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Effect of Enriched Phosphatic Sludge Application on Yield and Nutrient Uptake by Field Bean

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ABSTRACT

A field experiment was conducted to assess the effect of different levels of enriched phosphatic sludge application on growth, yield and nutrient uptake by field bean during *kharif* 2016 at Zonal Agricultural Research Station, V. C. Farm, Mandya. Enriched phosphatic sludge was characterized for various parameters *viz.,* alkaline in nature and rich in organic matter and phosphorus (P_2O_5) content. The response of crop increased with increase in the levels of enriched phosphatic sludge application up to certain levels. Significantly higher pod and stalk yield (944.67 and 2314.4 kg ha^{-1}) was recorded with application of RDF + enriched phosphatic sludge @ 750 kg ha^{-1}, however, it was on par with application of RDF + enriched phosphatic sludge @ 1000 kg ha^{-1} and RDF + FYM treated plots. Lower pod and stalk yield (545.33 and 1387.9 kg ha^{-1}, respectively) was recorded in control. Similar trend was noticed in the nutrient uptake. Higher N (78.79 kg ha^{-1}), P (17.10 kg ha^{-1}) and K (46.66 kg ha^{-1}) uptake was observed in RDF + enriched phosphatic sludge @ 750 kg ha^{-1} treated plots.

Keywords : Enriched phosphatic sludge, yield, nutrient uptake, field bean

COMMON bean (*Phaseolus vulgaris* L.) is an annual leguminous, self-pollinated plant having non endospermic seeds which mostly differ in size and colour from wild type. It is important in all over the world as a second legume after chickpea and as second source of nutrients after cereal and is known as main herbaceous protein resource. Recycling of renewable organic wastes and industrial by-products as a nutrient source for maintenance of soil health is vital for increasing crop production. Disposal of organic wastes is a major problem faced by many industries as dumping of these wastes in the vicinity of industrial areas causes environmental hazards. Hence, recycling is one of the best options of managing wastes.

Aditya Birla Chemicals (India) Limited (ABCL) is one of the leading industrial giant in India manufacturing various products. Recently they have developed soil conditioners with substantial quantity of organic matter by blending pressmud with phosphatic sludge (containing 10 to 12 per cent phosphorus in insoluble form). It also contains substantial quantities of calcium, potassium, nitrogen and micro-nutrients. It can be used as a rich source of phosphorus to plants and also organic matter which help to improve the physical, chemical and biological properties of soil.

MATERIAL AND METHODS

The experiment was conducted during *kharif* 2016 in B-block at Zonal Agricultural Research Station, V. C. Farm, Mandya located between 76^0 82' 12" longitude and latitude with field bean as a test crop. In order to assess enriched phosphatic sludge as soil conditioner, a field experiment was conducted to study the effect of different levels of enriched phosphatic sludge application on yield and nutrient uptake by field bean.

Enriched phosphatic sludge was powdered (0.5 g) and was treated with 10 ml of concentrated HNO_3 and kept for pre-digestion overnight. The samples were then digested with 10 ml of di acid mixture (HNO_3 in $HClO_4$ in 9:4 ratio) until a white residue was left. The residue was cooled and diluted to 100 ml using distilled water, filtered and used for further estimation. The P content in the enriched phosphatic sludge was determined by Vanado-molybdo phosphoric yellow colour method. The intensity of yellow colour was read using spectrophotometer at 420 nm wavelength (Piper, 1966). Potassium was determined using flame photometer as outlined by Piper (1966). Calcium and magnesium was determined by versenate titration method as outlined by Piper (1966). Sulphur was determined turbidimetrically. The intensity of turbidity was measured using spectrophotometer at 420 nm of wavelength. Micro nutrients and heavy metals were analyzed by making suitable dilution of di-acid extract, the samples were fed to the atomic absorption spectrophotometer using appropriate hallow cathode lamp.

Initial soil samples were collected from the field and analyzed for physical and chemical properties. Soil samples were collected using core sampler. Soil samples collected from the experimental sites were dried under shade, mixed thoroughly and gently ground with wooden pestle and mortar without breaking the primary particles and passed through 2 mm sieve. The 2 mm sieved samples were thoroughly mixed and analyzed for pH, electrical conductivity and available nutrients status (N, P, and K). The soil was sandy clay loam in texture with slightly acidic in reaction (6.5), normal electrical conductivity (0.35 dSm^{-1}), and low in organic carbon (0.41 per cent) content. The soil was low in available nitrogen (247.48 Kg ha^{-1}) medium in available P_2O_5 (26.37 Kg ha^{-1}) and low in available K_2O (69.26 Kg ha^{-1}).

