FARMING PRACTICE
INTERCROPPING

IMPACT: PESTS AND DISEASES

Reference 8

Zhang, CC; Dong, Y; Tang, L; Zheng, Y; Makowski, D; Yu, Y; Zhang, FS; van der Werf, W 2019 Intercropping cereals with faba bean reduces plant disease incidence regardless of fertilizer input; a meta-analysis Eur. J. Plant Pathol. 154, 931–942 10.1007/s10658-019-01711-4

Background and objective

Ecological intensification of agriculture calls for ecological mechanisms to replace anthropogenic inputs. Cereal/legume intercropping increases yields due to species complementarities, it produces high protein food and feed, and it reduces the need for artificial N fertilizer because legumes fix N biologically. In addition, intercropping has the potential to suppress plant diseases, but its efficacy for disease suppression in cereal/legume mixtures has not been well characterized quantitatively. Authors conducted meta-analysis to quantify the disease suppressive effect of intercropping cereals with legumes at different levels of N fertilizer.

Search strategy and selection criteria

A literature search was performed in Web of Science Core Collection and the China National Knowledge Infrastructure (CNKI) using the terms "disease", "intercropping", "nitrogen fertilizer" or "N fertilizer", in various combinations in the fields for title, keywords and abstract. The search was originally done in 2010 and updated in May, 2018. Authors excluded review papers, studies without replicates, studies without quantitative data on disease incidence, or studies that did not report the rate of N fertilizer. To reduce heterogeneity in the data, and because of the expected environmental benefit of an integration of legumes in cropping systems, authors surther focused the search on cereal/legume mixtures.

Data and analysis

Analyses were conducted using linear mixed effects models. All models included nested random effects reflecting the effects of factors associated with publications, and within publication the effect of study (site × year). The optimal random effects structure (publication and study as nested random effects) was identified using Akaike's Information Criterion. A Box-Cox transformation was applied to normalize the log of the odds ratio and an optimal exponent for this transformation was selected using the Shapiro test. The normality of the residuals of the selected model was checked graphically. All analyses were performed in R using the R function lme for fitting linear mixed effects models.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
17	Cereals and faba bean	Intercropping	Monoculture	Metric: Disease incidence; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- Intercropping reduced disease incidence by 45% on average.

Factors influencing effect sizes

- Season : The effect of intercropping on disease incidence varied over the season, with a greater control effect during early ($\Delta y = \beta time(early) = -0.407$, effect of intercropping = 33%, $P < 0.001$) and midseason ($\Delta y = \beta time(mid) = -0.305$, effect of intercropping = 26%, $P < 0.001$;) than during late season ($\Delta y = \beta time(late) = -0.118$, effect of intercropping =11%, $P = 0.055$).
- Pathogen species : Disease reduction by intercropping was significant ($P < 0.01$) for four out of six studied pathogens: yellow rust (Puccinia striiformis f.sp. tritici) and mildew (Blumeria graminis) in wheat (Triticum aestivum), and chocolate spot (Botrytis fabae) and Fusarium wilt (Fusarium oxysporum) in faba bean (Vicia faba). Disease reduction was marginally significant for yellow rust in barley (Puccinia striiformis f.sp. hordei) ($P < 0.10$) and not significant for bean rust (Uromyces fabae).

Conclusion

Intercropping has a substantial and consistent effect on disease incidence in cereal/faba bean mixtures across studies, but is not sufficient to provide complete disease control. Intercropping is therefore best used as a component in an integrated approach for managing plant diseases.