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Effect of Different Levels of Enriched Phosphatic Sludge Application on Growth, Yield and Nutrient Uptake by Maize

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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 maize during *kharif* 2016 at Zonal Agricultural Research Station, V. C. Farm, Mandya. The response of crop increased with increase in the levels of (125,250,500,750 and 1000 kg ha^{-1}) enriched phosphatic sludge (EPS) application along with recommended dose of fertilizer up to certain levels. Significantly higher plant growth (208.51cm) was recorded with application of enriched phosphatic sludge at RDF + 750 kg ha^{-1}, however it was on par with application of enriched phosphatic sludge at RDF + 1000 kg ha^{-1} and RDF + FYM. Significantly higher grain yield (90.84 q ha^{-1}) and stover yield (110.80 q ha^{-1}) of maize was observed with enriched phosphatic sludge at RDF + 750 kg ha^{-1}, and was on par with application of enriched phosphatic sludge at RDF+ 1000 kg ha^{-1} and RDF + FYM. Lower grain and stover yield (55.14 and 67.90 q ha^{-1}, respectively) was recorded in control. Similar trends were observed with respect to nutrient uptake. Higher N (203.48 kg ha^{-1}), P (47.53 kg ha^{-1}) and K (170.74 kg ha^{-1}) uptake was observed with enriched phosphatic sludge (RDF+ 750 kg ha^{-1}).

Keywords : Enriched phosphatic sludge, growth and yield of maize, nutrient uptake

MAIZE (*Zea mays* L.) is one of the important crop cultivated in India, it is grown over an area of 7.3 m ha with a production of 15.9 m t with an average productivity of 2.1 t ha^{-1}. In India, Karnataka, Rajasthan, Madhya Pradesh and Maharashtra are the leading maize growing states. In Karnataka, maize is cultivated over an area of 1.1 m ha with a production of 4.0 m t and an average productivity of 3.7 t ha^{-1} which is far below the potential yield level.

Sludge generated from the ortho-phosphoric acid and phosphate fertilizer manufacturing plants, which was enriched with pressmud, sea weed extractant and plant growth hormones to improve its physical and chemical properties. Enriched phosphatic sludge have alkaline in reaction, with normal electrical conductivity and high organic matter and phosphorus content, with moderate N, K and micro nutrient content. Objective of these study was to know the effect of enriched phosohatic sludge on soil properties, growth and yield of maize.

MATERIAL AND METHODS

The experiment was conducted at Zonal Agricultural Research Station Farm, Mandya, which falls under the southern dry zone (Zone VI). It lies between 76°82'12" to 76°82'21" E longitude and 12°57'04" to 12°57'06" N latitude with an average elevation of 705-714 m above MSL. Soil samples were collected before initiation of the field experiment and after harvest of crop, analysed for various parameters by following standard protocol. Similarly enriched phosphatic sludge and plant samples were analysed for various parameters by using standard procedure. The soil was sandy clay loam in texture, neutral in reaction with a pH of 6.99, EC of 0.33 dSm^{-1}, SOC 0.38 %, available N, P_2O_5 and K_2O of 263.5, 29.73 and 78.09 kg ha^{-1}, respectively. Enriched phosphatic sludge (EPS) was alkaline in nature having pH of 8.07, EC of 0.87 dSm^{-1}, OC of 11.3 per cent and total P of 6.80 per cent.

Field experiment was laid out in RCBD design consisting of 12 treatments *viz.,*control (T_1); RDF + FYM @ 10 t ha^{-1}(T_2); RDF + 125 kg ha^{-1} EPS (T_3); RDF + 250 kg ha^{-1} EPS (T_4); RDF + 500 kg ha^{-1} EPS (T_5); RDF+750 kg ha^{-1} EPS (T_6); RDF+1000 kg ha^{-1} EPS (T_7); Balanced RDF + 125 kg ha^{-1} EPS (T_8); Balanced RDF + 250 kg ha^{-1} EPS (T_9); Balanced RDF + 500 kg ha^{-1} EPS (T_{10}); Balanced RDF+750 kg ha^{-1}

EPS (T_{11}) and Balanced RDF + 100 kg ha^{-1} EPS (T_{12}); with tree replication, Full dose of RDF was applied for treatments from T_3 to T_7 and for T_8 to T_{12} RDF (NPK) was balanced.

Plant growth parameters were recorded at 15 days interval by employing standard procedures and yield parameters were recorded at harvest as per standard protocol. Grain and straw samples were collected separately from each plot soon after the harvest of the crop. The samples were initially air-dried cut to pieces and then oven dried at 70^0 C for overnight, later grounded in willey mill to powder and stored. The powdered grain and straw samples drawn at harvest from each treatment in each replication were analysed for various parameters.

