Enhanced Fertilizer Management for Optimizing Yield and Protein in Field Pea

Field peas are the most widely adapted pulse crop in Saskatchewan and are important to many growers for both the rotational benefits associated with legumes and as a key option for maintaining diversity in crop rotations. The project objectives were simply to evaluate, across a range of Saskatchewan environments, the yield and protein response of yellow field pea to various rates and combinations of nitrogen (N), phosphorus (P) and sulphur (S) fertilizer. The trial was set up at six locations which includes Scott, Indian Head, Outlook, Melfort, Swift Current and Yorkton. The experiment included 13 treatments of assorted fertilizer applications (Table 1).

Table 1. Proposed treatments in SaskPulse 2019 Field Pea Fertility Demonstration.

#	kg N-P_2O_5-K_2O-S/ha	#	kg N-P_2O_5-K_2O-S/ha
1	0-0-0-0 (no fertilizer)	7	17.2-40-0-0 (0 S)
2	17.2-0-0-10 (0 P)	8	17.2-40-0-5 5 S)
3	17.2-20-0-10 (20 P)	9	21.6-40-0-15 (15 S)
4	17.2-40-0-10 (40 P / 10 S)	10	40-40-0-10 (40 N as MAP/AS/urea)
5	21.4-60-0-10 (60 P)	11	17.2-40-0-10 + 40 N in-crop broadcast urea
6	25.7-80-0-10 (80 P)	12	40-40-0-10 * (40 N as MAP/AS/ESN)
		13	40-80-0-15 * (ultra high fertility / ESN)

* Supplemental N provided as ESN in treatments 12 and 13

The trials were analyzed separately due to the environmental constraints at each location. Looking at the average fertilizer responses, yields were lowest in the unfertilized control as expected while the highest yields were achieved with balanced fertility package of 17-40-0-10 kg N-P_2O_5-K_2O-S/ha as side-banded mono ammonium phosphate and ammonium sulfate.

At Indian head, P fertilizer rate had the greatest impact with a strong linear response detected ($P < 0.001$) and yields tended to decline when additional N fertilizer was applied. Whereas at Melfort, there was a slight response to P but no impacts of N and S were detected. At Outlook, P rates above 20 kg P_2O_5/ha had a marginal increase on yield. It appears that most of the yield gains at Outlook could be due to the low rate (17 kg N/ha) of background N provided in all the treatments combined the 20 kg P2O5/ha. Whereas at Scott, there was a highly significant quadratic P response ($P = 0.007$) with most of the benefit realized at the lowest rate of 20 kg P_2O_5/ha (Figure 1). There was also a significant negative impact of additional urea on yield because the more N available at early levels may have delayed the rhizobial colonization and N fixation. At Swift Current also, there was quadratic response for yield by P fertilization but, again, most of the benefit realized at the lowest rate of (20 kg P_2O_5/ha). At Yorkton, there was no evidence of a P response specifically ($P = 0.302$-0.773) but the comparison between control and fertilized treatments was significant ($P = 0.011$) and, somewhat unexpectedly (considering the soil test results), the linear response for S rate was also significant ($P = 0.030$) (Figure 2)**.**

Average seed protein concentrations of individual locations ranged from 19.9-24.7%. Averaged across all locations, seed protein concentrations ranged from 22.2-22.9% with no significant differences amongst individual treatments. There was a significant overall linear increase in protein with increasing P rate ($P = 0.046$). The additional N fertilizer did not impact field pea seed protein when averaged across locations ($P = 0.738$).

At Indian Head, there was no significant difference between individual treatments but in the comparison of the control vs fertilized treatments, a slight decline in protein was recorded with fertilizer application ($P < 0.001$). At Swift Current, the opposite occurred where the lowest protein concentrations were observed in the unfertilized control and protein increased linearly with the P rate ($P < 0.001$). At Outlook, P rate also had a positive effect on protein; however, this could be mostly due to the comparatively high values observed at the 80 kg P_2O_5/ha rate. At Scott, there was slight positive impact of extra N on protein detected; however, this mostly appeared to be associated with the side-banded urea where yields were also lowest; this is likely a function of the inverse relationship between yield and protein (low yields results in high protein) At Yorkton, there was a slight negative impact of extra N on protein ($P = 0.038$) and no noteworthy trends were observed at Melfort.

