Intercropping

Impact: Crop yield

Reference 25

Kiaer, LP; Skovgaard, IM; Ostergard, H 2009 Grain yield increase in cereal variety mixtures: A meta-analysis of field trials Field Crops Res. 114, 361–373 10.1016/j.fcr.2009.09.006

Background and objective

Plant ecology theory predicts that growing seed mixtures of varieties (variety mixtures) may increase grain yields compared to the average of component varieties in pure stands. Published results from field trials of cereal varietymixtures demonstrate, however, both positive and negative effects on grain yield. Authors used established meta-analysis techniques to investigate overall effects on grain yield when cereal varieties are grown in mixtures, as compared to the average yield when varieties are grown in pure stand. Furthermore, authors analyzed to which extent this relates to a number of mixture characteristics and growing conditions.

Search strategy and selection criteria

The main criterion for inclusion of studies in the meta-analysis was publication in a peer-reviewed journal included in The Science Citation Index Expanded database (Web of Science, 2008), spanning the period from 1900 to 19 January 2008. A wide Boolean search was made on all possible combinations of typically used wordings for variety mixtures and the common names for the crop species of interest (Table 1). For consistency, authors chose not to include any unpublished results. As a first coarse filtering, only references contained in the subject categories Agricultural Engineering, Agronomy, Biology, Ecology, Multidisciplinary Agriculture, and Plant Sciences (in total 3526) were retained. References related to subjects such as livestock, intercropping, toxicity and genetics were discarded, as were references with a strictly phytopathological focus. For a study to be accepted for the meta-analysis, a number of criteria had to be met. A prerequisite was that the study provided a relevant measure of experimental variation (see below). In the optimal case, the study provided retrievable yields for mixtures as well as component varieties in pure stand, either in absolute values or relative to some standard yield. Acceptable exceptions were studies reporting average yields in either of two cases: (1) across component varieties for each mixture grown, as such values corresponded with our method of calculating mixing effect (see below) and (2) from field trials (see below) repeated over several sites and/or years, but only when the number of these was apparent and a measure of variation relating directly to the estimates was retrievable. However, average yield results combined from different treatments could not be accepted. Finally, a few studies were discarded due to the spatial designs of trials, and a few studies were discarded due to selective reporting of results (apparent or stated).

Data and analysis

All meta-analyses were carried out running the metafor (W. Viechtbauer) package in R 2.9.1 (R Development Core Team, 2009), in which all other computations were also run. As the algorithms in metafor are not able to handle factors, crop type was coded as three dummy variables. The test of the hypothesis of similar mixing effects of crop

types and the tests of the hypotheses of crop type specific relationships with each covariate were done with Wald tests at the 5% level, using the covariance matrix of the estimates for calculation of the test statistic.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
26	Wheat and barley	Varietal mixtures	Pure stand	Metric: Grain yield difference; Effect size: Standardized relative difference of the considered metrics between intervention and control	88%

Results

- Relative mixing effects ranged from -30% to 100% with an overall meta-estimate of at least 2.7% ($p < 0.001$), reconfirming the potential of overall grain yield increase when growing varieties in mixtures.
- NA
- NA
- NA
- NA

Factors influencing effect sizes

- Crop type : Mixing effects differed significantly between crop types, being significant for winter wheat and spring barley and insignificant for spring wheat and winter barley.
- Crop/cultivar combinations : Mixing effect increased significantly with (1) diversity in reported grain yields in pure stands, (2) diversity in disease resistance, and (3) diversity in weed suppressiveness, calculated among the different component varieties. Mixing effect was also found to increase significantly with the effective number of component varieties. The effects of the latter two differed significantly between crop types.
- Latitude : Mixing effect increased significantly with latitude for spring wheat and decreased with latitude for winter wheat

Conclusion

The results obtained through meta-analysis confirm the potential of cereal variety mixtures as a means of obtaining higher grain yields, on average, compared to growing the crop in pure stand.