Treatment details : The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Enriched phosphatic sludge (EPS) was applied at different levels ranging from 125 to 1000 kg ha^{-1} along with recommended dose of fertilizer. The experiment comprised of twelve treatments. The treatment details are : T_1: Absolute Control, T_2: RDF+FYM, T_3: RDF+ EPS @125Kg ha^{-1},T_4: RDF + EPS @ 250 Kg ha^{-1}, T_5: RDF + EPS @ 500 Kg ha^{-1}, T_6: RDF + EPS @750 Kg ha^{-1}, T_7: RDF + EPS @1000 Kg ha^{-1}, T_8: Balanced NPK + EPS @125Kg ha^{-1}, T_9: Balanced NPK + EPS @250 Kg ha^{-1}, T_{10}: Balanced NPK + EPS @500 Kg ha^{-1}, T_{11}: Balanced NPK + EPS @750 Kg ha^{-1} and T_{12}: Balanced NPK + EPS @1000Kg ha^{-1}. The crop was maintained at protected irrigation condition over the entire crop growth period.

RESULTS AND DISCUSSION

The enriched phosphatic sludge was analyzed for various parameters (Table I). The enriched phosphatic sludge was alkaline (8.07) in nature, medium in EC (0.97dSm^{-1}) and high organic carbon (11.5 per cent) in content. Among macro nutrients phosphorus was high (6.88 per cent) when compared to nitrogen (1.51 per cent) and potassium (1.2 per cent). Among the micro nutrients Fe (4800 mg kg^{-1}), Mn (1200 mg kg^{-1}), Zn (2100 mg kg^{-1}), were higher when compared to Cu (67 mg kg^{-1}). All the heavy metals recorded in the enriched phosphatic sludge were below the permissible limits as per the Indian standards. Chromium was not detected in the sludge. pH of sewage sludge was found to be slightly alkaline and had higher salt content. The sludge was found to be rich in organic carbon and available nitrogen. (Maiti *et al.,* 2002).

TABLE I

Characterization of enriched phosphatic sludge.

Parameters	Values
pH (1:10)	8.06
EC (1:10)	0.97
OC (%)	11.5
N (%)	1.51
P (%)	6.88
K (%)	1.2
Ca (%)	1.5
Mg (%)	1.1
Sulphur (%)	1.2
Fe (mg kg^{-1})	4800
Mn (mg kg^{-1})	1200
Cu (mg kg^{-1})	67
Zn (mg kg^{-1})	2100
Pb (mg kg^{-1})	28
Ni (mg kg^{-1})	16
Cr (mg kg^{-1})	12
Cd (mg kg^{-1})	ND

ND- Not detected

Increasing levels of enriched phosphatic sludge application increased the pod and stalk yield of field bean. Application of RDF + enriched phosphatic sludge @ 750Kg ha^{-1} recorded significantly higher pod yield (944.67 Kg ha^{-1}) and stalk yield (2314.4 Kg ha^{-1}) which was on par with application of RDF + enriched phosphatic sludge @1000 Kg ha^{-1} and RDF + FYM with pod yield of 941.67 Kg ha^{-1} and 936.67 Kg ha^{-1} and stalk yield of 2194.5 Kg ha^{-1} and 2237.6 Kg ha^{-1}, respectively (Table II). Significantly lower pod and stalk yield (545.33 and 1387.9 Kg ha^{-1}, respectively) were recorded in the control. Increase in grain yield might be due to the higher photosynthetic activity leading to better supply of carbohydrates resulted in more number of branches and dry matter accumulation in the plant. Similar results were obtained by Farad *et al*. (2010); Hussain *et al.* (2011) and Thesiya *et al.* (2013).

Harvest index (HI), which denotes the proportion of economically produced part to the above ground biomass, increased significantly in plants compared to control. However, there was no significant increase in harvest index among different levels of sludge application. This suggests that plants maintained a higher supply of photosynthates to reproductive part as compared to vegetative biomass to sustain higher HI. But at increasing rates of sludge application it seems that plants utilized higher photosynthates and hence a significant increase in HI. (Singh and Agrawal 2010)

Application of enriched phosphatic sludge resulted in positive effect in terms of increasing the nutrient content and uptake by field bean. Higher uptake of N (46.28 and 32.5 Kg ha^{-1} in pod and stalk, respectively), P (5.94 and 11.16 Kg ha^{-1} in pod and stalk, respectively) and K (30.26 and 16.40 Kg ha^{-1} in pod and stalk, respectively) was recorded in the treatment with RDF + enriched phosphatic sludge @750Kg ha^{-1} of enriched phosphatic sludge (Table III). However, lower uptake of N (22.66 and

TABLE II

Effect of enriched phosphatic sludge application on yield and harvest index of field bean during kharif 2016

