SINGLE-IMPACT FICHE INTERCROPPING

IMPACT: PESTS AND DISEASES

Data extracted in May 2021
Fiche created in December 2023

Note to the reader: This fiche summarises the effects of Intercropping on PESTS AND DISEASES. It is based on 7 synthesis papers[1], including from 11 to 180 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

Intercropping of both multiple crop species (i.e., crop mixture cropping) or genotypes (i.e., cultivar mixture cropping), as compared to monoculture or pure stands, resulted in an overall positive effect on pests and diseases (**Table 1**). The considered pests are insects, pathogens and weeds.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- crop mixture cropping: from a total of 6 results, 5 were positive and 1 showed a non-significant effect, as compared to monoculture.
- cultivar mixture cropping: from a total of 4 results, 3 were positive and 1 showed a non-significant effect.

Out of the 7 selected synthesis papers, 4 included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**. Some synthesis papers may report effects for more than one impact or more than one effect for the same impact.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Decrease pests and diseases	Pest and disease control	Crop mixture cropping	monoculture	5	0	1	0
		Cultivar mixture cropping	monoculture	3	0	1	0

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

2. IMPACTS

The main characteristics and results of the 7 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices, are provided in the **summaries of the synthesis papers** available in this WIKI.

Table 2: Main characteristics of the synthesis papers reporting effects on pests and diseases. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref1	Multiple crops	Global	55	Intercropping	Pure stand	Parasitism (bacteria, fungi or viruses)	Cultivar diversification is a sustainable solution for disease control and yield improvement	94%

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref3	Grain legumes and cereals	Africa	180	Grain legume and cereal intercropping	Monoculture	Weed biomass, Striga hermonthica emergence, stemborer larvae abundance and stemborer parasitism	Intercropping grain legumes into cereals increased weed and Pest and disease control service	62%
Ref8	Cereals and faba bean	China	17	Intercropping	Monoculture	Disease incidence	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.	69%
Ref11	Multiple crops	Global	22	Varietal mixtures	Pure stand	Predator abundance, herbivore abundance and damage	The results of the study provide limited support for the suggestion that genotypically diverse cultivar mixtures can be used as an effective pest management tool	75%
Ref20	Multiple crops	Global	26	Intercropping	Monoculture	Plant damage, predator abundance and pest abundance	Intercropping had beneficial effects on biocontrol	88%
Ref23	Wheat	Global	11	Cultivar mixtures	Pure stand	Wheat stripe rust intensity	Using cultivar mixture with different resistance backgrounds is effective in controlling wheat stripe rust	75%
Ref24	Multiple crops	Global	45	Intercropping	Monoculture	1) Pest Arthropod herbivore abundance; 2) natural enemy abundance; 3) crop damage	Overall, herbivore suppression, enemy enhancement, and crop damage suppression effects were significantly stronger on diversified crops than on crops with none or fewer associated plant species.	88%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Decrease pests and diseases	Pest and disease control	Crop mixture cropping	monoculture	Ref3, Ref8, Ref20 and Ref24		Ref20	
		Cultivar mixture cropping	monoculture	Ref1, Ref11 and Ref23		Ref11	

3. FACTORS INFLUENCING THE EFFECTS ON PESTS AND DISEASES

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on pests and diseases, according to the synthesis papers reviewed.

Factor	Reference number
Crop type	Ref1
Crop/cultivar combinations	Ref1, Ref23 and Ref20
Disease severity	Ref23
Pathogen species	Ref8
Season	Ref8
Sowing density	Ref23
Type of herbivore pest	Ref11

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref3	Studies that focus on indigenous African grain legumes or cereals should be encouraged because, with the exception of cowpea and teff, most past studies have focused on non-native species.
Ref11	Future studies should 1) manipulate the amount of genetic variance in phenotypic traits, as opposed to just the number of genotypes and 2) explore the potential interactions between plant species and genetic diversity effects on arthropodsthe and 3) focus on the consequences of losses of plant genetic diversity for pollination services, below-ground herbivory and nutrient cycling performed by the soil and litter arthropods
Ref20	There is the need for a greater investment in researching the underlying relationships between multiple agroecosystem services so we can better achieve agroecosystem multifunctionality.
Ref24	More research is needed to better discern which schemes deliver the desired results for biological control, and what underlying mechanisms can be used to predict the "right kind of diversity" for providing these ecosystem services for pest regulation while maintaining crop yield.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref1	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
Ref3	Daryanto, S; Fu, BJ; Zhao, WW; Wang, S; Jacinthe, PA; Wang, LX	2020	Ecosystem service provision of grain legume and cereal intercropping in Africa	Agric Syst 178, 102761	10.1016/j.agsy.2019.102761
Ref8	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
Ref11	Koricheva, J; Hayes, D	2018	The relative importance of plant intraspecific diversity in structuring arthropod communities: A meta-analysis	Funct Col 32, 1704-1717	10.1111/1365-2435.13062
Ref20	Iverson, AL; Marin, LE; Ennis, KK; Gonthier, DJ; Connor-Barrie, BT; Remfert, JL; Cardinale, BJ; Perfecto, I	2014	Do polycultures promote win-wins or trade-offs in agricultural ecosystem services? A meta-analysis	J Appl Ecol 51, 1593–1602	10.1111/1365-2664.12334
Ref23	Huang, C; Sun, ZY; Wang, HG; Luo, Y; Ma, ZH	2012	Effects of wheat cultivar mixtures on stripe rust: A meta-analysis on field trials	Crop Prot 33, 52-58	10.1016/j.cropro.2011.11.020
Ref24	Letourneau, DK; Armbrecht, 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

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