2025 Final Project Report

for the

Saskatchewan Pulse Crop Development Board

Mitigating Yield Losses Due to Pea Leaf Weevil in Field Pea and Faba Bean

(Project #AP-2409a)

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2. **Project Title:** Mitigating Yield Losses Due to Pea Leaf Weevil Feeding in Field Peas and Faba Beans

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5. **Introduction** (background and rationale, include references to original research projects where necessary)

The pea leaf weevil (PLW; *Sitona lineatus*) is one of relatively few insect pests affecting field peas (*Pisum sativum*) in western Canada. It also affects faba bean (*Vicia faba*) and, anecdotally, may feed preferentially on this crop. In Saskatchewan, the distinct leaf damage caused by feeding adults was first documented in 2007 (Hartley 2007). Pea leaf weevil was initially observed in the southwest corner of the province, presumably having migrated from Southern Alberta, but has since expanded throughout Saskatchewan and into Manitoba. In 2023, pressure was highest in the northwest and east side of Saskatchewan, with essentially no PLW observed in the southwest and south-central (Government of Saskatchewan 2023), presumably due to the lack of field peas in these regions. The most obvious damage caused by PLW is the feeding of adults on foliage, which results in distinct U-shaped notching on the leaf margins. Damage to the newest terminal leaves, sometimes referred to as clam leaves, indicates that the insects are still actively feeding. While such feeding can reduce stands if pressure is extremely high while the field peas are just emerging, the greatest economic losses associated with PLW come from larval feeding on *Rhizobium* root nodules; thus, reducing N fixation and potentially leading to N deficiencies. Although adult PLW will feed on numerous wild or tame legume hosts (i.e., alfalfa, clover, soybeans, etc.), only field peas and faba beans are suitable hosts for their reproduction. Therefore, these are the crops that are most vulnerable in the spring and suffer the greatest damage and potential for yield loss (i.e., Landon et al. 1995; Carcamo and Vankosky 2011; Bogdan 2023).

Seed-applied systemic insecticides are generally recognized as the most effective chemical control for reducing yield losses due to PLW, largely because foliar insecticide applications are difficult to time and have no impact on eggs or larvae (i.e., Carcamo and Vankosky 2011; Carcamo et al. 2018; Bogdan 2023). Examples of seed treatments currently registered for control of pea leaf weevil in field pea are Cruiser 5FS (thiamethoxam), Stress Sheild 600 (imidacloprid), and Lumivia CPL (chlorantraniliprole). Vankosky et al.

(2011), observed significant reductions in terminal leaf damage with thiamethoxam at the three and five node stage of field pea, but not at the eight-node stage. Yield responses, however, were inconsistent and even trended negative in one year. In faba bean trials at Lethbridge and Lacombe, Wijerathna et al. (2021), observed fewer plants with terminal leaf damage with a seed treatment (thiamethoxam) but not a foliar insecticide (lambda-cyhalothrin) at the five-node stage (three leaves unfolded). Both seed-applied and foliar insecticide applications resulted in a reduction in feeding at the seven-node (five leaves unfolded). Importantly, yields were approximately 700-800 kg/ha higher (21-24%) with the seed treatments, but there was no yield benefit to either single or dual foliar insecticide applications. Further to this, faba bean yields were related to the proportion of plants with terminal leaf damage at the three-leaf stage but not at the five-leaf stage.

Because the yield loss associated with PLW infestations is often due to nodule feeding as opposed to above-ground defoliation, a reasonable practice to reduce yield loss might be planting field peas on high nitrogen (N) soils or applying N fertilizer to compensate for the reduction in N_2 fixation. Corre-Hellou and Crozat (2005) observed that the contribution of N fixation to total N uptake in field pea fell from 72% to 49% as the observed PLW feeding on leaves became increasingly severe. While, under heavy PLW pressure, Vankosky et al. only improved pea yields with N fertilizer in one of three years, they consistently reduced nodulation with the addition of 60 kg N/ha. As such, N fertilized plants were still attractive for adult feeding, but may be less suitable for supporting larvae and reproduction.

Due to the ability of adult PLW to disperse long distances in the early spring, crop rotation is not always beneficial; however, multiple studies have shown that delaying field pea seeding until later in May can reduce PLW leaf and nodule feeding (i.e., Carcamo et al. 2018; Bogdan 2023). There is, however, a high risk that later seeded field peas (and faba beans) will yield less under normal environmental conditions. While detailed measurements were not completed, this was anecdotally observed in faba bean treatments seeded at the beginning versus end of May at Indian Head in 2023 (Chris Holzapfel, personal communication). While beyond the scope of this demonstration, but for similar reasons that delayed seeding can be beneficial, trap crops of winter peas combined with targeted foliar insecticide applications have also been shown to be effective in reduced feeding in the main field pea crop (i.e., Carcamo and Vankosky 2011).

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6. Objective(s) or purpose of the project

The objectives of the project are to demonstrate and investigate, for both field pea and faba bean:

1) What is the relative efficacy of insecticide seed treatments for reducing pea leaf weevil (PLW) feeding and subsequent impacts on seed yield.
2) Is delaying seeding an effective management practice for reducing PLW feeding, albeit recognizing that delays in seeding can also result in lower seed yields?
3) When PLW pressure is high, can yield losses be reduced by applying supplemental nitrogen (N) at the time of seeding?
4) Recognizing that seed-applied insecticides are unlikely to provide complete control, will combining a seed treatment with supplemental N fertilizer be beneficial over either of these inputs on their own?

7. Materials and Methods (experimental design, methods used, details of growing the crop(s), materials used, sites, statistical analyses, etc.)

Field trials were established at five Saskatchewan locations in 2024 (24) and 2025 (25) to demonstrate and investigate the relative efficacy of chemical and cultural strategies to reduce the impact of pea leaf weevil (PLW; *Sitona lineatus*) on field pea (*Pisum sativum*) and faba bean (*Vicia faba*) yield. The locations were Indian Head (IH; R.M. #156), Melfort (ME; R.M. #428), Redvers (RV; R.M. #61), Scott (SC; R.M. #380), and Yorkton (YK; R.M. #244), strategically selected based on observed PLW feeding pressure in recent years. Due to space limitations, no trials were conducted at Redvers in 2024 and only the field pea trial was conducted at Yorkton (both years). The treatments were a factorial combination of two seeding dates (early versus delayed), two seed-applied insecticide treatments (fungicide only versus fungicide plus insecticide), and two fertility treatments (Standard versus Extra N). The treatments were arranged in a four-replicate split-plot design with seeding date as the main plot and seed-applied insecticide and fertility treatments as the sub-plots. The initial seeding date was intended to be as early possible (late April / early May) while the delayed seeding date was targeted for 10-14 days after the first. The seed treatments were either Trilex EverGol (fungicide only) or Trilex EverGol SHIELD (fungicide plus insecticide) applied at label recommended rates, with the higher rate of insecticide used in the field pea trials. The fertilizer treatments were defined as either Standard (N provided from required PKS fertilizers) or Extra N (required PKS fertilizers plus side-banded urea to bring the total fertilizer N rate to 110 kg N/ha). A granular rhizobial inoculant was always applied in-furrow at the label recommended rate. The treatments are detailed in Table 1.

Plot sizes varied by location but, to minimize potential edge effects, each plot was three drill passes wide with all data collection focused on the centre pass. All factors other than those being evaluated were intended to be non-limiting. Crop protection product applications were tailored to the individual seeding dates wherever logistically feasible. Weeds were managed using registered pre-emergent and in-crop herbicides with supplemental hand weeding as required. At least one preventative foliar fungicide application was required by protocol, with timing tailored to each individual seeding date, regardless of disease pressure; however, no fungicide was applied at Redvers. Early-season foliar insecticide applications were prohibited (due to the potential impacts on PLW); however, foliar insecticides were permitted from the R1 stage onwards (i.e., to protect against pests such as grasshoppers, blister beetles, and aphids) and utilized as required based on the actual insect pressure. Pre-harvest herbicides and/or desiccants were used at the discretion of site managers, and the centre plot was harvested with a small plot combine as soon as possible after it was fit to do so. Like pesticide applications, harvest dates were tailored to each seeding date

wherever it was possible and practical to do so. Selected agronomic information, including dates of key field operations and data collection activities, are provided for 2024 and 2025 in Tables 2 and 3 of the Appendices, respectively.

Table 1. Treatments evaluated in pea leaf weevil (PLW) management demonstrations conducted with field pea and faba bean at various Saskatchewan locations in 2024 and 2025.

Trt #	Seeding Date[Z] (main plot)	Seed Treatment	Nitrogen Treatment[W]
1	Early	Fungicide[Y] only	Standard Fertility
2	Early	Fungicide only	Standard Fertility + Nitrogen
3	Early	Fungicide + Insecticide[X]	Standard Fertility
4	Early	Fungicide + Insecticide	Standard Fertility + Nitrogen
5	Delayed	Fungicide only	Standard Fertility
6	Delayed	Fungicide only	Standard Fertility + Nitrogen
7	Delayed	Fungicide + Insecticide	Standard Fertility
8	Delayed	Fungicide + Insecticide	Standard Fertility + Nitrogen

[Z] Early seeding occurs as early as possible (late April / early May), target 10-14 days later for delayed seeding

[Y] Fungicide is Trilix EverGol (3.85 g penflufen, 3.85 g trifloxystrobin, and 5.1 g metalaxyl/100 kg seed

[X] Insecticide is Stress Shield 600 (62.4 g imidacloprid/100 kg for faba bean and 124.8 g imidacloprid/100 kg for field pea)

[W] Standard fertility intended PKS to be non-limiting while treatments with Nitrogen received side-banded urea to bring the total fertilizer N rate to 110 kg N/ha

Various data were collected during the growing season and from the harvested seed samples. A composite, two-depth (0-15 cm, 15-60 cm) soil sample was collected from each site with, in most cases, separate samples for each crop type, and submitted to AgVise laboratories for analyses. Spring plant densities for each plot were estimated by counting seedlings in a minimum of 2 x 1 m sections of crop row and converting the averaged values to plants/m^2. Pea leaf weevil feeding pressure was quantified at the 4-5 node stage by counting leaf notches (LN) on 40 plants per plot and calculating both the average number of LN/plant and the proportion of plants with at least one LN (incidence). These counts were focussed on the clam leaf in peas and the most recently unfolded pair of leaves in faba bean. The Julian date when each plot reached physiological maturity was recorded and used to calculate days from seeding to maturity. Maturity was defined as when 70% of pods have turned or were turning brown in peas and when approximately 80% of pods had started to turn colour and 33% had completely turned for faba bean. Seed yields (expressed as kg/ha) were calculated from the harvested grain samples and are adjusted for dockage and to 16% seed moisture content, by mass. For consistency, IHARF completed the protein analyses on behalf of all sites using a FOSS Infratech NOVA NIR analyser and protein is expressed on a dry seed basis. Daily minimum and maximum temperatures and precipitation amounts were recorded at the nearest Environment and Climate Change Canada or privately owned weather stations.

For each crop type, data were combined across sites (location by year) for statistical analyses. The sole exception was for faba beans at Redvers which was analysed on its own due to high variability for several response variables. An arcsine square root transformation was applied to the PLW feeding incidence values prior to analyses; however, treatment means were back transformed to the original units and multiplied by 100 for presentation. All response data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS Studio with effects of site (S), seeding date (D), seed-applied insecticide (I), and N fertility (N), along with all possible interactions, considered fixed while replicate and D x replicate effects (nested within sites) were included as random effects. Heterogeneity amongst variance component estimates (by site) was tested for and permitted when significant and doing so improved model convergence. Where

justified by the overall tests of fixed effects, Fisher's protected LSD test was used to separate treatment means. All treatment comparisons were contained within sites and the slicediff statement was used to help identify differences in responses when interactions with site were detected. All treatment effects and differences between means were considered significant at $P \leq 0.05$; however, meaningful trends or p-values ≤ 0.10 may also be acknowledged.

8. **Results and Discussion** (results presented and discussed in the context of existing knowledge and relevant literature or comparison to existing recommendations, detail any major concerns or sources of error, provide proper statistical significance)

Soil Test Results and Growing Season Weather

Soil test results for all locations are provided in Tables 4 and 5 of the Appendices for field pea and faba beans, respectively. At SC-24, SC-25, and RV-25, a single composite soil sample was submitted for both crops. Overall residual NO_3-N levels (0-60 cm) were relatively high for the field peas at YK-24 and YK-25 (71-72 kg N and intermediate for the faba beans at ME-24 and ME-25 (54 kg NO_3-N/ha), but reasonably low (24-36 kg NO_3-N/ha) in all other cases. Residual phosphorus (P), potassium (K), and sulfur (S) levels were not of specific interest and were intended to be non-limiting across sites and treatments. Soil pH, organic matter, and cation exchange capacities (CEC) ranged widely but were generally typical of the regions for which each location was intended to represent.

Mean monthly temperatures and precipitation totals for May through August are provided relative to the long-term (1981-2010) averages in Tables 6 and 7 of the Appendices. In 2024, soil moisture reserves were initially low; however, the weather in May and June was cool and wet to the point that excess moisture was occasionally detrimental in some cases (i.e., field peas at IH-24). Heading into July, however, weather patterns changed with temperatures shifting to well above normal at all sites and precipitation totals for the month ranging from approximately 30-60% of average. August weather was variable, with temperatures remaining slightly above-average and precipitation totals ranging from very dry (i.e., ME-24) to well above-average (IH-24). The August precipitation at IH-24, however, was too late to be of much benefit to the crops and mostly came in the form of thunderstorms, often coupled with heavy rainfall and high winds. In 2025, weather patterns varied by location. May was warmer than average at all locations and relatively wet at the southern locations (IH-25 and RV-25), but extremely dry at the more northern locations (ME-25, SC-25, and YK-25). As the season progressed, temperatures fell to average or cooler than average and IH-25 became progressively drier and was the driest of all sites over the four-month period (136 mm or 56%). Precipitation over the latter part of the season was highly variable at RV-25 but still below average (73%) over the four-month period. At the initially dry northern locations (ME-25, SC-25, and YK-25), moisture conditions improved dramatically in June, July was dry, and the rains returned in August, with totals ranging from 195-237 mm (72-105% of average) over the four-month period. While peas are quite tolerant to drier conditions and heat during flowering, excess moisture earlier in the season can reduce root health and yields while increasing overall variability. Faba beans generally do better in high moisture environments, but high temperatures during flowering and pod fill can reduce pod retention and seed set, especially when coupled with drought stress.

