SOIL ORGANIC CARBON LIMITS SYNERGISTIC EFFECT OF BIOFERTILIZERS AND CHEMICAL FERTILIZERS ON THE EARLY GROWTH AND SYMBIOTIC NODULATION OF BLACK GRAM (*Vigna mungo* L.)

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Abstract

Biofilm biofertilizers (BFBFs) are known to enhance soil quality and reduce dependence on chemical fertilizers (CF). BFBFs outperform conventional mono- or mixed-culture biofertilizers, depending on the soil condition. Further, the BFBF increases microbial abundance over other biofertilizers, which synergistically helps increase the efficiency of CF. This study examined the effects of BFBF and Rhizobium biofertilizers, compared with CF, on seed germination, early growth, and nodulation of black gram grown in soil with extremely low soil organic carbon (SOC < 0.5%), and assessed the extent to which the low SOC limits the benefits of soil carbon enhancement. A pot experiment was established with eight treatments (T1-T8), including BFBF, Rhizobium, their combination, 50% and 100% of recommended chemical fertilizer levels, and two controls: the un-amended soil having extremely low-SOC (C1), and a coir dust-amended soil control (C2). The pots were arranged in a completely randomized design with four replicates. Measurements included germination percentage, shoot and root length, fresh and dry weights, chlorophyll content, and nodulation. Coir dust amendment (C2) markedly increased SOC to 1.76% and produced significantly higher shoot and root biomass by 200% over the control (C1). In contrast, neither biofertilizer nor distilled water improved germination or biomass. Both the coir dust control (C2) and the combined BFBF + Rhizobium treatment without requiring coir dust and CF (T8) significantly increased root length by over 30% relative to the low-SOC control (C1). Although the combined biofertilizer application (T8) increased shoot length over C1 by 10%, it remained significantly lower than coir dust control, resulting in reduced biomass when coir dust was absent. Overall, the findings indicate that under extremely low SOC conditions (< 0.5%), neither biofertilizers nor CF can compensate for the foundational benefits provided by adequate SOC. Enhancing soil carbon is essential to maximize the effectiveness of biofertilizers in black gram cultivation under very low SOC conditions.

Keywords: Biofilm biofertilizer, Black gram, Coir dust amendment, Seed germination, Soil organic carbon

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