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Nutrient Content and Uptake by Soybean (*Glycine max* L. Merril) as Influenced by use of Enriched Compost and Biofertilizers

Kamlesh Yadav, S.C. Meena*, Gajanand Jat, R.H. Meena and Atul Dhansil

Department of Soil Science and Agricultural Chemistry
Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

**Corresponding author*

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The field investigation was carried out at Agronomy Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur, to the evaluate influence of combined use of enriched compost and biofertilizers soybean nutrition grown under typic *haplustepts* clay loam soil. The results obtained from field investigation indicated a significant improvement in content and uptake of micro and macro nutrient. The data indicates that application of enriched compost (5 t) ha^{-1}along with *Rhizobium* + PSB recorded significant improvement in N, P_2O_5,K_2O, Zn, Cu, Fe and Mn content and uptake over control after harvest of soybean crop. The treatment enriched compost (4 t) ha^{-1} along with *Rhizobium* + PSB, enriched compost (5 t) ha^{-1} + *Rhizobium* (T_8) and enriched compost (5 t) ha^{-1}+ PSB (T_9) were found statistically at par with enriched compost (5 t) ha^{-1} along with *Rhizobium* + PSB (T_{10}) in respect to N, P_2O_5, K_2O, Zn, Cu, Fe and Mn content.

Introduction

India has a prominent position on oilseed map of the world, both in respect to area and production. In terms of acreage, production and economic value, oilseeds are second only to food grains. India is the 4th largest edible oil economy in the world after USA, China & Brazil and contributes about 10 per cent of the world oilseeds production, 6-7% of the global production of vegetable oil, and nearly 7 percent of protein meal. Soybean [*Glycine max* (L.) Wilczek] is a globally important oilseed crop and source of high-quality protein for human consumption, used as fodder for animal and is also important in improved crop rotation systems (Manyong *et al.*, 1996; Carsky *et al.*, 1997).Soils having low concentrations of plant available nutrients and AOC, alkaline pH, low EC values, and low soil enzyme activity generally gives low yields of crops (Li *et al.*, 2017)**.**The element phosphorus plays a crucial role in plant development and yield of crops. The region of experimentation had medium phosphorus availability which may be due to the fixation of phosphorus under alkaline condition and this leads to the reduction in decrease in crop yields as reported by Ghosal *et al.*, 2012. The organic manure is considered as balanced nutrient source because it has both macro and micro nutrients (Rekha *et al.,* 2018). Rock phosphate (RP) is a natural P source and could be used as an alternative to chemical phosphatic fertilizers, but it is only soluble under acidic conditions and is not applicable to alkaline soils (Caravaca *et al.,* 2004). Recently, RP solubilization with the use of microbes having phosphate solubilizing ability is gaining more attention (Gyaneshwar *et al.*, 2002; Vassilev *et al.*, 2006). In this regard, phosphate-solubilizing bacteria could be utilized for the solubilization of RP as bacterial solubilization is more efficient than fungi and could easily be utilized for industrial application (Yadav *et al.,* 2017). RP along with phosphate-solubilizing bacteria utilized as P source in alkaline soils. However, the efficiency of bacteria to solubilize RP providing an easily available nutrient source for microbes such as organic fertilizer produced through composting. It has been well known that combined application of RP, phosphate solubilizing bacteria, and organic fertilizer resulted in better agronomic efficiency than chemical lphosphatic fertilizers when applied in equal amounts of total P_2O_5 basis (Yadav *et al.*, 2017).Recently, interest has been developed in compound fertilizers composed of suitable phosphate solubilizing bacteria, organic matter, and RP. Additionally, the organic matter in the form of organic fertilizers improves soil physico-chemical properties and increases the amount of active organic carbon, thereby improving soil quality and soil vitality (Biau *et al.*, 2012). However, sole application of organic fertilizers cannot support food production from poor/less fertile soils for the world population which is increasing at an alarming rate.

Materials and Methods

The experiment was conducted at Agronomy, Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) in *kharif* 2018 on sandy clay loam soil which is slightlyalkaline in nature comprised of 10 treatments, only RDF, Enriched compost (3 t) ha^{-1}+ *Rhizobium*, Enriched compost (3 t) ha^{-1} + PSB, Enriched compost (3 t) ha^{-1} + *Rhizobium* + PSB, Enriched compost (4 t) ha^{-1} + *Rhizobium*, Enriched compost (4 t) ha^{-1} + PSB, Enriched compost (4 t) ha^{-1} + *Rhizobium* + PSB, Enriched compost (5 t) ha^{-1}+ *Rhizobium*, Enriched compost (5 t) ha^{-1} + PSB and Enriched compost (t) ha^{-1} + *Rhizobium* + PSB. These treatments were evaluated under randomized block design (RBD) with three replications. Soybean cultivar (JS -9560) was taken as test crop. The enriched compost was prepared as method followed by Biswas and Narayanasamy. The enriched compost contains N (0.75 %), P_2O_5 (2.03 %) and K_2O (0.67 %).

