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Influence of different microbial inoculants on biological health of soil and economics in Soybean crop grown on Vertisol

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Abstract
A Field experiment was conducted during summer season of 2014-15 on Research farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to enhance the biological properties of soil and economics of crop using different microbial isolates by using soybean as a test crop. The results emerged out indicated that the soil alkaline phosphatase and acid phosphatase enzyme activity was improved with RDF + *Rhizobium* + *Bacillus megaterium* after harvest of soybean. Whereas, biological properties are improved with the application of RDF along with inoculation of *Rhizobium* + *Trichoderma viride* after harvest of soybean. Economics (GMR, NMR and B:C) of soybean was found highest with *Rhizobium* and *Trichoderma viride* along with recommended dose of fertilizers.

Keywords: Enzyme activity, biological properties, microbial inoculants, soybean

Introduction
Soybean (*Glycine max.* L. Merrill) a grain legume is considered as a wonder crop due to its dual qualities *viz.*, high protein (40-43%) and oil content (20%). Soybean is an important oil seed crop belonging to family *Leguminaceae*, sub family papilionaceae and tribe phaseoleae. It helps in fixing atmospheric nitrogen in soil and improves the soil fertility and productivity. Therefore it is called as 'Gold of soil". It is well known that common Indian diet is deficient in protein both in quality and quantity. In this respect, soybean could be regarded as the boneless meat, as it is rich in protein. In Maharashtra state, soybean crop is grown on an area of 38.08 lakh hectare with total production 30.72 lakh MT with average productivity of 808 kg/ha (Anonymous, 2014) [1]. Under such situations, use of *Rhizobium* and phosphate solubilizing bacteria (PSB) had shown advantage in enhancing soybean productivity. Microbial inoculants are cost effective, eco-friendly and renewable sources of plant nutrients. Plant beneficial living microbial cultures (bio-fertilizers) are supposed to be a safe supplement to chemical fertilizers in order to minimize the ecological disturbance. The biochemical properties of soil have often been proposed as early and sensitive indicators of soil ecosystem health. Activities of soil enzymes indicate the direction and strength of all kinds of biochemical processes in soil and act as key biological indicator of soil. Soil enzymes play an essential role in energy transfer environmental quality, organic matter decomposition, nutrient cycling and crop productivity (Mina *et al*., 2011) [7]. A number of microorganisms are considered important for agriculture to promote better enzyme activity and biological health of soil. Since the information on soybean to inoculation with different microbial inoculants is meagre. Summer soybean has a tremendous potential to be used as seed for *kharif* season. Keeping these points in consideration, field trial was conducted to enhance the enzyme activity and biological properties in soil using different microbial cultures in soybean grown on Vertisol.

Material and methods
The field experiment was carried out at Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on Vertisol during 2014-15. The initial soil pH was 7.96, EC- 0.28 dSm^{-1}, organic carbon-5.26 g kg^{-1}, $CaCO_3$- 37.0 g kg^{-1}. Initial enzymatic activity such as acid phosphatase activity - 44.56 µg g^{-1}, alkaline phophatase activity - 112 µg g^{-1} and dehydrogenase activity - 56.09 µg g^{-1}. Whereas, biological properties as bacterial population 15.3 - CFU x 10^7 g^{-1} soil, fungi - 3.3 CFU x 10^4 g^{-1} soil and actinomycetes - 26.4 CFU x 10^5 g^{-1} soil. The treatments comprising inoculation with liquid inoculants of *Bradyrhizobium* and *Bacillus megaterium* (PSB) for soybean, used 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* + *Burkholderia cepacia*; T_3 RDF + *Rhizobium* + *Burkholderia cenocepacia*; T_4 RDF + *Rhizobium* +*Pseudomonas fluorescens;* T_5 RDF + *Rhizobium* + *Pseudomonas striata;* T_6 RDF + *Rhizobium* + *Trichoderma viride;* T_7 RDF + *Rhizobium* + *Trichoderma harzianum;* T_8 RDF + *Rhizobium* + *Bacillus megaterium.* 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 MAUS- 162. The soil samples were collected after harvest of soybean for analysis of enzyme activity and biological properties of soil. Enzyme activity was determined as per the method developed by Tabatabai and Bremner (1969). A biological property was determined by serial dilution plate technique for isolation and enumeration of soil fungi, actinomycetes and bacteria as per procedure given by Dhingra and Sinclair, (1993) [3]. The results obtained were statistically analyzed and appropriately interpreted as per the methods described in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme (1985) [10]. Appropriate Standard Error (S.E.) and critical differences (C.D.) at 5% level were worked out as and when necessary.

