Intercropping

Impact: Nutrient use efficiency

Reference 6

Rodriguez, C; Carlsson, G; Englund, JE; Flohr, A; Pelzer, E; Jeuffroy, MH; Makowski, D; Jensen, ES 2020 Grain legume-cereal intercropping enhances the use of soil-derived and biologically fixed nitrogen in temperate agroecosystems. A meta-analysis Eur. J. Agron. 118, 126077 10.1016/j.eja.2020.126077

Background and objective

Grain legumes are known for their benefits to deliver ecosystem services on provisioning of protein-rich food and feed, reducing greenhouse gas emissions through the symbiotic nitrogen fixation function and diversification of cropping systems. Intercropping is an agroecological practice in which two or more crop species are grown simultaneously in the same field, thereby maximizing the use of resources to enhance yields in low input systems and the resilience of cropping systems. Authors quantified the effect of grain legume-cereal intercropping on the use of N resources in temperate agroecosystems, focusing on dinitrogen (N2) fixation and soil-derived nitrogen acquisition

Search strategy and selection criteria

Authors searched for peer-reviewed literature using the Web of Science academic citation database (https://apps.webofknowledge.com (https://apps.webofknowledge.com)) on 09 October 2017. The initial search equation was intercrop* AND (legum* OR pulse* OR faba* OR pea OR pisum OR lentil OR lupin OR soybean OR vetch OR vicia OR “common bean” OR phaseolus) AND (cereal OR barley OR wheat OR oat* OR maize OR triticale OR rye) AND (nitrogen OR N). (i) at least one intercropping between a cereal and a grain legume studied, (ii) written in English, (iii) based on field experiments conducted in a temperature climate latitude from 30−66° and (iv) full-text articles were available. Eligible articles were additionally reviewed to check that the following data were reported: (v) N2 fixation by the legume in intercropping and by the sole crop, (vi) total crop N uptake for both intercrop and sole crop treatments, and (vii) N fertilization rates when applied. If the same data were reported in multiple articles, they were only included once, from the article containing most detailed descriptions.

Data and analysis

Authors used a mixed effect models for estimating the mean log ratio. The weighted average of the individual log ratios was estimated by fitting a mixed-effect model to the whole data set by restricted maximum likelihood using the variance as weight. The significance of the difference between intercrop and sole crop was analysed by computing the 95 % confidence interval of the mean log ratio. Authors then assessed the influence of different moderators including them as categorica variables in mixed effect models. The strength of the effect of each moderator was also analysed by comparing the Akaike’s Information Criterion (AIC) of the models fitted with and without each moderator. Multiple comparisons (Tukey’s Post hoc test) were performed to compare between moderator levels using a general linear hypothesis (glht) function from the R package multcomp. All analyses were performed with the rma.mv() function from the metafor package in R.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
29	Cereals and legumes	Intercropping	Monoculture	Metric: Dinitrogen (N2) fixation and Soil-derived N acquisition; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	88%

Results

- The proportion of N derived from N2 fixation was on average 14 % (95 % CI = [11, 16]) higher in intercropped grain legumes (76 %) compared to legume sole crops (66 %). On the other hand, intercropping reduced the amount of N2 fixed (kg ha−1) by about 15 %, when N2 fixation in inter- and sole cropped legumes was expressed at equivalent density by compensating for the sown legume proportion in intercrops relative to their sole crop sowing rate.
- Soil-derived nitrogen acquisition in intercropped grain legumes was significantly reduced (−47 %, 95 % CI = [−56, −36]) compared to sole crop legumes, expressed at equivalent density, while the soil N acquired by intercropped cereals was much higher (+61 %, 95 % CI = [24, 108]) than in sole crop cereals. Total soil N acquisition (legume+cereal) was significantly higher in intercrops than in legume sole crops (+25 %, 95 % CI = [1, 54]), while there was no significant difference between intercrops and cereal sole crops.
- NA
- NA
- NA

Factors influencing effect sizes

- Crop/cultivar combinations : The proportion of each species in the intercrops and the species of legume influenced N2 fixation andsoil-derived nitrogen acquisition.
- Fertiliser application : Intercropping had a more negative effect on Ndfa when N fertilizers were applied than under zero fertilization, but the difference was significant only between zero-N and the application of 1−50 kg N ha−1. The fertilization rate was affecting soil-derived nitrogen acquisition measured for intercrop legume compared to sole legume, with more negative effects of fertilized intercropping than unfertilized ones.
- Method used to quantify Nitrogen fixation : There was a significant difference between natural abundance and isotope dilution methods, with a negative effect of intercropping on Ndfa, when the isotope dilution method was used.

Conclusion

The meta-analysis confirms and highlights that intercropping consistently stimulates complementary N use between legumes and cereals by increasing N2 fixation by grain legumes and increasing soil N acquisition in cereals. Based on the results of this analysis it would be suggested that cropping systems diversification via intercropping can be used for simultaneous production of both cereals and grain legumes, while increasing the use of N-sources and reducing external inputs of N fertilizers, thereby enhancing the sustainability of agriculture.