Introduction to Field Trial Results

Due to the complexity of results with three treatment factors, two crop types, and 16 sites, all results tables are deferred to the Appendices with those for field pea in Tables 8-27, faba bean in Tables 28-47, and faba bean results for RV-25 (analyzed separately) in Tables 48-50. Particularly for the interactions between treatment factors, only significant responses will be discussed in any detail. For efficiency, we will look at the results from both crops simultaneously for each response variable. Results from the overall tests of fixed effects will be referred to repeatedly throughout this section and are in Tables 8 and 28 for field peas and faba beans, respectively. Similarly, the overall site averages will also be referred to frequently and are

presented for all response variables in Tables 9 and 29 for field peas and faba beans, respectively. For both crop types and all response variables, the site (S) effect was highly significant ($P < 0.001$).

Crop Establishment / Plant Density

In addition to site, field pea establishment was affected by nitrogen fertility (N; $P < 0.001$), but not seeding date (D; $P = 0.843$) nor seed-applied insecticide (I; $P = 0.285$; Table 8). SaskPulse recommends targeting 85 plants/m^2 for field peas (https://saskpulse.com/resources/calculating-seeding-rates). In the current project, only 4/9 sites met or exceeded this target; however, those that did not were never so low to be of much concern (Table 9). An S x D interaction ($P < 0.001$) was attributed to variable conditions during and after the seeding operations, with the advantage going to early seeding at 3/9 sites, delayed seeding at 2/9 sites, and no effect at 5/9 sites or on average (Table 10). An S x N effect on field pea plant densities ($P < 0.001$) revealed no effect 67% of the time, but negative effects at ME-24, ME-25, and SC-25. Across sites, field pea plant densities were 8% lower with side-banded urea but, again, this was due to a minority of sites where either poor seeding conditions or severe early season drought likely exacerbated the potential for ammonium toxicity. For interest and transparency, means for the two- and three-way interactions for field pea plant densities are provided in Tables 16 and 22, respectively.

The recommended target for faba beans is 45 plants/m^2; however, the actual range was 31-41 plants/m^2 (Table 9) which was slightly less than ideal but unlikely to limit crop development or yield potential. An S x D interaction showed that faba bean establishment was worse with delayed seeding at 2/9 sites but there was no impact in the remaining 7/9 cases (Table 30). Across sites, there was a trend ($P = 0.059$) for slightly lower plant densities with later seeding, but this is less meaningful than the interaction itself. An S x N effect ($P = 0.047$) was due to a similar reduction in emergence with side-banded urea at ME-25 as we saw with field peas but, in general, faba beans appeared to be less sensitive to fertilizer injury than field peas. An S x I interaction ($P = 0.010$) was due to poorer emergence with seed-applied insecticide at ME-24 but no other sites; however, the reasons for this response are unclear. Poorer establishment without seed-applied insecticide might be attributed to extreme PLW feeding; however, it would be rare to see such heavy and sustained pressure and such a response was never observed in the current project. Means for the two- and three-way interactions for field pea plant densities are provided in Tables 36 and 42, respectively.

Pea Leaf Weevil Feeding Pressure

Because these variables are closely related, results for PLW leaf notch (LN) numbers/plant and LN incidence (percentage of plants with feeding damage) will be discussed together, mostly focusing on incidence but referring to the former when doing so provided additional insights on feeding intensity or severity. For field pea, LN incidence ranged from as low as 0.1% at IH-24 and ME-24 to 37% at YK-24 (Table 9). Feeding was more intermediate at the remaining sites averaging 6-8% LN incidence at ME-25, RV-25, SC-25, and YK-25 and approximately 2% at SC-24 and IH-25. While these numbers were mostly well below the 30% threshold where one might consider foliar insecticide, they show that the insect was present and actively feeding with potential for larval damage to root nodules at most sites. An S x D interaction for LN incidence revealed that delayed seeding substantially reduced feeding pressure in field pea at 4/9 sites, but had the opposite effect at 2/9 sites, and no effect at 3/9 sites (Table 12). Across sites, the benefit to delayed seeding was small at best, only reducing LN incidence from 5.9% to 4.5% and, due to much more severe feeding with delayed seeding at YK-24 (1.84 versus 0.10 notches/plant; Table 11), no overall benefit with respect to average LN numbers/plant. The addition of N fertilizer had no impact on PLW feeding for individual sites or averaged across them for field pea. With significant I and S x I effects for both LN severity and incidence ($P < 0.001$), seed-applied insecticide worked well, significantly reducing LN incidence at 6/9 sites and from 10.1% to 1.9% on average. Effects on LN numbers/plant were less frequent but followed similar patterns, and the overall average went from 0.34 in the control to 0.09 with seed-applied insecticide. Significant S x D x I interactions for both LN numbers/plant and incidence ($P < 0.001$) were due to subtle inconsistences in the insecticide

response between seeding dates for individual sites that could largely be explained by differences in the overall feeding pressure (Tables 17 and 18). The three-way interactions for LN numbers/plant and LN incidence in field pea are provided in Tables 23 and 24, respectively.

Results from the overall tests of fixed effects for faba bean (Table 28) were much like those for field pea. For LN incidence, significant S, D, I, S x D, S x I, and S x D x N effects were detected ($P < 0.001$-0.009) while, for LN numbers/plant, the results mimicked those for incidence except D x I and S x D x I interactions were also detected ($P = 0.001$-0.013). Importantly, the values for both variables were consistently much higher for faba beans than they were for field peas, clearly indicating preferential feeding with this crop. Like field peas, seeding date effects on PLW pressure were such that delayed seeding was advantageous overall, but with inconsistencies amongst individual sites. For LN numbers/plant, there was an advantage to delayed seeding at 3/6 sites (4/7 when RV-25 was considered), but the opposite occurred at IH-25 and seeding date had no effect at 2-3/6 sites, depending on the specific variable. Both the average LN numbers/plant and incidence were reduced with seed-applied insecticide at 4/6 sites (5/7 including RV-25) with, on average, the LN numbers/plant essentially halved and incidence falling from 41% to 27% with seed-applied insecticide. An S x D x I interaction was detected for LN numbers/plant which could largely be explained by differences in feeding pressure between seeding dates (i.e., no insecticide effect when PLW pressure was low with delayed seeding at SC-25; Table 38). The S x D x N interaction was difficult to explain, but due to inconsistent N effects on PLW feeding depending on seeding date at ME-25 and increased feeding with extra N when seeding was completed early at SC-25 (Tables 37 and 38). We have no reason to expect extra N fertility to impact adult PLW feeding; however, if coupled with a reduction in nodulation it could reduce their reproductive success. The three-way interactions for LN numbers/plant and LN incidence in faba bean are provided in Tables 43 and 44, respectively.

Maturity

Field pea maturity ranged from 86-99 days from seeding for individual sites with IH-24 and SC-24 being the earliest and RV-25 being the latest (Table 9). In addition to the site effects, field pea maturity was affected by seeding date (D) and N fertility with S x D and S x N interactions also detected ($P < 0.001$). The S x D interaction was due to 7/9 sites exhibiting the expected response of hastened maturity with delayed seeding (Table 13), and either the opposite response or no effect at the remaining two sites (ME-25 and YK-25). The unusual responses at ME-25 and YK-25 may have been due to the extremely dry May weather leading to slow emergence with delayed seeding and the August precipitation prolonging maturity with delayed, but not early seeding where the crop may have been too advanced to benefit from the late rains. Averaged across sites, delayed seeding hastened maturity by 3.5 days; however, the spread in days to maturity between seeding dates was as high as 7.5 days for individual sites. The S x N interaction showed that extra N delayed maturity at 7/9 sites individually and had no effect at 2/9 sites (Table 13). Averaged across sites, maturity was delayed by 1.7 days with extra N; therefore, the effect was small relative to that of seeding date. Means for the two- and three-way interactions for field pea maturity are provided in Tables 19 and 25, respectively.

For faba bean, the long growing season requirements can be a challenge in some geographic locations and years. The site effect showed that, across treatments, days to maturity ranged from as low as 100 days at IH-24 to 118 days at ME-25 (Table 29). Treatment effects on maturity for this crop were more complex than they were for field pea, showing significant D, S x D, N, and S x N effects but also S x D x N, I x N, and S x I x N interactions (Table 28). Seeding date effects on faba bean maturity were as expected and similar to field pea, showing nearly a 7-day reduction in days from seeding to maturity when planting was delayed (Table 33). The S x D effect was simply due to variation in the magnitude of the treatment differences across sites since all sites responded in a similar manner. The N effects were small and relatively infrequent, but unusual in that, unlike field peas, extra N hastened maturity in the 2/6 cases where it had an effect (IH-24 and SC-

24). The nature of the S x D x N effect was similar whereby, at ME-24, extra N hastened maturity with early but not delayed seeding (Table 39). Similarly, the S x I x N effect revealed that the N effect at SC-24 was only significant in the absence of seed-applied insecticide. At RV-25, the treatment effects were consistent with most other sites whereby delaying seeding hastened days to maturity by 9 days from 120 days to 111 days going from early to delayed seeding) and extra N hastened maturity by 1 day (Table 48). Ultimately, all treatment effects on faba bean maturity except for those of seeding date were too small to be of much agronomic importance or concern. Mean faba bean maturities for the three-way interactions are provided in Table 45 for interest and transparency.

Seed Yield

Overall average field pea seed yields ranged from 3675 kg/ha at IH-24 to 5481 kg/ha at IH-25 (Table 9). In addition to the S effects, seeding date, insecticide, and N fertilizer all impacted field pea yield with S x D and S x N interactions also detected (Table 8; $P < 0.001$ for all). The S x I effect was only marginally significant ($P = 0.070$) but will be explored due to the importance of this response in meeting the project objectives. Field pea yields were lower with delayed seeding at 4/9 sites and not affected at the remaining 5/9 sites (Table 14). For the affected sites, the yield penalty associated with delayed seeding ranged from 699-905 kg/ha or 15-23% while, across all 9 sites, the reduction was 300 kg/ha or 6.5%. Significant yield increases with seed-applied insecticide occurred at 3/9 sites. The lack of a truly significant S x I response ($P = 0.070$) was attributed to the responses being relatively small (212-372 kg/ha or 5-10%) and trends for higher yields with insecticide at several sites where the response was not quite strong enough to be significant when considered alone (i.e., IH-25 and ME-25; 168-194 kg/ha or 4%). The more responsive sites were, as expected, those where PLW feeding pressure was highest, especially in the cases of YK-24 and YK-25. Across all 9 sites, yields were 148 kg/ha or 3.4% higher with seed-applied insecticide. The S x N interaction revealed significant field pea seed yield increases with additional N at 4/9 sites (IH-24, ME-25, YK-24, and YK-25), a positive trend at 1/9 site (IH-25; $P = 0.099$), and no response at the remaining 4 sites (Table 14). Positive yield responses generally occurred at sites with relatively high PLW feeding with one major exception, IH-24, where yields were increased by an astounding 933 kg/ha or 29% with extra N, despite low PLW pressure. This site was affected by root disease with the prolonged wet conditions early in the season followed by drought. While the peas persisted through these adverse conditions reasonably well, the unhealthy roots may have led to reduced nodulation/N fixation and subsequently strong responses to fertilizer N application. Means for the two and three-way interactions for field pea seed yield are in Tables 20 and 26, respectively.

Faba bean yields ranged from 2034 kg/ha at IH-24, our driest site, to 4938 kg/ha at ME-25, one of our wettest sites which is also situated in the heart of a traditional growing area for this crop. Seeding date (D), I, and N effects were all detected ($P < 0.001$-0.030) with S x D, S x I, and S x N interactions ($P \leq 0.001$) revealing that each of these main effect responses varied with environment (Table 28). Additionally, S x D x I ($P < 0.001$) and S x D x N ($P = 0/007$) effects were detected. The S x D effect was such that yields declined with delayed seeding at 4/6 sites (5/7 including RV-25) but at least tended to increase with delayed seeding at the remaining 2/6 sites (ME-24 and ME-25). Importantly, at ME-25 where delaying seeding increased yields by 921 kg/ha (21%), early and delayed seeding were completed on April 30 and May 15, respectively, at least 5-7 days ahead of most other sites. For the sites where yields declined with seeding delays, the penalty was 334-1257 kg/ha or 9-44% and, averaged across all six sites, 349 kg/ha or 10%. At RV-25, yields also trended lower (795 kg/ha or 29%) with delayed seeding but the overall variability was too high to declare the response significant ($P = 0.080$). The S x I interaction showed that seed-applied insecticide increased yields at 3/6 sites but there was no response at the remaining 3/6 sites or RV-25 (Table 48). Where significant, the yield increases with insecticide ranged from 169-454 kg/ha (4-25%) and, averaged across all six sites, the magnitude was 173 kg/ha (5%). The S x N response revealed yield increases with N at 2/6 sites (IH-24 and IH-25), a negative response at 1/6 sites (ME-24), and no response at 3/6 sites. Residual N was relatively high at ME-24, and this may have contributed to the negative response to additional N fertilizer at

this site. While not significant at the desired probability (P = 0.066), there was a trend for higher yields with extra N at RV-25 (343 kg/ha or 16%). The S x D x I interaction was due to a stronger seed-applied insecticide response with delayed seeding at ME-24 and SC-24, but the opposite occurring at ME-25 (Table 40). Particularly in the cases of ME-25 and, to a lesser extent, SC-24, these responses corresponded to the dates where the heaviest PLW feeding pressure was observed. Similarly, the S x D x N effect was due in part to an N response at ME-25 only occurring at the early seeding date under the heavier PLW feeding pressure. Also contributing to this interaction, the positive N response at IH-25 was primarily with early seeding and the negative response at ME-24 only occurred with early seeding. Mean faba bean yields for the three-way interactions are provided in Table 46.

