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

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Abstract

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 fertiliser. 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, soil health improvement, and crop yield. 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 fertilisers loaded onto biochar improve yields in vegetable crop plants, compared to the same fertiliser applied pure? and ii) Does the way of placement matter, i.e. homogenous mixing into the soil versus root zone placement? Two vegetable crops (red radish and celery) were grown in potted sandy soil in open field-controlled beds at Geisenheim University, Germany. Two nitrogen sources (analytical grade mineral nitrogen or cow-urine derived nitrogen) along with other nutrients were applied by either thorough mixing of nitrogen-enriched biochar into the topsoil layer or by more concentrated root-zone placement. Interestingly, the two vegetable species responded different to the treatments. The fresh and dry matter yield of radish was not ($p=0.184$) influenced by any application or placement method, or source of nitrogen. However, thorough mixing of urine nitrogen/mineral nitrogen loaded biochar (38.87 % and 5.31 %) and rootzone application significantly increased (39.36 % and 43.15 %, respectively) celery fresh mass over that of the controls without biochar. The celery dry matter was also increased in the range of 2.64 % to 39.15 %, with thorough mixing/root-zone placement of urine/mineral N enriched biochar over control. Thus, the results suggest that in some N-demanding vegetable crops, biochar may have the potential to increase N uptake by increasing crop yields, reducing nitrogen losses, and thereby improving crop productivity.

Keywords: Carbon sequestration, organic farming, waste management

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