Results and Discussion

Results of indicated that combined use of enriched compost along with biofertilizers improved the nutrient content and uptake by the soybean crop. Data presented in Table 1 showed that integrated use of enriched compost (5 t) ha^{-1}along with *Rhizobium* + PSB brought about significant improvement in N, P, K, Zn, Cu, Mn, and Fe content and uptake over unfertilized control. This indicated a favorable soil micro climate régime induced by the incorporation of enriched compost and biofertilizer.

RP-enriched organic fertilizer, showed an improvement in the availability of N and P (Ditta *et al.*, 2018). Inoculation of black gram seeds with Rhizobium and PSB enhance the N and P mineralization (Jangir *et al.*, 2017). The organic acids produced during composting by the soil microbes (PSMs) might be a reason to decrease the pH of the material being composted, *i.e.*, RP and compost, and resulted in an increased release of P from RP-enriched organic fertilizer (Rashid *et al.,* 2004).

Table.1 Effect of enriched compost and bio-fertilizers on N, P, K (%) content in seed and straw of soybean

Treatments	Nitrogen		Phosphorus		Potassium	
	Seed	Straw	Seed	Straw	Seed	Straw
Control	5.677	1.030	0.241	0.198	1.001	0.918
Enriched compost (3 t) + *Rhizobium*	6.130	1.153	0.258	0.223	1.056	1.036
Enriched compost (3 t) + PSB	5.947	1.122	0.266	0.227	1.054	1.034
Enriched compost (3 t) + *Rhizobium* +PSB	6.366	1.213	0.282	0.251	1.094	1.080
Enriched compost (4 t) + *Rhizobium*	6.687	1.340	0.314	0.258	1.130	1.228
Enriched compost (4 t) + PSB	6.607	1.311	0.322	0.275	1.128	1.225
Enriched compost (4 t) + *Rhizobium* +PSB	6.930	1.420	0.341	0.304	1.166	1.285
Enriched compost (5 t) + *Rhizobium*	7.094	1.451	0.369	0.328	1.170	1.291
Enriched compost (5 t) + PSB	6.964	1.440	0.376	0.335	1.167	1.288
Enriched compost (5 t) + *Rhizobium* + PSB	7.001	1.459	0.388	0.359	1.172	1.304
SEm ±	0.072	0.017	0.003	0.003	0.011	0.011
CD (P=0.05)	0.214	0.050	0.010	0.009	0.032	0.032

Table.2 Effect of enriched compost and bio-fertilizers on Zn, Cu, Fe, Mn content (ppm) in seed and straw of soybean

Treatments	Zn		Cu		Fe		Mn	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Control	34.220	17.841	13.143	4.683	29.563	46.160	38.727	45.617
Enriched compost (3 t) + *Rhizobium*	35.249	19.257	13.560	5.053	30.580	47.928	39.973	47.173
Enriched compost (3 t) + PSB	35.232	19.250	13.527	5.040	30.557	47.856	39.927	47.125
Enriched compost (3 t) + *Rhizobium* +PSB	35.947	19.513	13.962	5.334	31.480	49.201	41.126	48.271
Enriched compost (4 t) + *Rhizobium*	36.555	20.256	14.384	5.537	32.587	50.569	42.816	50.013
Enriched compost (4 t) + PSB	36.542	20.241	14.333	5.529	33.417	50.498	42.778	49.974
Enriched compost (4 t) + *Rhizobium* +PSB	37.147	20.671	14.804	5.798	33.520	51.924	44.001	51.226
Enriched compost (5 t) + *Rhizobium*	37.374	20.917	14.048	5.819	33.814	52.021	44.562	51.964
Enriched compost (5 t) + PSB	37.363	20.901	13.998	5.816	33.771	52.007	44.548	51.941
Enriched compost (5 t) + *Rhizobium* + PSB	37.559	20.948	14.131	5.851	34.018	52.074	44.816	52.004
SEm ±	0.196	0.126	0.113	0.056	0.281	0.424	0.385	0.370
CD (P=0.05)	0.581	0.373	0.337	0.165	0.834	1.260	1.143	1.098

Table.3 Effect of enriched compost and bio-fertilizers on N, P, K uptake (kg ha^{-1}) by seed and straw of soybean

