Intercropping

Impact: Crop yield

Reference 13

Reiss, ER; Drinkwater, LE 2018 Cultivar mixtures: a meta-analysis of the effect of intraspecific diversity on crop yield Ecol. Appl. 28, 62–77 10.1002/eap.1629

Background and objective

Extensive research has shown that greater plant community diversity leads to higher levels of productivity and other ecosystem services, and such increased diversity has been suggested as a way to improve yield and agricultural sustainability. Increasing intraspecific diversity with cultivar mixtures is one way to increase diversity in agricultural systems. Authors conducted a global meta-analysis using an extensive database to assess the impact of intraspecific diversity on crop yield and yield stability in a wider range of food crops and growing conditions.

Search strategy and selection criteria

Using the Web of Science database, authors searched the literature for a variety of search terms to target cultivar mixtures of important annual food crops (excluding rice, due to its specialized and varied cultivation) and limited our search to journal articles published in English that fell within the Web of Science categories related to ecology or agriculture. (1) the study was field based (not conducted in a greenhouse or microcosm) and conducted for at least one full growing season; (2) the study reported either actual yields for all treatments, or relative yield of cultivar mixtures compared to component monocultures; (3) the study included only simultaneous plantings of cultivar mixtures and monocultures, with only one harvest (i.e., not relay planting or multiple cuttings for forage); and (4) a replacement series experimental design was used. Ultimately, 91 papers published between 1939 and 2014 met the four criteria and were included in the meta-analysis.

Data and analysis

With relative yield as the effect size, the measure of the magnitude of the effect of mixing, authors used MetaWin version 2.1 software to explore the mean response of RY to a variety of environmental and experimental variables. As RY = r, and RY is already normally distributed, no transformation was needed to change it to a normally distributed effect size. Very few papers reported study variance. Consequently, authors performed an unweighted meta-analysis, assigning a variance of 1 to all observations. To improve the statistical significance of results without experimental variance, authors calculated the mean RY and a bias-corrected 95% confidence interval using a bootstrapping method with 9999 iterations.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
91	Multiple crops	Cultivar mixtures	Pure stand	Metric: Relative yield (RY, it compares the productivity of plants grown as monocultures and those grown in combination with others) and yield stability (it compares the average monoculture coefficient of variation to that of the mixtures); Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	81%

Results

- Yield increased by 2.2% overall in cultivar mixtures relative to their monoculture components
- Cultivar mixtures generally showed higher yield stability over time compared to monocultures
- Cultivar mixtures did not show higher yield stability over space compared to monocultures
- NA
- NA

Factors influencing effect sizes

- Crop type : Authors observed a significant yield increase for all crops tested in three or more studies, with the exception of sorghum. The highest increase was recorded for corn and legumes.
- Crop/cultivar combinations : Mixtures with more cultivars (i.e. higher than three) and those with more functional trait diversity showed higher relative yields. Planned mixtures based on both disease and physical characteristics were significantly better than those mixtures based on either a physical or a disease basis alone
- Soil organic matter : Auhtors found a negative correlation between soil organic mater and RY, suggesting that, in environments where nutrient supply from organic matter mineralization may be more limited, mixtures resulted in greater yield benefits.

Conclusion

Cultivar mixtures are a viable strategy to increase diversity in agroecosystems, promoting increased yield and yield stability, with minimal environmental impact.