Sl. No.	Treatment	Pod yield (Kg ha^{-1})	Stalk yield (Kg ha^{-1})	Harvest Index
T_1 -	Absolute Control	545.33	1387.95	0.28
T_2 -	RDF + FYM	936.67	2237.60	0.30
T_3 -	RDF + enriched phosphatic sludge @125Kg ha^{-1}	764.00	1722.77	0.31
T_4 -	RDF + enriched phosphatic sludge @ 250 Kg ha^{-1}	790.67	1810.29	0.30
T_5 -	RDF + enriched phosphatic sludge @500 Kg ha^{-1}	818.00	1904.76	0.30
T_6 -	RDF + enriched phosphatic sludge @750 Kg ha^{-1}	944.67	2314.45	0.29
T_7 -	RDF+ enriched phosphatic sludge @1000 Kg ha^{-1}	941.67	2194.53	0.30
T_8 -	Balanced NPK + enriched phosphatic sludge @125 Kg ha^{-1}	753.33	1616.89	0.32
T_9 -	Balanced NPK + enriched phosphatic sludge @250 Kg ha^{-1}	780.67	1723.18	0.31
T_{10} -	Balanced NPK + enriched phosphatic sludge @ 500 Kg ha^{-1}	803.00	1816.64	0.32
T_{11} -	Balanced NPK + enriched phosphatic sludge @750 Kg ha^{-1}	923.67	2029.03	0.31
T_{12} -	Balanced NPK + enriched phosphatic sludge @1000Kg ha^{-1}	916.67	2018.65	0.31
	S.Em±	29.71	133.69	0.01
	CD @5 %	87.13	392.11	NS

TABLE III

Effect of enriched phosphatic sludge application on macro nutrient uptake by field bean during kharif 2016

Treatment	N uptake (Kg ha^{-1})			P uptake (Kg ha^{-1})			K uptake (Kg ha^{-1})		
	Pod	Stalk	Total	Pod	Stalk	Total	Pod	Stalk	Total
T_1 - Absolute Control	22.66	17.28	39.94	2.39	6.61	9.00	16.70	9.82	26.52
T_2 - RDF+FYM	44.88	31.43	76.30	5.49	11.15	16.64	29.82	16.28	46.10
T_3 - RDF+ enriched phosphatic sludge @125Kg ha^{-1}	35.11	23.68	58.79	4.66	8.34	13.00	23.30	12.24	35.54
T_4 -RDF+ enriched phosphatic sludge @ 250 Kg ha^{-1}	38.20	25.16	63.37	4.75	9.19	13.93	24.49	13.40	37.89
T_5 - RDF+ enriched phosphatic sludge @500 Kg ha^{-1}	38.75	27.49	66.24	5.22	9.33	14.56	26.31	13.39	39.70
T_6 - RDF+ enriched phosphatic sludge @750 Kg ha^{-1}	46.28	32.51	78.79	5.94	11.16	17.10	30.26	16.40	46.66
T_7 - RDF+ enriched phosphatic sludge @1000 Kg ha^{-1}	45.43	30.82	76.25	5.76	10.71	16.47	30.47	15.54	46.00
T_8 - Balanced NPK + enriched phosphatic sludge @125 Kg ha^{-1}	35.38	22.63	58.00	3.96	7.66	11.62	23.13	11.64	34.77
T_9 - Balanced NPK + enriched phosphatic sludge @250 Kg ha^{-1}	37.57	24.27	61.84	4.19	8.26	12.45	23.51	12.41	35.92
T_{10} - Balanced NPK + enriched phosphatic sludge @ 500 Kg ha^{-1}	37.00	25.56	62.56	4.64	8.98	13.62	25.09	13.47	38.55
T_{11} - Balanced NPK + enriched phosphatic sludge @750 Kg ha^{-1}	44.16	27.40	71.56	5.52	9.88	15.40	28.69	15.38	44.07
T_{12} - Balanced NPK + enriched phosphatic sludge @1000Kg ha^{-1}	43.74	29.38	73.12	5.14	9.96	15.10	27.72	14.82	42.54
S.Em±	1.86	2.03	3.50	0.18	0.69	0.80	0.93	0.87	1.59
CD @ 5 %	5.45	5.96	10.26	0.54	2.01	2.34	2.73	2.56	4.67

17.28 Kg ha^{-1} in pod and stalk, respectively), P (2.39 and 6.61 Kg ha^{-1} in pod and stalk, respectively) and K (16.70 and 9.82 Kg ha^{-1} in pod and stalk, respectively) was recorded in control.

Total uptake of macro nutrients in field bean increased with increasing levels of enriched phosphatic sludge. Application of RDF + enriched phosphatic sludge @750Kg ha^{-1} increased the nutrient uptake (78.79, 17.10 and 46.66Kg $ha^{-1}$of N, P and K respectively)(Table-III). Increased uptake of nutrients with application of enriched phosphatic sludge may be due to the fact that organic matter in the sludge stimulates higher microbiological activity and thereby enhances nutrient uptake and also biomass yield. Addition of organic materials increases available fraction of phosphorus. Microbial activity also increased and there by biochemical transformation. (Ranganathan and Salvseelan, 1997)

The study indicated that RDF + enriched phosphatic sludge @ 750Kg $ha^{-1}$was found to be superior and was found on par with application of RDF + enriched phosphatic sludge @ 1000Kg ha^{-1} and RDF + FYM. However there was increase in the pod and biomass yield with application of RDF + enriched phosphatic sludge @ 750Kg ha^{-1} which resulted in higher nutrient uptake.

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