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Letourneau, DK; Armbrrecht, I; Rivera, BS; Lerma, JM; Carmona, EJ; Daza, MC; Escobar, S; Galindo, V; Gutierrez, C; Lopez, SD; Mejia, JL; Rangel, AMA; Rangel, JH; Rivera, L; Saavedra, CA; Torres, AM; Trujillo, AR 2011 Does plant diversity benefit agroecosystems? A synthetic review *Ecol. Appl.* 21, 9-21. 10.1890/09-2026.1

Background and objective

Predictive theory on how plant diversity promotes herbivore suppression through movement patterns, host associations, and predation promises a potential alternative to pesticide-intensive monoculture crop production Do specific types of diversification schemes designed for associational resistance to herbivores, attraction of natural enemies, or moving herbivores away from crops have the predicted effects? Do more diverse cropping schemes in general have an overall negative effect on herbivores, a positive effect on natural enemies, reduce crop damage and increase crop yield?

Search strategy and selection criteria

Authors reviewed the 62 publications selected by Poveda et al. (Poveda, Katja, María Isabel Gómez, and Eliana Martínez. "Diversification practices: their effect on pest regulation and production." *Revista Colombiana de Entomología* 34.2 (2008): 131-144.) from their initial 279 articles published between 1998 and 2008 addressing insect pests, biological control, and plant diversification in agroecosystems. Poveda et al. (2008)'s criteria for selecting these 62 articles were that the articles were available and reported field experiments on vegetation diversification within or surrounding crop fields, implemented simultaneously. with the crop production cycle. Authors' additional criteria for the meta-analysis were that: (1) plant species richness was quantified, described, or manipulated in a way that could be construed as a relatively species-poor vs. species-rich condition for crop production and (2) researchers reported or were able to provide us with means for arthropod herbivore response variables (abundance of natural enemies, herbivore abundance, herbivore mortality caused by natural enemies, crop damage by herbivores, and/or crop yield), variance around the means, and numbers of replicates. Because most of the articles provided multiple experiments involving different herbivores and/or different natural enemy manipulations at different locations or in different years, our general approach was to include only tests that could not be logically dropped from the analysis. However, authors excluded experiments that were confounded by differential insecticide applications on plant diversity treatments or that used planting densities that were deemed by the authors to be impractical for effective crop production.

Data and analysis

To calculate the effect as a proportional change in plant species diversity, authors used bias-corrected Hedges' d to calculate the overall treatment effect size (dp). Authors did not include the precision of each study's estimates in this analysis (i.e., variance weighting). Differences in effect sizes were calculated using mixed effects models performed with MetaWin 2.0 statistical software. Authors used the bootstrap confidence intervals because resampling methods are appropriate when data are not normally distributed; Authors standardized effect sizes on the extreme ends of the distribution did not all fall within a normal distribution.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
45	Multiple crops	Intercropping	Monoculture	Metric: Crop yield from only the main crop; Effect size: Hedge d (standardized difference) comparing the considered metrics between intervention and control	87.5

Results

- Diversification schemes using intercropping resulted in significantly lower crop yields than when crop plants were not diversified.

Factors influencing effect sizes

- No factors influencing effect sizes to report.

Conclusion

A relatively small, but significantly negative, mean effect size for crop yield indicated that pest-suppressive diversification schemes interfered with production, in part because of reducing densities of the main crop by replacing it with intercrops. Especially for additive designs of intercrops, pooling the yields of all crops to calculate the land-equivalent ratios or relative yield total probably would have resulted in a more positive overall yield for the diversification scheme than for a monoculture crop.