Results and Discussion

Plant height : Data pertaining to plant height as effected by different levels of enriched phosphatic sludge are presented in (Table I). It is evident from the result that enriched phosphatic sludge had a significant effect on plant height. Higher plant height was observed in case of RDF + 750 kg ha^{-1} EPS treatment, followed by RDF + 1000 kg ha^{-1} EPS, RDF + FYM, balanced RDF + EPS at 750 kg ha^{-1} and balanced RDF + EPS at 1000 kg ha^{-1}, while lowest plant height was noticed in control. Higher plant height might be due to release of nutrient from enriched phosphatic sludge and improvement in soil physical condition. It is evident from the results that by addition of industrial waste at the rate of 20-30 t ha^{-1} influenced in increase of plant height. But further increase in the levels of industrial sludge had negative effect on the plant height (Bose & Bhattacharyya, 2008).

Yield parameters : The results revealed that there was significant effect of varied levels of enriched phosphatic sludge on yield parameters (cob length, cob weight, number of rows per cob, number of seeds per cob and test weight) (Table II). Application of RDF + 750 kg ha^{-1} EPS significantly increased the cob length, cob weight, no of rows per cob and no of seeds per row (22.86 cm, 228.00 g, 17.30 and 45.83, respectively) and it was on par with RDF + EPS at 1000 kg ha^{-1}, RDF + FYM, balanced RDF + EPS at 750 and 1000

Table I

Effect of different levels of enriched phosphatic sludge application on plant height of maize

Treatment	30 DAS (cm)	60 DAS (cm)	Harvest (cm)
T1 - Absolute Control	45.20	129.23	139.47
T_2 - RDF+FYM	63.25	163.38	193.05
T_3 - RDF+ enriched phosphatic sludge @125Kg ha^{-1}	49.39	159.12	189.96
T_4 - RDF+ enriched phosphatic sludge @ 250 Kg ha^{-1}	53.59	161.77	192.06
T_5 - RDF+ enriched phosphatic sludge @500 Kg ha^{-1}	62.27	166.93	197.29
T_6 - RDF+ enriched phosphatic sludge @750 Kg ha^{-1}	64.37	171.45	208.51
T_7 - RDF+ enriched phosphatic sludge @1000 Kg ha^{-1}	62.27	164.26	195.63
T_8 - Balanced NPK + enriched phosphatic sludge @125 Kg ha^{-1}	57.79	165.12	185.23
T_9 - Balanced NPK + enriched phosphatic sludge @250 Kg ha^{-1}	58.49	163.26	190.56
T_{10} - Balanced NPK + enriched phosphatic sludge @ 500 Kg ha^{-1}	60.87	164.29	201.10
T_{11} - Balanced NPK + enriched phosphatic sludge @750 Kg ha^{-1}	61.43	165.25	201.43
T_{12} - Balanced NPK + enriched phosphatic sludge @1000Kg ha^{-1}	61.93	161.56	187.97
S.Em±	1.82	4.71	5.59
CD @ 5 %	5.35	13.80	16.39

kg ha^{-1} EPS and lowest yield parameters was recorded in control. This might be due to better cell division and cell elongation of maize on application of enriched phosphatic sludge along with chemical fertilizers. Also attributed to the addition of nutrients from enriched phosphatic sludge that supplies phosphorus, nitrogen, potassium, calcium and sulphur which are required for plant growth and development.

Grain and stover yield : Application of RDF + EPS at 750 kg ha^{-1} recorded significantly higher grain yield (90.84 q ha^{-1}) and stover yield (110.80 q ha^{-1}) which was on par with application of RDF + FYM, RDF + EPS at 1000 kg ha^{-1} + RDF, balanced RDF + EPS at 750 and 1000 kg ha^{-1}. Significantly lower grain yield and stover yield (55.14 and 67.90 q ha^{-1}, respectively) was recorded in control (Fig. 1). Yield increase in the sludge treated plots were attributed to an improvement in the soil physical conditions, the supply of additional P, N, other nutrients and carbon from the sludge (Christie *et al.,* 2001; Tanu *et al.,* 2004). In addition, the increased maize yield might be due to synthesis of more carbohydrates for grain filling through higher photosynthesis and thus increase in grain production. It is better explained by the improvement in soil properties due to the organic matter and plant nutrients present in sewage sludge (Melo *et al.,*2007).