Seed Protein

Field pea protein at individual sites ranged from 19.3% at IH-25 to 22.8% at RV-25 (Table 9), moderately but not perfectly correlated to the corresponding seed yields that were achieved. Protein was affected by seeding date (P < 0.001), insecticide (P = 0.022), and N fertility (P < 0.001) with S x D (P < 0.001) and S x N (P < 0.001) interactions indicating that these responses varied across sites (Table 8). Additional interactions were also detected for S x D x N (P = 0.014) and I x N (P = 0.005). The S x D interaction showed no effect of seeding date at 3/9 sites, lower protein with delayed seeding at 2/9 sites, and higher values at the remaining 4/9 sites (Table 15). These responses were not simply a function of yield as, in several cases, delayed seeding simultaneously reduced both seed yields and protein concentrations. The S x N effect showed significant increases in field pea protein at 5/9 sites and no effect at the remaining 4/9 sites. Across all 9 sites, protein was increased from 20.5% to 21.5% with supplemental N fertilizer while individual responses ranged from 0.9-3.3%. These positive protein responses did not exclusively occur at sites with heavy PLW feeding; however, these were where the strongest responses occurred (i.e., YK-24 and YK-25). The S x D x N interaction (Table 21) was due to the protein response to N exclusively occurring with early seeding at YK-24 and RV-25 but with delayed seeding at ME-24. The I x N response occurred because, when averaged across all 9 sites, we saw a stronger response to N and the highest overall field pea protein values in the absence of a seed-applied insecticide. This may have been related to the higher yields when N fertilizer was combined with a seed-treatment as opposed to being applied alone. Field pea seed protein concentration means for the three-way interactions are provided in Table 27.

Faba bean seed protein concentrations ranged from 27.6-29.9% for individual sites and were not well correlated with the corresponding yields (Table 29). Significant effects of seeding date and insecticide were also detected with significant S x D, S x N, and S x D x N interactions (P < 0.001-0.023; Table 28). The S x D response revealed higher protein with delayed seeding at 4/6 sites and no seeding date effect in the remaining cases (Table 35); however, the higher protein values here were often coupled with lower yield. Seed protein also trended higher with delayed seeding at RV-25 (P = 0.066; Table 48). Faba bean protein was significantly less with seed-applied insecticide when averaged across sites; however, the response was small as the dilution effect often associated with higher yields was likely offset by increased N fixation when PLW were controlled. The S x N effect was due to inconsistencies across sites whereby the protein response to N was positive at 2/6 sites, negative at 3/6 sites, and not significant at 1/6 sites. The S x D x N effect was due to the overall positives N response only occurring with early seeding at one site (IH-24) and the negative responses only occurring with early seeding at two sites (IH-25 and ME-25) and delayed seeding at another (SC-25). Means for the three-way interactions for faba bean protein are provided in Table 47.

9. Economic and Practical Implications for Growers

Detailed economic analyses were beyond the scope of this project since marginal profits will vary widely depending on the assumptions used for field pea and faba bean prices, seed-applied insecticide prices,

seeding rates (due to the implications for seed treatment costs), and N fertilizer. Each of these can fluctuate substantially from year-to-year and farm-to-farm depending on broader market conditions, field pea and faba bean market class, and overall grain quality.

While delaying seeding frequently reduced pea leaf weevil (PLW) feeding pressure, this strategy was not consistently effective and often led to lower yields. Considering the results for both field pea and faba bean, delaying seeding reduced PLW leaf notch (LN) incidence in 8/16 (50%) possible cases, increased incidence in 2/16 (13%), and had no effect in 6/16 (37%). Despite the frequently observed reductions in PLW pressure, yields were reduced with delayed seeding in 10/16 (63%, including RV-25 faba beans where the response was only marginally significant) possible cases, increased in 1/16 cases (6%), and had no effect in 5/16 (31%) cases. Although the sole positive yield response to delayed seeding occurred with faba beans, this was also the earliest seeded site by a substantial margin. Importantly, faba beans were typically more sensitive to seeding delays than field peas with respect to the frequency and magnitude of the observed yield losses. Due to the long growing season requirements of faba beans, delaying seeding this crop until later in May also comes with added risks of severe yield and quality losses that many would consider acceptable. While this recommendation will always be relative to when seeding is actually possible (i.e., delaying seeding until May 15 will not pose the same risks as delaying seeding until May 25 or later), delaying seeding with the expressed purpose of potentially reducing the impact of PLW will not be a practical or economical option in most cases for field peas or faba beans. Although this was often the case, the yield reductions frequently seen with seeding delays did not always lead to higher seed protein.

While measurable or statistically significant benefits did not always occur, seed treatments were effective for reducing PLW feeding and, in many cases, improving yields, especially when the insect was present in sufficiently high numbers. The use of a seed-applied insecticide reduced LN incidence in 11/16 (69%) possible cases and had no impact in the remaining 5/16 (31%) of cases. For all three of the non-responsive cases in field pea, feeding pressure was low overall while, for faba beans, we did have cases where the seed-treatment did not affect LN incidence despite moderate PLW pressure (i.e., ME-24 and SC-24). Seed yields were increased with seed-applied insecticide in 6/16 (38%) possible cases but had no significant effect on yield in the remaining 10/16 (62%). For both crops, there was a consistent trend for higher yields with seed treatments regardless of whether the response was statistically significant. Averaged across sites, the field pea yield increases were 148 kg/ha (3.4%) but as high as 372 kg/ha (10%) under heavy PLW pressure. For faba beans, the average response was 173 kg/ha (5.3%) and as high as 454 kg/ha (25%) under stressful conditions with moderate PLW pressure. Insecticide effects on protein were rare and, if they did occur (i.e., across sites with faba beans), small. This can be explained by the fact that reducing PLW feeding likely led to improved N fixation which was subsequently able to support higher yields while maintaining seed protein. Occasional interactions between site, seeding date, and seed-applied insecticide were mostly attributable to differences in PLW pressure or other environmental stresses between seeding dates within specific sites. While a positive return on investment is not guaranteed, this project has shown that seed-applied insecticides continue to be an effective and relatively low risk/cost method of managing PLW and reducing the risk of yield losses associated with this pest.

Looking at both average LN numbers/plant and LN incidence, there were no cases where simply applying extra N reduced PLW feeding pressure; however, we never hypothesized that this would occur. Rather, the expected benefit to extra N was through compensating for reductions in biological N fixation and, thereby, mitigating the negative impacts on seed yield. Theoretically, applying high rates of N could reduce nodulation and, thereby, the breeding success of PLW (by depriving larvae of feeding sites) over the longer-term; however, this will not be an effective or economical strategy for managing PLW if it is not coupled with a sizable yield benefit. In the current project, we increased yields with extra N in 6/16 (38%) possible cases, reduced yield in 1/6 (6%), and had no effect in 9/16 (56%). In certain instances, the yield benefits

were quite dramatic (i.e., IH-24 peas and ME-25 peas). While the positive responses usually coincided with reasonably high PLW pressure, this was not always the case. For example, PLW feeding was quite low with the IH-24 peas where we increased yields by 29% with N fertilizer. The strong response at ME-25 peas also appeared to be largely independent of PLW feeding pressure in that it was consistent across seeding dates despite much lower insect pressure with delayed seeding. These extreme responses were likely related to broader issues affecting root health, nodulation, and N fixation as opposed to being specifically attributable to PLW feeding. Looking more broadly, we saw no response or negative responses in 63% of the possible cases and predicting when positive yield responses to N might occur for crops like field peas or faba beans remains difficult. Furthermore, despite the yield increases frequently being significant, the rate used in this project (110 kg N/ha) would not be economically viable in most cases. Nitrogen fertilizer effects on protein were positive in 7/16 (44%) possible cases, negative in 4/16 (25%), and not significant in 5/16 (31%). Peas more consistently benefited from N than faba beans for both yield and protein. Interactions between N fertility and other factors (i.e., seeding date and insecticide) were relatively rare, difficult to predict or explain, and likely not important.

10. **Conclusions & Recommendations** (how do results relate to objectives or original research that project is based on; is there a need to refine current recommendation based on the results from this project?)

    In conclusion, our results were largely in agreement with past research in that the most consistent and cost-effective method for reducing pea leaf weevil (PLW) feeding and subsequent yield loss in field pea and faba bean was a seed-applied insecticide. Delaying seeding did frequently reduce PLW feeding but was not always effective, sometimes had the opposite effect, and often came with substantial yield penalties. Extra nitrogen (N) never affected PLW feeding but did increase seed yields 38% of the time; however, we cannot confidently attribute some of the strongest N responses we observed to PLW feeding.

    Field pea and faba bean growers who have observed potentially damaging PLW feeding in recent crops are strongly recommended to use a registered, seed-applied insecticide to reduce the potential impacts of this pest. While PLW pressure could be higher, seeding early will usually produce the healthiest, highest yielding crops across a broad range of conditions. This is true for both crops, but especially for faba beans which have longer growing season requirements and are particularly sensitive to delayed seeding. The N rates used in this project were too high to be economical in most cases; however, it would be a reasonable practice for growers who are specifically concerned about PLW to consider growing peas and/or faba beans on soils with higher residual N than they might normally be inclined. Applying a modest amount of N fertilizer on low N soils would also help to buffer against potential yield losses associated with PLW, even when using a seed-applied insecticide; however, the optimum rates and likelihood of seeing a positive return on investment to fertilizer N remain uncertain and difficult to predict.

11. **Future Research** (did the project identify a need for future research or further work)

    We observed preferential feeding in faba beans relative to field peas. This raises questions regarding thresholds specific to this crop and whether the pea leaf weevil (PLW) maps generated exclusively from field pea surveys will accurately predict the pressure that faba bean growers may face, or even regional pressure where both crops are grown in proximity to one another. Counting the PLW leaf notches in faba beans in an objective manner has proven slightly more challenging than with field peas due to the need to focus on new growth, slightly different growth patterns, and generally higher numbers. As such, focussing on percent incidence of plants with feeding damage on new growth, as opposed to the intensity of feeding on individual plants, might be a better indicator to focus on when developing economic thresholds. This may, however, be a worthy subject of future research.

Our results from Indian Head in 2024 and, perhaps, Melfort in 2025 raise questions regarding the potential for N fertilization to improve the ability of field peas to tolerate wet, heavy soils when root health and, potentially, N fixation, may be negatively impacted. While we will refrain from making blanket recommendations to apply N to field peas, this concept may be worth investigating, particularly where growers have struggled with root health in the past and are questioning the viability of this crop on their farms. While past work has looked at lower rates of starter N (i.e., ~55 kg N/ha), the rate used in the current project was more in line with what might be applied in cereal crops. In the case of using N fertilizer to mitigate potential yield losses associated with PLW, questions remain regarding the appropriate rates since those applied in the current project were likely too high to be economical except, perhaps, in the previous discussed cases where the responses were unusually strong. Another approach to using N to mitigate yield losses in field pea that may warrant further investigation might be to top-dress N at the 2-5 node stage specifically in fields where heavy feeding is observed. This practice has been used successfully to reduce yield losses associated with nodulation failures in soybeans; however, field peas have a much shorter growing season and tend to be grown in drier regions which may be limit the practicality and effectiveness of in-crop N with this crop. That being said, growers who are observe heavy feeding pressure and wish to salvage their crops will surely have questions on the viability of this practice.

Finally, this project utilized a single insecticide product (Imidacloprid, Group 4) for managing PLW in susceptible crops; however, other registered options also exist (i.e., Chlorantraniliprole, Group 28; Thiamethoxam, Group 4) and farmers may have questions about their relative efficacy for reducing PLW feeding and improving yields in field pea and faba bean.

12. Technology Transfer Activities (include presentations, extension material, field days, articles published, etc.)

At Indian Head in 2024 the trials were shown during the Crop Management Field Day (July 16, 145 participants) and a National Circle for Indigenous Agriculture and Food (August 7, 40 participants). Chris Holzapfel presented preliminary results from Indian Head 2024 during the IHARF Soil & Crop Management Meeting in Melfort (Feb. 5, 2025; 97 participants). At Melfort, the trial was not a formal stop during the field day; however, sponsor and treatments signs were in place, and the plots were shown in passing (July 18, 100 participants). At Yorkton, the trial was shown during the annual field day (July 23, 100 participants). Additionally, Mike Hall prepared a YouTube video summarizing the 2024 results for field pea (https://www.youtube.com/watch?v=qTa5bjB4Cgo). No tech transfer was conducted at Scott in 2024. In 2025, the field trials were shown during the SERF field day on July 10 at Redvers (80 attendees) and at Yorkton during the ECRF farm tour on July 24 (100 attendees). At Melfort, the project was highlighted during both the NARF/AAFC Joint Annual field day on July 23 (126 attendees) and the AAFC/NARF Minor/Niche Crops field day on July 24 (36 attendees) where Mike Brown (SaskPulse) presented on the topic. Additionally, Brianne McInnes shared preliminary results during the NE Ag Update in Melfort on Feb. 3, 2026 (80 attendees). These 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.

13. Funding Contributions (acknowledge partners and contributors to the project)

Financial support for this demonstration was provided by the Saskatchewan Pulse Crop Development Board (SaskPulse). Signs were in-place for any plot tours to acknowledge the funding sources and appropriate acknowledgements made in all written communications, oral presentations, or other printed materials pertaining to the project. We would like to acknowledge the Boards of Directors for the participating organizations in addition to the many technical and support staff who worked on the project. Bayer CropScience provided the seed treatment products used in the field trials as an in-kind contribution and several of the other inputs and crop protection products utilized were also donated. IHARF, NARF, and

WARC have strong working relationships and memorandum of understanding with Agriculture and Agri-Food Canada, and all participating organizations have received funding for infrastructure and basic operating expenses from the Saskatchewan Ministry of Agriculture and several other producer/commodity groups, all of which has helped to make work like this possible.

14. **Appendices** (detailed data tables, maps, photos, etc.)

Table 2. Selected agronomic information and dates of operations from pea leaf weevil (PLW) management trials completed with field pea at Indian Head (IH), Melfort (ME), Redvers (RV), Scott (SC), and Yorkton (YK) in 2024 (24) and 2025 (25).

