Legume-based intercropping: A pathway to reduced N_2O emissions from agriculture?

Luke Harrold, Kairsty Topp, Christine Watson & Robin Walker

Introduction

- Intercropping of legumes with cereal crops can play a crucial role in the path towards sustainable agriculture and achieving net-zero.
- Literature and IPCC report suggests a reduction in N_2O emissions in legume intercropped systems. However, reductions have been shown to be dependent on the variety of pea used.
- We aim to explore if legume-based intercropping systems (pea/barley) can support sustainable farming by balancing environmental (N_2O emission, soil health) and economic (yield) goals.

Methods

Treatments

Barley and pea were planted in isolation (Sole crop) and together (Intercrop) using three fertilizer rates (Table 1)

Plots organized in a randomized block design, replicated four times.

Table 1 – Crop treatment including fertilizer addition

Treatment	Fertiliser
Sole crop Barley (Laureate)	Full N 120 kg/ha
Sole crop Pea (Prophet)	No N
Intercrop Barley/Pea	No N
Intercrop Barley/Pea	Half N 60 kg/ha
Sole crop Barley	No N

Sampling

Gas sampled from chambers (Figure 1) on days 1,2,4,8 and 10 then twice a week for four weeks followed by once per month until experiment end.

N_2O concentration measured via gas chromatograph.

Periodically soil samples were taken to determine soil nitrogen in the form of NH_4^+ and NO_3^-.

Soil moisture and temperature were also measured continuously on an hourly basis using soil probes and a data logger.

Also measured

Bulk density
Infiltration
Soil carbon
Soil structure (VESS)
Earthworm count

Figure 1 – Gas sampling from static chamber. Two static chambers per subplot. Photo by Robin Walker.

Figure 2 – Plots with stacked chambers. A few weeks before harvest

Results

N_2O flux closely linked to soil water content, peaks corresponding to higher soil moisture (Figure 3).

Significant differences in cumulative N_2O emissions are seen within 21 days (Figure 4).

N addition to barley doubled N_2O emissions over 21 days compared to no-N barley (Figure 4).

No difference between sole crop pea and sole crop barley with no N (Figure 4)

Intercrop with half standard N rate had the same N_2O emissions as full-rate barley treatment (Figure 4).

