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Research Article

EFFECT OF DIFFERENT MICROBIAL INOCULANTS ON YIELD, MICROBIAL POPULATION AND CHEMICAL PROPERTIES IN SOIL OF GROUNDNUT GROWN ON VERTISOL

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Abstract- The experiment was conducted on zinc deficient soil on farmer's field Parbhani, Maharashtra during summer season of 2014 to assess the ability of different microbial inoculants in improving the yield, microbial and chemical properties of soil by taking groundnut as a test crop. Bioinoculants used such as *Burkholderia cepacia, Burkholderia cenocepacia, Pseudomonas fluorescens, Pseudomonas striata, Trichoderma viride, Trichoderma harzianum* and *Bacillus megaterium.* Tenth day after sowing 24 hrs old fresh culture of microbial isolates was inoculated at the rate 10 ml per plot. The results indicated that highest values of actinomycetes and bacterial population were noted in treatment RDF +Rhizobium and *Bacillus megaterium* whereas, fungal population was highest in the RDF+ Rhizobium+ *Trichoderma* sp. treated soil. Among the chemical properties of soil such as pH, EC and $CaCO_3$ after harvest of groundnut showed non-significant results. However, soil organic carbon was also influenced significantly with the seed inoculation of Rhizobium and *Pseudomonas striata* along with RDF as compared to controls.

Keywords- *Groundnut, microbial population,* microbial inoculants.

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Introduction

Groundnut (*Arachis hypogea* L.) is an important oil seed crop and food grain legume. Groundnut cultivation occurs in 108 countries around the world, which is grown in all tropical and subtropical countries. It is a valuable cash crop planted by millions of small farmers because of its economic and nutritional value. It is a predominant oilseed crop of which approximately 53 per cent of total global production is crushed for high quality edible oil, 32 per cent for confectionary consumption and the remaining 15 per cent is used for food and seed production. Groundnut is good source of dietary proteins, minerals and vitamins. Being a legume crop it can fix atmospheric nitrogen and thereby improves soil fertility [10] . India ranks first in respect of area and second in respect of production after China, contributing about 40 per cent of world's production. According to 4th advanced estimates in India area, production and yield of groundnut during 2013-14 was 4.19 million hectares, 5.62 million tones and 1341 kg ha^{-1} and in Maharashtra 0.29 million hectares, 0.36 million tones and 1341 kg ha^{-1} respectively. In Maharashtra total yield of oilseeds during the year 2012-13 was 1394 kg ha^{-1} and during 2013-14 reduced to 1228 kg ha^{-1} and yield of *kharif* and *rabi* oilseeds during 2013-14 was 1271 kg ha^{-1} and 720 kg ha^{-1} [1].

PGPR influenced the plant growth by direct or indirect modes [4-6] Direct modes are production of growth stimulators, improvement in plant nutrient status (release of phosphates and micronutrients from insoluble sources), lowering of the ethylene level in plant, and induction of systemic resistance. Indirect modes of action are production of antibiotics, production of biocontrol agents and degradation of xenobiotics [9]. Numerous microorganisms especially those associated with roots, have the ability to increase plant growth and productivity. Many bacterial enzymes contain zinc in the active centre or in a structurally important site. Bacteria can contribute to metal immobilization by several processes such as precipitation and adsorption [2]. It is well recognized that microbial inoculants constitute an important component of integrated nutrient management system that would lead to sustainable agriculture. Biofertilization is known to help in the expansion of root system and better seed germination[7]. Keeping these points in consideration, field trial was conducted to enhance the yield, microbial and chemical properties in soil using different PGPR in groundnut grown on Vertisol.