Site	Prev. Crop	Row Spacing	Inoculant	kg N-P_2O_5-K_20-S/ha [z]	Seeding Dates	Plant Counts	PLW Notch Counts	Harvest Dates
IH-24	Wheat	30 cm	3.1 kg/ha TagTeam P/L	8-40-0-0	May-6 (D1) May-24 (D2)	Jun-3 (D1) Jun-18 (D2)	Jun-3 (D1) Jun-18 (D2)	Aug-13 (D1) Aug-23 (D2)
IH-25	Oat	30 cm	3.1 kg/ha Nodulator Duo SCG P/L	8-40-0-0	May-6 (D1) May-24 (D2)	Jun-4 (D1) Jun-16 (D2)	Jun-4 (D1) Jun-16 (D2)	Aug-19 (D1) Sep-3 (D2)
ME-24	Wheat	30 cm	4.3 kg/ha Cell Tech P/L	8-40-0-0	May-6 (D1) May-27 (D2)	Jun-12 (D1) Jun-21 (D2)	Jun-12 (D1) Jun-26 (D2)	Aug-20 (D1) Sep-11 (D2)
ME-25	Wheat	30 cm	2.5 kg/ha Lalfix Spherical P/L	8-40-0-0	Apr-30 (D1) May-14 (D2)	May-26 (D1) Jun-3 (D2)	May-26 (D1) Jun-6 (D2)	Aug-20 (D1) Sep-8 (D2)
RV-25	Oats	30 cm	4.5 kg/ha AGTIV FUEL P/L	8-40-0-0	May-9 (D1) May-23 (D2)	Jun-9 (D1) Jun-18 (D2)	Jun-6 (D1) Jun-16 (D2)	Aug-28 (D1) Sep-10 (D2)
SC-24	Wheat	25 cm	3.7 kg/ha Nodulator Duo P/L	8-40-0-0	May-5 (D1) May-22 (D2)	May-29 (D1) Jun-14 (D2)	May-29 (D1) Jun-14 (D2)	Aug-23 (all)
SC-25	Wheat	25 cm	3.7 kg/ha Nodulator Duo P/L	8-40-0-0	May-5 (D1) May-26 (D2)	May-28 (D1) Jun-10 (D2)	May-28 (D1) Jun-10 (D2)	Aug-25 (D1) Aug-27 (D2)
YK-24	Canola	30 cm	2.5 kg/ha LALFIX Start	8-40-0-0	May-6 (D1) May-21 (D2)	May-28 (D1) Jun-14 (D2)	May-28 (D1) Jun-14 (D2)	Aug-19 (D1) Aug-23 (D2)
YK-25	Wheat	30	4.0 kg/ha Primo GX2	8-40-0-0	May-12 (D1) May-27 (D2)	Jun-2 (D1) Jun-9 (D2)	Jun-3 (D1) Jun-11 (D2)	Aug-29 (D1) Sep-3 (D2)

[z] Fertility for all treatments whereby 'Extra N' treatments had total N rates topped up to 110 kg N/ha (not including soil N)

Table 3. Selected agronomic information and dates of operations from pea leaf weevil (PLW) management trials completed with faba bean at Indian Head (IH), Melfort (ME), Redvers (RV), and Scott (SC) in 2024 (24) and 2025 (25).

Site	Prev. Crop	Row Spacing	Inoculant	kg N-P_2O_5-K_20-S/ha [z]	Seeding Dates	Plant Counts	PLW Notch Counts	Harvest Dates
IH-24	Wheat	30 cm	3.1 kg/ha TagTeam BioniQ	8-40-0-0	May-6 (D1) May-24 (D2)	Jun-3 (D1) Jun-18 (D2)	Jun-3 (D1) Jun-18 (D2)	Sep-6 (D1) Sep-16 (D2)
IH-25	Oat	30 cm	3.1 kg/ha Nodulator Duo SCG P/L	8-40-0-0	May-6 (D1) May-24 (D2)	Jun-10 (D1) Jun-16 (D2)	Jun-4 (D1) Jun-17 (D2)	Sep-9 (D1) Sep-24 (D2)
ME-24	Wheat	30 cm	3.0 kg/ha TagTeam BioniQ	8-40-0-0	May-8 (D1) May-27 (D2)	Jun-12 (D1) Jun-24 (D2)	Jun-18 (D1) Jun-26 (D2)	Sep-24 (all)
ME-25	Wheat	30 cm	2.5 kg/ha Lalfix Spherical P/L	8-40-0-0	Apr-30 (D1) May-14 (D2)	May-26 (D1) Jun-3 (D2)	May-26 (D1) Jun-6 (D2)	Sep-26 (all)
RV-25	Oat	30 cm	4.5 kg/ha AGTIV FUEL P/L	8-40-0-0	May-9 (D1) May-23 (D2)	Jun-9 (D1) Jun-18 (D2)	Jun-2 (D1) Jun-16 (D2)	Sep-26 (D1) Oct-2 (D2)
SC-24	Wheat	25 cm	4.5 kg/ha TagTeam BioniQ	8-40-0-0	May-5 (D1) May-22 (D2)	May-30 (D1) Jun-14 (D2)	May-30 (D1) Jun-14 (D2)	Aug-23 (all)
SC-25	Wheat	25 cm	3.7 kg/ha Cell Tech Multi-Pulse	8-40-0-0	May-5 (D1) May-26 (D2)	May-28 (D1) Jun-10 (D2)	May-28 (D1) Jun-10 (D2)	Sep-9 (D1) Sep-23 (D2)

[z] Fertility for all treatments whereby 'Extra N' treatments had total N rates topped up to 110 kg N/ha (not including soil N)

Table 4. Selected soil test results for pea leaf weevil (PLW) management in field pea demonstration trials conducted at Indian Head (IH), Melfort (ME), Redvers (RV), Scott (SC), and Yorkton (YK) in 2024 (24) and 2025 (25). Unless otherwise indicated, all measurements are for the 0-15 cm soil profile.

Parameter	IH-24	IH-25	ME-24	ME-25	RV-25	SC-24	SC-25	YK-24	YK-25
pH	7.5	7.4	6.2	6.2	8.0	6.5	5.0	6.8	7.1
Organic Matter (%)	5.6	6.3	8.5	6.0	2.7	4.0	3.6	5.3	5.4
CEC (meq)	43.8	41.3	35.4	36.9	34.7	14.6	16.0	22.6	23.9
NO_3-N (kg/ha) [Z]	27	22	24	34	30	32	36	71 [Y]	72 [Y]
Olsen-P (ppm)	12	13	18	14	8	16	13	15	14
K (ppm)	628	856	562	360	153	219	176	370	267
kg S/ha (kg/ha) [Z]	43	70	63	123	>538	139	99	104 [Y]	54 [Y]

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

[Y] Values estimated from a 30 cm soil sample by multiplying values by 1.5

Table 5. Selected soil test results for pea leaf weevil (PLW) management in faba bean demonstration trials conducted at Indian Head (IH), Melfort (ME), Scott (SC), and Yorkton (YK) in 2024 (24) and 2025 (25). Unless otherwise indicated, all measurements are for the 0-15 cm soil profile.

Parameter	IH-24	IH-25	ME-24	ME-25	RV-25	SC-24	SC-25
pH	7.5	7.3	5.9	6.3	8.0	6.5	5.0
Organic Matter (%)	5.9	6.1	11.7	4.3	2.7	4.0	3.6
CEC (meq)	51.1	20.3	35.4	34.9	34.7	14.6	16.0
NO_3-N (kg/ha) [Z]	31	22	54	54	30	32	36
Olsen-P (ppm)	10	11	15	14	8	16	13
K (ppm)	721	722	437	251	153	219	176
kg S/ha (kg/ha) [Z]	31	52	60	63	>538	139	99

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

Table 6. Mean monthly temperatures along with long-term (1981-2010) averages for the 2024 and 2025 growing seasons at Indian Head, Melfort, Redvers, Scott, and Yorkton, Saskatchewan.

Location	Year	May	Jun	Jul	Aug	Avg.
		---------- Mean Temperature (°C) ----------				
Indian Head	2024	10.6	13.6	19.5	17.9	15.4 (-0.2)
	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	2024	10.1	13.2	19.4	17.4	15.0 (-0.2)
	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
Redvers	2025	13.2	16.2	17.5	17.9	16.2 (+0.2)
	Long-term	11.1	16.2	18.7	18.0	16.0
Scott	2024	9.8	13.3	18.9	17.4	14.9 (+0.1)
	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
Yorkton	2024	10.5	14.2	20.3	17.7	15.7 (+0.5)
	2025	12.4	15.7	17.5	18.3	16.0 (+0.8)
	Long-term	10.4	15.5	17.9	17.1	15.2

Table 7. Total monthly precipitation amounts along with long-term (1981-2010) for the applicable growing seasons at Indian Head, Melfort, Redvers, Scott, and Yorkton, Saskatchewan.

Location	Year	May	Jun	Jul	Aug	Total
		---------- Precipitation (mm) ----------				
Indian Head	2024	63.7	74.9	37.4	71.2	248 (102%)
	2025	42.6	39.4	27.1	26.9	136 (56%)
	Long-term	51.7	77.4	63.8	51.2	244
Melfort	2024	73.0	84.0	36.1	16.9	210 (93%)
	2025	4.8	93.2	25.9	113.5	237 (105%)
	Long-term	42.9	54.3	76.7	52.4	226
Redvers	2025	65	9	80	40	212 (79%)
	Long-term	60.0	95.2	65.5	46.6	267
Scott	2024	74.2	112.0	26.7	42.8	256 (113%)
	2025	11.8	103.7	28.7	64.5	209 (92%)
	Long-term	38.9	69.7	69.4	48.7	227
Yorkton	2024	56.0	120.4	22.9	42.3	242 (89%)
	2025	23.6	63.4	36.8	71.2	195 (72%)
	Long-term	51.3	80.1	78.2	62.2	272

Field Pea Results

Table 8. Overall tests of fixed effects for selected field pea response variables in trials conducted at 9 Saskatchewan sites. Data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with the effects of site (S), seeding date (D), seed-applied insecticide (I), supplemental nitrogen fertilizer (N) management (NIT), and all possible interactions considered fixed. Replicate effects (within site) were considered random. Heterogeneity of variance components was tested for and permitted when significant at $P \leq 0.05$.

Source	Plant Density	Leaf Notches	Leaf Notch Incidence	Maturity	Seed Yield	Seed Protein
	Pr > *F* (p-values)					
S	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
D	0.843	**0.028**	**0.014**	**<0.001**	**<0.001**	0.602
S x D	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
I	0.285	**<0.001**	**<0.001**	0.281	**<0.001**	**0.022**
S x I	0.403	**<0.001**	**<0.001**	0.094	**0.070** [Z]	0.385
D x I	0.522	0.577	0.097	0.546	0.438	0.845
S x D x I	0.457	**<0.001**	**<0.001**	0.566	0.173	0.107
N	**<0.001**	0.585	0.718	**<0.001**	**<0.001**	**<0.001**
S x N	**<0.001**	0.972	0.896	**<0.001**	**<0.001**	**<0.001**
D x N	0.289	0.273	0.074	0.610	0.761	0.141
S x D x N	0.305	0.964	0.884	0.415	0.493	**0.014**
I x N	0.679	0.669	0.679	0.660	0.420	**0.005**
S x I x N	0.765	0.982	0.853	0.445	0.969	0.175
D x I x N	0.758	0.645	0.719	0.469	0.637	0.531
S x D x I x N	0.739	0.998	0.885	0.877	0.543	0.104

[Z] While not significant at $P \leq 0.05$, the S x I interaction for field pea seed yield will be explored due to its importance in achieving the objectives of this project

Table 9. Overall location means for selected field pea response variables. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$) and values in parentheses are the standard error of the treatment mean (S.E.M.).

Site [Z]	Plant Density	Leaf Notches	Leaf Notch Incidence [Y]	Days to Maturity	Seed Yield	Seed Protein
	--- plants/m^2 ---	---- #/plant ----	-- % of plants --	------ days ------	----- kg/ha -----	--------- % ---------
IH-24	96 a	0.01 e	0.1 d	86.6 e	3675 e	21.0 cd
ME-24	71 d	0.00 e	0.1 d	88.7 d	5231 a	20.5 d
SC-24	62 e	0.06 de	2.3 c	86.2 e	4617 bc	19.5 e
YK-24	91 ab	0.97 a	37.2 a	89.4 d	4409 c	22.0 b
IH-25	78 c	0.06 de	1.7 c	91.6 c	5481 a	19.3 e
ME-25	66 de	0.14 cd	7.3 b	94.6 b	4728 b	20.7 d
RV-25	62 e	0.14 cd	5.6 b	98.6 a	3384 f	22.8 a
SC-25	65 de	0.19 c	8.0 b	91.7 c	4399 c	21.3 bcd
YK-25	86 b	0.35 b	7.2 b	88.6 d	4098 d	21.7 bc
S.E.M.	2.2	0.038	–	0.41	95.4	0.28

[Z] IH – Indian Head; ME – Melfort; SC – Scott; YK – Yorkton; RV – Redvers

[Y] An arcsine square root transformation was used prior to analyses and the means were back transformed for presentation. Due to the non-linear transformation, S.E.M. values do not reflect the true variability for this variable and are not reported.

