4, 2026; 185 attendees), and the AgVise Soil Fertility Seminars in Portage la Prairie, MB (March 3, 2025, attendance TBD) and Saskatoon, SK (March 5, 2025; attendance TBD). Results may be incorporated into future Fact Sheets prepared by IHARF and SaskPulse and the final technical report will be available online through IHARF and AgriARM websites. We will continue to incorporate results highlights into future presentations where appropriate opportunities arise.

Conclusions and Recommendations

Describe what was learned from the demonstration. Highlight any significant conclusions and provide recommendations for the application and adoption of the project results. Be sure that you have presented the relevant data to support your conclusions. Identify any further research, development and communication needs, if applicable.

Overall, our results showed that side-banding was consistently a safe and effective placement option for applying P fertilizer to field peas. With in-furrow placement, the potential for seedling injury varied by both location and P formulation, whereby the greatest potential for injury occurred with the MAP+AMS blend and MES15 (relative to MAP alone, MAP+MST, and Synchro 50) and in the coarser textured, lower organic matter soils (i.e., injury at Swift Current > Scott > Melfort > Indian Head). Despite relatively high soil test P levels (13-14 ppm Olsen-P), P fertilization produced a reasonably consistent increase in early-season growth; however, some of the formulation and placement effects varied.

The early-season growth response at Indian Head was weaker with side-banded Synchro 50, possibly due to the lower solubility of this product and interference with the urea and ammonium sulfate with which the P was banded in this treatment. The early-season growth response tended to be better with in-furrow placement at Melfort (despite negative effects on emergence) while the opposite occurred at Swift Current and there was no difference between placement methods at Indian Head and Scott. Yield responses to P ranged from small and essentially not significant at Indian Head (~3%), more intermediate at Melfort (5%) and Scott (7%), and highest at Swift Current (10%). Averaged across sites, P/S fertilizer products increased field pea yields by ~6% when N was balanced and 8% when compared to no fertilizer at all. With no significant differences between side-banded MAP versus side-banded MAP+AMS, we can be confident that the observed yield increases were attributable to P and not S. Protein was not affected by any of the treatments at Indian Head, Melfort, or Scott, but was negatively affected by seed-placed fertilizer at Swift Current, particularly for MES15. The reason for this discrepancy is unclear, but may have been due to the greater fertilizer injury and/or the extremely high residual NO_3-N levels at Swift Current.

Overall, our results highlight the importance of P fertilizer for achieving high field pea yields. Side-banding is the preferred placement option where possible, performing equal to or better than seed-placed P in essentially all possible cases except for the early-season growth response with Synchro 50 at Indian Head, where in-furrow placement was advantageous. While the probability of field pea yield responses to S may be low, balanced fertility is always a worthy consideration; however, our results suggest that seed-placing sulfate S (i.e., AMS or MES15) should be avoided if possible. At a rate of 45 kg P_2O_5/ha and under the conditions encountered, the elemental S in MAP+MST did not increase the risk of crop injury relative to MAP and using Synchro 50 as an alternative to MAP did not appear to measurably reduce the risk. We did not see any significant advantages to any of the more novel P forms relative to MAP applied alone for any of the variables measured; however, they still may be a fit under certain circumstances. For example, growers looking for alternatives to AMS as an S source might consider MES15 or MAP+MST; however, elemental S is best utilized as a longer-term strategy since it may not be available to the crop in the year of application. Additionally, Synchro 50 or MAP/struvite blends might be appropriate for field pea growers who require added assurance that they will not injure their crop when seed-placing high rates of P fertilizer (i.e., Synchro 50).

Sustainable Canadian Agricultural Partnership (Sustainable CAP) Performance Indicators

a) List of performance indicators

Sustainable CAP Indicator	Total Number
Scientific publications from this project (List the publications under section b)	
• Published	0
• Accepted for publication	0
Highly Qualified Personnel (HQPs) trained during this project	
• Master's students	0
• PhD students	0
• Post docs	0
Knowledge transfer products developed based on this project (presentations, brochures, factsheets, flyers, guides, extension articles, podcasts, videos)[1]. List the knowledge transfer products under section (c)	8+

[1] Please only include the number of unique knowledge transfer products.

b) List of scientific journal articles published/accepted for publication from this project. Please ensure that each line includes the following: **Title, Author(s), Journal, Date Published or Accepted for Publication and Link to Article (if available).** *Add additional lines as needed*.

1. Not Applicable – no scientific articles associated with this project have been submitted for peer-review or publication.

c) List of knowledge transfer products/activities developed from this project.