Results and Discussion

Enzyme activity of soil

The data presented in Table 1 indicates that the enzyme activity of soil after harvest of soybean crop. Results indicated that alkaline phosphatase activity was noted significantly highest in treatment RDF + *Rhizobium* + *Bacillus megaterium* over rest of treatments. It was closely at par with RDF + *Rhizobium* + *Pseudomonas fluorescens*. Whereas, acid phosphatase activity was also noted maximum in RDF + *Rhizobium* + *Bacillus megaterium*. But it was found at par with the treatment RDF + *Rhizobium* + *Pseudomonas fluorescens*, RDF + *Rhizobium* + *Pseudomonas striata* and RDF + *Rhizobium* + *Trichoderma viride*. However, dehydrogenase activity was recorded significantly highest in with treatment RDF + *Rhizobium* + *Trichoderma viride* which was at par with treatment RDF + *Rhizobium* + *Pseudomonas fluorescens* and lowest enzyme activity of alkaline phosphatase, acid phosphatase and dehydrogenase was noted in treatment RDF + *Rhizobium*. These results are corroborate with the reports of Panwar *et al.* (2003) [11] who noticed that increase in dehydrogenase and phosphates activity in soil due to inoculation of microbial cultures which might be due to increased microbial population in soil because of the presence of greater organic substances as a result of rhizo deposition and leaf fall. Dotaniya *et al.* (2014) [4] reported the maximum DHA (Dehydrogenase activity) was at 75 DAS. It is might be due to vigorous growth of the crop at 75 DAS and root exudation also more in this period. Further, Nihorimbere *et al.*, (2011) [8] reported more microbial activities and increase in the DHA in rhizosphere due to more availability of food material for its growth.

Soil microbial population after harvest of soybean.

The scrutiny of the data given in Table 2 showed that significant increase in microbial population in soil after harvest of soybean crop. The microbial population of actinomycetes and fungi were noted significantly highest in treatment RDF + *Rhizobium* + *Trichoderma viride* and was found at par with RDF + *Rhizobium* + *Trichoderma harzianum*. However, bacterial population was recorded significantly highest value in treatment RDF + *Rhizobium* + *Bacillus megaterium* which was found to be at par with RDF + *Rhizobium* + *Pseudomonas fluorescens* and RDF + *Rhizobium* + *Pseudomonas striata*. These results are also corresponds with the findings of Sarawgi and Tiwari (2012) [13] who reported that seed treatment with biofertilizers had their significant effect on microbial population in conjugation with P application in soybean field. These results are also in agreement with Kundu and Gaur (1980) [6] and Qureshi *et al.*, (2005) [12]. Similarly, Gupta *et al*., (1992) [5] revealed that the maximum population of fungi and actinomycetes were attained at 60 DAS by treating the seeds with *Aspergillus awamori* and found significantly superior over all treatments which were followed by *Bacillus Polymixa*. Increase of fungal population may be due to growth promoting substances secreted during crop growth period.

Economics of soybean.