Table 10. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on field pea plant density (plants/m²) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	Plant Density (plants/m²)									
Early	84 b	75 a	62 a	85 b	79 a	65 a	71 a	65 a	90 a	75
Delay	107 a	67 b	61 a	97 a	78 a	66 a	52 b	65 a	82 b	75
S.E.M	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	1.0
	Pr > F (p-value)									
Effect Slice [Z]	**<0.001**	**0.080**[Y]	0.751	**0.007**	0.736	0.834	**<0.001**	0.911	**0.047**	–
Insecticide (I)	Plant Density (plants/m²)									
No	95	73	62	94	80	64	62	63	87	76
Yes	97	69	61	88	77	67	62	67	84	75
S.E.M	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.9
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
Nitrogen (N)	Plant Density (plants/m²)									
No	97 a	77 a	64 a	91 a	80 a	77 a	64 a	70 a	86 a	78 A
Yes	95 a	65 b	59 a	91 a	76 a	54 b	60 a	61 b	85 a	72 B
S.E.M	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.9
	Pr > F (p-value)									
Effect Slice [Z]	0.553	**<0.001**	0.189	0.900	0.275	**<0.001**	0.318	**0.007**	0.736	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

[Y] Effect slice not quite significant at *P* ≤ 0.05, interpret individual treatment differences at this site cautiously

Table 11. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on pea leaf weevil (PLW) notch counts (average number of notches per plant) in field pea for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	PLW Notches (#/plant)									
Early	0.02 a	0.01 a	0.04 a	0.10 b	0.04 a	0.21 a	0.26 a	0.34 a	0.64 a	0.18 B
Delay	0.00 a	0.00 a	0.08 a	1.84 a	0.08 a	0.07 b	0.02 b	0.03 b	0.06 b	0.24 A
S.E.M	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.018
	Pr > F (p-value)									
Effect Slice [Z]	0.809	0.936	0.629	**<0.001**	0.574	**0.082[Y]**	**0.005**	**< 0.001**	**<0.001**	–
Insecticide (I)	PLW Notches (#/plant)									
No	0.01 a	0.01 a	0.08 a	1.48 a	0.11 a	0.24 a	0.18 a	0.26 a	0.69 a	0.34 A
Yes	0.01 a	0.00 a	0.04 a	0.47 b	0.01 a	0.05 b	0.10 a	0.11 b	0.01 b	0.09 B
S.E.M	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.018
	PLW Notches (#/plant)									
Effect Slice [Z]	0.935	0.935	0.626	**<0.001**	0.169	**0.014**	0.330	**0.053[Y]**	**<0.001**	–
Nitrogen (N)	PLW Notches (#/plant)									
No	0.01	0.01	0.06	1.03	0.08	0.14	0.12	0.19	0.34	0.22
Yes	0.01	0.00	0.06	0.92	0.04	0.14	0.16	0.18	0.36	0.21
S.E.M	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.181
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

[Y] Effect slice not quite significant at $P \leq 0.05$, interpret individual treatment differences at this site cautiously

Table 12. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on pea leaf weevil (PLW) notch incidence (percentage of plants with recent feeding) in field pea for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	PLW Notch Incidence (% of plants)									
Early	0.5 a	0.1 a	0.9 b	5.0 b	1.2 a	13.5 a	16.3 a	22.4 a	14.9 a	5.9 A
Delay	0.0 a	0.0 a	4.5 a	78.2 a	2.2 a	2.9 b	0.4 b	0.6 b	2.2 b	4.5 B
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	0.054	0.697	**0.002**	**<0.001**	0.269	**<0.001**	**<0.001**	**<0.001**	**<0.001**	–
Insecticide (I)	PLW Notch Incidence (% of plants)									
No	0.1 a	0.1 a	3.5 a	53.7 a	5.6 a	17.1 a	7.7 a	12.3 a	25.0 a	10.1 A
Yes	0.1 a	0.0 a	1.4 a	22.0 b	0.0 b	1.5 b	3.9 b	4.6 b	0.0 b	1.9 B
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	0.907	0.694	0.057	**<0.001**	**<0.001**	**<0.001**	**0.023**	**<0.001**	**<0.001**	–
Nitrogen (N)	PLW Notch Incidence (% of plants)									
No	0.1	0.0	2.6	37.3	1.8	7.4	4.4	8.6	7.0	5.1
Yes	0.1	0.2	2.1	37.0	1.6	7.2	7.0	7.5	7.4	5.3
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	–	–	–	–	–	–	–	–	–	–

[Z] Due to the non-linear data transformations, S.E.M. values do not reflect the true variability for this variable and are not reported.

[Y] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 13. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on field pea maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	Maturity (days from seeding)									
Early	89.7 a	90.1 a	89.9 a	92.3 a	93.5 a	94.3 a	101.8 a	95.1 a	85.0 b	92.4 A
Delay	83.4 b	87.4 b	82.4 b	86.6 b	89.6 b	94.9 a	95.4 b	88.3 b	92.3 a	88.9 B
S.E.M	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.17
	Pr > F (p-value)									
Effect Slice [Z]	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.300	**<0.001**	**<0.001**	**<0.001**	–
Insecticide (I)	Maturity (days from seeding)									
No	86.6	88.9	85.6	89.0	91.4	94.8	98.6	91.6	88.9	90.6
Yes	86.6	88.6	86.8	89.9	91.7	94.4	98.6	91.8	88.4	90.7
S.E.M	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.16
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
Nitrogen (N)	Maturity (days from seeding)									
No	85.8 b	88.1 b	86.0 a	89.0 b	91.1 b	92.7 b	98.3 a	90.0 b	87.1 b	89.8 B
Yes	87.3 a	89.4 a	86.4 a	89.9 a	92.1 a	96.5 a	98.9 a	93.3 a	90.2 a	91.5 A
S.E.M	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.16
	Pr > F (p-value)									
Effect Slice [Z]	**<0.001**	**0.003**	0.392	**0.047**	**0.023**	**<0.001**	0.154	**<0.001**	**<0.001**	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 14. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on field pea seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	---------- Seed Yield (kg/ha) ----------									
Early	3661 a	5648 a	5070 a	4759 a	5402 a	4629 a	3737 a	4468 a	4000 a	4597 A
Delay	3690 a	4815 b	4165 b	4060 b	5559 a	4828 a	3031 b	4330 a	4196 a	4297 B
S.E.M	134.9	134.9	134.9	134.9	134.9	135.9	134.9	134.9	134.9	45.0
	---------- Pr > F (p-value) ----------									
Effect Slice [Z]	0.878	**<0.001**	**<0.001**	**0.001**	0.418	0.309	**0.001**	0.475	0.313	–
Insecticide (I)	---------- Seed Yield (kg/ha) ----------									
No	3687 a	5247 a	4454 b	4303 b	5384 a	4644 a	3372 a	4351 a	3912 b	4373 B
Yes	3664 a	5216 a	4781 a	4515 a	5578 a	4812 a	3396 a	4446 a	4284 a	4521 A
S.E.M	109.2	109.2	109.2	109.2	109.2	110.5	109.2	109.2	109.2	36.5
	---------- Pr > F (p-value) ----------									
Effect Slice [YZ]	0.829	0.770	**0.003**	**0.048**	0.071	0.125	0.821	0.374	**<0.001**	–
Nitrogen (N)	---------- Seed Yield (kg/ha) ----------									
No	3209 b	5264 a	4658 a	4296 b	5392 a	4166 b	3320 a	4458 a	3867 b	4292 B
Yes	4142 a	5199 a	4577 a	4523 a	5569 a	5290 a	3448 a	4340 a	4329 a	4602 A
S.E.M	109.2	109.2	109.2	109.2	109.2	110.5	109.2	109.2	109.2	36.5
	---------- Pr > F (p-value) ----------									
Effect Slice [Z]	**<0.001**	0.546	0.449	**0.034**	0.099	**<0.001**	0.229	0.269	**<0.001**	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

[Y] While the S x I effect was only marginally significant, we chose to explore this interaction due to the importance of this response in achieving the project objectives

Table 15. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on field pea seed protein concentrations (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
Seeding Date (D)	Seed Protein (%)									
Early	21.4 a	21.8 a	20.0 a	22.3 a	18.0 b	20.1 b	22.2 b	22.0 b	21.4 a	21.0
Delay	20.7 a	19.3 b	19.0 b	21.7 a	20.5 a	21.4 a	23.4 a	20.6 a	21.9 a	20.9
S.E.M	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.12
	Pr > F (p-value)									
Effect Slice [Z]	0.075	**<0.001**	**0.021**	0.154	**<0.001**	**0.003**	**0.005**	**0.002**	0.207	–
Insecticide (I)	Seed Protein (%)									
No	21.2	20.6	19.6	21.8	19.5	21.0	23.0	21.5	21.6	21.1
Yes	20.9	20.5	19.5	22.1	19.0	20.5	22.7	21.1	21.7	20.9
S.E.M	0.31	0.31	0.31	0.31	0.31	0.32	0.31	0.31	0.31	0.10
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
Nitrogen (N)	Seed Protein (%)									
No	20.1 b	20.0 b	19.3 a	21.3 b	19.1	20.8	22.3 b	21.5 a	20.1 b	20.5 B
Yes	22.0 a	21.1 a	19.7 a	22.6 a	19.4	20.7	23.4 a	21.1 a	23.3 a	21.5 A
S.E.M	0.31	0.31	0.31	0.31	0.31	0.32	0.31	0.31	0.31	0.10
	Pr > F (p-value)									
Effect Slice [Z]	**<0.001**	**<0.001**	0.228	**<0.001**	0.211	0.606	**<0.001**	0.105	**<0.001**	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 16. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea plant density (plants/m^2) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	Plant Density (plants/m^2)									
Early – No	84	77	66	90	82	63	71	63	89	76
Early – Yes	85	72	59	80	76	67	72	67	91	74
Delay – No	106	70	59	98	77	65	53	64	86	75
Delay – Yes	109	65	63	96	78	67	52	66	78	75
S.E.M	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	1.2
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
D x N	Plant Density (plants/m^2)									
Early – No	84	80	68	87	82	77	75	68	91	79
Early – Yes	85	69	56	84	76	53	67	63	89	71
Delay – No	110	75	59	95	78	77	52	71	82	78
Delay – Yes	105	60	62	98	77	55	53	59	81	72
S.E.M	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	1.2
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
I x N	Plant Density (plants/m^2)									
No – No	97	79	64	96	81	75	62	68	90	79
No – Yes	93	67	61	92	78	53	62	59	85	72
Yes – No	97	75	64	85	79	79	65	71	83	78
Yes – Yes	97	62	58	91	75	55	59	63	85	72
S.E.M	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	1.2
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 17. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch counts (average number of notches per plant) in field pea for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	PLW Notches (#/plant)									
Early – No	0.03 a	0.01 a	0.05 a	0.15 c	0.08 a	0.33 a	0.34 a	0.48 a	1.26 a	0.30
Early – Yes	0.01 a	0.00 a	0.03 a	0.05 c	0.00 a	0.09 b	0.18 ab	0.21 b	0.01 b	0.06
Delay – No	0.00 a	0.00 a	0.10 a	2.80 a	0.15 a	0.15 ab	0.01 b	0.05 b	0.13 b	0.38
Delay – Yes	0.00 a	0.00 a	0.05 a	0.89 b	0.01 a	0.00 b	0.03 b	0.01 b	0.00 b	0.11
S.E.M	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.026
	Pr > F (p-value)									
Effect Slice [Z]	0.995	0.999	0.918	**<0.001**	0.495	**0.023**	**0.010**	**<0.001**	**<0.001**	–
D x N	PLW Notches (#/plant)									
Early – No	0.03	0.01	0.03	0.09	0.04	0.20	0.23	0.35	0.63	0.18
Early – Yes	0.01	0.00	0.05	0.11	0.04	0.23	0.29	0.34	0.65	0.19
Delay – No	0.00	0.00	0.09	1.96	0.13	0.09	0.01	0.04	0.06	0.26
Delay – Yes	0.00	0.00	0.06	1.73	0.04	0.06	0.03	0.03	0.06	0.22
S.E.M	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.026
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
I x N	PLW Notches (#/plant)									
No – No	0.01	0.01	0.06	1.58	0.15	0.25	0.14	0.28	0.69	0.35
No – Yes	0.01	0.00	0.09	1.38	0.08	0.23	0.21	0.25	0.70	0.33
Yes – No	0.01	0.00	0.05	0.48	0.01	0.04	0.10	0.11	0.00	0.09
Yes – Yes	0.00	0.00	0.03	0.46	0.00	0.06	0.10	0.11	0.01	0.09
S.E.M	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.026
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 18. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch incidence (percentage of plants with recent feeding) in field pea for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	PLW Notch Incidence (% of plants)									
Early – No	0.6 a	0.2 a	1.9 ab	9.8 c	3.9 a	23.7 a	22.4 a	30.5 a	48.7 a	11.7
Early – Yes	0.5 a	0.0 a	0.2 b	1.7 d	0.0 b	5.8 c	11.0 b	15.3 b	0.0 c	2.0
Delay – No	0.0 a	0.0 a	5.5 a	94.2 a	7.6 a	11.3 b	0.5 c	1.7 c	7.4 b	8.6
Delay – Yes	0.0 a	0.0 a	3.6 a	55.8 b	0.0 b	0.0 d	0.4 c	0.1 d	0.0 c	1.7
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	0.256	0.926	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	–
D x N	PLW Notch Incidence (% of plants)									
Early – No	0.6	0.1	0.7	4.2	0.7	12.8	14.1	22.1	14.2	5.4
Early – Yes	0.5	0.2	1.1	5.9	1.8	14.2	18.6	22.7	15.6	6.5
Delay – No	0.0	0.0	5.6	80.0	3.3	3.4	0.2	1.1	2.2	4.9
Delay – Yes	0.0	0.2	3.5	76.4	1.3	2.5	0.8	0.3	2.1	4.2
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	–	–	–	–	–	–	–	–	–	–
I x N	PLW Notch Incidence (% of plants)									
No – No	0.1	0.1	2.9	54.2	5.9	17.7	5.6	13.9	24.2	9.8
No – Yes	0.2	0.2	4.1	53.3	5.3	16.4	10.1	10.8	25.8	10.4
Yes – No	0.2	0.0	2.3	21.8	0.0	1.3	3.4	4.4	0.0	1.9
Yes – Yes	0.0	0.2	0.8	22.2	0.0	1.6	4.4	4.7	0.0	1.9
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	Pr > F (p-value)									
Effect Slice [Y]	–	–	–	–	–	–	–	–	–	–

[Z] Due to the non-linear data transformations, S.E.M. values do not reflect the true variability for this variable and are not reported

