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# Pulse crops differ in nitrogen fixation dynamics

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The research suggests that improving pulse nitrogen fixation by targeting an increase in nodule numbers and nodule biomass could help improve long term cropping sustainability and reduce reliance on inorganic N fertilizer. In addition, developing pulse varieties with improved water-stress tolerance may improve the N-fixation trait.

The objectives of the study were to determine N accumulation in seed and straw of different pulse crops, and assess the dynamics of nodulation between early and late flowering stages in different pulse species and varieties.

Field experiments were conducted at the Agriculture and Agri-Food Canada Research Centre, Swift Current, Saskatchewan over three years. The plots were on different field locations, and did not have a pulse grown 5 years prior to the research. All varieties were inoculated with a commercial *Rhizobium* inoculant at seeding.

Eight market classes of pulse crops, each with two or three varieties, were included in the experiments along with one dry bean and one faba bean variety:

- Green field pea
- Yellow field pea
- Desi chickpea
- Kabuli chickpea
- Large green lentil
- Small green lentil
- Extra small red lentil
- Small red lentil
- Dry bean
- Faba bean

Rainfall over the three years impacted nodulation. Year 1 had slightly above normal precipitation, Year 2 was 75% of normal precipitation and Year 3 had almost twice the normal precipitation. In Year 1, chickpea, faba bean, field pea, and lentil had similar nodule numbers at early flowering. In the drier Year 2, the number of nodules was generally low for all pulses. In the wettest year, there were large variations, with faba bean producing the most nodules at 50/plant, followed by field pea at 41 and chickpea at 38.

Overall, nodule biomass was higher at late flowering than at early flowering, indicating that nodule growth continued into later plant stages. For pea, lentil and faba bean, more nodules were observed at early flowering, but higher nodule biomass was obtained at late flowering. Chickpea had higher nodule biomass at late flowering but the number of nodules per plant varied with year. Dry bean had a low number of nodules per plant with higher late flower nodule biomass.

Averaged over three years, the pulses significantly differed in seed N uptake. Field pea had the highest seed N uptake (72 lbs./ac) followed by faba bean (70 lbs./ac), while dry bean had the lowest seed N uptake (33 lbs./ac). The high seed N uptake by field pea and faba bean was attributable to their higher seed yield and greater N-fixation ability.

Overall, straw N uptake was highest in faba bean at 41.9 lbs. N/ac. Lentil, chickpea and field pea straw N uptake were around 40 lbs. N/ac.  These pulse crops contribute N to the soil when the straw decomposes. This N contribution from pulse crop residues may build up an active N pool in

the soil over time, which would increase the soil N supply and lower fertilizer-N requirements of subsequent cereals in the rotation. Dry bean straw N uptake was around 12 lbs. N/ac.

The total N uptake in seed plus straw was measured to determine the relative contribution of biological nitrogen fixation (BNF) and soil N. The overall contribution of BNF to N uptake of the pulses was about 40% to 54% except dry bean at about 20%.

| Pulse Crop | BNF $N_2$-fixation (lbs./ac) | 3 Year Average Yield (lbs./ac) |
|---|---|---|
| Chickpea | 46.0 | 1486 (25 bu/ac) |
| Dry Bean | 8.3 | 1136 (19 bu/ac) |
| Faba Bean | 60.0 | 1733 (29 bu/ac) |
| Field Pea | 48.5 | 2152 (36 bu/ac) |
| Lentil | 43.9 | 1628 (27 bu/ac) |

Adapted from Hossain et al. 2017

Overall, dry bean fixed the lowest amount of N at 8.3 lbs./ac (9.3 kg/ha) and faba bean fixed the highest amount at 60 lbs./ac (67.5 kg/ha), a trend that matched nodule number and biomass.

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Hossain, Z., Wang, X., Hamel, C., Gan, Y. 2018. Nodulation and nitrogen accumulation in pulses vary with species, cultivars, growth stages and environments. Can. J. Plant Sci. 98: 527-542 https://doi.org/10.1139/cjps-2017-0114

Hossain, Z., Wang, X., Hamel, C., Diane Knight, J., Morrison, M.J., Gan, Y. 2017. Biological nitrogen fixation by pulse crops on semiarid Canadian prairies. Can. J. Plant Sci. 97: 119-131 https://doi.org/10.1139/cjps-2016-0185