SINGLE-IMPACT FICHE
COVER AND CATCH CROPS

IMPACT: SOIL NUTRIENTS

Data extracted in January 2022
Fiche created in February 2024

Note to the reader: This fiche summarises the effects of Cover and catch crops on SOIL NUTRIENTS. It is based on 6 synthesis papers[1], including from 8 to 269 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effect of cover/catch crops, as compared to bare soil, on SOIL NUTRIENTS (soil total nitrogen, phosphorous and potassium) is reported in **Table 1**.

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.

- The effect of cover/catch crops, as compared to bare soil, on SOIL NUTRIENTS is variable: positive (i.e. increase soil nutrients) according to 4 out of 8 results while non-significant according to 4 (3 with a quality score of at least 50%) other results.
- The effect of cover/catch crop depends on cover-crop residues management (incorporation as green manure vs removal), the duration of cover crop period, the type of cover crops.
- More specifically, cover crops belonging to both leguminous species and non-legume species resulted in significantly increased soil nutrients, as reported by 2 and 1 results, respectively.
- The effect of cover crops or vegetation cover applied in orchards/tree crops was variable, with 2 results reporting a positive effect and another 1 result indicating no significant effect.

Out of the 6 selected synthesis papers, 5 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	
Increase soil nutrients	Soil nutrients	Cover crops	Bare soil	4	0	4 (3)	0
		Legume cover crops	Bare soil	1	0	0	0
		Non-legume cover crops	Bare soil	1	0	0	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 6 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.

[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.

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

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref2	fruit tree species (apple, citrus, grape, jujube, kiwi fruit, peach, pear, plum)	Global	116	Ground cover (including cultivated green manure, sod cultivation, natural, vegetation, grass, and cover crop)	Clean tillage management	1) Soil total nitrogen; 2) Soil total phosphorous; 3) Soil total potassium;	Cover crops (both legume and non-legume) significantly increase soil total N, P and K.	69%
Ref10	Data from North America, Europe, Africa, and Asia, specifically eastern China; Cash crop type: corn, soybean, wheat, vegetable, corn-soybean rotation, corn-soybean-wheat rotation, and other	Global	269	Cover and catch crops (legume, grass, multi-species mixture, and other)	No cover/catch crop	1) Soil total nitrogen; 2) Soil total phosphorous; 3) Soil total potassium;	Soil total N, P and K showed no significant change in cover crop treatments compared to controls.	62%
Ref13	Tree crops (Orchards, vineyards) in the Mediterranean area. The fruit tree crops used for the study were mostly grapevines (Vitis vinifera L.) at 36% of the sample size, olive trees (Olea europaea L.) at 34% of the sample size, almond trees (Prunus dulcis (Mill.) D.A. Webb) at 15% of the sample size and citrus trees (Citrus x sinensis Osbeck, Citrus x limon (L.) Osbeck) at 7% of the sample size. We also used other fruit trees, such as avocado (Persea americana Mill.), carob (Ceratonia siliqua L.), peach (Prunus persica (L.) Stokes), chestnut (Castanea sativa Mill.) and walnut (Juglans regia L.), representing 8% of the total dataset.	Global (mediterranean climates)	46	1) Permanent intercropping; 2) Annual intercropping;	Mono-cropping in orchards. Mono-cropping indicates the presence of the tree crop alone with no other vegetation cover in the alleys (bare soil).	Soil nitrogen	The growth of annual crops had no significant effect on soil N, although 71% of values observed were positive. The growth of permanent alley crops was associated with a significant increase in N compared to mono-cropping.	81%
Ref22	Arable crops	Global (including EU)	48	1) Cover crops (overall). All or part of the N fertilizer rate was added as green manure; 2) Mix cover crops. All or part of the N fertilizer rate was added as green manure; 3) Legume cover crops. All or part of the N fertilizer rate was added as green manure; 4) Non-legume cover crops. All or part of the N fertilizer rate was added as green manure; 5) Incorporation of mix cover crops. All or part of the N fertilizer rate was added as green manure; 6) Mix cover crops removed.	Bare soil with the same treatments than in the intervention	Soil nitrogen content	Cover crops increased soil total nitrogen by 12% compared to no cover crop. Incorporation of cover crop residue into the soil increased soil total nitrogen, while having no effect with residue removal.	69%
Ref26	Agricultural soils	USA	16	Cover crops	No cover crop	Potentially mineralizable nitrogen (PMN)	Potentially-mineralizable nitrogen was 104% higher in cropping systems with a cover crop in comparison to cropping systems without a cover crop (although the positive effect was limited to legume cover crops).	81%
Ref35	Not specified	Europe	8	Catch and cover crops	No cover crop	Soil total nitrogen stock	Overall, the effect of catch and cover crops did not significantly influence soil total nitrogen stock. However, the longer time of the practice significantly increased total nitrogen stock, comparing to short time.	25%

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	
Increase soil nutrients	Soil nutrients	Cover crops	Bare soil	Ref2, Ref13, Ref22 and Ref26		Ref10, Ref13, Ref22 and Ref35	
		Legume cover crops	Bare soil	Ref22			
		Non-legume cover crops	Bare soil	Ref22			

3. FACTORS INFLUENCING THE EFFECTS ON SOIL NUTRIENTS

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

Factor	Reference number
Cover crop residue management	Ref22

Factor	Reference number
Cover crop type	Ref22
Duration	Ref35

4. KNOWLEDGE GAPS

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

Ref Num	Gap
Ref26	More studies that report both PMN and crop yield are needed to directly link laboratory measurements of PMN to crop production.

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
Ref2	Fang, LF; Shi, XJ; Zhang, Y; Yang, YH; Zhang, XL; Wang, XZ; Zhang, YT	2021	The effects of ground cover management on fruit yield and quality: a meta-analysis	ARCHIVES OF AGRONOMY AND SOIL SCIENCE	10.1080/03650340.2021.1937607
Ref10	Jian, Jinshi; Lester, Brandon J.; Du, Xuan; Reiter, Mark S.; Stewart, Ryan D.	2020	A calculator to quantify cover crop effects on soil health and productivity	Soil and Tillage Research 199, 104575	10.1016/j.still.2020.104575
Ref13	Morugan-Coronado, A; Linares, C; Gomez-Lopez, MD; Faz, A; Zornoza, R	2020	The impact of intercropping, tillage and fertilizer type on soil and crop yield in fruit orchards under Mediterranean conditions: A meta-analysis of field studies	Agric. Syst. 178, 102736	10.1016/j.agsy.2019.102736
Ref22	Muhammad, I., Sainju, U.M., Zhao, F., (...), Fu, X., Wang, J.	2019	Regulation of soil CO_2 and N_2O emissions by cover crops: A meta-analysis	Soil and Tillage Research 192, pp. 103-112	10.1016/j.still.2019.04.020
Ref26	Mahal, NK; Castellano, MJ; Miguez, FE	2018	Conservation Agriculture Practices Increase Potentially Mineralizable Nitrogen: A Meta-Analysis	SOIL SCI SOC AM J, 82, 1270–1278	10.2136/sssaj2017.07.0245
Ref35	Pecio A., Jarosz Z.	2016	Long-term effects of soil management practices on selected indicators of chemical soil quality [Wpływ wieloletniego stosowania zabiegów agrotechnicznych na wybrane właściwości chemiczne gleb]	Acta Agrobotanica 69, 2	10.5586/aa.1662

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