Characterization of enriched phosphatic sludge and studies on nutrient releasing pattern from enriched phosphatic sludge under submerged condition

Abstract

A laboratory experiment was conducted to characterize the enriched phosphatic sludge (EPS) and to know the nutrients release pattern from different levels of enriched phosphatic sludge under flooded condition during 2016 at UAS, GKVK, Bengaluru. Enriched phosphatic sludge was characterized for various parameters. The analysis of the samples revealed that the pH value of enriched phosphatic sludge was alkaline in reaction (8.03) and medium in salt content (0.97 dS m^{-1}) and OC (11.30 %). The enriched phosphatic sludge had high quantity of phosphorus (6.88 %) and the total N, K, Ca, Mg and S contents were also appreciable in the enriched phosphatic sludge (1.51, 1.20, 1.50, 1.10 and 1.20 %, respectively). Heavy metal content in sludge was much lower than that indicated for PROM (phosphate rich organic manure) and other organic fertilizers listed in the FCO amendment. Significantly higher available nutrients (NPK) were recorded in treatment T_7 which received 1250 kg EPS ha^{-1}.

Keywords: Enriched phosphatic sludge, characterization, nutrients and incubation.

Introduction

Industrialization is must in uplifting the nation’s economy. On the other hand it has caused serious problems relating to environmental pollution consequent to generation of enormous quantity of solid/liquid wastes.

Raw sludge generated from the ortho-phosphoric acid manufacturing plant, located at Karwar, Karnataka and it was further enriched with pressmud, sea weed extract and plant growth promoting substance to improve its physical and chemical properties. Enriched phosphatic sludge have alkaline in reaction with low soluble salts and high organic matter and phosphorus content and it also contain moderate amount of N, K and micronutrients. Thus, enriched phosphatic sludge can be used in crop production as a source of nutrients and or as soil conditioner along with chemical fertilizers. Further, the compost prepared from industrial sludge or enriched waste containing higher organic carbon provides labile organic matter in sufficient quantities to stimulate soil microorganisms. These organic sources improve the soil properties like soil water holding capacity, percentage of stable aggregates and enhanced nutritional quality of soil. So, enriched industrial wastes can be used as organic manure.

Materials and method

The soil was collected from B block, ZARS, V. C. Farm, Mandya. The sample was air dried, crushed, powdered and sieved with 2 mm mesh size. These processed soils were used for incubation. The soil collected was neutral (pH 7.12) in reaction with low in soluble salts (EC of 0.57 dS m^{-1}) The soil was low in organic carbon content (4.80 g kg^{-1}) with medium in available N, P and K (283.90, 19.20 and 160.00 kg ha^{-1}, respectively) and secondary nutrients like Ca and Mg (8.10 and 3.70 C mol (p^{+}), respectively) and available sulphur (18.10 mg kg^{-1}).

Two hundred grams of processed soil was taken and filled in plastic pots. The soil was treated with calculated amount of enriched phosphatic sludge at six levels (0, 250, 500, 750, 1000 and 1250 kg ha^{-1}) and mixed properly. The moisture content was maintained at flooded condition and the loss of moisture was maintained regularly by weighing each pot till 120 days. Destructive soil sampling was done on 15, 30, 45, 60, 90, 105 and 120th day after incubation (DAI) by mixing soil of each pot and these samples were periodically analyzed for pH, N, P, K, exch. Ca and Mg and S. Samples were analysed by adopting standard procedure.

Results and discussion

Characterization of enriched phosphatic sludge (Table 1)

Enriched phosphatic sludge (EPS) supplied from ortho-phosphoric acid manufacturing industry owned by Aditya Birla Chemical and Fertilizer, Limited, located at Karwar, Karnataka. The enriched phosphatic sludge was characterized in order to ascertain its suitability as a soil conditioner in crop production. Perusal of the data presented in the Table 1 revealed that the WHC of EPS was 38.10 per cent due to higher organic carbon content of 11.30 per cent. The pH of EPS was alkaline in reaction (pH 8.03) and medium in EC (0.97 dS m^{-1}). The alkaline reaction of the EPS might be due to enrichment of sludge with pressmud which is generally alkaline in reaction (Jitendra *et al*., 2014). With respect to nutrients content of EPS was higher in total phosphorus (6.88 %) than any of the conventional organic manures (FYM, city compost or rural compost) and the total N, K, Ca, Mg and S contents were also in appreciable amount (1.51, 1.20, 1.50, 1.10and 1.56 %, respectively) in the EPS.

