**LUARS Research 2018 – Results from Experiments on Fertilizers and Soil Amendments**

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***Cereals:***

*Winter rye cover crop – seeding and NPK fertilizer rates:*

* Winter rye seeded on August 24, 2017 at 50 % recommended seed and NPK rates gave the highest grain yield (4,848 kg/ha) among all treatments (50-100 % seed rates/and NPK), which statistically equaled grain yield from spring barley (5,034 kg/ha) without winter rye cover crop in the fall/winter. However, this was a single replication demonstration.
* Soybean seeded after winter rye cover crop was damaged by the deer and hence no grain yield could be recorded or reported.

*Nitrogen and sulphur management for malting barley (Cultivar CDC Bow) production:*

* N from urea and urea + ESN (3:1 on N basis) was compared at 3 rates of N (35, 70 and 105 kg/ha along with a check – zero N) at 3 rates of S (0, 8, 16 and 24 kg S/ha).
* Grain yield with urea leveled off/or declined above 70 kg N/ha, whereas with urea + ESN the grain yield continued to increase up to 105 kg/ha (with each increment of N from zero to 105 kg/ha) though the response followed the Law of Diminishing Returns.
* Grain yields from urea and urea + ESN (3:1 on N basis), without S, were 6,573 kg/ha and 7,005 kg/ha, respectively.
* Malting barley didn’t respond to S application even though available S at seeding was only 7 ppm. It seems that above average heat during the summer transformed the native soil S to available form.
* Grain yield from urea @ 35 kg/ha + 16 kg S/ha (6,816) statistically equaled grain yield from urea (6,693 kg/ha)/or urea + ESN (6,618 kg/ha) @ 70 kg/ha.
* Straw yield was highest with urea @ 70 kg N/ha + 8 kg S/ha (5,989 kg/ha) followed closely by urea @ 105 kg/ha/or urea + ESN (3:1 on N basis) @ 70 kg/ha (~5,910 kg/ha).
* Quality parameters indicated excellent malting quality irrespective of the treatments; grain protein (10.5 % in zero N and 16 kg S/ha to 12.2 % with ESN @ 105 kg N/ha + 8 kg S/ha), plumpness (96.6-98.6 %), Chitted grains (0.5-6.0; least with ESN and more with S), zero wheat, wild oats, green seeds or Ergot and negligible dockage (0.1 in all treatments) and stained seeds (1.5-2.0 %).

*Evaluation of Fish Waste (a liquid product) as a Source of N for Spring Wheat (Prosper) Production:*

* Urea + ESN (3:1 on N basis), fish waste and 50:50 N blend of fish waste + (urea + ESN) were compared at 4 rates of N; 0, 40, 80 and 120 kg/ha (applied at seeding).
* Application of N irrespective of its source or blend significantly increased the grain yield (by 870 kg/ha to over 1,000 kg/ha).
* Grain yield was in the order of urea + ESN (7,632 kg/ha) ≥ fish waste + (urea + ESN) – 7,593 kg/ha > fish waste (7,042 kg/ha). Straw yield followed the same trend as the grain yield. Low yield from fish waste is attributed to low plant stand in fish waste plots (450/m2 as compared to 482/m2 in urea + ESN), which means that the fish waste had a deleterious effect on the emerging wheat seedlings.
* Grain yield with urea + ESN @ 80 kg N/ha (8,630 kg/ha) equaled that with fish waste + (urea + ESN) @ 120 kg N/ha (8,657 kg/ha). The latter produced the highest straw yield (5,605 kg/ha).
* Urea + ESN @ 80 kg N/ha resulted in highest grain protein content (15.4 %)!

***Grain Legumes and Oil Seeds:***

*Effect of P and bio-ag products on soybean grain yield:*

* Soybean was damaged by the deer and hence no grain yield could be recorded or reported.
* Neither application of Quickroots a microbial (Bacillus amyloliquefaciens and Trichoderma virens based) nor Jumpstart (Penicillium bilaii; a fungus providing better access to soil and applied P) seed inoculants increased the soybean dry matter yield.
* Application of 20 kg P2O5 gave the maximum (2,238 kg/ha) dry matter yield

