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Effect of Biofertilizer Consortia on Productivity in Rainfed Groundnut

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ABSTRACT

Groundnut (*Arachis hypogea*) is a valuable oilseed crop. In Anantapuram district of Andhra Pradesh, groundnut is the major oilseed crop cultivated during kharif and rabi seasons. A field experiment was carried out at Agricultural Research Station, Ananthapuramu, to study the effect of biofertilizer application of P consortia and K mobilizers as seed treatment which includes the treatments of T_1:Control, T_2: RDF (20-40-40 N-P_2O_5-K_2O kg ha^{-1}),T_3: RDF (20-40-40) + P consortia + K mobilizer, T_4: 50% RDF of P & K (20-20-20) + P consortia + K mobilizer, T_5: 50% RDF P (20-20-40) + P consortia, T_6: 50% RDF of K (20-40-20) + K mobilizer, T_7: STBF + P consortia+ K mobilizer, T_8: P consortia + K mobilizer. Significant groundnut pod yields were recorded during kharif 2020. Treatment with 50% RDP (20-20-40) + P consortia recorded higher pod yield (779 kg ha^{-1}) followed by STBF + P consortia+ K mobilizer.

Keywords: *Biofertilizers, Groundnut pod yield and Phosphorus Solubilizing Bacteria (PSB).*

Soil organic matter is a major factor in regulating the cycling of nitrogen, phosphorus and sulphur and their supply to the plants. It is well understood that different soil organic fractions have varying properties and have greater influence on different soil properties. In soil, the unavailable phosphorus forms that are can be mobilized to plants by selective microorganisms by producing specific acids and enzymes. A phosphate-solubilizing microorganism (PSM) increases the bioavailability of soil phosphorus and is highly useful in the production of phosphorus biofertilizers. It has been evidenced from ongoing long term integrated nutrient management studies; there is a buildup of phosphorus in soils. The organic fraction of soil P and K has received relatively little attention, because of its complex nature. In order to become available to plants, P and K compounds must be hydrolyzed by solubilizers / mobilizers, which are of plant and microbial origin. Measurement of specific enzyme activity is useful in determining soil biological activity, which might be used as an index of soil fertility.

The proper use of bio fertilizer in rainfed agro ecology could be available approach to increase crop yield and improve soil health. The effect of added biofertilizers could be enhanced along with chemical fertilizers and different organic sources. Phosphorous (P) and Potassium are the major limiting factors for plant growth in many soils. The P and K transformations in soils involve complex microbiological, chemical and biological processes.

The simplest paradigm is that decomposition and nutrient cycling are emergent consequences of extracellular enzyme activities that are regulated directly by site-specific factors such as temperature, moisture and nutrient availability. Characterization of soils Phosphorous and K-inorganic and –organic pools is fundamental in improving the understanding of P and K cycling in plant-soil system. Information about the fractionation of Phosphorous and K

compounds in *alfisols* is needed to develop strategies to improve the efficiency of use of soil Phosphorous and K resources.

MATERIAL AND METHODS

The experiment was conducted in 2020 with randomized block design, three replications of eight treatments *viz:* T_1: Control, T_2: 100% RDF (20-40-40 N-P_2O_5-K_2O kg ha^{-1}), T_3: 100% RDF (20-40-40) + P consortia* + K mobilizer**, T_4: 50% Rec. Fert. Dose P & K (20-20-20) + P consortia* + K mobilizer *, T_5 : 50% RDF of P (20-20-40) + P consortia, T_6 : 50% RDF of K (20-40-20) + K mobilizer T_7: STBF + P consortia+ K mobilizer, T_8: P consortia + K mobilizer only.

Crop is Groundnut (K6 variety).The initial soil status of the experimental site is pH 6.29, EC 0.08dSm^{-1}, Organic carbon is 0.41%, available nitrogen is 121 kg ha^{-1}, available phosphorus is 65 kg ha^{-1} and available potassium is 264 kg ha^{-1}. Micronutrient status of Copper, Manganese, Iron and Zinc are 0.85 ppm, 3.65 ppm, 2.11 ppm and 0.66 ppm, respectively. Soil pH was determined in soil: water suspension (1: 2.5) using glass electrode pH meter and electrical conductivity was estimated from the supernatant using conductivity bridge (Jackson, 1973). Modified method of Walkley and Black (1934) was used for determination of organic carbon. Available nitrogen was determined by alkaline permanganate method as suggested by Subbiah and Asija (1956), available phosphorus as outlined by Olsen (1954) and available potassium using flame photometer (Jackson, 1973). Micronutrients were determined by the method of Lindsay and Norvell, 1978.

