

## IMPACT: SOIL WATER RETENTION

### Reference 7

Edeh, IG; Masek, O; Buss, W 2020 A meta-analysis on biochar's effects on soil water properties - New insights and future research challenges Sci Total Environ. 643:926–35. 10.1016/j.scitotenv.2020.136857

### Background and objective

Biochar can significantly alter water relations in soil and therefore, can play an important part in increasing the resilience of agricultural systems to drought conditions. Quantify the effect of biochar with different characteristics on soil water properties.

### Search strategy and selection criteria

An extensive literature search was performed using key words such as: biochar and soil physical properties and/or hydraulic properties, and/or water retention, and/or available water capacity, and/or moisture characteristics. The treatment and control were established as being identical for this MA with regards to all variables other than the addition of biochar. Therefore, only studies including a control (no biochar) and biochar treated soils were collected. Studies without replicated treatments and control as defined were excluded from the MA. Studies that measured water holding capacity (by drainage method) as field capacity were excluded because water holding capacity does not include water potential, which describes how freely water drains in soils and how much is available for plant use

### Data and analysis

The log transformed data were used in calculating overall effect and 95% confidence intervals for each group. For each parameter, groups with fewer than three treatments were excluded from the analysis. All data treatment and processing were done using Microsoft Excel 2010.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
37	Laboratory and field studies	Soil amendment with biochar	No amendment	Metric: Soil water content: field capacity (FC), available water content (AWC), permanent wilting point (PWP), hydraulic conductivity constant at saturation (K sat); Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.5625

### Results

- Biochar significantly increased soil water retention (available water content and permanent wilting point), compared to the control due to an increase in field capacity.
- Among the assessed biochar physical properties specific surface area (SSA) had the greatest effect on soil properties.
- The greatest effect of biochar on soil water properties was observed for coarse-textured soil for studies conducted in laboratories with application rates of 30–70 t/ha.

### Factors influencing effect sizes

- Experiment type : When compared to field studies, AWC was on average 9.8% higher in lab studies. The same was true for FC where lab studies showed 3.4% increase in FC compared to field studies.
- Soil texture : Biochar addition had the greatest effect in coarse textured soils (sand) with AWC, FC and PWP increasing by 32.9%, 23.9% and 22.2% compared to the control, respectively. The effect of biochar on fine textured soils (clay) was lower, but still showed a significant increase of AWC and FC by 9.1% and 3.5%, and a decrease of PWP by 0.4% compared to the control, respectively. As the % sand in soil increased, the effect of biochar on the AWC, FC and PWP also increased, while the reverse was the case for % clay content. Biochar increased AWC by 37% in soils with >75% sand content. For >30% clay content, AWC was reduced by 31.2%.
- Biochar particle size : Smaller biochar particle size (<2 mm) increased AWC significantly by 38.2% when compared to >2 mm, most likely due to a 22.3% increase in field capacity.
- Biochar specific surface area : Biochar with >300 m<sup>2</sup>/g SSA increased available water capacity and FC by 70% and 52%, respectively, when compared to the control. The results also showed that as the SSA increased the effect of biochar on available water capacity also increased. Studies that used biochar with >300 m<sup>2</sup>/g observed an increase in available water capacity by 33.3% when compared to those that used biochar with SSA of <20 m<sup>2</sup>/g.
- Biochar carbon content : An increase in the carbon content of biochar caused an increase of its effect on AWC. Biochar with >70% carbon significantly increased AWC by 33.3% when compared to biochar with <50% carbon. A similar trend was seen in case of FC, where biochar with >70% carbon increased FC by 26%.

### Conclusion

Application of biochar significantly increases soil available water content. The increase in AWC was directly associated with increase in field capacity and permanent wilting point.