Treatments	Nitrogen uptake by		Phosphorus uptake by		Potassium uptake by	
	Seed	Straw	Seed	Straw	Seed	Straw
Control	50.18	15.03	2.12	2.89	8.94	13.381
Enriched compost (3 t) + *Rhizobium*	62.36	19.61	2.63	3.80	10.77	17.584
Enriched compost (3 t) + PSB	61.32	18.99	2.74	3.85	10.86	17.594
Enriched compost (3 t) + *Rhizobium* + PSB	78.84	23.05	3.46	4.78	13.44	20.501
Enriched compost (4 t) + *Rhizobium*	90.97	28.24	4.27	5.40	15.37	25.836
Enriched compost (4 t) + PSB	90.85	27.42	4.43	5.75	15.48	25.550
Enriched compost (4 t) + *Rhizobium* +PSB	108.83	32.72	5.35	6.98	18.29	29.526
Enriched compost (5 t) + *Rhizobium*	114.13	34.06	5.92	7.68	18.76	30.160
Enriched compost (5 t) + PSB	112.95	33.51	6.09	7.79	18.90	29.876
Enriched compost (5 t) + *Rhizobium* + PSB	116.05	34.33	6.41	8.42	19.35	30.545
SEm ±	3.31	0.98	0.14	0.20	0.48	0.806
CD (P=0.05)	9.83	2.91	0.42	0.60	1.42	2.40

Table.4 Effect of enriched compost and bio-fertilizers on Zn, Cu, Fe, Mn uptake (ppm) by seed and straw of soybean

Treatments	Zn uptake by		Cu uptake by		Fe uptake by		Mn uptake by	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Control	301.00	259.72	117.03	14.57	260.64	672.83	341.90	1124.02
Enriched compost (3 t) + *Rhizobium*	358.44	328.56	138.21	17.07	312.55	818.47	408.42	1360.26
Enriched compost (3 t) + PSB	363.37	325.82	139.36	16.92	315.14	809.44	412.35	1342.64
Enriched compost (3 t) + *Rhizobium* +PSB	440.42	370.28	171.94	18.98	387.14	933.93	503.47	1551.86
Enriched compost (4 t) + *Rhizobium*	497.38	425.90	195.61	21.03	443.57	1063.53	582.57	1773.01
Enriched compost (4 t) + PSB	501.85	422.73	196.90	20.87	459.26	1053.80	587.35	1783.40
Enriched compost (4 t) + *Rhizobium* +PSB	582.84	474.49	232.28	22.97	525.83	1191.98	689.87	1952.19
Enriched compost (5 t) + *Rhizobium*	599.99	488.43	225.32	23.37	542.40	1217.09	714.57	2055.74
Enriched compost (5 t) + PSB	605.67	486.26	226.72	23.26	546.73	1207.67	720.39	2067.85
Enriched compost (5 t) + *Rhizobium* + PSB	620.23	490.92	233.25	23.44	562.74	1230.12	737.01	2088.81
SEm ±	15.41	11.88	5.97	0.61	12.79	36.46	15.86	76.22
CD (P=0.05)	45.79	35.31	17.73	1.80	37.99	108.34	47.13	226.46

The application of vermicompost along with phosphorus solubilizing bio-inoculants reduce P fixation by releasing considerable P and variety of organic acids during decomposition and as well as inducing chelating effects on micronutrients which probably enhanced the availability of phosphorus. According to Jansson *et al.*,1988; Shekhawat *et al.*, 2017, it may also be due to the production of enzymes and chelating agents (organic acids) by the microbes which play a critical role in the mineralization of organic P present in the compost. Similarly, reduction in pH of materials being composted might also be due to the production of a large amount of carbon dioxide during composting, which forms carbonic acids after combining with water. Applications of enriched compost not only solubilize the availability of nutrients but also contains significant amount of N, P and K.The production of organic acids such as acetate, lactate, oxalate, tartrate, succinate, citrate, gluconate, ketogluconate, glycolate, etc., during the composting process by the microbes might have resulted in increasing the availability of nutrients especially P as observed the chemical analysis after composted material (Ditta *et al.*, 2017). Due to mineralization of micronutrients present in compost by microorganisms, availability of carbon and other nutrients is increased during composting, which increases the microbial population and ultimately the production of organic acids (Biswas and Narayanasamy, 2006; Chakraborty *et al.*, 2011). Significant improvement in uptake of both macro and micro nutrient were seen which might be better root development and translocation of assimilated nutrients as observed by Rekha *et al.*, 2018; Shankar *et al.*, 2014. This could be also due to increased root nodulation through better root development and more nutrient availability, resulting in better absorption and utilization of all the plant nutrients (Singh and Pareek, 2003) The greater uptake of nutrient might also be due to the low loss of solubilized nutrient due to chelate formation. The uptake of micronutrient may be enhanced due to synergetic effect between macro and micronutrient.

In conclusion, excessive use of chemical fertilizers leads to the deterioration of soil quality and health. Use of organic manure or nutrient enriched organic manure could be best alternative to these high cost inputs to maintain soil health.

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