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Evaluation of novel bio formulation for yield enhancement in soybean

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Abstract
The field experiment was conducted in field at Regional Research Center, Amravati, Maharashtra during *kharif* season in 2022-23. The experiment was laid out in Randomized block design with three replications. The treatment combination comprised of seven *viz*., Control, RDF only, 75% RDF, 75% RDF + Bio Zn, 75% RDF + Bio NPK, 75% RDF + Bio Zn + Bio NPK, 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing). Sowing of Soybean was done by dibbling. The observation on dry matter was recorded at 30 DAS, 45 DAS and 60 DAS, CGR and RGR on 30-45 DAS and 45-60 DAS. The observation on Yield attributes *viz*., branches per plant, pods per plant, seed index, seed yield kg/ha, straw yield kg/ha, biological yield and harvest index was recorded at the time of harvesting. Maximum values of Yield and Yield attributes *viz*., branches per plant, pods per plant, seed index, seed yield kg/ha, straw yield kg/ha, biological yield and harvest index was observed significantly superior with the application of 75% RDF + Bio Zn + Bio NPK, 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing).

Keywords: Soybean, Bioformulations, Nutrient uptake, *Burkholderia arboris*

Introduction
Recent improvements in the biofertilizers have shifted the focus of modern agriculture towards environmentally friendly sustainable agricultural practices which are known to reduce the dependence on chemical fertilizers and in future it is expected to offer the Plants need macro and micronutrients for their growth and development. Individual application of each of the bioinoculants would be expensive and laborious. Hence, development of consortia with consistent efficiency under field conditions and longer shelf life will pave way for successful commercialization of this technology. Therefore, bioinoculants consisting of biofertilizer strains capable of mobilizing N, P and K nutrients as a single inoculant with enhanced shelf-life will be useful technology in present agriculture. Among the soil bacteria, diazotrophs such as Gluconacetobacter and Azospirillum are found beneficial to crops which belong to Gramineae family (Raja *et al*., 2006) [8]. These are most commonly applied for fixing atmospheric nitrogen to enhance its availability and uptake by plants for their growth and development. In order to achieve an increased beneficial effect of these diazotrophs and other nutrient mobilizing microorganisms on growth and yield enhancement (Jain *et al*., 2012) [4]. Microbial consortium is a combination of more than two beneficial microorganisms and is preferred as consortial inoculation performs better than single inoculations (Alagawadi and Gaur, 1998) [1] due to their synergistic effect in consortia. Earlier studies conducted on the use of microbial consortia in different combinations of inoculants (Jayashree and Jagadeesh, 2017 [5]; Vijaykumar and Brahmaprakash, 2018 [12]) reported enhanced growth and yield of crops inoculated. However, studies on consortia formulated in different carriers and their effect on soybean is needed. Hence, this investigation was conducted to observe the effects of two microbial consortia each consisting of Bio NPK and Bio Zn.

Materials and Methods
The field experiment was conducted in field at Regional Research Center, Amravati, Maharashtra during *kharif* season in 2022-23. The topography of experiment site was fairly

uniform, leveled and have medium black soil in texture having pH 7.52, organic carbon 0.45%. bulk density 1.46 g cm^3 and available N, P_2O_5, K_2O: 212, 18, 342 kg ha^{-1} respectively. The experiment was laid out in Randomized block design with three replications. The treatment combination comprised of seven *viz*., Control, RDF only, 75% RDF, 75% RDF + Bio Zn, 75% RDF + Bio NPK, 75% RDF + Bio Zn + Bio NPK, 75% RDF + Rhizobium + MDSR14 + 12c (12c= Burkholderia arboris-High P solubilizing).

Sowing of Soybean was done by dibbling. The net plot size was 5.0 m x 2.7 m. Crop was sown in first week of July and harvest in second week of October. Five plants were taken for recording growth parameters. The seed yield was taken plot wise and converted into kg ha^{-1}. The observation on dry matter was recorded at 30 DAS, 45 DAS and 60 DAS, CGR and RGR on 30-45 DAS and 45-60 DAS. The observation on Yield attributes *viz*., branches per plant, pods per plant, seed index, seed yield kg/ha, straw yield kg/ha, Biological yield and harvest index was recorded at the time of harvesting. Data were analysed as per the statistical methods given by Panse and Sukhatme (1967) [6].

