Intercropping

Impact: Crop yield

Reference 4

Li, CJ; Hoffland, E; Kuyper, TW; Yu, Y; Li, HG; Zhang, CC; Zhang, FS; van der Werf, W 2020 Yield gain, complementarity and competitive dominance in intercropping in China: A meta-analysis of drivers of yield gain using additive partitioning Eur J Agron. 113, 125987 10.1016/j.eja.2019.125987

Background and objective

Intercropping is known to increase the efficiency of land use, but no meta-analysis has so far been made on the yield gain of intercropping compared to sole cropping in terms of absolute yield per unit area. Yield gain could potentially be related to a relaxation of competition, due to complementarity or facilitation, and/or to the competitive dominance of the higher yielding species. (1) How large is the yield gain of intercropping in units of grain yield per hectare? (2) What is the contribution of the complementarity effect (CE) and selection effect (SE) to the yield gain in various intercropping systems, and (3) What are the effects of species trait combination, temporal niche differentiation, and N and P input on the net effect, CE and SE?

Search strategy and selection criteria

A literature search was conducted on the Chinese National Knowledge Infrastructure. We used the search terms “intercrop” and “yield” in the topic field and “field experiment” in the full text. An additional literature search was conducted on Web of Science using the search terms “intercrop” and “yield” and “field experiment” in the topic field and “China” in the author address. The two datasets were combined and doubles were removed. Authors selected studies that met the following criteria: (1) field studies were carried out in China, (2) both crop species produced grain and the yield was calculated on the basis of dry kernel weight (crop species included wheat, maize, barley, rice, faba bean, soybean, chickpea, pea, peanut, mungbean, adzuki bean, oilseed rape, oilseed radish, sesame; for the frequencies of each species combination see Fig. 1), (2) yield data that are based on aboveground biomass, fiber or tuber mass were not used (e.g. grass, cotton, potato, cabbage, capsicum and sugarcane), (3) grain yields for both intercrops and sole crops were reported, (4) plant density of intercrops was reported or could be calculated from row distance and plant distance. Data records in which the relative density total (RDT) was lower than 1 were excluded.

Data and analysis

Linear regression with mixed-effects models (function lme in R package nlme) was used for the analyses. Authors used the publication and the experiment within publications as random effects to account for differences among the studies (publications) and the experiments (sites × years) within studies. A variance model (function varIdent in R package nlme) was used to account for the heterogeneity of variance between intercrops with and without maize. The associations between the yield gain (NE) of intercrops and the variables were further visualized with principal component analysis, using the vegan package in R.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
69	Multiple crops	Intercropping	Monoculture	Metric: Overall yield gain (NE, difference between the observed yield and the expected yield); Effect size: Difference of the considered metrics between intervention and control	81%

Results

- Total yield in intercrops exceeded the expected yield, estimated on the basis of sole crop yields, by 2.14 ± 0.16 Mg ha−1 (mean ± standard error). This yield gain was largely due to competitive relaxation (complementarity effect, CE) with a small contribution from the selection effect (SE).
- Intercropping increased the relative use efficiency of land (LER)
- NA
- NA
- NA

Factors influencing effect sizes

- Crop/cultivar combinations : The yield gains due to intercropping increased with the temporal niche differentiation of the intercrops (i.e. the proportion of the total growing period of the crop mixture during which species grow alone). The yield gain was substantially greater in intercrops with maize than in intercrops without maize, but there was no difference in yield gain between systems with and without legumes.
- Fertiliser application : The yield gain increased with nitrogen (N) input in maize/C3-cereal intercrops but not in cereal/legume intercrops.
- NA : NA

Conclusion

Total yield in intercrops exceeded the expected yield, estimated on the basis of sole crop yields, by 2.14 ± 0.16 Mg ha−1 (mean ± standard error). The study highlights that net effects of Chinese intercropping on yield are highly dependent on the presence of maize. The results confirm that intercropping is a promising pathway for ecological intensification of agriculture which demands for design of optimized cropping systems that are highly productive and resource use efficient