RESULTS AND DISCUSSION

In enhancement of nutrient use efficiency and productivity using biofertilizer consortia in rainfed groundnut growing Alfisols, significant groundnut pod yields were recorded during kharif, 2020 in treatment with T_4 (Soil test based fertilizer application along with application of P consortia+ K mobilizer (809 kg ha^{-1}) followed by 50% Rec. Fert. Dose P (20-20-40) + P consortia (745.50 kg ha^{-1}) then followed by recommended dose of fertilizer. The Haulm yield recorded the highest yield in STBF + P consortia + K mobilizer (1501 kg ha^{-1}) followed by 50% RFD of P (20-20-40) + P consortia (1421 kg ha^{-1}). Shelling percentage ranged from 67.50 to 70.50 % (Table.1.)

The biofertilizer consortia has shown a significant effect on soil available phosphorus treatment with STBF + P consortia + K mobilizer has recorded highest phosphorus content (76.00 kg ha^{-1}) followed by RDF (20-40-40) + P consortia +K mobilizer (71.50 kg ha^{-1}) and for available potassium the highest potassium content was recorded in the treatment RFD (20-40-40) + P consortia +K mobilizer (248.54 kg ha^{-1}) followed by 50% RFD of K (20-40-20) + K mobilizer (193.92 kg ha^{-1}). There is no significant difference on available micronutrient (Table 2.)

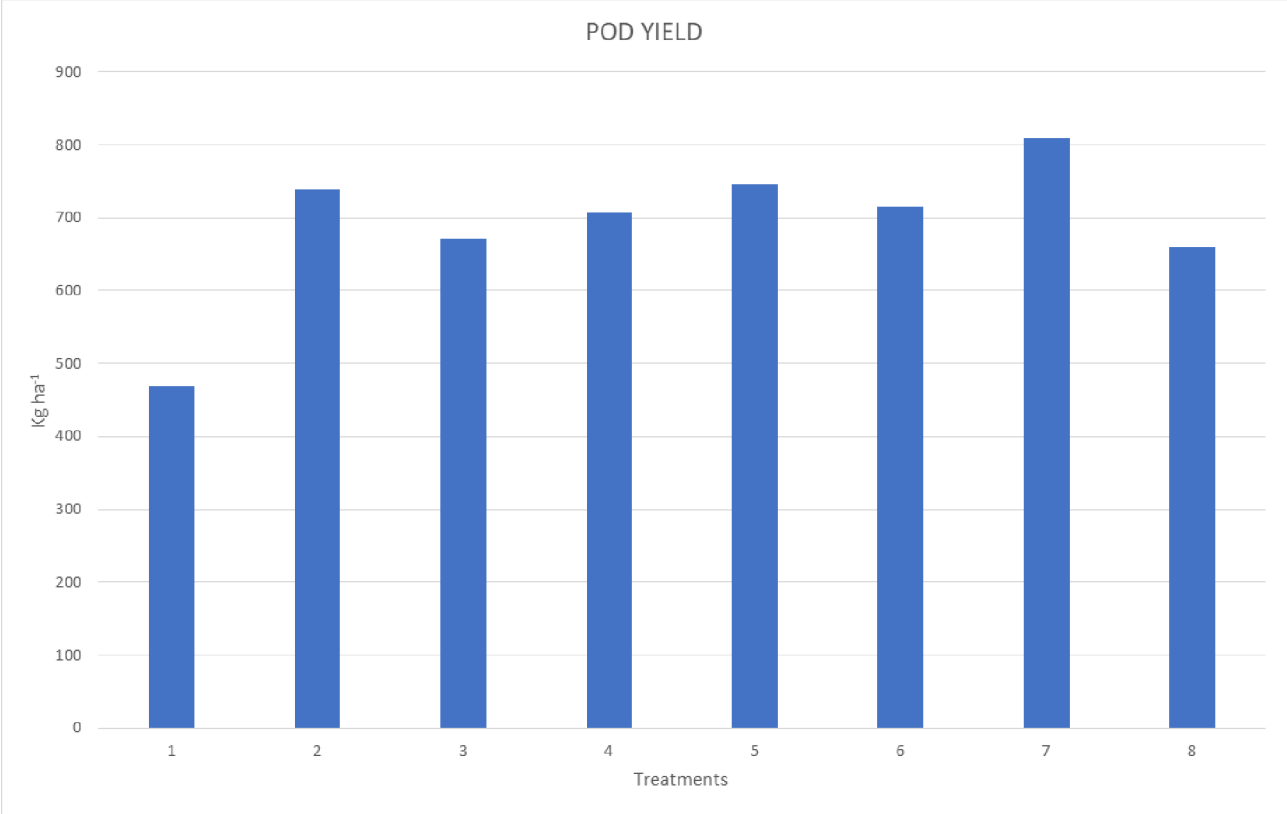
The enhancement in the soil available phosphorus and potassium when compared to the initial soil status may be due to the addition of microbes in the form of biofertilizers like PSB, AM. Organic P is known to be sensitive to microbial activity and has a fast turnover. This is because the major component of labile P is a diester PO_4, preventing it from binding strongly to soil minerals and making it susceptible to rapid mineralization (Trassar-Cepeda and Carballas, 1991).Organic acids produced together with their carboxyl and hydroxyl ions chelate cations or reduce the pH to release P (Seshachala and Tallapragada, 2012). The organic acids are produced in the periplasmic space by the direct oxidation pathway (Zhao *et al.,* 2014). The excretion of these organic acids is accompanied by a drop in pH that results in the acidification of the microbial cells and the