Results and Discussion

Bioformulations on number of nodules and fresh and dry weight of nodules

Number of nodules, fresh and dry weight of nodules as influenced by novel bioformulations is presented in Table 1. Significantly highest number of nodules per plant (44.33), fresh weight of nodules (300.16 mg) and dry weight of nodules (110.45 mg) was found in treatment with application 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) at full booming stage (R2) as compared to other treatments. Whereas, significantly lower number of nodules (14.0), fresh weight of nodules (88.61 mg) and dry weight of nodules (33.95 mg) was recorded in control. Similarly at initial seed filling stage (R5) stage, same trend was noticed. The higher nodules and dry weight which might be due to greater availability of nutrients in the soil and better nodulation under the influence of inoculation (Rhizobium and phosphate solubilizing bacteria) resulted in better growth and development which might be attributed to better mobilization of phosphorus and might be increased number of nodules and dry weight. These findings are in accordance with the results of Devi *et al*. (2013) [2], Jaga and Sharma (2015) [3] and Somanagouda *et at*. (2024) [11] reported in soybean.

Table 1: Effect of Bioformulation on Nunber of root nodules, fresh and dry weight of nodules at R2 and R5 stage of Soybean

Treatment	Nodule parameters at R2			Nodule parameters at R5		
	Numbers	Fresh weight (mg)	Dry weight (mg)	Numbers	Fresh weight (mg)	Dry weight (mg)
Control	14.00	88.61	33.95	7.33	33.80	11.75
RDF only	17.67	111.87	43.19	10.00	51.39	16.36
75% RDF	15.00	92.19	36.63	9.00	46.63	15.06
75% RDF + Bio Zn	17.33	110.65	45.07	10.00	52.68	17.11
75% RDF + Bio NPK	33.67	219.91	86.35	11.33	56.63	18.36
75% RDF + Bio Zn + Bio NPK	40.67	266.63	101.09	13.67	71.38	23.72
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	44.33	300.16	110.45	15.00	80.15	26.98
S.E(m)+	1.11	9.96	3.06	0.74	4.91	2.21
CD (P=0.05)	3.42	30.68	9.43	2.29	15.13	6.81

Bioformulations on plant dry weight, CGR and RGR

Data presented in Table 2 revealed that, significantly highest dry matter accumulation per plant at all growth stages was recorded in treatment 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) i.e. 3.65 g, 6.48 g and 12.46 g at 30 DAS, 45 DAS and 60 DAS respectively. It is might be due to the favorable effect of microbial consortia along with RDF on the availability of nutrients to the crop. Somanagouda *et at*. (2024) [11] also reported similar results. The lowest dry matter accumulation per plant at all growth stages was recorded in cotrol i.e. 2.32 g, 4.09 g, 10.10 g at 30 DAS, 45 DAS and 60 DAS respectively. Same trend was recorded in respect of CGR at 30-45 and 45-60 DAS and were found to be 8.49 and 17.94 g/m2/day respectively. Maximum RGR at 30-45 DAS was noticed in treatment application of 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) (0.05 g/g/day).

Table 2: Effect of Bioformulation on Plant dry weight (g), CGR, RGR as influenced by different treatments in soybean

Treatment	Plant dry weight (g)			CGR (g/m2/day)		RGR (g/g/day)	
	30 DAS	45 DAS	60 DAS	30-45 DAS	45-60 DAS	30-45 DAS	45-60 DAS
Control	2.32	4.09	10.10	5.30	18.02	0.05	0.07
RDF only	3.26	5.08	10.35	5.45	15.82	0.04	0.06
75% RDF	2.48	4.79	10.31	6.93	16.58	0.05	0.06
75% RDF + Bio Zn	2.90	5.09	10.77	6.57	17.06	0.04	0.06
75% RDF + Bio NPK	3.10	5.19	10.86	6.26	17.02	0.04	0.06
75% RDF + Bio Zn + Bio NPK	3.42	5.41	11.20	5.99	17.35	0.04	0.06
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	3.65	6.48	12.46	8.49	17.94	0.05	0.05
S.E(m)+	0.12	0.26	0.40	0.82	1.50	--	--
CD (P=0.05)	0.38	0.80	1.24	NS	NS	--	--