Nutrient uptake : The nutrient uptake in plants is a function of growth and availability of nutrients. Higher the availability of nutrients in soil better is the nutrient uptake and plant growth. The nitrogen, phosphorus and potassium uptake by maize (grain + stover) increased with the levels of enriched phosphatic sludge. Uptake of macro nutrients (NPK) was highest in RDF + EPS at 750 kg ha^{-1} which was on par with the treatments receiving RDF + EPS at

TABLE II

Effect of different levels of enriched phosphatic sludge application on yield parameter of maize

Treatment	Cob length (cm)	Cob weight (cm)	No. of rows per cob	No. of seeds per row
T_1 - Absolute Control	15.89	132.53	13.30	34.47
T_2 - RDF+FYM	21.25	192.48	16.70	45.97
T_3 - RDF+ enriched phosphatic sludge @125Kg ha^{-1}	18.14	172.35	15.43	41.79
T_4 - RDF+ enriched phosphatic sludge @ 250 Kg ha^{-1}	19.21	186.27	14.67	42.00
T_5 - RDF+ enriched phosphatic sludge @500 Kg ha^{-1}	19.86	204.00	16.07	42.50
T_6 - RDF+ enriched phosphatic sludge @750 Kg ha^{-1}	22.86	228.00	17.30	45.83
T_7 - RDF+ enriched phosphatic sludge @1000 Kg ha^{-1}	21.04	212.00	16.27	47.85
T_8 - Balanced NPK + enriched phosphatic sludge @125 Kg ha^{-1}	17.60	164.93	14.37	41.67
T_9 - Balanced NPK + enriched phosphatic sludge @250 Kg ha^{-1}	19.00	176.00	15.40	41.79
T_{10} - Balanced NPK + enriched phosphatic sludge @ 500 Kg ha^{-1}	20.29	184.27	15.27	41.09
T_{11} - Balanced NPK + enriched phosphatic sludge @750 Kg ha^{-1}	21.14	181.46	15.77	41.89
T_{12} - Balanced NPK + enriched phosphatic sludge @1000Kg ha^{-1}	20.72	182.00	16.47	41.12
S.Em±	0.78	6.14	0.69	1.60
CD @ 5 %	2.29	18.00	2.03	4.68

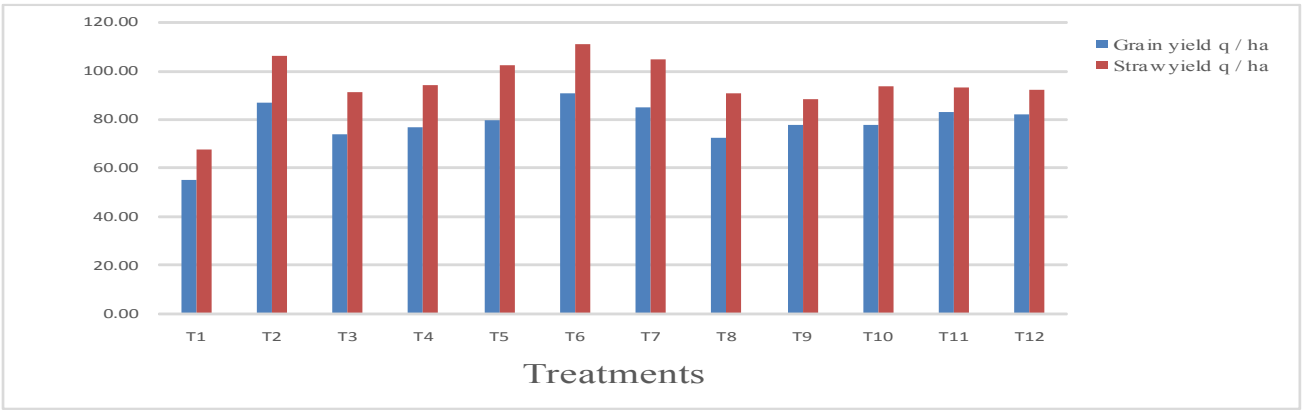

Fig. 1: Effect of different levels of enriched phosphatic sludge application on grain and stover yield (q/ha) of maize.

1000 kg ha^{-1} and RDF + FYM. However, lower nitrogen, phosphorus and potassium uptake by maize was recorded in control.

Maize has high demand for N as indicated by the high N uptake compared to P across all treatments. The high uptake of N is linked to the high demand for protein production being utilized in crop development (vegetative and reproductive stages) while P is mostly required to boost early root development resulting in uptake of other soil nutrients for plant growth and development. The uptake trend for K study confirms that maize has higher requirement of K after nitrogen. Comparing sewage sludge and biochar to inorganic fertiliser, previous studies also showed that organic amendments (sewage sludge and biochar) treated treatments shows significantly higher NPK uptake and it may be due to more balanced available nutrient for plant uptake (Lehmann, 2003).

From this study it is clearly indicated that application of enriched phosphatic sludge @ RDF + 750 kg ha^{-1}was considered as the best treatment which recorded higher grain yield and stover yield. Uptake of macro nutrients increases with increase in the levels of enriched phosphatic sludge upto 750 kg ha^{-1}.

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