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Impact of different biochar and urea fertilizer ratios on soil microbial activity, growth and physiological performances of rice (*Oryza sativa* L.)

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This study investigated the interplay between biochar, urea, soil microbes, and rice growth. Biochar, a carbon-rich material, and urea, a nitrogen-containing compound, were investigated for their potential to enhance soil health, microbial activity, and rice crop physiological performance. The experiment evaluated the outcomes of varying urea levels (0, 30, 70, and 100 %) along with different biochar levels (0, 1, 2 and 3 t/ha) including a control with 0.62 t/ha partially burned paddy husk in accordance with a split-plot design. Data were collected 6 weeks after the experiment was established reveling significant interactions among urea, biochar and soil microbial activities. Soil microbial activity was measured by using carbon mineralization process, which involves the respiration of microorganisms. CO_2 emitted due to microbial respiration on soil substrate was trapped by 0.1M NaOH solution and titrated with 0.1M HCl solution to determine soil microbial activity. Data were analyzed using STAR for windows version 2.0.1. It was observed that microbial activity (23.53 mg/kg) was increased with higher biochar levels (2 t/ha) especially when combined with 70 % urea. Biochar nurtures microbial communities, which then enhance nutrient cycling, organic matter decomposition and improvement of soil matrix, potentially contributing to the significant water holding capacity (64.53 %) observed at 2 t/ha biochar rate. Rice growth parameters including tiller count (717.39 m^2), plant height (70.55 cm), total chlorophyll content (4.66 mg/g) and carotenoid concentration (0.77 mg/g) were also significantly improved with the combined application of 70 % urea and 2 t/ha biochar. The improvements compared to the control were 3.77, 7.20, 7.08, 2.59 % respectively. Therefore, it can be concluded that the synergistic effect of the combination of urea and biochar significantly effects microbial activity and rice growth 6 weeks after treatment application. These results highlighted the potential for biochar-urea interactions to optimize, rice crop performance after 6 weeks, offering a roadmap for sustainable agricultural practices that influence environmental conservation.

Keywords: Biochar, Physiology, Rice, Soil microbes, Urea