Bioformulations on yield and yield parameters

Result depicted in Table 3 shows that inorganic and bioinoculant doses as well as their combinations significantly affect growth attributes *viz*., seed yield kg/ha, straw yield kg/ha, pods per plant. Significantly no difference was observed in respect of number of branches per plant and seed index. The application of 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) gave higher values in seed yield (2142 kg/ha), straw yield (2740 kg/ha), pods per plant (25.80)., seed index (11.47) and biological yield (4882 kg/ha). This might be due to the combined application of inorganic fertilizer and bioinoculant which increased nutrients availability, photosynthetic activity, chlorophyll formation, nitrogen metabolism in plants which ultimately improving plant growth and yield. Similar beneficial combined effect of inorganic and bio-inoculant on growth and yield parameter was also recorded by Somanagouda *et. al*, (2023) [10] and Jaga and Sharma (2015) [3]. Branches per plant (2.33) and harvest index (46.77) was highest in application of 75% RDF + Bio Zn + Bio NPK and 75% RDF + Bio NPK respectively.

Table 3: Effect of Bioformulation on Number of Branches-1, Number of pods-1, Test weight (g), Seed yield (kg-1), Straw yield (kg-1), Biological (kg/ha) and Harvest Index (%) as influenced by different treatments in soybean

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Branches /plant	Pods/ plant	Seed index	Biological yield (kg/ha)	HI (%)
Control	1293	1691	1.33	14.60	10.84	2984	43.36
RDF only	1884	2374	1.60	17.53	11.19	4258	44.25
75% RDF	1437	1739	1.87	16.53	10.97	3176	45.25
75% RDF + Bio Zn	1898	2162	1.87	20.73	11.26	4060	46.77
75% RDF + Bio NPK	2015	2377	1.80	22.53	11.32	4392	45.88
75% RDF + Bio Zn + Bio NPK	2128	2568	2.33	23.33	11.38	4696	45.26
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	2142	2740	2.00	25.80	11.47	4882	43.86
S.E(m)±	71.21	91.56	0.22	1.17	0.54		
CD (P=0.05)	219.41	282.12	NS	3.60	NS		

Bioformulations on availability of nutrients

Regarding the availability of nutrient status in soil before sowing of crop, 186.25 Kg/ha N, 23.38 Kg/ha P2O5, 392.31 kg K2O, 0.70 ppm Zn and 5.17 ppm Fe was observed in initial soil sample. After harvesting of soybean crop, significantly highest available N, P2O5 and K2Okg/ha was noticed with the application of 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) i.e. 262.95, 29.04 Kg/ha and 470.08 respectively. Same trend was observed in Zn and Fe also. Application of 75% RDF + Bio Zn + Bio NPK i.e. 1.08 and 5.96 ppm respectively. Somanagouda *et. al*, (2023) [10] also reported increase in nutrients uptake by application of RDF, Bio-NPK, Bio-Zn and inoculation of Rhizobium + MDSR14 + 12c together with the higher yield which ultimately leads to higher nutrients availability in the soil.

Table 4: Effect of Bioformulation on available nutrient status in soil as influenced by different treatments in soybean

Treatment	N (Kg/ha)	P2O5 (Kg/ha)	K2O (Kg/ha)	Zn (ppm)	Fe (ppm)
Control	194.08	19.81	412.36	0.75	5.25
RDF only	244.59	26.26	445.33	1.01	5.43
75% RDF	243.47	25.53	430.41	0.96	5.82
75% RDF + Bio Zn	246.24	27.18	447.12	0.85	5.78
75% RDF + Bio NPK	251.28	27.20	451.84	1.06	5.96
75% RDF + Bio Zn + Bio NPK	254.28	28.03	457.30	0.94	5.85
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	262.95	29.04	470.08	1.08	5.96
S.E(m)±	9.38	0.97	10.78	0.03	0.20
CD (P=0.05)	28.90	3.00	33.22	0.08	NS
Initial Nutrient Status in soil	186.253	23.389	392.314	0.70	5.17

Bioformulations on uptake of nutrients

Regarding uptake of nutrient by soybean, significantly highest N, P, K, Zn and Fe uptake was observed with the application of 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing). The uptake of N, P, K, Zn and Fe increase with the application of microbial consortium were also observed by Pradip Kumar and Sharma (2018) [7].