*Evaluation of NK21 as a Source of N and K for Soybean (25-10RY) Production:*

* NK21 (a relatively new fertilizer with 21 % N and 21 % K2O) was compared @ 21, 42, 63 and 84 kg/ha N and K2O with urea and MOP (0-0-60) at equal rates of N and K2O along with three checks (No N, No K2O and No N or K2O).
* Grain yield increase at rates higher than 21 kg N + 21 kg K2O/ha from NK21 was marginal, whereas with urea + MOP, there was 509 kg/ha increase in grain yield with increasing rates of N and K2O from 21 to 63 kg/ha. Grain yield from NK21 @ 21 kg N + 21 kg K2O/ha (3,836 kg/ha) was only marginally lower than that from urea + MOP @ 63 kg N + 63 kg K2O/ha (4,030 kg/ha).
* Averages for main factors revealed that grain yield response (increase over check) to (i) N @ 21, 42 and 63 kg/ha was 754, 879 and 978 kg/ha and (ii) K2O @ 21, 42 and 63 kg/ha was nil, 320 and 419 kg/ha. Grain yield declined at rates higher than 63 kg/ha N or K2O. Grain yield with NK21 was ~350 kg/ha more than that with urea + MOP.
* *NK21 has the advantage of applying two nutrients from one source and may therefore be preferred over urea and MOP*.

*Maximizing canola (L252) yield with nitrogen and other nutrients and fungicides/growth retardant:*

* Nutrients (N, S, B, Zn and Mn) effect on canola yield was assessed over uniform recommended rates of P and K. The seed yield this year with hot summer was less than last year.
* Application of N @ 150 kg/ha increased the canola seed yield by more than 1 MT/ha. Addition of S with N raised the seed yield further by 738 kg/ha. Addition of B and Zn along with N and S improved the seed yield by 240 kg/ha (as compared to N + S). Peak seed yield (4,329 kg/ha) was recorded when nutrient (N, S, B, and Zn) supply was supported by Proline spray (@ 315 ml/ha) at 25 % flowering.
* Neither Mn (@ 2 kg/ha) nor Manipulator 620 (@ 1.8 l/ha) spray improved the seed yield.
* Straw yield was highest (6,651 kg/ha) without application of secondary and micronutrients/or fungicide and growth retardant.
* Averaged over 2016-’18, maximum seed (5,340 kg/ha), straw (8,254 kg/ha) and biomass (13,593 kg/ha) yields were obtained when N was supplemented with secondary and micronutrients (S, B, Zn and Mn) with or without Proline spray. As you may note from the next experiment, 150 kg N/ha is not enough to maximize economic yield of canola!

*Maximizing canola (L252) yield with nitrogen and growth retardant:*

* Application of N @ 60,120, 180 and 240 kg/ha from urea/or urea + ESN (2:1 ratio on N basis) significantly improved the canola seed yield and the maximum seed yield in both cases was obtained with 240 kg N/ha (6,530/6,452 kg/ha). Straw yield was also highest at 240 kg N/ha; 7,572 kg/ha with urea and 7,687 kg/ha with urea + ESN.
* Application of N @ 240 kg N/ha as urea and urea + ESN increased the seed yield over 180 kg N/ha by 1,214 kg/ha and 643 kg/ha, respectively. At 180 kg N/ha, urea + ESN gave ~500 kg/ha extra seed yield than urea.
* Averaged over N rates, without Manipulator spray, urea + ESN (2:1 ratio on N basis) gave somewhat higher seed yield than urea. This was true for straw yield too.
* Averaged over 2016-‘18, at 180 kg N/ha, urea + ESN @ 180 kg N/ha gave 742 kg/ha extra seed yield than urea.
* Manipulator 620 spray appeared to lower the seed yield.
* Averaged over 2016-’18, it was found that (i) the seed and straw yields were highest at the highest rate of N (240 kg/ha), (ii) at 180 kg N/ha, urea + ESN gave 742 kg/ha extra seed yield than urea and (iii) Manipulator 620 spray tended to lower the seed yield.