Materials and Method

The experiment was conducted at farmer's field in Kehal village, Tq. Jintoor, Dist. Parbhani on Vertisol during summer season of 2014-15 on groundnut. The soil was clayey in texture, moderately alkaline in reaction, low in organic carbon. The treatments comprising inoculation with liquid inoculants of *Bradyrhizobium* and *Bacillus megaterium* (PSB) for Groundnut seed in alone and in combinations. Total eight treatments of microbial inoculants were replicated three times in RBD. The experiment consists of 8 treatments of laboratory tested P and Zn solubilizers T_1 RDF+ *Rhizobium*; T_2 RDF + *Rhizobium* + *Bacillus megaterium*; T_3 RDF + *Rhizobium* + *Burkholderia cepacia*; T_4 RDF + *Rhizobium* + *Burkholderia cenocepacia*; T_5 RDF + *Rhizobium* +*Pseudomonas fluorescens;* T_6 RDF + *Rhizobium*+ *Pseudomonas striata;* T_7 RDF + *Rhizobium* + *Trichoderma viride;* T_8 RDF + *Rhizobium* + *Trichoderma* harzianum. Seed treatment was done before sowing with liquid bioinoculants each @ 50 ml 10 kg^{-1} seed. The crop was raised following recommended agronomic practices. The recommended dose of chemical fertilizers was applied @ 30:60:30 NPK kg ha^{-1} at the time of sowing. Intercultural operations like thinning, weeding, spraying of insecticides, fertilizer application and schedule of irrigation for soybean crop was carefully followed. The crop variety used was TAG 37A. The soil samples were collected after harvest of groundnut for analysis of microbial and chemical properties of soil as per standard procedures. The data obtained was statistically analyzed and appropriately interpreted as per the methods described in "Statistical Methods for Agricultural

Workers" by Panse and Sukhatme, [8].

Results and Discussion

The results narrated in [Table-1] indicated significant impact of different microbial inoculants on dry pod and dry haulm yield of groundnut. Significantly highest dry pod yield and dry haulm yield of groundnut was noted with RDF + *Rhizobium* +*Pseudomonas striata* but treatment RDF+ *Rhizobium*+ *Pseudomonas fluorescens*, RDF + Rhizobium + *Trichoderma viride* and RDF+ *Rhizobium* + *Trichoderma harzianum* were found statistically at par. Lowest biological yields were obtained in control treatment. These results are corroborate with Sable [11] also reported significant increase in grain yield with inoculation with *Rhizobium* + *RDF*.

Table-1 *Effect of different microbial inoculants on dry pod and dry haulm yield of summer groundnut*

Sr. No.	Treatment	Dry Pod yield (q ha^{-1})	Dry Haulm yield (q ha^{-1})
T_1	RDF+*Rhizobium*	23.50	30.73
T_2	T1+*Bacillus megaterium*	24.96	32.19
T_3	T1+*Burkholderia cepacia*	25.63	32.86
T_4	T1+*Burkholderia cenocepacia*	26.67	33.90
T_5	T1+*Pseudomonas fluorescens*	28.43	35.66
T_6	T1+*Pseudomonas striata*	29.10	36.33
T_7	T1+*Trichoderma viride*	28.60	35.83
T_8	T1+*Trichoderma harzianum*	27.83	35.06
	S.E.±	0.62	0.62
	C.D. at 5 %	1.88	2.61
	C.V. %	4.01	3.15

The data given in [Table-2] shows that significant increase in microbial population in soil after harvest of groundnut crop. The population of actinomycetes and fungi were noted significantly highest in RDF +Rhizobium + *Pseudomonas striata*. In case of actinomycetes population treatment RDF + Rhizobium + *Pseudomonas fluorescens*) and Rhizobium + *Trichoderma viride* was found to be at par. In fungi treatment Rhizobium + *Trichoderma viride* was found to be at par with T_6 treatment. Moreover, bacterial population was recorded significantly highest in treatment RDF + Rhizobium + *Pseudomonas striata* which was found to be statistically at par with RDF + Rhizobium + *Burkholderia cenocepacia*, RDF + Rhizobium + *Pseudomonas fluorescens* and RDF + Rhizobium + *Trichoderma harzianum* and lowest value was recorded in treatment RDF + *Rhizobium*. Inoculation of seed with either Zn solubilizers or other nutrient mobilizing culture when get added to the soil multiply and population buildup takes place.

