Microbial Augmentation of Low Productive Soil towards Increased Productivity in Organic Farming of Soybean Plants

Abstract

Intensification of crop production through extensive use of agrochemicals has been the major driving force for a quantum leap in crop yield after the green revolution. Over-exploitation of arable lands to feed the rapidly growing world population, has negatively impacted the structure and function of soil by depleting nutrient levels, lowering microbiological diversity, and crop productivity posing a serious threat to global food security. In modern sustainable agriculture, manipulation of soil microbiome has been emerging as a promising environment-friendly strategy to enhance crop yield in damaged arable lands. The potential of residual multi-strain PGP bacterial consortia as effective microbial inoculant to rejuvenate damaged arable land and to improve plant vigour, is yet to be properly explored. In the perspective of West Bengal, India, there has been very few studies. The present investigation was an an endeavour to explore the implications of soil amendment with residual plant-growth promoting (PGP) bacterial consortia. The experiment was conducted on two different types of nutrient-depleted agricultural soil (alluvial soil of Bahadurpur and lateritic soil of Sadaipur) of West Bengal, India. From these two soil samples, three *Bacillus.* spp. and one *Pseudomonas* sp. with multiple PGP traits, were isolated and used to design two novel multi-strain consortia. The impacts of soil augmentation on plant-growth promotion, soil nutrient level upgradation, and resident bacterial community composition were investigated in pot trial conditions growing *Glycine max* (L.) Merill. as the test plant. As per the current study, a significant improvement was achieved in various vegetative and reproductive characteristics of soybean plants, grown in the novel consortia-inoculated field soil, both in vermicompost–amended (SVBC) and vermicompost-non-amended condition (SBC). Analysis of soil nutrient status indicated better acquisition and mobilization of organic carbon, available nitrogen, phosphate, and potassium in the both types of field soil at consortium inoculated conditions. Metagenomic analysis of untreated and treated soil samples revealed improved bacterial diversity and presence of higher number of unique genera in SVBC condition indicating a shift in the resident bacterial community structure, might be due to an improvement in overall soil health, promoting more and more agriculturally beneficial associative bacterial assemblages. The functional genera in the field soil sample in SVBC set-up showed the highest level of enrichment. This unique approach of soil bioaugmentation using the combined treatment of residual PGP consortium and vermicompost to enrich over-used agricultural soil, may emerge as a promising strategy in sustainable cultivation practices.

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