*Evaluation of Ammonium Sulphate and Gypsum as Sources of Sulphur (S) for Canola Production:*

* Ammonium sulphate and Gypsum were compared at 5 rates of S application; 0, 12, 24, 36 and 48 kg/ha. Seed yield continued to increase up to 36 kg S/ha with every increase in S from 0 to 36 kg/ha and declined thereafter. However, increase in yield from 24 to 36 kg/ha S with Gypsum wasn’t significant.
* Maximum seed yield (6,079 kg/ha) was recorded with ammonium sulphate @ 36 kg/ha, which was 2,080 kg/ha higher than the check (No S application). Straw yield too was highest (8,029 kg/ha) with ammonium sulphate @ 36 kg/ha.
* Averaged over rates of S application, Gypsum didn’t gave significantly higher seed or straw yield than ammonium sulphate, which is the prevalent S source with the area producers.
* Averaged over 2017 and 2018, highest seed yield was obtained with 36 kg S/ha irrespective of S source and Gypsum seemed to be a better source than ammonium sulphate.
* It may be advisable to increase the rate of S application to canola from 24 (current) to 36 kg/ha in 2019 and Gypsum could be preferred in fields deficient/or marginal in available calcium.

*Evaluation of Gypsum and Ammonium Sulphate as sources of S for Barley, Canola and Pea Production (Gypsum was applied @ 19.5 kg S/ha in the seed row and ammonium sulphate at the same rate of S was broadcast incorporated at seeding!):*

* Barley grain yield (5,810-6,213 kg/ha) was better than canola seed yield (4,501-4,822 kg/ha). Whereas, straw yield in canola (6,258 kg/ha) was higher than in barley (4,162 kg/ha). It shows that canola (a cool loving crop) was affected by excessive heat this year. Even in other experiments, we didn’t get as high seed yield in canola this year as last year.
* Excessive heat this year lead to crop failure in peas (grain yield up to 500 kg/ha only).
* Ammonium sulphate, which resulted in 403 kg/ha extra grain yield in barley and 311 kg/ha more seed yield than Gypsum, appeared to be a better source of S for crop production than Gypsum! At low canola yield, response to S would be low too.
* Residual effect of crops grown and Gypsum and ammonium sulphate applied in 2017 was studied on the spring wheat in 2018 (no S was applied). Wheat grain yield was significantly higher when grown after canola (6,802 kg/ha) than after barley (6,037 kg/ha) or pea (6,143 kg/ha). Gypsum and ammonium sulphate exerted a negative residual influence on wheat grain yield (probably due to higher yield and nutrient removal in the previous year leaving the soil a bit poor).

*Effect of nitrogen and growth regulator on flax seed yield:*

* Application of N @ 35 kg/ha) increased the flax seed yield significantly (by 348 kg/ha). Each unit increase in N from 35 to 105 kg/ha improved the yield only marginally; unless 1/3rd N in 105 kg N/ha was replaced from urea with ESN (356 kg/ha higher seed yield than that at 35 kg N/ha)!
* Straw yield (2,960 kg/ha) was highest with N @ 105 kg (2/3rd from urea and 1/3rd from ESN).
* The experiment was not on a relatively poor site and hence the yield in this experiment was poor.
* Manipulator spray did not improve seed or straw yield.
* Averaged over 2016-’18, application of urea N @ 105 kg/ha and growth regulator (Manipulator 620) spray produced the highest seed (2,535 kg/ha), straw (4,424 kg/ha) and biomass (~7,260 kg/ha) yields.

*Effect of P and K on flax seed yield:*

* Treatments included all combinations of 3 rates of P2O5 and 3 rates of K2O application (both @ 0, 20 and 40 kg/ha).
* Application of 40 kg P2O5/ha, but not 20 P2O5/ha, (without application of K2O) improved the seed yield significantly from 3,051 kg/ha (check – No P2O5) to 3,415 kg/ha, which was also the maximum seed yield.
* Straw yield (~5,300 kg/ha) was highest with 40 kg P2O5/ha + 40 kg K2O/ha; though this wasn’t significantly higher than the straw yield with 40 kg P2O5/ha alone (5,120 kg/ha).
* Without application of P, application of 40 kg K2O/ha, but not 20 K2O/ha, increased the seed yield significantly by 313 kg/ha.
* Averaged over K rates, P didn’t exert any significant influence on seed yield, which was true for K when the seed yield was averaged over P rates. This was true for averages over 2016-’18.
* From the three nutrient management experiments on flax for three years, it appears that flax can be grown with application on N alone!

*Effect of sulphur on flax seed yield:*

* Application of S @ 10, 20 or 30 kg/ha didn’t increase seed yield of flax, which ranged from 3,103 kg/ha without S to 3,281 kg/ha with 30 kg S/ha.
* Straw yield ranged from 4,594 kg/ha without S to 8,195 kg/ha S @ 20 kg/ha.

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