

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) (8.51 cm). 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, gibberic 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 rhizospheric competent, able to handle biotic and abiotic stressors, and able to colonise in the rhizosphere [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

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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 *Frateria* spp.

Test for in vitro seed germination:

After being surface sterilised with 0.1% HgCl₂ 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.

References

1. Hariprasad P, Navya HM, Chandra nayaka S, Niranjana SR (2009) Advantage of using PSIRB over PSRB and IRB to improve plant health of tomato. *Biological control* 50: 307-316.
2. Arshad M, Jr Frankenberger WT (1993) Microbial production of plant growth regulators. In *Soil microbial ecology applications in agricultural and environmental management*. F.B. Metting, Marcel Dekker Inc., New York.
3. Boddey RM, Dobereiner J (1988) Nitrogen fixation associated with grasses and cereals: recent results and perspectives for future research. *Plant Soil* 108: 53-65.
4. Scher FM, Baker R (1982) Effect of *Pseudomonas putida* and a synthetic iron chelator on induction of soil suppressiveness to *Fusarium wilt* pathogens. *Phytopathology* 72: 1567-1573.
5. Shanahan P, O'Sullivan DJ, Simpson P, Glennon JD, O'Gara F (1992) Isolation of 2,4-diacetylphloroglucinol from a fluorescent pseudomonad and investigation of physiological parameters influencing its production. *Appl Environ Microbiol* 58: 353-358.
6. Flaishman MA, Eyal ZA, Zilberstein A, Voisard C, Hass D (1996) Suppression of *Septoria tritici* blotch and leaf rust of wheat by recombinant cyanide producing strains of *Pseudomonas putida*. *Mol Plant microbe Interact* 9: 642-645.
7. Gaur AC (1990) Phosphate solubilising microorganisms as biofertilizers. Omega Scientific Publishers. New Delhi.
8. Cattelan AJ, Hartel PG, Fuhrmann JJ (1999) Screening for plant growth promoting rhizobacteria to promote

- early soybean growth. *Soil Sci Soc Ame J* 63: 1670-1680.
9. Kloepper JW, Lifshitz R, Zablotowicz RM (1989) Free-living bacterial inocula for enhancing crop productivity. *Trends Biotechnol* 7: 39-43.
 10. Chanway CP, Holl FB (1993) First year yield performance of spruce seedlings inoculated with plant growth promoting rhizobacter. *Can J Microbiol* 39:1084-1088.
 11. Esitken A, Hilal E, Yildiz, Sezai Ercisli, Figen Donmez M, et al. (2010) Effects of plant growth promoting bacteria (PGPB) on yield, growth and nutrient contents of organically grown strawberry. *Scientia Horti* 124: 62-66.
 12. Kuldeep J Patel, Anil K Singh, Nareshkumar G, Archana G (2010) Organic acid-producing, phytate-mineralizing rhizobacteria and their effect on growth of pigeon pea (*Cajanus cajan*). *App. Soil Ecol* 44: 252-261.
 13. Madhaiyan M, Poonguzhali S, Bo-Goo Kang, Yun-Jeong Lee, Jong-Bae Chung, et al. (2010) Effect of co-inoculation of methylotrophic *Methylobacterium oryzae* with *Azospirillum brasilense* and *Burkholderia pyrrocinia* on the growth and nutrient uptake of tomato, red pepper and rice. *Plant Soil* 328: 71-82.
 14. Castic P (1977) Glycine metabolism of *Pseudomonas aeruginosa*: Hydrogen cyanide biosynthesis. *J Bacteriol* 130: 826-831.
 15. Cappuccino JC, Sherman N (1992) In: *Microbiology: A Laboratory Manual*, (3rd edn), Benjamin/Cummings Publication Co., New York.
 16. Booth C (1971) Fungal culture media. In *Methods in Microbiology*. Acad Press.
 17. Ammar MS, Louboudy SS, Azab MS, El-Deeb AA, Afifi MM (1995) Pectolytic activities and identities of the fungal flora of Tut Ankh Amon Tomb allowed to grow under Solid State Fermentation (SSF) conditions. *AL-Azhar Bull Sci* 6: 361-374.
 18. Malik CP, Singh MB (1980) *Plant enzymology and Histo-enzymology*. Text manual.
 19. Lim H, Kim Y, Kim S (1991) *Pseudomonas stutzeri* YLP-1 genetic transformation and antifungal mechanism against *Fusarium solani*, an agent of plant root rot. *Appl Environ Microbiol* 57: 510-516.
 20. Kazempour MN (2004) Biological control of *Rhizoctonia solani*, the causal agent of rice sheath blight by antagonistic bacteria in greenhouse and field conditions. *Plant Pathology Journal* 3: 88-96.
 21. Backman P A, Wilson M, Murphy JF (1997) Bacteria for biological control of plant diseases. In: *Environmentally safe approaches to crop disease control*. CRC Lewis Publishers, Boca Raton, Florida.
 22. Arshad MF, Frankenberger WT (1998) Plant growth regulating substances in the rhizosphere: microbial production and functions. *Adv Agron* 62: 45-45.
 23. Cooper R (1959) Bacterial fertilizers in the Soviet Union. *Soils fertility* 22: 327-331.
 24. Kloepper JW (1993) Plant growth-promoting rhizobacteria as biological control agents. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management* 255-274.
 25. Kloepper JW (2003) A review of mechanism for plant growth promotion by PGPR. 6th international workshop, India.
 26. Murphy JF, Zehnder GW, Schuster DJ, Sikora EJ, Polston JE, Kloepper JW (2000) Plant growth-promoting rhizobacterial mediated protection in tomato against tomato mottle virus. *Plant Disease* 84: 779-784.
 27. Bashan, Holguin G (1997) Proposal for division of plant growth promoting rhizobacteria into two classes: biocontrol- PGPBs and PGPB. *Soil Biol Biochem* 30: 1225-1228.
 28. Alagawadi AR, Gaur AC (1992) Inoculation of *Azospirillum brasilense* and phosphate-solubilizing bacteria on yield of sorghum (*Sorghum bicolor* L. Moench). In *Dry Land Trop Agric* 69: 347-50.
 29. Barbieri P, Zanelli T, Galli E, Zanelli G (1986) Wheat inoculation with an *Azospirillum brasilense* Sp6 and some mutants altered in nitrogen fixation and indole-