The data narrated in Table 3 revealed that gross monetary return and net monetary return of soybean crop obtained was highest in treatment RDF + *Rhizobium* + *Trichoderma viride* followed by treatments RDF + *Rhizobium* + *Pseudomonas fluorescens* and *Rhizobium* + *Burkholderia cenocepacia*. Whereas, Benefit cost ratio of soybean was noted in treatment RDF+ *Rhizobium* + *Trichoderma viride* followed by RDF + *Rhizobium* + *Pseudomonas fluorescens*, RDF + Rhizobium + *Burkholderia cenocepacia* and RDF + *Rhizobium* + *Pseudomonas striata* these treatments were found to be at par with each other. Similar results were reported by Pannase *et al*., (2001) [9] who noticed that application of 75% NPK + 5t/ha FYM + inoculation with *Rhizobium* + *PSB* gave highest gross return, net return and benefit cost ratio over other treatments followed by 100% NPK in combination with *Rhizobium* and *PSB*. It can be inferred that application of 100% NPK dose of inorganic fertilizer along with biofertilizers proved to be more remunerative than 100% NPK alone. Recently, Singh and Kushwaha (2013) [14] reported that the residual effect of organic manure and inorganic fertilizers which were used in previous soybean crop with 100% NPK to wheat has been given maximum net monetary returns (NMR) and B: C ratio residual effect of FYM @ 10 t ha^{-1} + 50 % NPK and direct effect of 100% NPK under soybean-wheat cropping sequence.

Table 1: Effect of different microbial inoculants on enzyme activities in soil after harvest of summer soybean

Tr. No.	Treatment	Enzyme activities in soil after harvest of Soybean(µg g^{-1})		
		Alkaline phosphatase	Acid Phosphatase	Dehydrogenase
T_1	RDF+ *Rhizobium*	99.6	44.6	37.03
T_2	T_1+*Burkholderia cepacia*	114.6	52.6	39.6
T_3	T_1+*Burkholderia cenocepacia*	106.3	48.1	41.5
T_4	T_1+ *Pseudomonas fluorescens*	118.3	53.5	44.1
T_5	T_1+*Pseudomonas striata*	120.3	55.5	41.0
T_6	T_1+*Trichoderma viride*	118.0	53.5	46.1
T_7	T_1+*Trichoderma harzianum*	115.6	52.8	42.4
T_8	T_1+*Bacillus megaterium*	131.5	57.1	42.1
	S.E. ±	2.29	1.35	0.58
	C.D. at 5 %	7.04	4.13	1.78
	C.V. %	3.44	4.47	2.42
	Initial value	112	44.5	42.1

Table 2: Effect of phosphorus and zinc solubilizing acidifiers on soil microbial population after harvest of summer soybean

Sr. No.	Treatment	Bacteria (CFU $X10^{-7}$)	Actinomycetes (CFU $X10^{-5}$)	Fungi(CFU X 10^{-4})
T_1	RDF+*Rhizobium*	24.6	14.3	3.00
T_2	T_1+*Burkholderia cepacia*	29.0	15.0	3.67
T_3	T_1+*Burkholderia cenocepacia*	28.6	15.6	3.33
T_4	T_1+ *Pseudomonas fluorescens*	32.3	16.0	4.33
T_5	T_1+*Pseudomonas striata*	31.0	17.3	5.00
T_6	T_1+*Trichoderma viride*	28.0	24.0	6.67
T_7	T_1+*Trichoderma harzianum*	27.6	21.0	5.66
T_8	T_1+*Bacillus megaterium*	36.0	16.1	4.00
	S.E.±	1.44	1.35	0.63
	C.D. at 5 %	4.42	4.15	1.93
	C.V. %	8.35	13.5	24.5
	Initial value	15.3	23.4	3.3

Table 3: Effect of phosphorus and zinc solubilizing acidifiers on economics of summer soybean

