SINGLE-IMPACT FICHE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: PLANT NUTRIENT UPTAKE

Data extracted in February 2021
Fiche created in May 2024

Note to the reader: This fiche summarises the effects of Soil amendment with biochar on PLANT NUTRIENT UPTAKE. It is based on 3 synthesis papers[1], including from 5 to 208 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effects of soil amendment with biochar, as compared to no-amendment, on plant nutrient uptake are 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.

- Soil amendment with biochar, compared to no-amendment, led to a positive effect (increase in plant nutrient uptake) in 2 synthesis papers.
- Another synthesis paper (assessing nutrients use efficiency in greenhouse vegetables cultivations) reported non-significant effect.

None of the selected synthesis papers 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**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase plant nutrient uptake	Nutrient uptake	Soil amendment with biochar	No amendment	2	0	0 (1)	0
Increase plant nutrient uptake	Nutrient use efficiency	Soil amendment with biochar	No amendment	0	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 3 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 plant nutrient uptake. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref9	Greenhouse vegetables	China	5	Soil amendment with biochar	No amendment	Nitrogen use efficiency	Biochar application to greenhouse vegetables tends to increase, but non-significantly, nitrogen utilisation efficiency.	75%
Ref18	Not specified (for N and P), Rice (for Silicon)	Global	171	Soil amendment with biochar	No amendment	Plant nutrients uptake (Si, P, N)	Higher amount of silicon and nutrients input through addition of biochars significantly improved crop silicon and nutrients (N,P) uptake.	62%
Ref27	Not specified	Global	208	Soil amendment	No	Plant nitrogen	Biochar leads to a significant increase in plant N uptake.	69%

[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
				with biochar	amendment	uptake		

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 plant nutrient uptake	Nutrient uptake	Soil amendment with biochar	No amendment	Ref18 and Ref27			
Increase plant nutrient uptake	Nutrient use efficiency	Soil amendment with biochar	No amendment			Ref9	

3. FACTORS INFLUENCING THE EFFECTS ON PLANT NUTRIENT UPTAKE

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

Factor	Reference number
Biochar application rate	Ref27
NA	Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref18, Ref18, Ref18, Ref18, Ref18, Ref18, Ref18, Ref18, Ref27, Ref27, Ref27 and Ref27
Soil cation exchange capacity	Ref27
Soil pH	Ref27
Soil texture	Ref27

4. KNOWLEDGE GAPS

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

Ref Num	Gap
Ref27	The biochar effects synthesized in the current paper are mainly derived from experiments characterized by single-dose designs and relatively short-term time scales (months to a few years). Biochar effects with respect to longer-term and repetitive additions require further evaluation with future more relevant experimental data.

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
Ref9	Gu, JX; Wu, YY; Tian, ZY; Xu, HH	2020	Nitrogen use efficiency, crop water productivity and nitrous oxide emissions from Chinese greenhouse vegetables: A meta-analysis	Sci Total Environ. 743:140696.	10.1016/j.scitotenv.2020.140696
Ref18	Li Z, Song Z, Singh BP, Wang H	2019	The impact of crop residue biochars on silicon and nutrient cycles in croplands.	Sci Total Environ 659:673–80	10.1016/j.scitotenv.2018.12.381
Ref27	Liu, Q; Zhang, YH; Liu, BJ; Amonette, JE; Lin, ZB; Liu, G; Ambus, P; Xie, ZB	2018	How does biochar influence soil N cycle? A meta-analysis	Plant Soil 426:211–25	10.1007/s11104-018-3619-4

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