Knowledge Transfer Product or Activity	Event/Location Where Knowledge Transfer Was Conducted	Estimated Number of Producers Participated in Knowledge Transfer	Link (if available)
Chris Holzapfel (IHARF) Presentation	Manitoba Agronomists Conference (Winnipeg, Dec. 10, 2025)	410	https://umanitoba.ca/agricultural-food-sciences/manitoba-agronomists-conference
Brianne McInnes (NARF) Plot Tour	NARF/AAFC Joint Annual Field Day (Melfort, July 23, 2025)	126	https://neag.ca/events/
Brianne McInnes (NARF) Plot Tour	NARF/AAFC Minor/Niche Crops field Day (Melfort, July 24, 2025)	36	https://neag.ca/events/
Amber Wall (WCA) and Glenda Lee Allan (various) Radio Show	Walk the Plots (online, recorded July 21, 2025)	not known	https://wheatlandconservation.ca/news-events/
Chris Holzapfel (IHARF) Presentation	IHARF Soil & Crop Management Seminar (Balgonie, Feb. 4, 2026)	185	https://iharf.ca/iharf-soil-and-crop-management-seminar-agm/
Chris Holzapfel (IHARF) Presentation	Agvise Soil Fertility Seminar (Portage la Prairie, March 3, 2025)	TBD	https://www.agvise.com/resources/seminars-and-events/
Chris Holzapfel (IHARF) Presentation	Agvise Soil Fertility Seminar (Saskatoon, March 5, 2025)	TBD	https://www.agvise.com/resources/seminars-and-events/
Final Project Report	IHARF Website (online)	not known	https://iharf.ca/full-reports/

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Appendices

Include any additional materials supporting the previous sections, e.g. detailed data tables, maps, graphs, specifications, literature cited (Use a consistent reference style throughout).

Table 9. Pertinent agronomic information for field pea phosphorus (P) fertilizer management demonstrations conducted at Indian Head, Melfort, Scott, and Swift Current, Saskatchewan in 2025.

Operation / Activity	Indian Head	Melfort	Scott	Swift Current
Previous Crop	Oat	Wheat	Wheat	Wheat
Row Spacing	30.5 cm	30.5 cm	25.4 cm	21.0 cm
Seedbed Utilization	~8%	~8%	~10%	~12%
Seeding Date	May 7	May 9	May 9	May 14
Plant Density	June 4	June 2	June 13	June 18
Canopy Cover	June 19	July 2	June 27	July 4
Desiccation	August 12 (glyphosate)	August 12 (glyphosate)	August 19 (diquat)	n/a
Harvest Date	August 19	August 20	August 25	September 11

Table 10. Mean monthly temperatures along with long-term (1981-2010) averages for the 2025 growing seasons at Indian Head, Melfort, Scott, and Swift Current, Saskatchewan.

Location	Year	May	June	July	August	Average
		-- Mean Temperature (°C) --				
Indian Head	2025	12.7	15.3	17.0	17.8	15.7 (+0.1)
	Long-term	10.8	15.8	18.2	17.4	15.6
Melfort	2025	13.8	15.0	17.0	18.0	16.0 (+0.8)
	Long-term	10.7	15.9	17.5	16.8	15.2
Scott	2025	12.9	14.6	15.8	17.4	15.2 (+0.4)
	Long-term	10.8	14.8	17.3	16.3	14.8
Swift Current	2025	13.1	15.9	18.0	19.0	16.5 (+0.7)
	Long-term	10.9	15.4	18.5	18.2	15.8

Table 11. Mean monthly precipitation amounts along with long-term (1981-2010) averages for the 2025 growing seasons at Indian Head, Melfort, Scott, and Swift Current, Saskatchewan.

Location	Year	May	June	July	August	Total
		------------------------------- Cumulative Precipitation (mm) -------------------------------				
Indian Head	2025	42.6	39.4	27.1	26.9	136 (56%)
	Long-term	51.7	77.4	63.8	51.2	244
Melfort	2025	4.8	93.2	25.9	113.5	237 (105%)
	Long-term	42.9	54.3	76.7	52.4	226
Scott	2025	11.8	103.7	28.7	64.5	209 (92%)
	Long-term	38.9	69.7	69.4	48.7	227
Swift Current	2025	34.2	31.3	78.2	92.6	236 (110%)
	Long-term	48.5	72.8	52.6	41.5	215

Table 12. Pre-determined contrast results exploring field pea response to phosphorus treatments for the response variable plant density. Data were analyzed using the generalized linear mixed model procedure of SAS Studio. Values in parentheses denote the specific treatment numbers that were included in each group.

Contrast	Indian Head	Melfort	Scott	S. Current	Average
	---------- Pr > F (p-value) ----------				
0P (2) vs P-Applied (3-12)	0.904	0.820	**0.028**	**<0.001**	**0.003**
0P vs SB (3-7)	0.718	0.274	0.234	0.054	0.404
0P vs IF (8-12)	0.896	0.127	**0.003**	**<0.001**	**<0.001**
SB vs IF	0.395	**<0.001**	**0.002**	**<0.001**	**<0.001**
MAP (3,8) vs MAP+AMS (4,9)	0.803	0.294	0.194	**0.019**	**0.014**
MAP vs MES15 (5,10)	0.164	0.486	0.907	**0.046**	**0.048**
MAP+AMS vs MES15	0.252	0.723	0.157	0.715	0.620
MAP vs MAP+MST (6,11)	0.950	0.726	0.616	0.643	0.491
MAP+AMS vs MAP+MST	0.852	0.484	0.423	0.058	0.074
MAP vs Sync50 (7,12)	0.076	0.677	0.472	0.406	0.530
MAP+AMS vs Sync50	0.126	0.144	0.560	**0.002**	0.065

Table 13. Pre-determined contrast results exploring field pea response to phosphorus treatments for the response variable canopy cover. Data were analyzed using the generalized linear mixed model procedure of SAS Studio. Values in parentheses denote the specific treatment numbers that were included in each group.