Table 1. Groundnut yield & yield attributes influenced by Enhancement of nutrient use efficiency using bio fertilizer consortium in rainfed groundnut under *Alfisols*

Treatments		Pod yield	Haulm yield	Shelling %	Rainwater Use Efficiency
		kg/ha	kg/ha		
T_1	Control	468	993	67.50	0.84
T_2	RFD (20-40-40)	738	1161	68.00	1.33
T_3	RFD (20-40-40)+ P consortia +K mobilizer	672	1113	67.50	1.21
T_4	50% RFD of P & K (20-20-20)+ P consortia + K mobilizer	707	1187	69.50	1.26
T_5	50% RFD of P (20-20-40)+ P consortia	745	1421	70.00	1.32
T_6	50% RFD of K (20-40-20)+ K mobilizer	715	1327	67.00	1.27
T_7	STBF + P consortia + K mobilizer	809	1501	70.50	1.45
T_8	P consortia + K mobilize only	660	1388	69.00	1.19
	CD @ 5 %	133	221	3.22	-
	S E (m±)	44	75	1.08	-
	CV	11	10	2.70	-

Table 2. Soil chemical properties as influenced by bio fertilizer consortium in rainfed groundnut under *Alfisols*.

Treatments		Avail.N	Avail P_2O_5	Avail. K_2O	Zn	Fe	Cu	Mn
		(kg ha^{-1})			(ppm)			
T_1	Control	146	69	158	0.79	6.35	1.06	5.89
T_2	RFD (20-40-40)	143	70	176	0.66	6.16	1.17	5.64
T_3	RFD (20-40-40)+ P consortia +K mobilizer	138	71	248	0.86	5.56	1.01	6.92
T_4	50% RFD of P & K (20-20-20)+ P consortia + K mobilizer	150	69	193	0.78	7.93	1.05	6.11
T_5	50% RFD of P (20-20-40)+ P consortia	150	68	173	0.92	4.18	1.00	4.43
T_6	50% RFD of K (20-40-20)+ K mobilizer	146	70	193	0.85	6.24	0.97	6.36
T_7	STBF + P consortia + K mobilizer	154	76	165	0.74	6.09	0.98	5.26
T_8	P consortia + K mobilize only	138	65	176	1.03	6.28	0.89	6.34
	CD @ 5 %	NS	6.3	53	0.02	0.2	0.1	0.4
	S E (m±)	12.3	2.1	18.1	0.19	1.24	0.1	0.86
	CV	10.1	7.6	16.6	13.8	16.2	14.4	12.3



Graph 1. Effect of Phosphorus Solubilizing Bacteria on Pod yield (kg ha^{-1}) of groundnut

surroundings, hence, P ions are released by substitution of H^+ for Ca^{2+} (Goldstein, 1994). P consortia include PSB, AM and K mobilizer includes Bacillus muscillagenous. Phosphate-solubilizing microorganisms (PSM) increase the bioavailability of soil phosphorus and are highly useful in the production of phosphorus biofertilizers.

The increase in pod yield and haulm yield of groundnut may be due to the addition of PSB. PSB is beneficial bacteria on enhancement of growth of the plants; it has shown a beneficial effect on growth and productivity of mung bean (Hassan *et al.*, 2017). It has been investigated that PSB inoculation increased the height, growth and productivity *i.e.*, number of branches/plant, number of leaves/plant, number of pods/plant and pod length of the plants *e.g.*, walnut, maize and soybean (Xuan *et al.*, 2011; Khan *et al.*, 2010; Hameeda *et al.*, 2008; Fernandez *et al.*, 2007).

CONCLUSION

Keeping in mind the harmful effects of artificial fertilizers and their increasing prices, it is the need of the day to find out and utilize environmental friendly and economical agro-technologies to improve crop production. In this regard, the use of PSB emerged as a potential strategy. The PSBs had a convincingly positive impact on the growth, development, productivity and nutrients uptake of the groundnut. Moreover, PSBs also enhanced P and K availability in the soil, without polluting the environment. We recommend PSB as an alternative biotechnological solution for sustainable agriculture.

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