Table 5: Effect of Bioformulation on nutrient uptake as influenced by different treatments in soybean

Treatment	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Zn (g/ha)	Fe (g/ha)
Control	92.48	9.73	61.49	1098.30	1399.93
RDF only	135.13	14.93	92.76	1696.59	2257.89
75% RDF	108.13	10.98	71.20	1439.02	1536.42
75% RDF + Bio Zn	140.97	14.98	120.35	2159.77	2079.49
75% RDF + Bio NPK	150.82	16.55	132.74	2013.94	2660.49
75% RDF + Bio Zn + Bio NPK	169.21	21.30	151.89	3010.44	3050.33
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	181.37	25.74	155.81	2582.26	3418.66
SE(m)±	8.04	0.84	7.13	92.68	96.27
CD (P=0.05)	24.77	2.59	21.98	285.56	296.62
Initial Nutrient Status in soil	186.253	23.389	392.314	0.70	5.17

Bioformulations on economics

Economics of different treatments was recorded depicted in table 6. Lowest cost of cultivation was noticed in Control plot while highest GMR, NMR and B:C ratio was observed in treatment 75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) i.e. Rs. 96210, Rs. 58463 and 2.55 respectively. The similar results were close conformity with findings of Sarawgi *et al*. (2012) [9] and Somanagouda *et. al*, (2023) [10]

Table 6: Economics as influenced by different treatments in soybean

Treatment	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Control	34619	58141	23522	1.68
RDF only	46564	84580	38015	1.82
75% RDF	35790	64385	28594	1.80
75% RDF + Bio Zn	37868	84859	46991	2.24
75% RDF + Bio NPK	38143	90224	52081	2.37
75% RDF + Bio Zn + Bio NPK	39141	95355	56214	2.43
75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing)	37746	96210	58463	2.55
S.E(m)+	297	3186	2958	--
CD (P=0.05)	917	9816	9116	--

Conclusion

It may be concluded from the present study that the combined application of inorganic fertilizer and dual inoculation (75% RDF + Rhizobium + MDSR14 + 12c (12c= *Burkholderia arboris*-High P solubilizing) was found to be beneficial in increasing the productivity of soybean, availability of nutrients and uptake of nutrients by the crop.

References

1. Alagawadi AR, Gaur AC. Associative effect of Rhizobium and phosphate solubilising bacteria on the yield and nutrient uptake of chickpea. Plant Soil. 1988;105:241-246.
2. Devi NK, Singh TB, Singh H, Singh NB, Diana S. Influence of inorganic, biological and organic manures on nodulation and yield of soybean [Glycine max (L.) Merrill.] and soil properties. Aust J Crop Sci. 2013;9(7):1047-1145.
3. Jaga PK, Sharma S. Effect of bio-fertilizer and fertilizers on productivity of soybean. Ann Plant Soil Res. 2015;17(2):171-174.
4. Jain A, Singh S, Sharma BK, Singh HB. Microbial consortium mediated reprogramming of defence network in pea to enhance tolerance against *Sclerotina sclerotiorum*. J Appl Microbiol. 2012; 112:537-550.
5. Jayashree C, Jagadeesh KS. Testing the effect of the microbial consortium on growth of vegetable seedlings in a farmer's nursery. Int J Microbiol Appl Sci. 2017;6(2):1636-1369.
6. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research. 1967; 328p.
7. Kumar P, Sharma HB. Effect of integrated nutrient management on yield, quality and nutrient uptake of soybean (*Glycine max*). Ann Plant Soil Res. 2018;20(1):57-60.
8. Raja P, Uma S, Gopal H, Govindarajan K. Impact of bio inoculants on rice root exudates, biological nitrogen fixation and plant growth. J Biol Sci. 2006;6(5):815-823.
9. Sarawgi SK, Sharma GK, Rajput RS. Effect of phosphorus and biofertilizers on microbial activity, yield and economics of soybean in Vertisol. Ann Plant Soil Res. 2008;10(1):44-47.
10. Somanagouda G, Huilgol S, Channakeshava R, Naidu GK, Banu Harshiya, Salkinkop SR. Response of soybean to novel bio formulation on growth and yield enhancement in soybean. J Oilseed Res. 2023;40:55-56.
11. Somanagouda G, Channakeshava R, Huilgol SN, Naidu GK, Banu H, Arabhanvi F. Influence of Bioformulations on Productivity, Profitability and Quality in Soybean under Rainfed Condition of Northern Transition Zone of Karnataka. Legume Res. 2024. DOI: 10.18805/LR-5270.
12. Vijaykumar G, Brahmaprakash GP, Krishna NL, Mudalagiriyappa. Screening of the selected formulations of a microbial consortium for their effectiveness on the growth of finger millet (*Eleusine coracana* L. Gaertn.). J Pharmacogn Phytochem. 2020;9(2):1-9.