Contrast	Indian Head	Melfort	Scott	S. Current	Average
	---------- Pr > F (p-value) ----------				
0P (2) vs P-Applied (3-12)	**<0.001**	0.083	**<0.001**	0.645	**<0.001**
0P vs SB (3-7)	**<0.001**	0.211	**<0.001**	0.095	**<0.001**
0P vs IF (8-12)	**<0.001**	**0.039**	**<0.001**	0.421	**<0.001**
SB vs IF	0.892	0.155	0.432	**<0.001**	0.327
MAP (3,8) vs MAP+AMS (4,9)	0.179	0.565	**0.014**	0.995	0.388
MAP vs MES15 (5,10)	0.073	0.378	0.287	0.432	0.739
MAP+AMS vs MES15	0.650	0.759	0.155	0.428	0.236
MAP vs MAP+MST (6,11)	0.195	0.985	0.917	0.704	0.691
MAP+AMS vs MAP+MST	0.961	0.577	**0.018**	0.709	0.208
MAP vs Sync50 (7,12)	0.079	0.129	0.402	0.932	**0.045**
MAP+AMS vs Sync50	**0.002**	0.343	0.100	0.927	0.248

Table 14. Pre-determined contrast results exploring field pea response to phosphorus treatments for the response variable seed yield. Data were analyzed using the generalized linear mixed model procedure of SAS Studio. Values in parentheses denote the specific treatment numbers that were included in each group.

Contrast	Indian Head	Melfort	Scott	S. Current	Average
	-------------------	-------------------	Pr > F (p-value)	-------------------	-------------------
0P (2) vs P-Applied (3-12)	0.118	**0.047**	**0.017**	**0.018**	**<0.001**
0P vs SB (3-7)	0.133	**0.026**	**0.014**	**0.009**	**<0.001**
0P vs IF (8-12)	0.136	0.116	**0.018**	0.056	**<0.001**
SB vs IF	0.985	0.248	0.882	0.204	0.195
MAP (3,8) vs MAP+AMS (4,9)	0.686	**0.028**	**0.024**	0.808	**0.032**
MAP vs MES15 (5,10)	0.170	0.202	0.424	**0.019**	0.127
MAP+AMS vs MES15	0.332	0.349	0.140	**0.036**	0.525
MAP vs MAP+MST (6,11)	0.838	0.216	0.752	0.080	0.150
MAP+AMS vs MAP+MST	0.543	0.330	**0.010**	0.131	0.469
MAP vs Sync50 (7,12)	0.413	0.085	**0.039**	0.105	**0.022**
MAP+AMS vs Sync50	0.678	0.629	0.839	0.167	0.887

Table 15. Pre-determined contrast results exploring field pea response to phosphorus treatments for the response variable seed protein concentration. Data were analyzed using the generalized linear mixed model procedure of SAS Studio. Values in parentheses denote the specific treatment numbers that were included in each group.

Contrast	Indian Head	Melfort	Scott	S. Current	Average
	-------------------	-------------------	Pr > F (p-value)	-------------------	-------------------
0P (2) vs P-Applied (3-12)	0.711	0.804	0.828	0.267	0.611
0P vs SB (3-7)	0.850	0.686	0.814	0.739	0.695
0P vs IF (8-12)	0.603	0.942	0.856	**0.015**	0.173
SB vs IF	0.566	0.566	0.925	**<0.001**	**0.003**
MAP (3,8) vs MAP+AMS (4,9)	0.751	0.870	0.156	0.273	0.938
MAP vs MES15 (5,10)	0.989	0.941	0.212	0.054	0.122
MAP+AMS vs MES15	0.761	0.928	0.864	**0.003**	0.105
MAP vs MAP+MST (6,11)	0.795	0.843	0.604	0.077	0.688
MAP+AMS vs MAP+MST	0.564	0.717	0.366	0.495	0.746
MAP vs Sync50 (7,12)	0.891	0.293	0.278	0.590	0.854
MAP+AMS vs Sync50	0.649	0.375	0.737	0.577	0.916

Expenditure Statement

You must provide an expenditure statement showing how ADOPT funds were used. Expenditures must be reported using the budget categories shown in Appendix B of your contract. We recommend that you report your expenditures using the Excel spreadsheet we have developed for this purpose (ADOPT Expenditure Statement.xls). That spreadsheet is available from the research branch project manager or the evaluation coordinator.

Note that the ADOPT contract requires you to retain all receipts and financial records relating to the project for at least six years after the project is completed.

Provided in a separate Excel workbook and available upon request.