Intercropping

Impact: Crop yield

Reference 10

Borg, J; Kiaer, LP; Lecarpentier, C; Goldringer, I; Gauffreteau, A; Saint-Jean, S; Barot, S; Enjalbert, J 2018 Unfolding the potential of wheat cultivar mixtures: A meta-analysis perspective and identification of knowledge gaps Field Crops Res. 221, 298-313 10.1016/j.fcr.2017.09.006

Background and objective

Increasing the biodiversity of cropped plants is a key leverage for agroecology, aiming to replace chemical inputs by ecological processes and regulations. Cultivar mixtures are a straightforward way to increase within-crop diversity, but they have so far been poorly used by farmers and they are not encouraged by advisory services. The objective of this study was to analyse various factors that may condition the success or failure of wheat mixtures by calculating overyielding, i.e. the difference in productivity of a variety mixture compared with the weighted mean of its component varieties in pure stand.

Search strategy and selection criteria

Only peered-reviewed publications, included in The Science Citation Index Expanded database (WOS: Web of Science 2015) were considered, over the largest time frame available: from 1900to oct.2015. For consistency, authors chose only papers in the categories agronomy, plant sciences, genetics heredity, agriculture multidisciplinary, multidisciplinary sciences, ecology, biodiversity conservation, agricultural engineering, and environmental sciences. First, a Boolean search of the WOS database was made on all possible combinations of typically used wordings for cultivars, and common names of cereal species: (cereal*OR rice OR wheat OR barley OR sorgh* OR oat OR rye OR millet NOT grass NOT legum*) AND (cultivar* OR variet* OR multiline* OR population* OR plant OR hybrid) AND (only for previously found papers) (AND mixture* OR mixing OR blend* OR intergenotypic* OR intervarietal* OR intravarietal*) Studies dedicated to wheat clearly reporting the yields of pure stands and their mixtures in field experiments.

Data and analysis

Meta-estimates of overyielding were obtained from random effects meta-analysis models in which calculated effect sizes were weighted by the inverse of their respective variances . A range of ‘mixed effect’ meta-regression models were used. Where appropriate, multiple meta-regressions were used to compare the correlation with continuous moderators. All analyses were run in the R environment, version 3.2.1 (R Development Core Team,2011), using matrix notation as implemented in the metafor package.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score

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32	Wheat	Cultivar mixtures	Pure stand	Metric: Overyielding (the difference in productivity of a variety mixture compared with the weighted mean of its component varieties in pure stand); Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	94%

Results

- The analysis highlighted a significant global overyielding of 3.5% ($p<0.001$), which reached 6.2% in condition of high disease pressures.
- NA
- NA
- NA
- NA

Factors influencing effect sizes

- Crop type : Mixtures of winter wheat provided a global overyielding (4.3%) that was significantly higher (p-value < 0.05) than mixtures of spring wheat, for which global overyielding was not significant
- Disease severity : Overyielding from mixtures generally increased with disease pressure. Global overyielding was significant under high disease pressure only (6.2%), based mostly on studies where mixtures were inoculated (56% of the studies) rather than naturally infected by fungal spores. This was significantly higher (p-value < 0.05) than the global overyielding under low disease pressure (2.6%; p-value= 0.093) where mixtures were treated with fungicides.
- Trait heterogeneity : Mixtures without reported consideration of height, and certainly displaying homogeneity for this trait, had significantly lower overyielding when compared to mixtures diverse in height (3.8%; pvalue< 0.05). Mixtures composed of varieties with contrasting levels of resistance towards one or more fungal diseases tended to provide larger overyielding, but with a marginally significant test (+2.5%;p-value < 0.1), than mixtures composed of cultivars with similar disease resistance or without any reported consideration of resistance. This overyielding was enhanced when handled resistances were specific to a disease seriously affecting the plots (2.9%; p< 0.05).

Conclusion

Cultivar mixtures increase yield relatively to pure varieties.