- 3-acetic acid production. FEMS Microbiol Lett 36: 87-90.
30. Xie H, Pasternak JJ, Glick BR, (1996) Isolation and characterization of mutants of the plant growth promoting rhizobacterium *Pseudomonas putida* GR12-2 that overproduce indoleacetic acid. Curr. Microbiol 32: 67-71.
 31. Fallik E, Sarig S, Okon Y (1994) Morphology and physiology of plant roots associated with *Azospirillum*. *Azospirillum/Plant Associations*. CRC Press, Boca Raton.
 32. Barbieri P, Galli E (1993) Effect of wheat root development of inoculation with an *Azospirillum brasilense* mutant with altered indole-3-acetic acid production. Res Microbiol 144: 69-75.
 33. Dubeikovesky AN, Modokhova EA, Kocheskov VV, Polikarpova FP, Boronin AM (1993) Growth promotion of blackcurrant softwood cuttings by recombinant strain *Pseudomonas fluorescens* BSP53a synthesizing an increased amount of indole-3-acetic acid. Soil Biol Biochem 25: 1211-1221.
 34. Srinivasan M, Peterson DJ, Holl FB (1996) Influence of IAA tempera producing *Bacillus* isolates on the nodulation of *Phaseolus vulgaris* by *Rhizobium etli*. Can J Microbiol 42: 1006-1014.
 35. Raupach G S, Liu L, Murphy JF, Tuzun S, Kloepper JW (1996) Induced systemic resistance in cucumber and tomato against cucumber mosaic cucumovirus using plant growth-promoting rhizobacteria (PGPR). Plant Dis 80: 891-894.
 36. Hasky-Günther K, Hoffmann-Hergarten S, Sikora RA (1998) Resistance
 37. Vidhyasekaran P, Kamala N, Ramanathan A, Rajappan K, Paranidharan V, et al.(2001) Induction of systemic resistance by *Pseudomonas fluorescens* Pf1 against *Xanthomonas oryzae* pv. *oryzae* in rice leaves. Phytoparasitica 29: 155-166.
 38. Viswanathan R, Samiyappan R (2002) Induced systemic resistance by fluorescent pseudomonads against red rot disease of sugarcane caused by *Colletotrichum falcatum*. Crop Protect 21: 1-10.
 39. Lemanceau P, Alabouvette C (1991) Biological control of *Fusarium* diseases by fluorescent *Pseudomonas* and non-pathogenic *Fusarium*. Crop Protec 10: 279-286.
 40. Schippers B (1992) Prospects for management of natural suppressiveness to control soilborne pathogens. Biological control of plant diseases, Progress and Challenges for the future. Plenum Press, New York.
 41. Thomashow LS, Weller DM, Bonsall RF, Pierson LS (1990) Production of the antibiotic phenazine-1-carboxylic acid by fluorescent *Pseudomonas* species in the rhizosphere of wheat. Appl Environ Microbiol 56: 908-912.
 42. Van Loon LC, Bakker P AHM, Pieterse CMJ (1998) Systemic resistance induced by Rhizosphere bacteria. Annu Rev Phytopathol 36: 453-483.
 43. Ramamoorthy V, Samiyappan R (2001) Induction of defence related genes in *Pseudomonas fluorescens* treated chilli plants in response to infection by *Colletotrichum capsici*. J Mycol Plant Pathol 31: 146-155.
 44. Aliferis KA, Jabaji S (2010) Metabolite composition and bioactivity of *Rhizoctonia solani* sclerotial exudates. J Agric Food Chem 58: 7604-7615.
 45. Pidwirny M (2006) Biogeochemical Cycling: Inputs and Outputs of Nutrients to Ecosystems. Fundamentals of Physical Geography, (2nd edn).