[Y] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 19. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on field pea maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	Maturity (days from seeding)									
Early – No	89.9	90.1	89.3	92.3	93.4	94.3	101.9	94.8	85.5	92.4
Early – Yes	89.5	90.0	90.6	92.4	93.6	94.3	101.6	95.4	84.5	92.4
Delay – No	83.3	87.6	81.9	85.8	89.5	95.3	95.3	88.4	92.3	88.8
Delay – Yes	83.6	87.1	83.0	87.4	89.8	94.6	95.5	88.1	92.3	89.0
S.E.M	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.20
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
D x N	Maturity (days from seeding)									
Early – No	88.9	89.6	89.5	92.0	92.9	92.5	101.3	93.0	83.6	91.5
Early – Yes	90.5	90.5	90.4	92.6	94.1	96.0	102.3	97.1	86.4	93.3
Delay – No	82.8	86.5	82.5	86.0	89.3	92.8	95.3	87.0	90.5	88.1
Delay – Yes	84.1	88.3	82.4	87.1	90.0	97.0	95.5	89.5	94.0	89.8
S.E.M	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.20
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
I x N	Maturity (days from seeding)									
No – No	85.9	87.9	85.1	88.8	91.0	93.0	98.4	90.3	87.3	89.7
No – Yes	87.3	89.9	86.0	89.3	91.9	96.5	98.8	92.9	90.5	91.4
Yes – No	85.8	88.3	86.9	89.3	91.1	92.3	98.1	89.8	86.9	89.8
Yes – Yes	87.4	88.9	86.8	90.5	92.3	96.5	99.0	93.8	89.9	91.7
S.E.M	0.56	0.56	0.56	0.56	0.56	0.57	0.56	0.56	0.56	0.19
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 20. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on field pea seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	Seed Yield (kg/ha)									
Early – No	3661	5713	4991	4609	5304	4428	3628	4405	3840	4509
Early – Yes	3660	5582	5148	4908	5501	4829	3846	4531	4160	4685
Delay – No	3713	4781	3917	3998	5465	4860	3116	4298	3984	4237
Delay – Yes	3668	4849	4413	4122	5654	4796	2946	4362	4408	4358
S.E.M	154.5	154.5	154.5	154.5	154.5	156.3	154.5	154.5	154.5	51.6
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
D x N	Seed Yield (kg/ha)									
Early – No	3244	5727	5096	4630	5225	4093	3628	4469	3816	4436
Early – Yes	4078	5568	5043	4887	5580	5164	3846	4467	4183	4757
Delay – No	3174	4800	4219	3961	5560	4239	3011	4447	3917	4148
Delay – Yes	4207	4830	4111	4159	5559	5417	3050	4213	4475	4447
S.E.M	154.5	154.5	154.5	154.5	154.5	156.3	154.5	154.5	154.5	51.6
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
I x N	Seed Yield (kg/ha)									
No – No	3242	5235	4510	4210	5319	4063	3352	4433	3723	4232
No – Yes	4132	5259	4398	4396	5449	5225	3391	4269	4100	4513
Yes – No	3175	5293	4806	4381	5466	4269	3287	4483	4010	4352
Yes – Yes	4153	5139	4756	4650	5690	5355	3505	4410	4558	4691
S.E.M	132.6	132.6	132.6	132.6	132.6	134.7	132.6	132.6	132.6	44.3
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 21. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on field pea seed protein concentrations (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I	Seed Protein (%)									
Early – No	21.4	21.8	20.1	21.8	18.3	20.3	22.3	22.3	21.7	21.1
Early – Yes	21.4	21.8	19.9	22.7	17.6	19.9	22.1	21.6	21.1	20.9
Delay – No	20.9	19.4	19.1	21.8	20.7	21.8	23.6	20.7	21.6	21.1
Delay – Yes	20.4	19.2	19.0	21.5	20.4	21.0	23.2	20.5	22.3	20.8
S.E.M	0.39	0.39	0.39	0.39	0.39	0.40	0.39	0.39	0.39	0.13
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–
D x N	Seed Protein (%)									
Early – No	20.6 b	21.7 a	19.9 a	21.3 b	17.8 b	20.2 b	21.5 b	22.4 a	20.0 b	20.6
Early – Yes	22.2 a	22.0 a	20.1 a	23.2 a	18.1 b	20.1 b	23.0 a	21.5 ab	22.8 a	21.4
Delay – No	19.5 c	18.4 c	18.8 b	21.3 b	20.4 a	21.5 a	23.1 a	20.6 b	20.2 b	20.4
Delay – Yes	21.9 a	20.1 b	19.3 ab	22.1 b	20.7 a	21.3 a	23.8 a	20.6 b	23.7 a	21.5
S.E.M	0.39	0.39	0.39	0.39	0.39	0.40	0.39	0.39	0.39	0.13
	Pr > F (p-value)									
Effect Slice [Z]	**<0.001**	**<0.001**	**0.051**	**<0.001**	**<0.001**	**0.0162**	**<0.001**	**<0.001**	**<0.001**	–
I x N	Seed Protein (%)									
No – No	20.1	20.0	19.4	21.0	19.2	21.2	22.2	21.7	19.6	20.5 C
No – Yes	22.2	21.3	19.7	22.6	19.8	20.9	23.7	21.3	23.7	21.7 A
Yes – No	20.0	20.1	19.3	21.6	19.0	20.5	22.3	21.3	20.6	20.5 C
Yes – Yes	21.8	20.8	19.6	22.6	19.1	20.5	23.0	20.8	22.8	21.2 B
S.E.M	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.12
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 22. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea plant density (plants/m²) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	---------- Plant Density (plants/m²) ----------									
Early – No – No	84	84	70	92	86	73	73	67	92	80
Early – No – Yes	85	70	62	88	78	54	68	60	86	72
Early – Yes – No	85	76	66	81	77	81	78	69	89	78
Early – Yes – Yes	85	69	51	80	74	53	67	65	92	71
Delay – No – No	110	75	57	100	77	78	50	70	87	78
Delay – No – Yes	101	65	60	95	78	52	56	58	85	72
Delay – Yes – No	109	74	62	89	80	77	53	73	77	77
Delay – Yes – Yes	109	56	65	102	75	57	50	60	78	72
S.E.M	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	1.7
	---------- Pr > F (p-value) ----------									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 23. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch index (average number of notches per plant) in field pea for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	---------- PLW Notches (#/plant) ----------									
Early – No – No	0.03	0.03	0.03	0.15	0.08	0.33	0.33	0.50	1.25	0.29
Early – No – Yes	0.03	0.00	0.08	0.15	0.08	0.34	0.34	0.45	1.28	0.31
Early – Yes – No	0.03	0.00	0.03	0.03	0.00	0.07	0.07	0.20	0.00	0.06
Early – Yes – Yes	0.00	0.00	0.03	0.08	0.00	0.12	0.12	0.23	0.03	0.07
Delay – No – No	0.00	0.00	0.10	3.00	0.23	0.18	0.18	0.05	0.13	0.41
Delay – No – Yes	0.00	0.00	0.10	2.60	0.08	0.12	0.12	0.05	0.13	0.34
Delay – Yes – No	0.00	0.00	0.08	0.93	0.03	0.00	0.00	0.03	0.00	0.12
Delay – Yes – Yes	0.00	0.00	0.03	0.85	0.00	0.00	0.00	0.00	0.00	0.10
S.E.M	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.036
	---------- Pr > F (p-value) ----------									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 24. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea plant density (plants/m²) for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	---------- PLW Notch Incidence (% of plants) ----------									
Early – No – No	0.3	0.3	1.2	9.6	2.7	23.1	17.9	32.9	48.7	10.9
Early – No – Yes	0.9	0.2	2.8	10.0	5.3	24.3	27.3	28.0	48.7	12.5
Early – Yes – No	0.9	0.0	0.3	0.9	0.0	5.2	10.7	13.0	0.0	1.7
Early – Yes – Yes	0.2	0.2	0.2	2.8	0.2	6.4	11.2	17.8	0.2	2.4
Delay – No – No	0.0	0.0	5.4	94.7	10.3	13.0	0.2	2.3	6.4	8.8
Delay – No – Yes	0.0	0.2	5.7	93.6	5.3	9.8	0.9	1.3	8.3	8.4
Delay – Yes – No	0.0	0.0	5.9	59.0	0.2	0.0	0.2	0.3	0.2	2.1
Delay – Yes – Yes	0.0	0.2	1.8	52.6	0.0	0.0	0.6	0.0	0.0	1.4
S.E.M [Z]	–	–	–	–	–	–	–	–	–	–
	---------- Pr > F (p-value) ----------									
Effect Slice [Y]	–	–	–	–	–	–	–	–	–	–

[Z] Due to the non-linear data transformations, S.E.M. values do not reflect the true variability for this variable and are not reported

[Y] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 25. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	---------- Maturity (days from seeding) ----------									
Early – No – No	89.0	89.5	88.8	92.0	92.8	92.5	101.5	92.8	84.0	91.4
Early – No – Yes	90.8	90.8	89.8	92.5	94.0	96.0	102.3	96.8	87.0	93.3
Early – Yes – No	88.8	89.8	90.3	92.0	93.0	92.5	101.0	93.3	83.3	91.5
Early – Yes – Yes	90.3	90.3	91.0	92.8	94.3	96.0	102.3	97.5	85.8	93.3
Delay – No – No	82.8	86.3	81.5	85.5	89.3	93.5	95.3	87.8	90.5	88.0
Delay – No – Yes	83.8	89.0	82.3	86.0	89.8	97.0	95.3	89.0	94.0	89.6
Delay – Yes – No	82.8	86.8	83.5	86.5	89.3	92.2	95.3	86.3	90.5	88.1
Delay – Yes – Yes	84.5	87.5	82.5	88.3	90.3	97.0	95.8	90.0	94.0	90.0
S.E.M	0.75	0.75	0.75	0.75	0.75	0.76	0.75	0.75	0.75	0.25
	---------- Pr > F (p-value) ----------									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 26. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	Seed Yield (kg/ha)									
Early – No – No	3217	5848	5047	4528	5133	3835	3604	4386	3742	4371
Early – No – Yes	4106	5578	4935	4690	5474	5021	3652	4424	3938	4646
Early – Yes – No	3270	5606	5145	4732	5317	4351	3652	4552	3891	4502
Early – Yes – Yes	4050	5558	5152	5084	5686	5307	4040	4510	4429	4868
Delay – No – No	3268	4621	3973	3893	5506	4291	3101	4481	3705	4093
Delay – No – Yes	4158	4941	3861	4103	5423	5429	3131	4115	4263	4380
Delay – Yes – No	3079	4979	4466	4029	5614	4187	2922	4413	4129	4202
Delay – Yes – Yes	4256	4720	4360	4216	5694	5404	2970	4311	4687	4513
S.E.M	187.6	187.6	187.6	187.6	187.6	190.4	187.6	187.6	187.6	62.6
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 27. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for field pea seed protein concentration (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	YK-24	IH-25	ME-25	RV-25	SC-25	YK-25	Avg
D x I x N	Seed Protein (%)									
Early – No – No	20.6	21.8	20.0	20.4	17.8	20.4	21.2	22.8	19.9	20.5
Early – No – Yes	22.2	21.9	20.1	23.2	18.8	20.2	23.4	21.9	23.5	21.7
Early – Yes – No	20.7	21.6	19.8	22.3	17.8	19.9	21.7	22.1	20.1	20.7
Early – Yes – Yes	22.1	22.1	20.0	23.2	17.5	19.9	22.5	21.1	22.2	21.2
Delay – No – No	19.6	18.1	18.8	21.6	20.6	21.9	23.2	20.7	19.2	20.4
Delay – No – Yes	22.3	20.7	19.3	22.1	20.7	21.6	24.0	20.7	24.0	21.7
Delay – Yes – No	19.4	18.7	18.8	21.0	20.1	21.0	22.9	20.4	21.1	20.4
Delay – Yes – Yes	21.5	19.6	19.2	22.1	20.7	21.0	23.5	20.6	23.4	21.3
S.E.M	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.16
	Pr > F (p-value)									
Effect Slice [Z]	–	–	–	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Faba Bean Results

Table 28. Overall tests of fixed effects for selected faba bean response variables in trials conducted at 6 Saskatchewan sites. Data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with the effects of site (S), seeding date (D), seed-applied insecticide (I), supplemental nitrogen fertilizer (N) management (NIT), and all possible interactions considered fixed. Replicate effects (within site) were considered random. Heterogeneity of variance components was tested for and permitted when significant at $P \leq 0.05$.

Source	Plant Density	Leaf Notches	Leaf Notch Incidence	Maturity	Seed Yield	Seed Protein
	---------- Pr > *F* (p-values) ----------					
S	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
D	0.059	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
S x D	**0.008**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
I	0.431	**<0.001**	**<0.001**	0.935	**<0.001**	**0.006**
S x I	**0.010**	**<0.001**	**<0.001**	0.141	**0.001**	0.067
D x I	0.790	**0.013**	0.098	0.568	0.116	0.647
S x D x I	0.517	**0.001**	0.778	0.555	**<0.001**	0.108
N	0.763	0.846	0.889	**0.013**	**0.030**	0.829
S x N	**0.047**	0.069	0.209	**0.049**	**<0.001**	**<0.001**
D x N	0.778	0.996	0.740	0.935	0.956	0.871
S x D x N	0.593	**0.003**	**0.009**	**<0.001**	**0.007**	**0.023**
I x N	0.963	0.445	0.271	**<0.001**	0.702	0.957
S x I x N	0.754	0.411	0.158	**<0.001**	0.777	0.205
D x I x N	0.436	0.701	0.703	0.935	0.608	0.829
S x D x I x N	0.795	0.954	0.776	0.141	0.728	0.676

[Z] While not significant at $P \leq 0.05$, the S x I interaction for seed yield will be explored due to its importance in achieving the objectives of this project

Table 29. Overall location means for selected faba bean response variables. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$) and values in parentheses are the standard error of the treatment mean (S.E.M.).

Site [Z]	Plant Density	Leaf Notches	Leaf Notch Incidence [Y]	Days to Maturity	Seed Yield	Seed Protein
	--- plants/m^2 ---	---- #/plant ----	-- % of plants --	------ days ------	----- kg/ha -----	--------- % ---------
IH-24	37.6 b	0.47 c (0.053)	25.9 cd	100.4 f (0.23)	2034 d	27.6 d
ME-24	31.0 d	0.43 c (0.053)	25.2 cd	104.1 d (0.21)	3892 b	27.8 cd
SC-24	33.7 c	0.34 c (0.053)	19.5 d	102.6 e (0.46)	2198 d	27.8 cd
IH-25	32.9 cd	1.83 a (0.101)	61.5 a	106.0 c (0.16)	3721 b	29.9 a
ME-25	32.4 cd	1.14 b (0.080)	45.0 b	118.0 a (0.78)	4938 a	29.1 b
SC-25	40.5 a	0.89 bc (0.308)	28.5 c	112.5 b (0.16)	3212 c	28.4 bc
S.E.M.	0.91	var [X]	–	var [X]	105.1	0.16

[Z] IH – Indian Head; ME – Melfort; SC – Scott

[Y] An arcsine square root transformation was used prior to analyses and the means were back transformed for presentation. Due to the non-linear transformation, S.E.M. values do not reflect the true variability for this variable and are not reported.