Table-2 *Effect of different microbial inoculants on soil microbial population after harvest of summer groundnut*

Sr. No.	Treatment	Bacteria (CFU X10^{-7} g^{-1})	Actinomycetes (CFU X10^{-5} g^{-1})	Fungi (CFU X 10^{-4} g^{-1})
T_1	RDF+*Rhizobium*	33.81	24.28	1.69
T_2	T1+*Bacillus megaterium*	34.89	28.65	2.84
T_3	T1+*Burkholderia cepacia*	34.67	25.56	1.99
T_4	T1+*Burkholderia cenocepacia*	35.44	25.34	1.97
T_5	T1+*Pseudomonas fluorescens*	35.75	26.44	2.16
T_6	T1+*Pseudomonas striata*	38.59	28.65	3.33
T_7	T1+*Trichoderma viride*	34.75	27.07	3.06
T_8	T1+*Trichoderma harzianum*	37.52	24.50	2.23
	S.E.±	1.06	0.85	0.08
	C.D. at 5 %	3.24	2.59	0.27
	C.V. %	5.27	5.81	6.78
	Initial	35.00	15.5	2.10

Similar results were reported by Ghodpage [3], they found that application of 75% RDF + Amrutpani + biofertilizer @ 3 kg ha^{-1} increased fungal population in cotton. Thakur [12] recorded maximum actinomycetes population in soil with combine use of organic and inorganic source.

The results presented in [Table-3] regarding changes in soil pH, EC and $CaCO_3$ after harvest of groundnut shows non-significant results. However, organic carbon was recorded significantly highest in treatment with inoculation of RDF+ *Rhizobium* + *Pseudomonas striata* and RDF + *Rhizobium* + *Bacillus megaterium*, RDF + *Rhizobium* + *Pseudomonas fluorescens* and RDF + *Rhizobium* +*Trichoderma harzianum* was noted at par and lowest organic carbon was noted in control treatment.

Table-3 *Effect of different microbial inoculants on chemical properties of soil after harvest of summer groundnut*

Sr. No.	Treatment	pH(1:2.5)	EC (dSm^{-1})	$CaCO_3$ (%)	Organic carbon (g kg^{-1})
T_1	RDF+*Rhizobium*	7.98	0.28	35.00	5.01
T_2	T1+*Bacillus megaterium*	7.97	0.25	36.10	5.69
T_3	T1+*Burkholderia cepacia*	7.61	0.26	36.20	5.37
T_4	T1+*Burkholderia cenocepacia*	7.66	0.26	36.00	5.33
T_5	T1+*Pseudomonas fluorescens*	7.57	0.27	36.10	5.75
T_6	T1+*Pseudomonas striata*	7.60	0.25	35.50	5.78
T_7	T1+*Trichoderma viride*	7.68	0.25	36.10	5.57
T_8	T1+*Trichoderma harzianum*	7.69	0.23	36.40	5.60
	S.E.±	0.20	0.02	0.43	0.12
	C.D. at 5 %	NS	NS	NS	0.36
	C.V. %	4.69	14.1	2.10	3.81
	Initial	8.00	0.28	37.00	4.86

Conclusion

The different microbial inoculants increased the dry pod and haulm yield of groundnut. Significantly, highest dry pod and haulm yield of groundnut was noted in inoculated plots with liquid form of *Rhizobium* and *Pseudomonas striata* over other treatments. The significant improvement in microbial population and organic carbon content in soil after harvest of groundnut crop was also noted with inoculation of *Rhizobium* and *Pseudomonas striata* along with recommended dose of fertilizers over control.

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Abbreviations: DAS- Days After Sowing; RDF- Recommended Dose of Fertilizer; PSB- Phosphorus Solubilizing Bacteria.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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