Intercropping

Impact: Crop yield

Reference 18

Yu, Y; Stomph, TJ; Makowski, D; Zhang, LZ; van der Werf, W 2016 A meta-analysis of relative crop yields in cereal/legume mixtures suggests options for management Field Crops Res. 198, 269–279 10.1016/j.fcr.2016.08.001

Background and objective

Intercrops of cereals and legumes are grown worldwide, both in smallholder agriculture in develop-ing countries and in organic farming systems in developed countries. The competitive balance betweenspecies is a key factor determining productivity in mixtures. Management factors, e.g. sowing time, sow-ing density and rate of N fertilizer, affect the relative competitiveness and performance of intercroppedspecies. There is a need for an overarching analysis to elucidate general principles governing the relativeperformance of legumes and cereals in mixtures. Authors conducted a meta-analysis of published studies to explore how the relative yield of legumes and cereals in mixtures responds to relative sowingtime, relative density and nitrogen fertilizer.

Search strategy and selection criteria

Data on yields in cereal/legume intercrops used here are a sub-set of records from a database built by Yu et al. 2015 (Yu, Y., Stomph, T.-J., Makowski, D., van der Werf, W., 2015. Temporal nichedifferentiation increases the land equivalent ratio of annual intercrops: ameta-analysis. Field Crops Res. 184, 133–144.). From the original database, all data records of cereal/legume intercrops (552) were extracted, representing data from 144 experiments out of 77 publications. See Yu et al. 2015 (Yu, Y., Stomph, T.-J., Makowski, D., van der Werf, W., 2015. Temporal nichedifferentiation increases the land equivalent ratio of annual intercrops: ameta-analysis. Field Crops Res. 184, 133–144.)

Data and analysis

All analyses were conducted in R. Mixed effects models were fitted using the R function lme from the R package nlme. The assumption of equal variance for mixed effects models was checked by analyses of quantile plots and plots of residuals against fitted values. A negative correlation structure of data between the cereal and the legume from the same data record was added in the mixed effects models using the R function corCompSymm for the argument of correlation in lme. A non-linear model of the relationship between PLER of the cereals and PLER ofthe legumes was fitted to the data using the R function gnls. A comparison of good-ness of fit between the linear mixed effects model (model 1) andthe non-linear model (model 10) was conducted with Akaike infor-mation criterion. In this meta-analysis, authors did not use the inverse variance of LER as a weight since there were toofew publications reporting measures of variance of yields.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score

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77	Cereals and legumes	Intercropping	Monoculture	Metric: Partial land equivalent ratio (PLER: the relative yield of an intercropped speciescompared to its yield in a sole crop); Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	81%

Results

- On average, intercrops were more efficient in land use thansole crops (the median LER was 1.16, the mean 1.17 and the standard deviation 0.24, indicating substantial variation)
- NA
- NA
- NA
- NA

Factors influencing effect sizes

- Crop type : PLER of the cereals was greater than that of the legumes in ~75%of the cases (409 out of 552 cases) indicating that the competitiveness of cereals is normally higher than that of legumes in a mixture.
- Sowing time : Sowing a species earlier than its companion increased its relative yield.
- Crop density : An increase in density of a species increased its relative yield and decreased the relative yield of the companion species

Conclusion

The performance of cereals and legumes in an intercrop is affected by sowing densities, relative sowing times, and nitrogen fertilizer. These findings can be used to enhance species complementarity, total productivity and economic profit of intercropping.