[X] Standard error of the treatment means varied by site due to heterogenous variance component estimates

Table 30. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on faba bean plant density (plants/m²) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	---------- Plant Density (plants/m²) ----------						
Early	37.4 a	31.6 a	32.2 a	35.2 a	35.5 a	40.4 a	35.4
Delay	37.9 a	30.4 a	35.2 a	30.7 b	29.2 b	40.7 a	34.0
S.E.M	1.22	1.22	1.22	1.22	1.22	1.22	0.50
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	0.781	0.501	0.078	**0.013**	**0.001**	0.872	–
Insecticide (I)	---------- Plant Density (plants/m²) ----------						
No	37.7 a	33.8 a	33.1 a	33.7 a	32.4 a	39.1 a	35.0
Yes	37.6 a	28.2 b	34.3 a	32.2 a	32.3 a	42.0 a	34.4
S.E.M	1.22	1.22	1.22	1.22	1.22	1.22	0.50
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	0.976	**<0.001**	0.459	0.349	0.942	0.074	–
Nitrogen (N)	---------- Plant Density (plants/m²) ----------						
No	37.4 a	30.1 a	33.2 a	32.0 a	34.7 a	41.4 a	34.8
Yes	37.9 a	31.9 a	34.2 a	33.9 a	30.0 b	39.7 a	34.6
S.E.M	1.22	1.22	1.22	1.22	1.22	1.22	0.50
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	0.778	0.292	0.551	0.263	**0.006**	0.330	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 31. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on pea leaf weevil (PLW) notch counts (average number of notches per plant) in faba bean for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	PLW Notches (#/plant)						
Early	0.48	0.66	0.27	1.48	1.81	1.65	1.06 A
Delay	0.46	0.21	0.41	2.19	0.47	0.14	0.65 B
S.E.M	0.076	0.076	0.076	0.143	0.111	0.428	0.081
	Pr > F (p-value)						
Effect Slice [Z]	0.908	**<0.001**	0.195	**0.003**	**<0.001**	**0.021**	–
Insecticide (I)	PLW Notches (#/plant)						
No	0.63 a	0.41 a	0.38 a	2.71 a	1.42 a	1.21 a	1.13 A
Yes	0.31 b	0.45 a	0.30 a	0.96 b	0.86 b	0.58 b	0.58 B
S.E.M	0.076	0.076	0.076	0.114	0.095	0.313	0.062
	Pr > F (p-value)						
Effect Slice [Z]	**0.003**	0.726	0.449	**<0.001**	**<0.001**	**<0.001**	–
Nitrogen (N)	PLW Notches (#/plant)						
No	0.49	0.49	0.42	1.83	1.16	0.75	0.86
Yes	0.44	0.38	0.26	1.84	1.13	1.04	0.85
S.E.M	0.076	0.076	0.076	0.114	0.095	0.313	0.062
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 32. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on pea leaf weevil (PLW) notch incidence (percentage of plants with recent

feeding) in faba bean for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	PLW Notch Incidence (% of plants)						
Early	25.5 a	39.9 a	17.7 a	59.4 a	70.8 a	57.6 a	44.6 A
Delay	26.3 a	13.1 b	21.4 a	63.7 a	20.5 b	6.8 b	23.6 B
S.E.M [Z]	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [Y]	0.900	**<0.001**	0.497	0.520	**<0.001**	**<0.001**	–
Insecticide (I)	PLW Notch Incidence (% of plants)						
No	33.5 a	22.7 a	21.7 a	78.8 a	52.4 a	39.2 a	41.1 A
Yes	19.0 b	27.9 a	17.4 a	42.7 b	37.7 b	18.8 b	26.7 B
S.E.M [Z]	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [Y]	**<0.001**	0.151	0.185	**<0.001**	**<0.001**	**<0.001**	–
Nitrogen (N)	PLW Notch Incidence (% of plants)						
No	26.3	27.3	21.8	61.3	42.0	25.8	33.6
Yes	25.5	23.3	17.3	61.8	48.0	31.2	33.8
S.E.M [Z]	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [Y]	–	–	–	–	–	–	–

[Z] Due to the non-linear data transformations, S.E.M. values do not reflect the true variability for this variable and are not reported.

[Y] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 33. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on faba bean maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only

provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	---------- Maturity (days from seeding) ----------						
Early	102.0 a	106.1 a	106.8 a	110.5 a	119.6 a	118.9 a	110.7 A
Delay	98.9 b	102.0 b	98.4 b	101.6 b	116.4 b	106.1 b	103.9 B
S.E.M	0.28	0.27	0.64	0.22	0.90	0.22	0.21
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.003**	**<0.001**	–
Insecticide (I)	---------- Maturity (days from seeding) ----------						
No	100.3	104.2	102.5	105.9	117.9	112.9	107.3
Yes	100.6	103.9	102.6	106.2	118.1	112.2	107.3
S.E.M	0.28	0.26	0.48	0.22	0.80	0.22	0.18
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	–	–	–	–	–	–	–
Nitrogen (N)	---------- Maturity (days from seeding) ----------						
No	100.8 a	104.3 a	103.1 a	105.9 a	118.0 a	112.5 a	107.4 A
Yes	100.1 b	103.9 a	102.1 b	106.1 a	117.9 a	112.6 a	107.1 B
S.E.M	0.28	0.26	0.48	0.22	0.80	0.22	0.18
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**0.018**	0.231	**0.002**	0.548	0.841	0.841	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 34. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on faba bean seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	---------- Seed Yield (kg/ha) ----------						
Early	2236 a	3775 a	2823 a	3888 a	4478 b	3840 a	3507 A
Delay	1833 b	4009 a	1573 b	3554 b	5399 a	2583 b	3158 B
S.E.M	119.5	119.5	119.5	119.5	119.5	119.5	48.8
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**0.002**	0.055	**<0.001**	**0.009**	**<0.001**	**<0.001**	–
Insecticide (I)	---------- Seed Yield (kg/ha) ----------						
No	1807 b	3859 a	2087 b	3708 a	4854 b	3158 a	3246 A
Yes	2261 a	3926 a	2309 a	3733 a	5023 a	3265 a	3419 B
S.E.M	111.3	111.3	111.3	111.3	112.5	111.3	45.5
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**<0.001**	0.362	**0.003**	0.741	**0.028**	0.149	–
Nitrogen (N)	---------- Seed Yield (kg/ha) ----------						
No	1895 b	3986 a	2206	3616 b	4907 a	3186 a	3299 B
Yes	2173 a	3799 b	2191	3825 a	4970 a	3237 a	3366 A
S.E.M	111.3	111.3	111.3	111.3	112.5	111.3	45.5
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**<0.001**	**0.013**	0.839	**0.005**	0.408	0.491	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 35. Seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) effects on faba bean seed protein concentrations (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only

provided when justified by the overall tests of fixed effects.

Main Effect	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
Seeding Date (D)	----------	----------	----------	Seed Protein (%)	----------	----------	----------
Early	27.1 b	27.7 a	27.0 b	30.1 a	27.8 b	28.1 b	28.0 B
Delay	28.0 a	28.0 a	28.5 a	29.8 a	30.3 a	28.7 a	28.9 A
S.E.M	0.20	0.20	0.20	0.20	0.20	0.20	0.08
	----------	----------	----------	Pr > F (p-value)	----------	----------	----------
Effect Slice [Z]	**0.002**	0.155	**<0.001**	0.149	**<0.001**	**0.037**	–
Insecticide (I)	----------	----------	----------	Seed Protein (%)	----------	----------	----------
No	27.9	28.0	28.0	29.9	29.0	28.4	28.5 A
Yes	27.3	27.7	27.6	29.9	29.1	28.4	28.3 B
S.E.M	0.19	0.19	0.19	0.19	0.19	0.19	0.08
	----------	----------	----------	Pr > F (p-value)	----------	----------	----------
Effect Slice [Z]	–	–	–	–	–	–	–
Nitrogen (N)	----------	----------	----------	Seed Protein (%)	----------	----------	----------
No	27.3 b	27.8 a	27.3 b	30.2 a	29.3 a	28.7 a	28.4
Yes	27.9 a	27.9 a	28.2 a	29.7 b	28.8 b	28.1 b	28.4
S.E.M	0.19	0.19	0.19	0.19	0.19	0.19	0.08
	----------	----------	----------	Pr > F (p-value)	----------	----------	----------
Effect Slice [Z]	**0.006**	0.792	**<0.001**	**0.021**	**0.022**	**0.005**	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 36. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean plant density (plants/m^2) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	Plant Density (plants/m^2)						
Early – No	38.0	35.5	31.8	36.2	35.1	37.9	35.7
Early – Yes	36.8	27.7	32.6	34.2	35.9	42.9	35.0
Delay – No	37.3	32.2	34.5	31.3	29.8	40.3	34.2
Delay – Yes	38.4	28.7	36.0	30.1	28.7	41.1	33.9
S.E.M	1.69	1.69	1.69	1.69	1.69	1.69	0.69
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–
D x N	Plant Density (plants/m^2)						
Early – No	37.2	31.8	31.6	34.2	36.7	40.7	35.4
Early – Yes	37.6	31.4	32.7	36.2	34.2	40.1	35.4
Delay – No	37.6	28.5	34.8	29.8	32.6	42.0	34.2
Delay – Yes	38.1	32.4	35.7	31.6	25.8	39.4	33.8
S.E.M	1.69	1.69	1.69	1.69	1.69	1.69	0.69
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–
I x N	Plant Density (plants/m^2)						
No – No	37.1	33.4	32.1	32.3	35.7	39.9	35.1
No – Yes	38.2	34.2	34.1	35.2	29.1	38.3	34.8
Yes – No	37.7	26.9	34.3	31.8	33.6	42.8	34.5
Yes – Yes	37.5	29.5	34.3	32.6	31.0	41.2	34.4
S.E.M	1.69	1.69	1.69	1.69	1.69	1.69	0.69
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 37. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch counts (average number of notches per plant) in faba bean for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	PLW Notches (#/plant)						
Early – No	0.69 a	0.68 a	0.30 a	2.26 b	2.20 a	2.20 a	1.39
Early – Yes	0.26 c	0.64 a	0.24 a	0.70 d	1.43 b	1.09 b	0.73
Delay – No	0.58 ab	0.15 b	0.46 a	3.16 a	0.64 c	0.21 b	0.87
Delay – Yes	0.35 bc	0.26 b	0.36 a	1.21 c	0.30 d	0.06 b	0.43
S.E.M	0.107	0.107	0.107	0.162	0.134	0.435	0.086
	Pr > F (p-value)						
Effect Slice [z]	**0.021**	**<0.001**	0.493	**<0.001**	**<0.001**	**<0.001**	–
D x N	PLW Notches (#/plant)						
Early – No	0.49 a	0.78 a	0.30 a	1.48 b	1.99 a	1.34 b	1.06
Early – Yes	0.46 a	0.54 a	0.24 a	1.49 b	1.64 b	1.95 a	1.05
Delay – No	0.50 a	0.20 b	0.54 a	2.19 a	0.33 c	0.15 c	0.65
Delay – Yes	0.43 a	0.21 b	0.29 a	2.19 a	0.61 c	0.13 c	0.64
S.E.M	0.107	0.107	0.107	0.162	0.134	0.435	0.086
	Pr > F (p-value)						
Effect Slice [z]	0.962	**<0.001**	0.200	**0.009**	**<0.001**	**<0.001**	–
I x N	PLW Notches (#/plant)						
No – No	0.69	0.51	0.50	2.64	1.41	1.14	1.15
No – Yes	0.58	0.31	0.26	2.79	1.43	1.28	1.11
Yes – No	0.30	0.46	0.34	1.03	0.90	0.35	0.56
Yes – Yes	0.31	0.44	0.26	0.89	0.83	0.80	0.59
S.E.M	0.107	0.107	0.107	0.137	0.121	0.322	0.069
	Pr > F (p-value)						
Effect Slice [z]	–	–	–	–	–	–	–

[z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 38. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch incidence (percentage of plants with recent feeding) in faba bean for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	PLW Notch Incidence (% of plants)						
Early – No	35.3	40.4	19.3	78.0	77.6	69.9	53.6
Early – Yes	16.9	39.3	16.0	39.2	63.5	44.7	35.7
Delay – No	31.8	8.9	24.2	79.5	26.5	12.5	29.1
Delay – Yes	21.2	17.8	18.7	46.1	15.2	2.7	18.6
S.E.M	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [z]	–	–	–	–	–	–	–
D x N	PLW Notch Incidence (% of plants)						
Early – No	25.7 a	44.3 a	17.0 a	57.5 a	73.3 a	50.6 b	44.2
Early – Yes	25.4 a	35.5 a	18.4 a	61.2 a	68.3 a	64.4 a	45.0
Delay – No	26.9 a	13.2 b	27.0 a	65.0 a	13.9 c	7.3 c	23.8
Delay – Yes	25.7 a	12.9 b	16.3 a	62.4 a	28.1 b	6.3 c	23.5
S.E.M	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [z]	0.994	**<0.001**	0.141	0.787	**<0.001**	**<0.001**	–
I x N	PLW Notch Incidence (% of plants)						
No – No	34.4	28.9	24.2	77.7	47.1	39.6	41.9
No – Yes	32.7	17.0	19.3	79.7	57.6	38.8	40.3
Yes – No	19.0	25.7	19.4	43.3	36.9	14.1	25.8
Yes – Yes	19.0	30.1	15.4	42.0	38.5	24.0	27.7
S.E.M	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [z]	–	–	–	–	–	–	–

[z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 39. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on faba bean maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	Maturity (days from seeding)						
Early – No	101.6	106.4	106.8	110.4	119.3	119.3	110.6
Early – Yes	102.4	105.9	106.8	110.6	119.9	118.6	110.7
Delay – No	98.9	102.0	98.3	101.4	116.5	106.5	103.9
Delay – Yes	98.9	102.0	98.5	101.8	116.3	105.8	103.9
S.E.M	0.36	0.34	0.68	0.31	0.93	0.31	0.22
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–
D x N	Maturity (days from seeding)						
Early – No	102.4 a	106.8 a	107.3 a	110.4 a	119.3 a	118.9 a	110.8
Early – Yes	101.6 a	105.5 b	106.3 b	110.6 a	119.9 a	119.0 a	110.5
Delay – No	99.3 b	101.8 c	98.9 c	101.5 b	116.8 b	106.1 b	104.0
Delay – Yes	98.5 b	102.3 c	97.9 d	101.6 b	116.0 b	106.1 b	103.7
S.E.M	0.36	0.34	0.68	0.31	0.93	0.31	0.22
	Pr > F (p-value)						
Effect Slice [Z]	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.001**	**<0.001**	–
I x N	Maturity (days from seeding)						
No – No	100.6 ab	104.5 a	103.1 a	106.0 a	117.9 a	112.8 a	107.5 A
No – Yes	99.9 b	103.9 a	101.9 c	105.8 a	117.9 a	113.0 a	107.0 B
Yes – No	101.0 a	104.0 a	103.0 ab	105.9 a	118.1 a	112.3 a	107.4 AB
Yes – Yes	100.3 ab	103.9 a	102.3 bc	106.5 a	118.0 a	112.1 a	107.2 AB
S.E.M	0.36	0.34	0.53	0.31	0.83	0.31	0.20
	Pr > F (p-value)						
Effect Slice [Z]	0.070 [Y]	0.437	**0.014**	0.347	0.931	0.159	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

