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The Effects of Nutrient Enriched Biochar Placed in the Root Zone Varied with two Vegetable Species in Sandy Soil

Ghulam Haider[1], Muhammad Asif[2], Claudia I. Kammann[3]

[1]National University of Sciences and Technology (NUST), Dept. of Plant Biotechnology, Pakistan; [2]MNS University of Agriculture Multan, Agronomy, Pakistan; [3]Hochschule Geisenheim University, Dept. of Applied Ecology, Germany

Introduction

Global climate is rapidly progressing, leading to unusual extreme weather conditions around the world. The major contributing factors identified are increasing greenhouse gas emissions and thereby global warming. On the other hand, increasing population puts growing pressure on existing farming practices to ensure global food security. Unfortunately, it often leads to non-judicious use of agrochemicals (more input-more output) like nitrogen fertilizer for grain and forage crops production to support human and livestock nutritional demands. Thus, mineral nitrogen losses as nitrate leaching or gaseous emission (nitrous oxide, a 300-fold potent greenhouse gas than carbon dioxide) are ever-increasing challenges for environmental sustainability since the late '70s. Biochar, a stable carbon product obtained by the pyrolysis of organic residues has demonstrated significant potential for carbon sequestration, reducing nitrogen losses (nitrate leaching or gaseous emission), soil health and crop yield improvement.

Aims

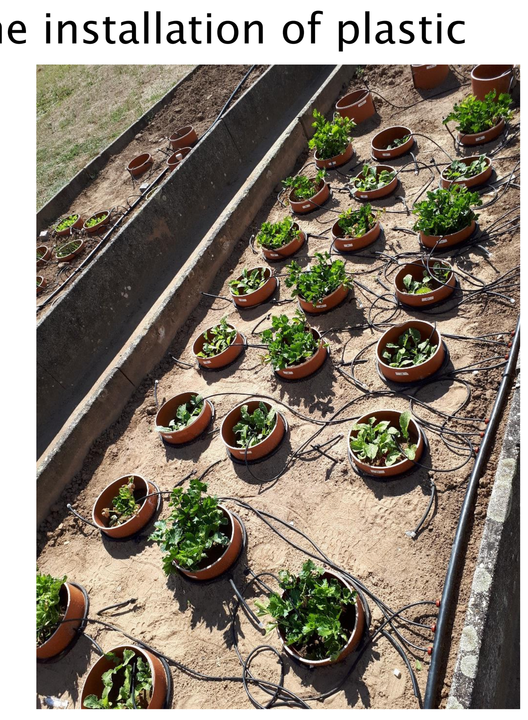
Based on our group's previous research, we observed that freshly produced biochar causes nitrogen uptake limitations in crops. Thus, in the present study, we aimed to improve our understanding of soil-plant nutrient interactions by addressing the following questions;

i) Can different fertilizers loaded onto biochar improve yields in vegetable crop plants, compared to the same fertilizer applied pure?

ii) Does the way of placement matter, i.e. homogenous mixing into the soil versus root zone placement?

Materials and Methods

A two-factor factorial experiment was carried out by the installation of plastic pots in the open field with boundary Figure 1.



Factor A: Nitrogen sources

i) Nitrogen derived from cow urine

ii) Synthetic nitrogen fertilizer

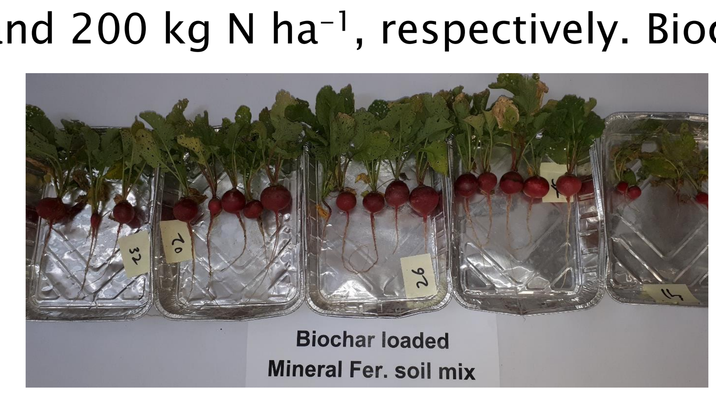
Factor B: Placement methods (biochar)

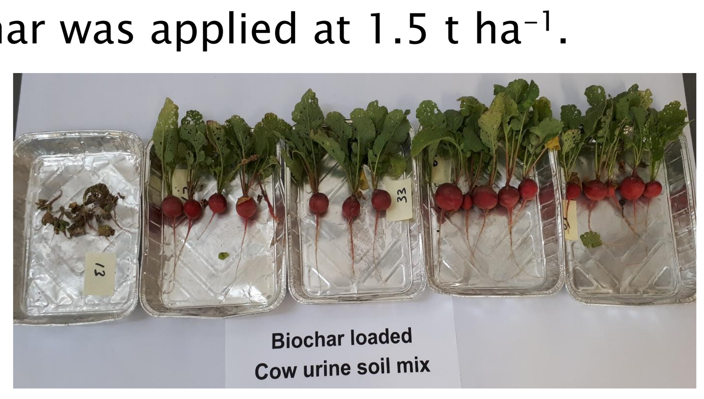
i) Control no biochar application

ii) Nitrogen enriched biochar through mixing in soil

iii) Nitrogen enriched biochar placement in root-zone

Two crops, Celery (*Apium graveolens* L.) and Red radish (*Raphanus sativus* L.) were sown in pots. Radish was grown with seeds, while 20 days old celery seedings were transplanted in the pots. Radish and celery were supplied with 70 and 200 kg N ha^{-1}, respectively. Biochar was applied at 1.5 t ha^{-1}.





