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Ecological Engineering Through Organic Amendments: Enhancing Pest Regulation, Beneficial Insect Populations, and Rhizosphere Microbial Diversity in Cabbage Ecosystems

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Abstract : The present studies on ecological engineering through soil amendments in cabbage crops for insect pests regulation were conducted at G. B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India. Ten treatments viz., Farm Yard Manure (FYM), Neem cake (NC), Vermicompost (VC), Poultry manure (PM), PM+FYM, NC+VC, NC+PM, VC+FYM, Urea+ SSP+MOP (Standard Check) and Untreated Check were evaluated to study the effect of these amendments on the population of insect pests, natural enemies and the microbial community of the rhizosphere in the cabbage crop ecosystem. The results revealed that most of the cabbage pests, viz., aphids, head borer, gram pod borer, and armyworm, were more prevalent in FYM, followed by PM and NC-treated plots. The best cost-benefit ratio was found in PM + FYM treatment, which was 1: 3.62, while the lowest, 1: 0.97, was found in the VC plot. The population of natural enemies like spiders, coccinellids, syrphids, and other hymenopterans and dipterans was also found to be prominent in organic plots, namely FYM, followed by VC and PM plots. Diversity studies on organic manure-treated plots were also carried out, which revealed a total of nine insect orders (Hymenoptera, Hemiptera, Lepidoptera, Coleoptera, Neuroptera, Diptera, Orthoptera, Dermaptera, Thysanoptera, and one arthropodan class, Arachnida) in different treatments. The Simpson Diversity Index was also studied and found to be maximum in FYM plots. The metagenomic analysis of the rhizosphere microbial community revealed that the highest bacterial count was found in NC+PM plot as compared to standard check and untreated check. The diverse microbial population contributes to soil aggregation and stability. Healthier soil structures can improve water retention, aeration, and root penetration, which are all crucial for crop health. The further analysis also identified a total of 39 bacterial phyla, among which the most abundant were Actinobacteria, Firmicutes, and the SAR324 clade. Actinobacteria and Firmicutes are known for their roles in decomposing organic matter and mineralizing nutrients. Their highest abundance suggests improved nutrient cycling and availability, which can directly enhance plant growth. Hence, organic amendments in cabbage farming can transform the rhizosphere microbiome, reduce pest pressure, and foster populations of beneficial insects, leading to healthier crops and a more sustainable agricultural ecosystem.

Keywords : cabbage ecosystem, organic amendments, rhizosphere microbiome, pest and natural enemy diversity
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