Sr. No.	Treatment	Cost of cultivation (Rs ha^{-1})	Gross monetary return (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	B:C
T_1	RDF+*Rhizobium*	31617	54110	22493	1.71
T_2	T_1+*Burkholderia cepacia*	31817	54751	22934	1.72
T_3	T_1+*Burkholderia cenocepacia*	31817	59605	27788	1.87
T_4	T_1+ *Pseudomonas fluorescens*	31817	60958	29141	1.92
T_5	T_1+*Pseudomonas striata*	31817	58963	27146	1.85
T_6	T_1+*Trichoderma viride*	31817	64371	32221	2.01
T_7	T_1+*Trichoderma harzianum*	31817	58531	26714	1.84
T_8	T_1+*Bacillus megaterium*	31817	53188	20671	1.66
	S.E. ±	-	2005	2005	0.08
	C.D. at 5 %	-	5916	5916	0.23
	C.V. %	-	11.68	15.88	11.68

Conclusions

On the basis of this present study it may be concluded that application of RDF + *Rhizobium*+ *Bacillus megaterium* significantly improved acid and alkaline phosphatase in soil. But dehydrogenase activity was noted more with RDF + *Rhizobium* + *Trichoderma viride* treated soil. The soil microbial population after harvest of soybean crop was also increased with *Rhizobium* and PSB along with recommended dose of fertilizers. Economics (GMR, NMR and B: C) of soybean also increased with *Rhizobium* and *Trichoderma viride* along with recommended dose of fertilizers.

References

1. Anonymous. Estimates of area, productivity and production of soybean in, 2014.
2. India during *kharif*. 2014. *www.sopa.org/crop-po.doc*
3. Dhingra OP, Sinclair IB. Basic plant pathology methods. CBS publisher, New Delhi, 1993, 179-180.
4. Dotaniya ML, Kushwah SK, Rajendra S. Rhizosphere effect of kharif crops on phosphatase and dehydrogenase activities in Typic Halpluster. Natl. Acad. Sci. Lett., 2014; 37c2:103-106.
5. Gupta RD, Bharadwaj KKR. Phosphotases and urease enzymatic activities in some soil profiles of North-West Himalayas. J. Indian Soc. Soil Sci. 1992; 38:756-759.
6. Kundu BS, Gaur AC. Establishment of nitrogen fixing and phosphate solubilizing bacteria in Rhizosphere and their effect on yield and nutrient uptake of Wheat crop. Plant and Soil. 1980; 57:223-230.
7. Mina U, Chaoudhary A, Kamra A. Effect of *Bt* cotton on enzymes activity and microorganisms in rhizosphere. J Agric. Sci. 2011; 3:96-104.
8. Nihorimbere V, Ongena M, Smargiaji M. Beneficial effect of rhizosphere microbial community for plant growth and health. Biotechnol. Agron S.C. Environ. 2011; 5(2):327-337
9. Pannase SK, Sharma RS, Singh O. Economy in soybean (*Glycine max L.*) cultivation through zero tillage and

biofertilizers. J. Oilseed Res. 2001; 18:85-88.
10. Panse UG, Sukhatme PV. Statistical Methods for Agricultural Workers. I.C.A.R. Pub., New Delhi. 1985, 600-604
11. Panwar J, Aseri GK, Yadav BK. Dehyrogenase and phosphates activities rhizosphere of different plant species of arid region. *Geobios.* 2003; 30:188-190.
12. Qureshi AA, Narayanasamy G. (Residual effect of phosphate rocks on the dry matter yield and P uptake of mustard and wheat crops. J Indian Soc. Soil. Sci. 2005; 53(1):132-134.
13. Sarawagi SK, Tiwari MP. Effect of Phosphorus application along with *PSB, Rhizobium* and VAM on P fractionation and productivity of soybean (*Glycine max*), Indian J. Agron. 2012; 57(1):55-60.
14. Singh N, Kushwaha HS. Residual impact in soybean-wheat system under irrigated condition of Bundelkhand. *Ann. Agric. Res*., 2013; 34(2):149-155.
15. Tabatabai MA, Bremner JM. Use of *P. nitrophenyl* phosphate for assay of soil phosphates activity. Soil Biol. Biochem. 1970; 1:301-307.