Conclusion

- Cow urine is the huge source of nitrogen and causes 2000 kg N ha^{-1} deposition at urination places in the filed which become hotspots of N_2O emission.
- Biochar, a widely known negative emission technology may contribute as a nitrogen sink at livestock farms.
- The urine N carrying biochar may be used as root-zone fertilizer in high nitrogen demanding crops like vegetables. For instance, here we found 47.26% and 27.98% greater dry matter with biochar loaded urine (through mix) and biochar loaded urine (root zone) compared to pure urine application

Results

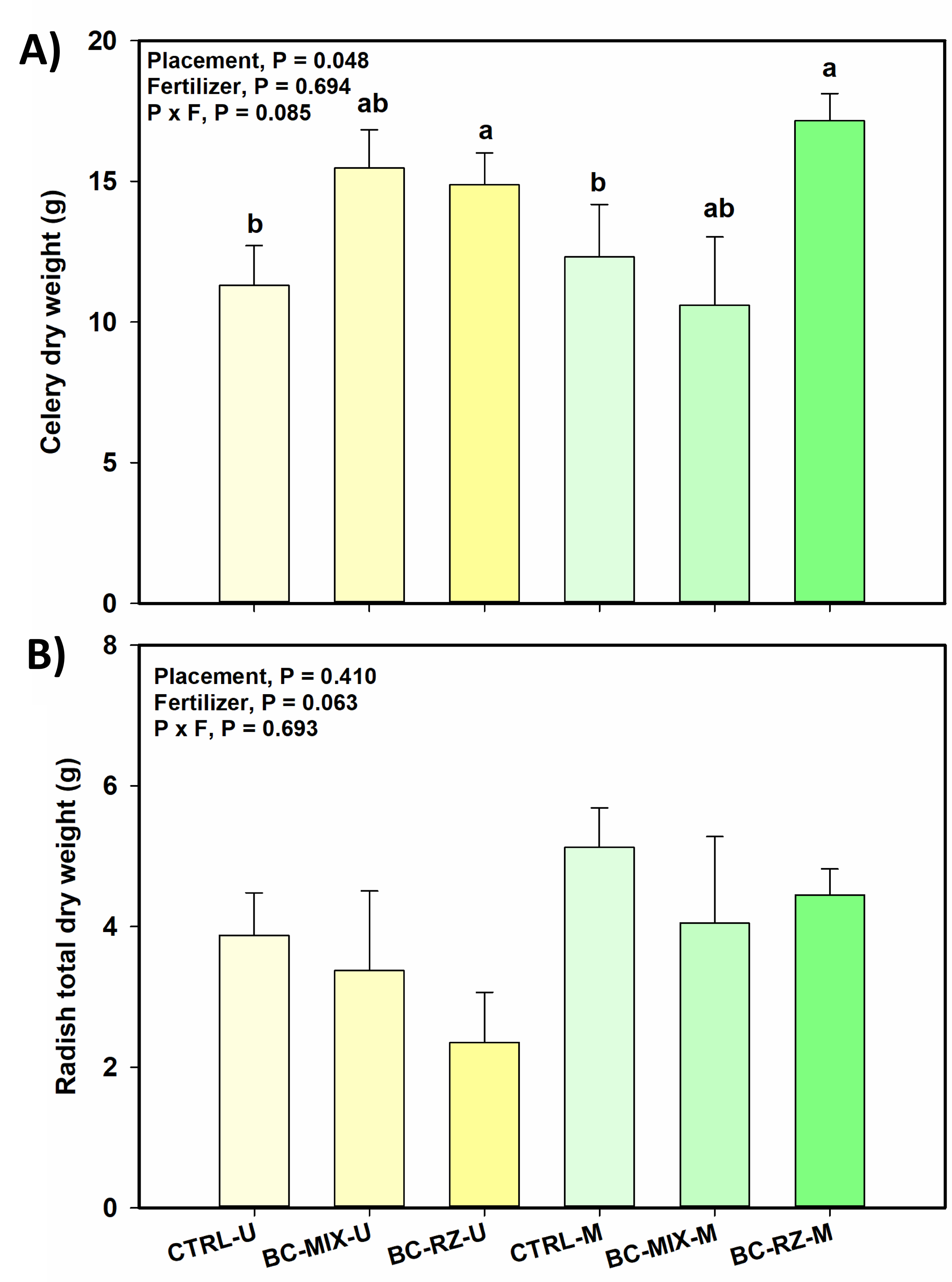


Figure 2. Effect of organic and inorganic nitrogen sources and application methods on dry matter production of **(A)** celery and **(B)** red radish (leaves + roots). Where CTRL-U = Cow urine N application without biochar, BC-MIX-U = cow urine N enriched biochar thoroughly mixed in potted soil, BC-RZ-U = cow urine N enriched biochar applied in root-zone in the pots, CTRL-M = mineral N application without biochar, BC-MIX-M = mineral N enriched biochar thoroughly mixed in potted soil, BC-RZ-M = mineral N enriched biochar applied in root-zone in the pots. The bars shows treatment means and error bars represents standard error of means at p=<0.05.

Ghulam Haider (PhD Plant Ecology)
National University of Sciences and Technology (NUST), Dept. of Plant Biotechnology, Islamabad Pakistan
ghulam.haider@asab.nust.edu.pk