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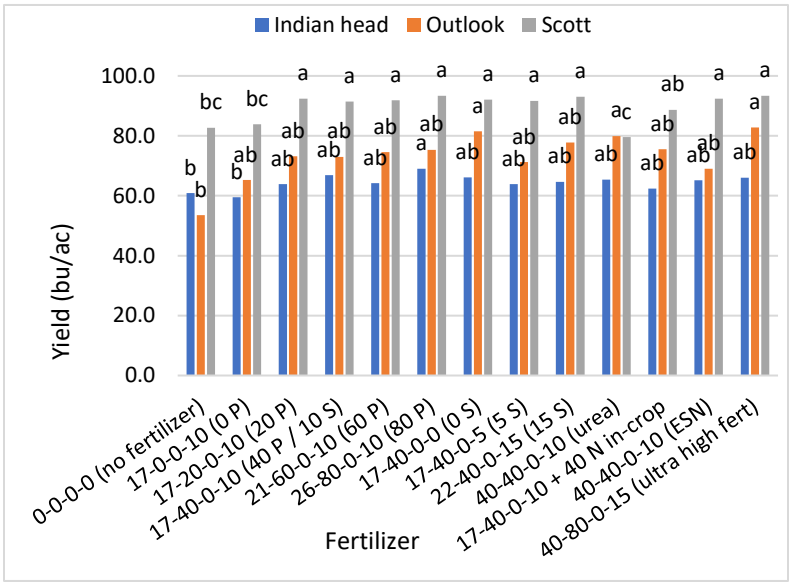

Figure 1. Pea yield (bu/ac) response to different rates of N, P and S at Indian Head, Outlook and Scott (2019)

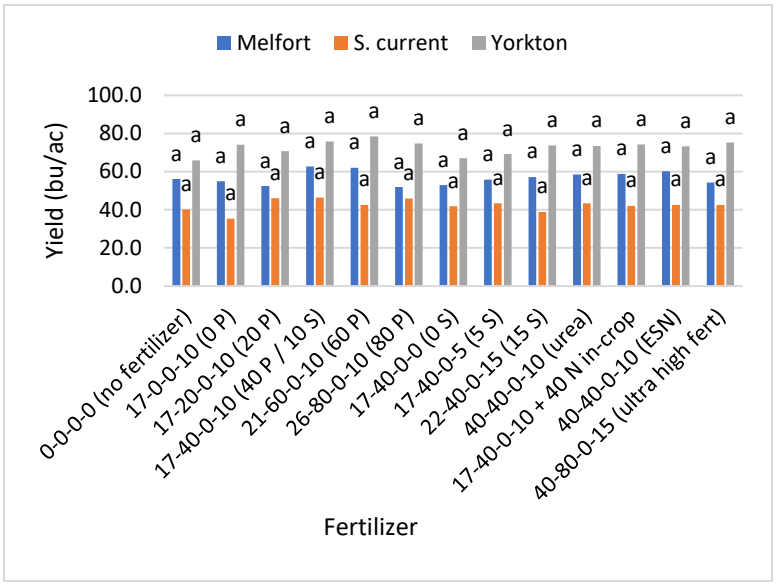

Figure 2. Pea yield (bu/ac) response to different rates of N, P and S at Melfort, Swift Current and Yorkton (2019)

The economic benefits associated with this research could arise from either enhanced yield through better fertilizer management or reduced fertilizer costs with no reduction in yield. For example, some growers may currently be under fertilizing their field peas, losing yield and further depleting soil reserves (i.e. phosphorus) and the results from this work may help them justify the higher costs of enhanced fertility. In contrast, other producers may be fertilizing excessively and they can utilize these results to reduce their fertilizer investment (i.e. starter N, S in non-limiting soils) without negatively impacting yields. Since P fertilizer provided the most consistent responses, average across all locations, the most economical P rate was 40 kg P2O5/ha. This was also the most economical rate at both Indian Head and Melfort. At Outlook, Scott, and Swift Current, the most economical P rate was 20 kg P2O5/ha while at Yorkton, it was 60 kg P2O5/ha. While useful for interpreting these results and guiding fertility decisions, these specific values (especially for individual site-years) should be used cautiously as they do not take in consideration whether responses were statistically significant. For example, at Yorkton the most profitable P rate was 60 kg P2O5/ha, higher than any other sites and the overall average, yet this was the sole site where the P response was not statistically significant. Notably, the most P rate treatment for each individual site and on average was unchanged regardless of whether the P fertilizer price was $550/Mt or $750/Mt.

From a broader agronomic perspective, our results support the use of soil tests and suggest that, of the major nutrients, phosphorus is the most likely to be limiting the field pea productivity and can provide sizeable yield benefits when applied as fertilizer. High residual S levels do not necessarily indicate that deficiencies cannot occur, at least on a site-specific basis. If deficiencies have been observed in the past for either field peas or other crops, applying a small amount of S may be justifiable. However, it is unlikely that S deficiency has been a critical yield-limiting factor for many field pea producers in Saskatchewan. Past research has found that N fertilization can frequently increase vegetative growth in field peas. Our results did not show any benefits to additional N fertilization and, unless residual levels are deficient or a nodulation failure is suspected. Any responses to N that did occur were small or negative. Negative protein responses to N fertilization are at least as probable as positive responses. Saskatchewan field pea producers are advised to avoid applying any more N fertilizer than what is provided by any P or S fertilizer products being utilized.

The full report will be available at www.warc.ca. The Saskatchewan Pulse Growers Association were the sole financial supporters of this project.