# FARMING PRACTICE
# SOIL AMENDMENT WITH BIOCHAR

## IMPACT: CROP YIELD

### Reference 37

Thomas SC, Gale N. Biochar and forest restoration: a review and meta-analysis of tree growth responses. 2015 Biochar and forest restoration: a review and meta-analysis of tree growth responses. New For 46:931–46. 10.1007/s11056-015-9491-7

### Background and objective

Since fire constitutes the most important agent of natural forest disturbance globally, additions of biochar to forest soils may also be viewed as a means to better "emulate" natural disturbance processes. Relatively few studies have examined char effects on trees and other woody vegetation, although there has been a recent rapid growth in this literature. The authors present a meta-analysis of existing data on growth responses of woody plants to biochar additions, examining variability in responses among biomes, between conifers and angiosperm trees, and with respect to experiment duration and type.

### Search strategy and selection criteria

We searched peer-reviewed literature published through Oct. 2014 to locate studies presenting growth responses of trees to biochar additions: we conducted searchers using Google Scholar (scholar.google.com) and Web of Science (thomasonreuters.com) databases using the search terms "biochar", "char", "charcoal", and "black carbon", and in addition consulted recent meta-analyses and reviews. The authors included all studies based on woody plant species that presented mean responses for aboveground biomass, or for both height and stem diameter. The authors only considered studies specifically examining responses to chars, and not wood ash, except cases of high-carbon wood ash with organic matter >30 %.

### Data and analysis

We employed a paired non-parametric Wilcoxon test to detect positive responses, considering tests significant at $P < 0.05$. Non-paired Wilcoxon test were used to compare responses between groups. Analyses were conducted in the statistical software R version 3.1.0.

| Number of papers | Population | Intervention | Comparator | Outcome | Quality score |
|---|---|---|---|---|---|
| 17 | Woody plants in forest restoration land | Soil amendment with biochar | No amendment | Metric: Crop yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control | 0.5 |

### Results

- The mean response ratio metric for the entire data set was 0.347 ± 0.046 ($P < 0.001$), corresponding to a 41 % increase in biomass in response to biochar additions. For all subgroups compared, response ratio metrics likewise were significantly greater than zero (at $P < 0.05$). Responses of both tropical and boreal trees were larger than those observed for temperate tree species ($P < 0.01$ in both cases), but tropical and boreal responses were similar.
- Responses of hardwoods (angiosperms) were on average considerably greater than those of conifers ($P < 0.001$).

### Factors influencing effect sizes

- Type of experiment : There were not detectable differences in response between pot trials (including greenhouse and growth chamber studies as well as shadehouse and similar studies with growth containers) and field trials with trees planted in native soils ($P > 0.05$).
- Time of : There were not detectable differences in responses relative to duration of study ($P > 0.05$: Fig. 1d); however, there was a trend toward shorter-term studies showing larger responses, and the pairwise comparison between medium-term studies (6–12 months) and long-term studies (>12 months) was marginally significant ($P = 0.098$).
- Tree species : Considering tree species with a relatively large number of trials represented in the data set ($N \geq 3$), there was very high apparent variation in responses among species (Fig. 2). Response ratio metrics were positive in all cases, but varied from ~0.05 to 0.75. Species-specific responses were significant (by the conservative Wilcoxon test used) in 5 of 14 cases.

### Conclusion

The meta-analysis on biochar responses of woody plants indicates a potential for large tree growth responses to biochar additions, with a mean 41 % increase in biomass. Responses are especially pronounced at early growth stages, and appear to be higher in boreal and tropical than in temperate systems, and in angiosperms than conifers.