Organic Biochar Based Fertilization

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Introduction

Instead of applying >10 tons biochar per hectare once and for all, it could be more economic and plant growth enhancing to apply annually low amounts of nutrient enhanced biochar concentrated into the crop root zone (0.5 – 2 t ha^{-1}).

Root zone applied organic and mineral enhanced biochar was tested in 22 field trials with 13 crop species throughout Nepal.

When enriching biochar with liquid nutrients, the biochar may serve as carrier material, holding the nutrients in its highly porous structure which may slow down the leaching of mobile nutrients, particularly in environments where heavy rainfalls occur.

Application of urine-biochar slurry and compost before seeding pumpkins

Methods:

All biochars were produced by Kon-Tiki type flame curtain pyrolysis kilns (Cornelissen et al., 2016) installed either in the fields or backyards of participating farmers. The feedstock for the biochar production was in most cases *Eupatorium adenophorum*, a frequently occurring invasive forest shrub species that local people call “ban mara” (*i.e.*, forest killer) and woody feed leftover (i.e. animals are frequently fed on leafy tree twigs where the woody parts are leftover). The biochar was then nutrient enriched either with cow urine or with dissolved mineral (NPK) fertilizer to produce biochar-based fertilizers containing between 60-100 kg N, 5-60 kg P_2O_5 and 60-100 kg K_2O, respectively, per ton of biochar.

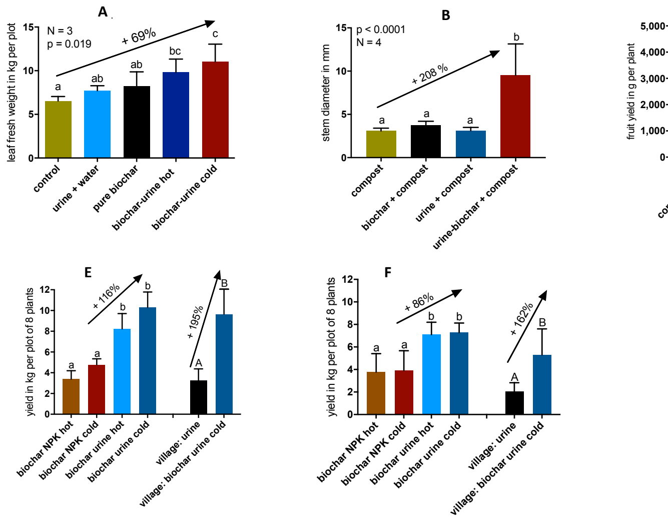

Fig. A-F: (A) Tea yield after after eight consecutive harvests over the whole tea season. (B) Stem diameter of cinnamon trees 10 months after planting with root substrate applications. (C) Total fruit yield per plant of Japanese melon after the first growing season (three harvests). (D) Mean pumpkin yield of 8 farmer sites (N = 8 x 5). (E-F) Cabbage head yield of two parallel cabbage field trials in Nalang (E) and Jhhapri (F) including average yields of farmer trials in the corresponding villages. N=5 for both primary trials; N=11 and N=9 for Nalang and Jhhapri village trials, respectively. Bars in all fig. show means + standard deviation, numbers of replicates per treatment are given in the figures. Different letters indicate significant differences between treatments. “Control” refers in to the standard compost broadcasting fertilization which had also been applied to all other treatments.

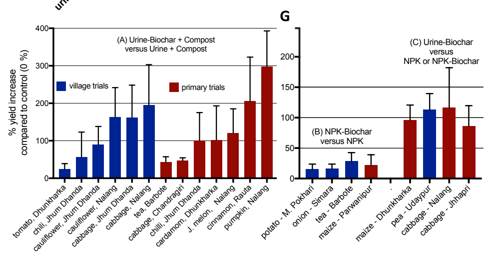

Fig. G: Average yield increases of (A) urine-biochar + compost treatments compared to urine + compost, (B) NPK-biochar compared to NPK only, and (C) urine-biochar compared to NPK only or to NPK-biochar. Yield increases are given as the absolute percentage increase above the control yield value. The bars show means and standard deviation. The red colored columns indicate primary trials, the blue columns village trials.

Results & Conclusion

All nutrient-enriched biochar substrates improved yields compared to their respective no-biochar controls. Biochar enriched with dissolved NPK produced on average 20% ± 5.1% (N=4 trials) higher yields than standard NPK fertilization without biochar. Cow urine-enriched biochar blended with compost resulted on average in 123% ± 76.7% (N=13 trials) higher yields compared to the organic farmer practice with cow urine-blended compost and outcompeted NPK-enriched biochar (same nutrient dose) by 103% ± 12.4% (N=4 trials), respectively. Thus, the results of 21 field trials robustly revealed that low-dosage root zone application of organic biochar-based fertilizers caused substantial yield increases in rather fertile silt loam soils compared to traditional organic fertilization and to mineral NPK- or NPK-biochar fertilization.

This can be explained by the nutrient carrier effect of biochar, causing a slow nutrient release behavior, more balanced nutrient fluxes, and reduced nutrient losses, especially when liquid organic nutrients are used for the biochar enrichment.

The results open up new pathways for optimizing organic farming and improving on-farm nutrient cycling.