Changes of nutrients content in soil due to application of enriched phosphatic sludge under flooded condition.

Available nitrogen content (Table 2)

During initial period of incubation 15 and 30 DAI, available nitrogen content was not significant. However, during 45 to 75 DAI period of incubation significantly higher available N content (292.59, 301.99 and 305.52 kg ha^{-1} at 45, 60 and 75 DAI, respectively) was recorded in treatment T_7 (1250 kg EPS ha^{-1}) than control and T_2 and it was on par with rest of the treatments. Further, slight decrease in available N content was recorded after 75 DAI. The increase in available N content might be attributed to release of N from applied EPS consequent to its mineralization. The slight decrease after 75DAI may be attributed to the utilization of N by increasing microbial population and simultaneous loss through denitrification and volatalization. At the later stages, the rate of denitrification loss of N exceeds the rate of mineralization of organic N as a result the values were lower (Zaman, 2002).

The results of the present investigation are similar to those reported by Rahman *et al.* (2013) who have reported that the N mineralization from manure and crop residues was initially very low. Mineralization was increased with the increase of incubation period up to 7 weeks and there after it declined with time. In waterlogged soils, the maximum amount of N was mineralized during the period between 28 and 42 days of incubation (Keeney and Nelson, 1982).

Available phosphorus content (Table 3)

The available P content increased progressively with time of incubation and thus the higher value was recorded at 90 DAI and thereafter slightly declined but it was still higher than initial level. Available P content was ranged from 23.13 to 59.58 kg ha^{-1} in treatment T_7 which received EPS @ 1250 kg ha^{-1} and lower P content was ranged from 18.51 to 18.83 kg ha^{-1} in control.

The extent of P release with addition of 1250 kg EPS ha^{-1} to soil ranged from 4.61 to 46.75 kg ha^{-1} during the entire period of incubation when compared to the release of P from untreated soil (control). The higher P release due to application of EPS might be attributed to its total P content (6.88 %). The increase in the concentration of available P as a result of application of organic materials may be due to the effective chelating process of Al and Fe in soil by organic matter functional groups (Alvarez *et al.,* 1997; Bhattacharyya *et al.,* 2005) suppressing precipitation of P with Al and Fe as respective phosphate, besides mineralization of organic P from the added organic materials (Haynes and Mokolobate, 2001). The decline in available P content with time might be due to P sorption by soil Opala *et al.* (2012).

Available potassium content (Table 4)

Effect of EPS application on available potassium was low during initial period of incubation (at 15 DAI) later on it increased with increase in incubation time and attained higher value at 75 DAI and declined thereafter. Increase in available potassium content from 15 to 75 DAI was ranged from 165.79 to 175.05 kg ha^{-1} in treatment T_7 (1250 kg EPS ha^{-1}) and it was significantly higher than that recorded in control (160.58 to 163.76 kg ha^{-1}). Available K content in all treatment was slightly decreased from 75 to 120 DAI.

Initial increase of potassium in soil was mainly due to continuous release of potassium upon decomposition of EPS and also release of organic acids during decomposition of ESP might have helped in the release of bound form of potassium to soil.

Conclusion: Significantly higher available N content (292.59, 301.99 and 305.52 kg ha^{-1} at 45, 60 and 75 DAI, respectively) was recorded in treatment T_7 (1250 kg EPS ha^{-1}). The available P content increased progressively with period of incubation and thus the higher value was recorded in treatment T_7 (59.58 kg ha^{-1}) which received 1250 kg ha^{-1} EPS at 90 DAI and the extent of K release with addition of 1250 kg EPS ha^{-1} to soil ranged from 6.31 to 11.29 kg ha^{-1} when compared to the release of K from untreated soil.

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Table: 1 Characterization of enriched phosphatic sludge

Parameter	Value
MWHC (%)	38.10
pH (1:10)	8.03
EC (1:100) d S m^{-1}	0.97
OC (g kg^{-1})	11.30
N (%)	1.51
P (%)	6.88
K (%)	1.20
Ca (%)	1.50
Mg (%)	1.10
Sulphur (%)	1.56

Table 2. Effect of different levels of enriched phosphatic sludge application on available nitrogen (kg ha^{-1}) content of soil during 120 days of incubation under flooded condition

