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Effect of Biochar Types and Rates on Some Soil properties and Nutrients Availability in a Calcareous Soil

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Introduction: Biochar is a material produced from organic matters under high temperature and low oxygen conditions. In recent years, scientific attention has been focused on its effects on soil amendment and ecological restoration.Due to its properties related to surface area and porosity, bulk density, nutrient content, stability, cation exchange capacity (CEC), pH value, and carbon content, biochar has the potential to improve physical and chemical soil properties and thus improve crop productivity and contribute to carbon sequestration. Biochars can have very different properties depending on the feedstock they are produced from and the pyrolysis conditions used to generate them.Biochar retains nutrients for plant uptake and soil fertility. The infiltration of harmful quantities of nutrients and pesticides into ground water and the runoff that erodes the soil and enters into the surface waters can be limited with the use ofbiochar. The actual effects of biochar on soil properties depend on the soil type and the plant species grown on the area of application, as well as biochar type and application rate.The aim of this study was to evaluate the effect of the biochar types and rates on some soil properties and nutrient availability in a calcareous soil.

Materials and Methods: An incubation experiment was conducted in a completely randomized design with three replications. The treatments were three type of biochar (apple pruning wastes, grape pruning wastes and wheat straw), and five biochar rates (0, 1, 2, 4 and 8% w/w). Biochars used in the experiment wereproduced at the final temperature of approximately 350°C for almost 3 hours. The biochars were ground and sieved over 1 mm sieve for the incubation experiment.100 g of soil sample was weighed into polyethylene pots and then thoroughly mixed with 1, 2, 4 and 8 g of the biochar samples. Soil controls were run without any amendment. Distilled water was added to the soil–biochar mixtures (soil samples) in order to keeptheir moisture content to 60% of their water-holding capacity. The incubation was carried out in a controlled incubation chamber at 25ºC for incubation in aerobically controlled non-leached conditions during 8 weeks.After 60 days, the samples were dried andsoil pH and electrical conductivity (EC) were determined in 1:5 soil to water extracts. Also, to determine mineral N, the soil samples with biochar were extracted with 2 M KCl. Organic matter was determined by dichromate oxidation. Soil extractable P and K were extracted with 0.5 M NaHCO3 (ratio 1:10) (Olsen-P) and 1 N NH4Ac (1:20) (NH4Ac-EK), respectively. DTPA-extractable Fe, Mn, Cu, and Zn were analyzed by atomic absorption spectrometry method (Shimadzu AA-6300).

Results and Discussion: The results indicated that adding biochar changed some soil properties such as soil organic carbon, pH, electrical conductivity and the availability of some macro and micro nutrients. These changes were also more evident with increasingin the rate of biochar. Soil organic carbon (SOC) contentsin the amount of 8% apple pruning wastes, grape pruning wastes and wheat straw biochar were 3.78, 3.80 and 5.24 times more than control, respectively. Available potassium and phosphorus increased further in derived biochar from wheat straw in the amount of 8% compared with apple pruning and grape pruning wastes. Soil available potassium in wheat straw biochar was 2.19 and 1.88 times higher than apple pruning and grape pruning wastesbiochars, respectively. Wheat straw biochar greatly increased soil EC compared to control, and a higher biochar addition finally resulted in a higher value of soil EC. Also, the mineral – N, comprising of ammonium nitrogen (NH_4-N) and nitrate nitrogen (NO_3-N), concentrationshowed significant reduction when different rates of biochar were added to the soil. Increase in the rate of applicationmarkedly reduced the concentration of both NH_4-N and NO_3-N. Wheat straw biochar significantly reduced available iron. Also, soil available copper significantly decreased by increasing the rate of biochar. But, soil available manganesesignificantly increased by increasing the rate of biochar. The type and rate of studied biochars had no significant effect on available Zn.

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Conclusion: Generally, the soil organic carbon (SOC) markedly increased with an increase in rate of application ofbiochar during the 60 days of incubation. This suggests that the biochar has great potential for carbon sequestration in soil.In conclusion, it became clear that in order to allow for accurate prediction of the effects ofbiochar on soil characteristics and nutrient availability, a deeper understanding of interactions between soil type, biochar production method, biochar feedstock, application rate and field crops is essential. Further research is needed to determine long term impacts of biochar on these soils.

Keywords: Biochar, Nutrient availability, Organic carbon, Pruning wastes,Wheat straw