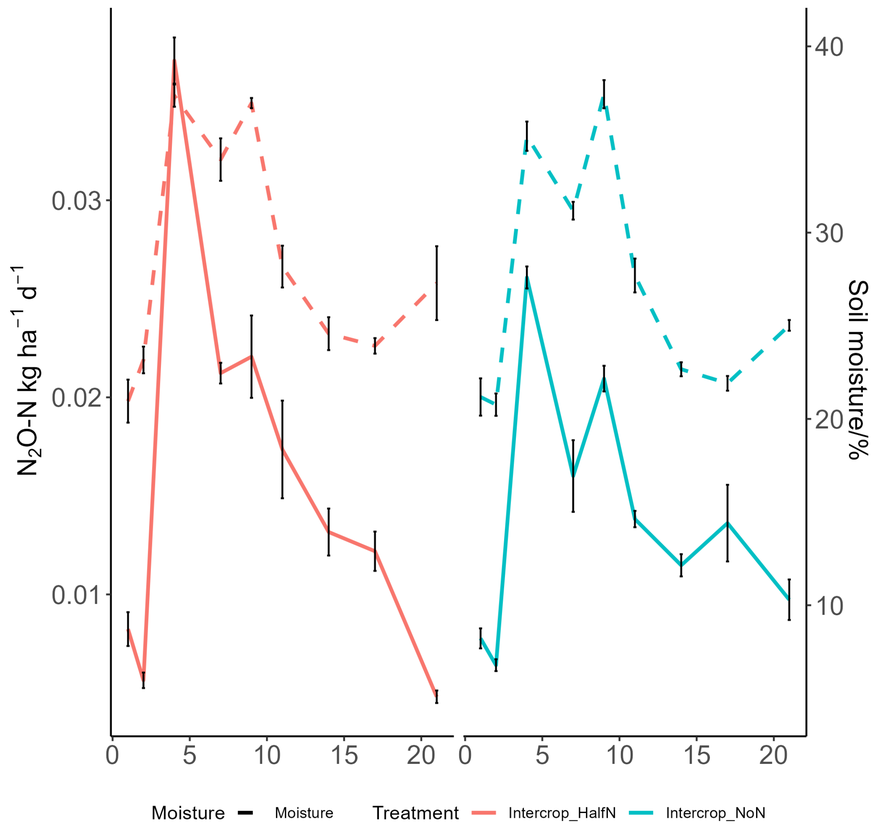

Figure 3 – N_2O flux and soil moisture for the first 21 days of Intercrop-Half N (left) and Intercrop No N (right). Solid lines show the flux of N_2O over time with the left-hand y-axis. Dashed lines show the soil moisture content (%) overtime with the right-hand y-axis. Standard error is shown.

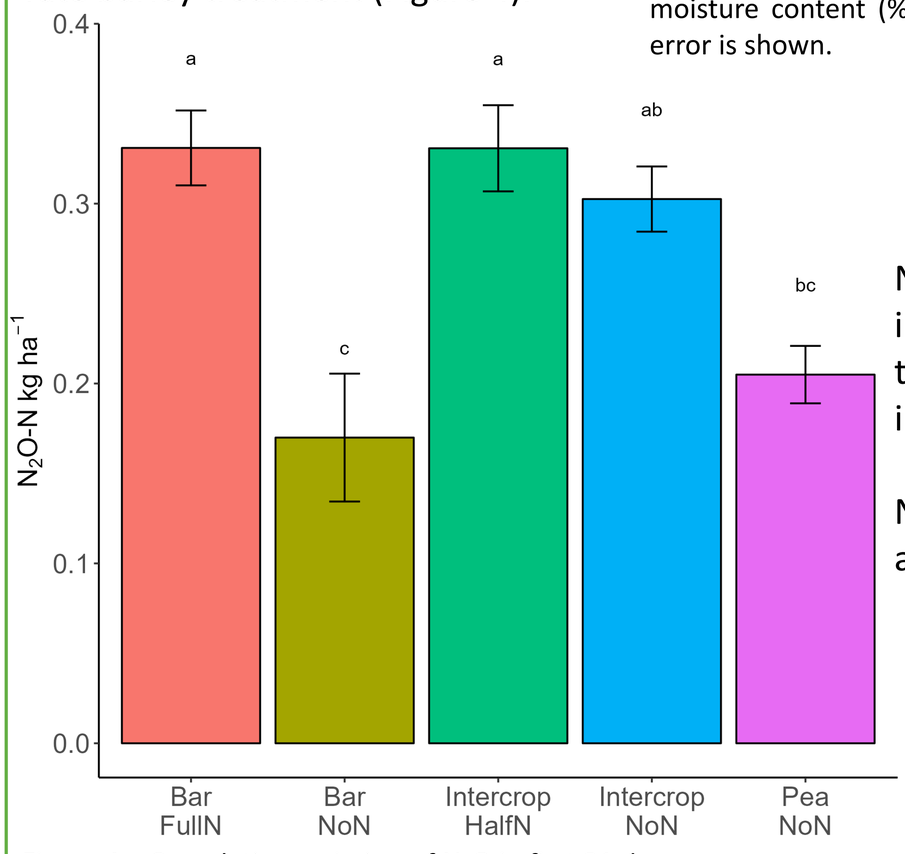

Figure 4 – Cumulative emission of N_2O in first 21 days

No difference in N_2O emission between intercropped barley/pea with no N and the full-rate barley or half rate intercrop (Figure 4).

No yield data yet but visible differences are evident (Figure 5)

Expectations

The effect of the cropping systems will become more evident as the experiment continues. Full crop cover is not achieved in the first 21 days and that is especially true for the peas.

Figure 5 – Yield plots for all treatments approximately one week before harvest.

Conclusions

- Pea has not lowered but raised the emission of N_2O so far.
- No significant difference between the N_2O emission from sole-barley with full rate of N-fertiliser and the intercrop with half-rate of N-fertilizer or the half-rate intercrop.
- Further data required to fully evaluate the impact of intercropping.

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