DOES LENTIL FIX NITROGEN FOR THE SUCCEEDING CROP IN ROTATION?

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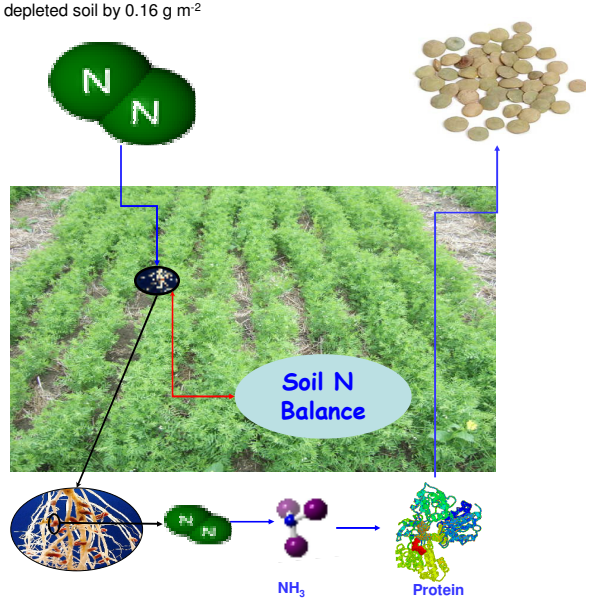
ABSTRACT

Higher rates of fixed N (N*dfa*) and lower rates of harvested N in seeds (NHI) both produce positive N incrimination (N*inc*) in soil. Positive effects of inoculated lentil on soil N*inc* were observed on soil from the Brown soil zone of Saskatchewan. Inoculants, N fertilizer and the control did not change soil N*inc* significantly. However, lentil crops grown with N fertilizer depleted soil by 0.16 g m^{-2}



BACKGROUND

The magnitude of fixed N compared with the harvested N in seed after legume cultivation defines the soil "N*inc*". Wide ranges of positive to negative N*inc* values reported were due to site effects, crop-rhizobia compatibility and the methodology of "N*inc*" estimation (e.g. ignorance of root N and root N exudates)[4].

Based on a previous estimation of 19 kg root N ha^{-1} (14% of total plant biomass N)[1], Van Kessel et al. (2000) evaluated that lentil credits the soil N balance by 59 kg N ha^{-1} [3]. We used the method proposed by Evans et al. (2001) to estimate N-benefits associated with lentil in the Brown soil zone of Saskatchewan. Soil N*inc* in this method is considered as a portion of fixed N which is not transported to seed. We did not include the root N biomass and the root N exudation portion to the data which is assumed approximately 20% extra soil N credit after legumes in a rotation.

METHODS

Three fertility treatments (rhizobia inoculant, 50 kg N ha^{-1} only, and no inoculant or N fertilizers called "Inoc", "N treat" and 'Control', respectively) were tested for N*dfa*, N*inc*, NHI and plant %N for seven cultivars of lentil in a No-till system in the Brown soil zone of Saskatchewan with a history of legumes in 2006. Nitrogen fixation (%N*dfa*) was measured by the natural abundance method and then modified to *Ndfa* (*g* N m^{-2}); N*inc* (N-balance) and NHI were calculated by the following equations:

$$NHI = \text{Total seed N} / \text{Total plant N}$$

$$Ninc = Ndfa - NHI$$

RESULTS

Individual soil rhizobia, drought conditions and available soil N caused similar N*dfa*, NHI and N*inc* among the treatments (Fig 1). Inoculated and the control credited the soil N by 2.1 and 0.5 g m^{-2}, respectively. Although the "N treat" had a negative impact on soil N balance, differences among the three treatments were not significant. Nitrogen fertilizers could increase plant growth and its N uptake at early growth stages, and also reduce rhizobia activity and N fixation at the same time.

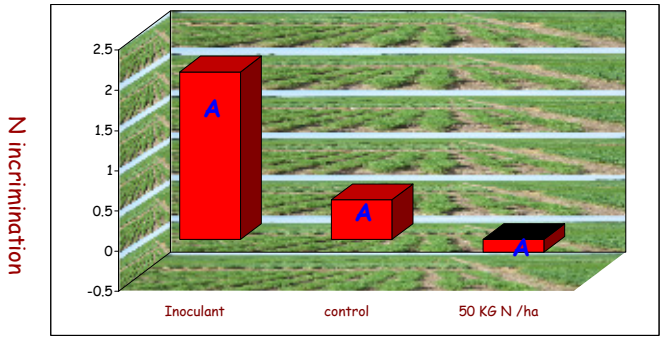


Figure 1- Soil N incrimination due to three fertility treatments on lentil

Nitrogen incrimination was mostly driven by N*dfa* rather than NHI as shown in Fig 2. The ability of plant N uptake was more effective on N*inc* than translocation of N to the seed. Higher N*inc* was achieved from higher N*dfa*, more plant N% and more above ground biomass (table 1), leaf N% showed a negative weak relation with N*inc* among the cultivars.

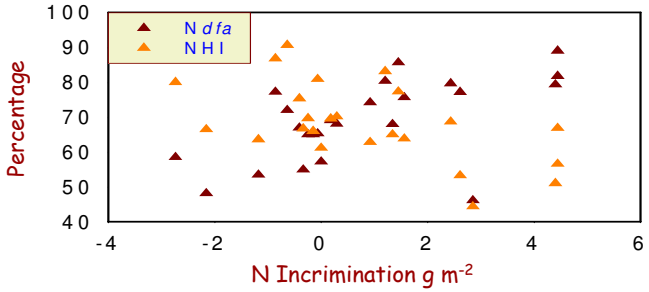


Figure 2- Relationship of % N*dfa* and %NHI with % N*inc* in different cultivars of lentil

A severe drought during the pod-filling stage in late August ceased plant growth, N uptake and N remobilization to the seed. Other studies have shown the variable effects of NHI on soil N*inc* [2, 4].

Table1- Mean N*inc* (g m^{-2}) and its correlation coefficients with growth parameters in different cultivars of lentil

	Blaze	Greenland	Milestone	Plato	Rouleau	Sedley	Viceroy
N*inc* g m^2	-0.1	1.52	1.68	0.33	0.64	1.97	0.32
Plant N%	0.68	0.30	0.57	0.42	0.63	0.56	0.12
Biomass	0.84	0.73	0.45	0.32	0.54	0.64	-0.14
N*dfa*	0.92	0.96	0.95	0.94	0.95	0.94	0.69
NHI	0.07	0.03	-0.10	-0.20	0.12	0.11	-0.46
Yield	0.18	-0.11	-0.13	-0.10	0.03	0.09	-0.54
Leaf N%	-0.31	-0.39	-0.29	-0.02	-0.38	-0.11	0.02

On average, Blaze was the only cultivar with negative N*inc* (table 1). Blaze is a red seeded cultivar with early maturity, low biomass and high harvest index. The highest correlations of biomass and plant N% with *Ninc* in this cultivar showed the importance of plant biomass and it's N uptake contributing to soil N in the succeeding rotation

CONCLUSIONS

Including lentil to the rotation increased soil N, due to the higher N*dfa* than NHI;

Fertilizers reduced N use efficiency by retarding N fixation;

Different cultivars had different effects on soil N*inc*;

REFERENCES

1- Bremer et al. 1991. Ph.D. diss. University of Saskatchewan.
2- Evans et al. 2001. Aust J. of Exp. Ag. 41:347-359.
3- Van Kessel et al. 2000. Field Crops Res. 65:165-181.
4- Walley et al. 2005. ASA Ann Meetings (November 6-10).

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