Treatments	15	30	45	60	75	90	105	120	Mean
	DAI								
T_1: Control (Soil)	282.42	283.40	283.63	283.82	284.72	283.40	280.00	278.24	**282.45**
T_2: Soil + 125 kg EPS ha^{-1}	283.04	284.10	284.80	285.41	286.51	285.10	283.76	281.37	**284.26**
T_3: Soil + 250 kg EPS ha^{-1}	283.94	285.61	286.73	287.20	291.13	289.61	285.27	285.15	**286.83**
T_4: Soil + 500 kg EPS ha^{-1}	284.28	287.63	288.74	291.02	294.18	291.63	287.27	287.20	**288.99**
T_5: Soil + 750 kg EPS ha^{-1}	284.97	287.73	291.89	294.22	296.42	266.07	289.36	288.75	**287.43**
T_6: Soil + 1000 kg EPS ha^{-1}	285.96	290.42	292.06	295.99	297.20	295.42	292.06	289.48	**292.32**
T_7: Soil + 1250 kg EPS ha^{-1}	287.16	291.53	292.59	301.99	305.52	298.53	295.03	291.87	**295.53**
Mean	**284.54**	**287.20**	**288.63**	**291.38**	**293.67**	**287.11**	**287.54**	**286.01**	
	Treat	**Days**	**T X D**						
S.Em±	**1.83**	**1.95**	**5.17**						
CD	**5.05**	**5.40**	**14.29**						

Table 3. Effect of different levels of enriched phosphatic sludge application on available phosphorus (kg ha^{-1}) content of soil during 120 days of incubation under flooded condition

Treatments	15	30	45	60	75	90	105	120	Mean
	DAI								
T_1: Control (Soil)	18.51	18.79	20.36	20.57	21.06	21.20	19.20	18.83	**19.82**
T_2: Soil + 125 kg EPS ha^{-1}	18.91	20.72	21.74	20.98	21.67	21.60	19.20	19.49	**20.54**
T_3: Soil + 250 kg EPS ha^{-1}	20.07	22.16	24.33	25.76	25.76	26.35	27.38	26.54	**24.79**
T_4: Soil + 500 kg EPS ha^{-1}	20.83	23.46	27.80	30.12	34.24	37.75	33.25	32.55	**30.00**
T_5: Soil + 750 kg EPS ha^{-1}	21.34	24.34	31.63	37.96	42.56	48.58	42.18	42.85	**36.43**
T_6: Soil + 1000 kg EPS ha^{-1}	22.20	25.05	37.26	42.47	49.59	55.10	51.18	51.48	**41.79**
T_7: Soil + 1250 kg EPS ha^{-1}	23.13	31.33	41.53	47.33	59.39	67.95	62.30	59.58	**49.07**
Mean	**20.71**	**23.69**	**29.24**	**32.17**	**36.33**	**39.79**	**36.38**	**35.90**	
	Treat	**Days**	**T X D**						
S.Em±	**0.27**	**0.29**	**0.76**						
CD	**0.74**	**0.80**	**2.10**						

Table 4. Effect of different levels of enriched phosphatic sludge application on available potassium (kg ha^{-1}) content of soil during 120 days of incubation under flooded condition

Treatments	15	30	45	60	75	90	105	120	Mean
	DAI								
T_1: Control (Soil)	159.48	160.58	162.31	163.66	163.76	161.31	160.13	160.45	**161.46**
T_2: Soil + 125 kg EPS ha^{-1}	159.96	161.52	163.00	164.4	165.14	164.52	162.8	161.13	**162.81**
T_3: Soil + 250 kg EPS ha^{-1}	160.07	162.22	164.68	166.53	166.95	165.51	165.01	163.13	**164.26**
T_4: Soil + 500 kg EPS ha^{-1}	161.28	163.45	165.75	167.3	167.26	167.64	166.31	164.25	**165.41**
T_5: Soil + 750 kg EPS ha^{-1}	163.06	164.38	166.25	169.81	169.98	168.33	167.61	166.94	**167.05**
T_6: Soil + 1000 kg EPS ha^{-1}	164.08	165.66	167.28	170.86	171.21	169.76	168.03	167.37	**168.03**
T_7: Soil + 1250 kg EPS ha^{-1}	165.79	167.82	170.24	173.83	175.05	173.41	171.68	169.02	**170.86**
Mean	**161.96**	**163.66**	**165.64**	**168.06**	**168.48**	**167.21**	**165.94**	**164.61**	
	Treat	**Days**	**T X D**						
S.Em±	**0.90**	**0.96**	**2.54**						
CD	**2.48**	**2.65**	**7.02**						