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Identification, Evaluation, and Development of Selected Microbial Consortia for Sustainable Agriculture

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Abstract

In Andhra Pradesh, India, soil samples from various agroclimatic zones were collected and tested for the isolation of useful microorganisms in 2009–2010. Nine microbial strains (Bacillus spp., Streptomyces spp., Azotobacter spp., and Frauteria spp.) were found and given new names based on their efficacy and in vitro compatibility (VBT 01 to VBT 09). Each strain was assessed for its antagonistic activity toward specific pathogens as well as its plant growth promoting efficacy (PGP) in black gramme (Vigna mungo (L.) Hepper). When the black gramme seeds were coated with VBT 09, as opposed to the untreated control (83.2%), pot culture tests found that a higher percentage of seeds germinated (94.7%).

When compared to the control, VBT 09 recorded the longest radical at a maximum length of 8.0 cm (0.53cm). Hydrogen cyanide (HCN), ammonia generation, and hydrolytic enzymes such cellulase, pectinase, protease, and amylase were all measured at varying amounts as PGP features for all strains. In VBT 05, positive HCN production was noted. Macrophomina phaseolina (VBT 03), Sclerotium rolfsii (VBT 07), Fusarium oxysporum (VBT 05), and Rhizoctonia solani all showed antagonistic action (VBT 04). In comparison to the control, the VBT 02 strain strongly inhibited Sclerotium rolfsii's sclerotial bodies (53.8%). However, against Rhizoctonia solani, none of the strains showed sclerotial parasitism.

Shoot length increased significantly in a pot culture experiment to evaluate the consortia effect at various ratios (11.2 cm compared to chemical fertiliser (9.77 cm) and control) (8.51cm). In comparison to the control, the root volume and shoot dry mass were 0.5 cm3 and 0.15 cm3, respectively. Compared to pots treated with chemical fertiliser, consortia-treated pots had a higher total dry mass (0.23g) (0.2g). The group is known as Omega. A field trial is being conducted to assess its effectiveness as a soil conditioner, a plant growth booster, and a disease resistance tool for sugarcane and paddy.

Keywords

Consortia; Mycoparasitism and antagonism; Plant growth promotion; Effective microbes; Streptomyces species; Bacillus species; Azotobacter species; Frauteria species; Rhizobacteria

Introduction

Plant growth-promoting microorganisms (PGPM), which live in and around the rhizosphere of the root, are heterogeneous in nature and include bacteria, fungus, and actinomycetes. PGPM either directly or indirectly increase plant growth and yield [1]. Directly promoting plant development entails mobilising or solubilizing crucial nutrients (phosphorus, potash, zinc, sulphur, and iron) or fixing atmospheric nitrogen for plant uptake. They are also known to produce a number of hormones that encourage plant growth, including ethylene, cytokinins, gibberlic acid, and indole acetic acid [2]. Indirectly, PGPM also lessens the negative impact of phytopathogens.
Although the PGPM's mechanisms of action have not been fully investigated, several potential causes include:

1. Manufacturing of plant growth inhibitors,
2. Symbiotic and asymbiotic N2 fixation [3];
3. Siderophore, antibiotic, and HCN synthesis [4–6];
4. Solubilization of mineral phosphates and other nutrients [7];
5. Substrate competition;
6. 8. Sclerotial and mycoparasitization, 6. Chitinase synthesis,
7. Cellulase, pectinase, protease, and starch hydrolysis. A successful PGPM should also be rhizosperic competent, able to handle biotic and abiotic stressors, and able to colonise in the rhizospere [8].

It has been demonstrated that the development of plants is enhanced by Bacillus spp, Pseudomonas spp, Azospirillum spp, Rhizobium spp, Azotobacter spp, Klebsiella spp, and Serratia spp [9]. Due of their superior field performance, Pseudomonas fluorescens and Bacillus subtilis were in fact included in the pesticide statute in India. However, PGPM's inconsistent and variable performance is a significant barrier that reduces its effectiveness. Agro-climatic conditions that are unfavourable, such as the climate, weather, and soil characteristics, are said to be some of the main obstacles. Consistent performance under stress from a single microbial inoculant is never easy to achieve. More crucially, field conditions cannot always be relied upon to repeat the in vitro results [10].

Numerous recent investigations revealed encouraging PGPM research trends [11–13]. One such innovation is the mixed inoculant (microbial consortia), which interact synergistically, promote plant growth, and subsequently shield it from phytopathogens. In order to evaluate nine efficient PGPM in terms of compatibility, nutrient convertibility/mobility, and antagonistic activity against phytopathogens, Varsha Bioscience and Technology India Pvt Ltd and Telengana University collaborated on this work. Based on the findings, a wettable powder formulation was successfully created that included each of the nine strains in a distinct ratio. The product was given the name Omega, and this article provides the study's findings.

Materials and Procedures:
cultures of microbes:
In the state of Andhra Pradesh, soil samples were taken from the rhizosphere of various crops, including cotton, chillies, rice, bananas, sugarcane, and chickpea. According to the prescribed procedure, collected samples were delivered to the lab. 14 strains of the isolated microbial community were essentially recognised as active microorganisms. Nine efficient microorganisms were chosen and given the numbers VBT 01 through VBT 09 based on their efficacy and in vitro compatibility. The nine bacteria essentially fell into the categories of Bacillus spp, Streptomyces spp, Azotobacter spp, and Frauteria spp.

Test for in vitro seed germination:
After being surface sterilised with 0.1% $HgCl_2$ for three minutes, sorghum seeds (cv CSV 15) were rinsed five times with sterile distilled water. The seeds were then cleaned three times with sterile distilled water after being steeped in 70% ethanol for 1 minute. After being thoroughly washed, the seeds were each submerged for 5 minutes in a 48-hour-old culture of VBT 01 through VBT 09 before being transferred to water-agar plates (agar-1.5%) with 9 seeds per plate and cultured for 4 days at 30°C. As a control, seeds immersed in sterile medium were retained.

Conclusion

Omega with nine useful microorganisms demonstrated that it was advantageous to black gramme as an effective PGPR with good soil conditioning qualities. Additionally, it might shield the plants against specific soil-borne fungi.A variety of diseases, including M. phaseolina, S. rolfsii, F. oxysporum, and R. solani. To better understand the potential mechanisms underlying nutrient mobilisation, biocontrol activity, and plant growth promotion, more research is required. More importantly, research of the efficacy of pesticides on farms are necessary for other crops besides black gramme. As a result, a multi-location study involving the field evaluation of Omega on rice and sugarcane is currently being conducted at four different sites in India.

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