[Y] Effect slice not quite significant at $P \leq 0.05$, interpret individual treatment differences at this site cautiously

Table 40. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on faba bean seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	---------- Seed Yield (kg/ha) ----------						
Early – No	2124 b	3844 b	2735 a	3929 a	4276 c	3754 a	3444
Early – Yes	2347 a	3707 b	2911 a	3846 ab	4679 b	3925 a	3569
Delay – No	1491 c	3874 b	1440 c	3488 c	5432 a	2562 b	3048
Delay – Yes	2174 ab	4145 a	1707 b	3619 bc	5366 a	2605 b	3269
S.E.M	130.3	130.3	130.3	130.3	131.3	130.3	53.3
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**<0.001**	**0.007**	**<0.001**	**0.016**	**<0.001**	**<0.001**	–
D x N	---------- Seed Yield (kg/ha) ----------						
Early – No	2124 b	3978 a	2847 a	3730 b	4360 c	3796 a	3472
Early – Yes	2347 a	3573 b	2799 a	4046 a	4596 b	3883 a	3541
Delay – No	1666 c	3994 a	1564 b	3503 b	5454 a	2576 b	3126
Delay – Yes	1999 b	4025 a	1582 b	3604 b	5344 a	2591 b	3191
S.E.M	130.3	130.3	130.3	130.3	131.3	130.3	53.3
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	–
I x N	---------- Seed Yield (kg/ha) ----------						
No – No	1665	3954	2075	3639	4863	3113	3218
No – Yes	1950	3763	2100	3778	4845	3203	3273
Yes – No	2125	4017	2336	3594	4951	3259	3380
Yes – Yes	2396	3835	2282	3872	5094	3271	3458
S.E.M	122.8	122.8	122.8	122.8	123.9	122.8	50.2
	---------- Pr > F (p-value) ----------						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 41. Means for two-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on faba bean seed protein concentrations (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

2-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I	Seed Protein (%)						
Early – No	27.5	27.8	27.0	30.2	27.7	28.3	28.1
Early – Yes	26.8	27.5	27.1	30.1	27.9	28.0	27.9
Delay – No	28.3	28.2	29.0	29.7	30.3	28.5	29.0
Delay – Yes	27.8	27.8	28.1	29.8	30.3	28.8	28.8
S.E.M	0.24	0.24	0.24	0.24	0.24	0.24	0.10
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–
D x N	Seed Protein (%)						
Early – No	26.6 b	27.7 a	26.6 c	30.5 a	28.1 b	28.3 b	28.0
Early – Yes	27.7 a	27.6 a	27.4 b	29.7 b	27.5 c	28.0 b	28.0
Delay – No	28.0 a	28.0 a	28.0 b	29.8 b	30.4 a	29.0 a	28.9
Delay – Yes	28.1 a	28.1 a	29.1 a	29.7 b	30.2 a	28.3 b	28.9
S.E.M	0.24	0.24	0.24	0.24	0.24	0.24	0.10
	Pr > F (p-value)						
Effect Slice [Z]	**<0.001**	0.469	**<0.001**	**0.011**	**<0.001**	**0.003**	–
I x N	Seed Protein (%)						
No – No	27.5	28.1	27.5	30.3	29.1	28.7	28.5
No – Yes	28.3	27.9	28.4	29.6	29.0	28.1	28.5
Yes – No	27.1	27.5	27.1	30.0	29.5	28.6	28.3
Yes – Yes	27.5	27.8	28.0	29.8	28.7	28.1	28.3
S.E.M	0.23	0.23	0.23	0.23	0.23	0.23	0.09
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 42. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean plant density (plants/m^2) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	Plant Density (plants/m^2)						
Early – No – No	37.5	36.5	30.3	34.9	38.6	38.4	36.0
Early – No – Yes	38.6	34.4	33.2	37.5	31.6	37.4	35.4
Early – Yes – No	36.9	27.1	33.0	33.6	34.9	43.1	34.8
Early – Yes – Yes	36.7	28.3	32.2	34.9	36.9	42.8	35.3
Delay – No – No	36.7	30.3	34.0	29.7	32.8	41.4	34.2
Delay – No – Yes	37.9	34.0	35.0	32.8	26.7	39.1	34.3
Delay – Yes – No	38.6	26.7	35.7	29.9	32.4	42.6	34.3
Delay – Yes – Yes	38.3	30.8	36.4	30.3	25.0	39.7	33.4
S.E.M	2.35	2.35	2.35	2.35	2.35	2.35	0.96
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 43. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) on pea leaf weevil (PLW) notch index (average number of notches per plant) in faba bean for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	PLW Notches (#/plant)						
Early – No – No	0.73	0.83	0.38	2.18	2.38	2.03	1.42
Early – No – Yes	0.65	0.53	0.23	2.35	2.03	2.38	1.36
Early – Yes – No	0.25	0.73	0.23	0.78	1.60	0.65	0.70
Early – Yes – Yes	0.28	0.55	0.25	0.63	1.25	1.53	0.75
Delay – No – No	0.65	0.20	0.63	3.10	0.45	0.25	0.88
Delay – No – Yes	0.50	0.10	0.30	3.23	0.83	0.18	0.85
Delay – Yes – No	0.35	0.20	0.45	1.28	0.20	0.05	0.42
Delay – Yes – Yes	0.35	0.33	0.28	1.15	0.40	0.08	0.43
S.E.M	0.151	0.151	0.151	0.194	0.171	0.449	0.097
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 44. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean plant density (plants/m^2) for individual sites (S) and across sites. Data for this variable was transformed (arc sign square root) prior to analysis and back-transformed for presentation. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by

the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	PLW Notch Incidence (% of plants)						
Early – No – No	35.1	48.1	20.6	75.3	78.2	65.0	53.9
Early – No – Yes	35.5	33.0	18.1	80.5	77.1	74.7	53.4
Early – Yes – No	17.4	40.5	13.6	38.6	68.0	36.2	34.8
Early – Yes – Yes	16.4	38.0	18.6	39.9	58.9	53.4	36.7
Delay – No – No	33.7	13.0	28.1	80.1	17.2	16.9	30.4
Delay – No – Yes	29.9	5.6	20.5	79.0	36.9	8.8	27.8
Delay – Yes – No	20.7	13.3	25.9	48.1	10.9	1.6	17.7
Delay – Yes – Yes	21.7	22.8	12.5	44.2	20.0	4.1	19.4
S.E.M [Z]	–	–	–	–	–	–	–
	Pr > F (p-value)						
Effect Slice [Y]	–	–	–	–	–	–	–

[Z] Due to the non-linear data transformations, S.E.M. values do not reflect the true variability for this variable and are not reported

[Y] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 45. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean maturity (days from seeding) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	Maturity (days from seeding)						
Early – No – No	102.0	107.0	107.5	110.5	118.8	119.0	110.8
Early – No – Yes	101.3	105.8	106.0	110.3	119.8	119.5	110.4
Early – Yes – No	102.8	106.5	107.0	110.3	119.8	118.8	110.8
Early – Yes – Yes	102.0	105.3	106.5	111.0	120.0	118.5	110.5
Delay – No – No	99.3	102.0	98.8	101.5	117.0	106.5	104.2
Delay – No – Yes	98.5	102.0	97.8	101.3	116.0	106.5	103.7
Delay – Yes – No	99.3	101.5	99.0	101.5	116.5	105.8	103.9
Delay – Yes – Yes	98.5	102.5	98.0	102.0	116.0	105.8	103.8
S.E.M	0.48	0.46	0.75	0.44	0.98	0.44	0.26
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 46. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean seed yield (kg/ha) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	Seed Yield (kg/ha)						
Early – No – No	2028	4049	2721	3810	4206	3633	3408
Early – No – Yes	2219	3638	2749	4049	4347	3875	3480
Early – Yes – No	2221	3906	2974	3650	4514	3960	3537
Early – Yes – Yes	2474	3509	2849	4043	4845	3891	3602
Delay – No – No	1302	3860	1430	3468	5521	2593	3029
Delay – No – Yes	1680	3888	1450	3508	5343	2531	3067
Delay – Yes – No	2030	4127	1699	3538	5387	2558	3223
Delay – Yes – Yes	2318	4162	1715	3701	5344	2651	3315
S.E.M	149.6	149.6	149.6	149.6	151.4	149.6	61.2
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effects

Table 47. Means for three-way interactions between seeding date (D), seed-applied insecticide (I), and supplemental nitrogen (N) for faba bean seed protein concentration (%) for individual sites (S) and across sites. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; *P* ≤ 0.05); however, letter groupings are only provided when justified by the overall tests of fixed effects.

3-Way Interaction	IH-24	ME-24	SC-24	IH-25	ME-25	SC-25	Avg
D x I x N	Seed Protein (%)						
Early – No – No	0.31	28.1	26.5	30.7	27.8	28.4	28.1
Early – No – Yes	0.31	27.5	27.4	29.7	27.6	28.1	28.1
Early – Yes – No	0.31	27.3	26.7	30.4	28.4	28.1	27.9
Early – Yes – Yes	0.31	27.8	27.4	29.7	27.4	27.8	27.9
Delay – No – No	0.31	28.2	28.5	29.9	30.4	28.9	29.0
Delay – No – Yes	0.31	28.3	29.5	29.5	30.3	28.2	29.0
Delay – Yes – No	0.31	27.8	27.5	29.7	30.5	29.2	28.7
Delay – Yes – Yes	0.31	27.9	28.7	30.0	30.1	28.4	28.8
S.E.M	0.31	0.31	0.31	0.31	0.31	0.31	0.13
	Pr > F (p-value)						
Effect Slice [Z]	–	–	–	–	–	–	–

[Z] Effect slices for individual sites are only presented when justified by the overall tests of fixed effect

Table 48. Treatment means and tests of fixed effects for seeding date, seed-applied insecticide, and nitrogen fertility effects on faba bean response variables at Redvers 2025.

Main Effect	Plant Density	Leaf Notch Numbers	Leaf Notch Incidence	Maturity	Seed Yield	Seed Protein
Seeding Date	- plants/m^2 -	--- #/plant ---	-- % plants --	----- days -----	---- kg/ha ----	------ % ------
Early	39.5 a	0.26 a	17.0 a	120.3 a	2719	26.4
Delayed	24.8 b	0.02 b	1.1 b	111.3 b	1924	27.8
S.E.M.	2.36	0.027	1.51	0.99	217.5	0.36
Pr > F (p-value)	0.014	0.006	0.005	0.007	0.080	0.064
Insecticide						
Untreated	34.9	0.18 a	12.0 a	116.1	2252	27.4
Treated	29.4	0.10 b	6.1 b	115.6	2391	26.9
S.E.M.	2.36	0.025	1.19	0.75	178.1	0.30
Pr > F (p-value)	0.068	0.027	<0.001	0.264	0.440	0.152
Nitrogen						
Standard	33.0	0.12	7.7 b	116.3 a	2150	27.5 a
Extra N	31.3	0.16	10.5 a	115.3 b	2493	26.8 b
S.E.M.	2.36	0.025	1.19	0.75	178.1	0.30
Pr > F (p-value)	0.544	0.203	0.015	0.033	0.066	0.039

Table 49. Two-way interaction treatment means and tests of fixed effects for seeding date (D), seed-applied insecticide (I), and nitrogen fertility (N) effects on faba bean response variables at Redvers 2025.

2-Way Interaction	Plant Density	Leaf Notch Numbers	Leaf Notch Incidence	Maturity	Seed Yield	Seed Protein
D x I	-- plants/m^2 --	---- #/plant ----	--- % plants ---	----- days -----	----- kg/ha -----	------- % -------
Early - Untreated	42.0	0.34 a	22.8 a	120.6	2669	26.8
Early - Treated	36.9	0.18 b	11.3 b	120.0	2769	26.1
Delay - Untreated	27.7	0.01 c	1.3 c	111.5	1836	27.9
Delay - Treated	21.9	0.03 c	0.9 c	111.1	2013	27.8
S.E.M.	3.08	0.033	1.68	1.03	250.4	0.42
Pr > F (p-value)	0.914	0.007	<0.001	0.777	0.828	0.389
D x N						
Early - Standard	40.8	0.23	14.7	121.1	2575	26.8
Early - Extra N	38.1	0.29	19.4	119.5	2863	26.1
Delay - Standard	25.2	0.01	0.6	111.5	1726	28.2
Delay - Extra N	24.4	0.03	1.6	111.1	2123	27.5
S.E.M.	3.08	0.033	1.68	1.03	250.4	0.42
Pr > F (p-value)	0.744	0.391	0.089	0.167	0.761	0.878
I x N						
Untr - Standard	38.8	0.14	9.4 b	116.4	1961	27.7
Untr - Extra N	31.0	0.21	14.7 a	115.8	2544	27.1
Trt - Standard	27.3	0.10	5.9 c	116.3	2339	27.3
Trt - Extra N	31.6	0.10	6.3 c	114.9	2442	26.5
S.E.M.	3.08	0.032	1.40	0.81	217.1	0.37
Pr > F (p-value)	0.044	0.203	0.028	0.399	0.188	0.795

Table 50. Three-way interaction treatment means and tests of fixed effects for seeding date, seed-applied insecticide, and nitrogen fertility effects on faba bean response variables at Redvers 2025.

3-Way Interaction	Plant Density	Leaf Notch Numbers	Leaf Notch Incidence	Maturity	Seed Yield	Seed Protein
D x I x N	-- plants/m^2 --	--- #/plant ---	--- % plants ---	----- days -----	---- kg/ha ----	------- % -------
Early - Untr – Std	45.5	0.28	18.1 b	120.8 a	2536	27.2
Early - Untr – Ext N	38.6	0.40	27.5 a	120.5 a	2803	26.4
Early - Trt – Std	36.1	0.18	11.3 c	121.5 a	2614	26.4
Early - Trt – Ext N	37.7	0.18	11.3 c	118.5 b	2924	25.8
Delay - Untr – Std	32.0	0.00	0.6 d	112.0 c	1386	28.1
Delay - Untr – Ext N	23.4	0.03	1.9 d	111.0 c	2285	27.8
Delay - Trt – Std	18.4	0.03	0.6 d	111.0 c	2065	28.2
Delay - Trt – Ext N	25.4	0.03	1.3 d	111.3 c	1960	27.3
S.E.M.	4.17	0.044	1.98	1.12	305.8	0.51
Pr > F (p-value)	0.512	0.391	0.051	0.033	0.153	0.535