Intercropping

Impact: Pest and disease control

Reference 1

Gibson, AK; Nguyen, AE 2021 Does genetic diversity protect host populations from parasites? A meta-analysis across natural and agricultural systems Evol. Lett. 5, 16-32 10.1002/evl3.206

Background and objective

If parasites transmit more readily between closely related hosts, then parasite burdens should decrease with increased genetic diversity of host populations. This important hypothesis is often accepted at face value—notorious epidemics of crop monocultures testify to the vulnerability of host populations that have been purged of diversity. Authors used a meta-analytic approach to ask if host diversity confers protection against parasites over the range of contexts in which it has been tested

Search strategy and selection criteria

In September 2018, authors searched PubMed and Web of Science for titles with the following terms: (“genetic diversity” OR “genetic variation” OR monoculture OR polyculture OR inbred OR inbreeding OR mixtur∗ OR heterogen∗ OR polyandr∗ OR polygyn∗ OR promisc∗ OR outcros∗) AND (parasit∗ OR infect∗ OR pathogen OR disease OR susceptib∗ OR epidemic OR resist∗) Authors received weekly Web of Science alerts of new search results through December 2019. We also searched Agricola (abstracts with genetic diversity AND disease resistance; monoculture AND pathogen) and ProQuest (abstracts with genetic diversity AND [disease resistance OR pathogen OR parasite]). Finally, Authors searched reference lists of reviews, meta-analyses and all full studies examined for inclusion. Authors evaluated full articles written in English reporting original data on variation in parasitism and host genetic diversity. We required population-level data for multiple populations, natural or experimental. Studies were excluded if data were limited to a single population, individual-level estimates (e.g., genomic heterozygosity), a subset of host genotypes, or transformed values. Genetic diversity of hosts had to be intraspecific and explicitly controlled or measured. Authors rejected studies that only reported aggregate data for diverse parasites because this prevented a test of whether effect size varied with parasite traits. Authors accepted several quantitative estimates of population-level parasitism, including prevalence (fraction of individuals scored as infected), mean load (a quantification of how infected hosts were), and virulence (parasite-induced mortality). We did not accept metrics that were qualitative (i.e., presence/absence of parasites) or unlinked to transmission (i.e., immune responses). Authors did not consider general estimates of host fitness—these were rarely provided in eligible studies. Moreover, the association between diversity and mean fitness lies outside the scope of this study and has been addressed elsewhere. Authors excluded a few studies from which they could not calculate an appropriate effect size.

Data and analysis

Authors analyzed the data with multilevel models using the metafor package’s rma.mv function in R version 3.6.0. For eight studies that reported standard deviations, auhtors calculated Hedges’ g. For forty-seven studies that did not report standard deviations, the log response ratio (lnRR) was weighted using sample sizes instead of sampling variances. To account for the hierarchical structure of the data, authors calculated the weighted mean effect size for each experiment within a study and for each study and then across experiments and studies. Authors calculated bootstrap confidence limits by sampling 10,000 times with replacement.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
55	Multiple crops	Intercropping	Pure stand	Metric: Parasitism (bacteria, fungi or viruses); Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control, Hedges’g	94%

Results

- In experimental crop host populations, genetic diversity reduces parasitism by ~50% compared to monocultures.
- NA
- NA
- NA
- NA

Factors influencing effect sizes

- Crop/cultivar combinations : Genetic diversity reduced parasitism more when cultivars were mixed unevenly
- Crop type : The negative effect of genetic diversity on parasitism was stronger for cereal crops (Poaceae) than for noncereal crops
- NA : NA

Conclusion

Cultivar diversification is a sustainable solution for disease control and yield improvement