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Mitigating drought stress in Arabica coffee seedlings through soil stabilisation with biochar derived from highland agricultural waste

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Abstract

The application of biochar has been demonstrated to enhance soil properties, promote plant growth and productivity, and mitigate drought stress by increasing soil water holding capacity (WHC) through the alteration of soil physicochemical characteristics. However, the efficacy of biochar is variable and contingent upon factors such as feedstock source, pyrolysis temperature, and application rate. Therefore, this study aimed at investigating the effect of applying different doses of biochar as a soil amendment on Arabica coffee seedling under various soil WHC conditions. The experiment was conducted in a greenhouse located in Chiang Mai University, utilising corncob biochar at 4 doses (0, 1, 2.5, and 5 % of soil weight) and 4 water irrigation conditions (100 %, 60 %, 40 %, and 20 % of WHC). Biochar derived from corncob was characterised by Field Emission Scanning Electron Microscope (FE-SEM). The basic physical and chemical characteristics of the soil and biochar were assessed. Growth and development of coffee seedlings were monthly measured. Plant responses were assessed through measurements of electrolyte leakage, relative water content, proline content, and total soluble sugar content. The results showed that biochar application contributed positively to growth and development of coffee seedlings ($p < 0.05$). No differences ($p > 0.05$) were observed between 100 % and 60 % WHC treatments, whereas the 40 % and 20 % WHC treatments with 2.5 % biochar exhibited the lowest levels of electrolyte leakage. The relative water content analysis revealed that 20 % WHC with 5 % biochar had the lowest value (26.57 %). The proline content was highest in 20 % WHC with 0 % biochar (43.73 mM g^{-1} FW). In contrast, the total soluble sugar content was generally the highest under 100 % WHC with 0 % biochar (192.66 mg g^{-1} FW). It can be concluded that biochar derived from highland agricultural waste has the potential to mitigate the negative impacts of drought stress on Arabica coffee seedlings.

Keywords: Arabica coffee, biochar, drought stress, highland agriculture

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