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Effect of Enriched Phosphatic Sludge Application on Growth and Nutrient Uptake of Finger Millet Crop under Greenhouse Conditions

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Authors' contributions

Author MH conducted this entire work and also wrote the entire manuscript and also performed the statistical analysis which was suitable for this study. Author NBP guided author MH during the entire work and also corrected the manuscript copy and also suggested author MH in improving the quality of the manuscript. Author Eresh helped in the analysis work and also helped author MH in searching the reviews which was suitable for this work.

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ABSTRACT

A pot culture experiment was conducted to assess the effect of different levels of enriched phosphatic sludge (EPS) application on growth and nutrient uptake of finger millet crop grown under greenhouse conditions. Before application, EPS was analyzed for various parameters. The analytical results revealed that the pH value of EPS was alkaline in reaction (8.03), medium in salt content (0.97 dS m^{-1}) and high in organic carbon (11.30 %) content. With respect to nutrient composition, EPS had high amount 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), Application of RDF + EPS at 750 kg ha^{-1} showed significantly higher plant height and number of leaves during all the plant growth stages. Maximum shoot (20.47 g pot^{-1}) and root dry matter (10.10 g pot^{-1}) of finger millet was recorded with application of RDF + EPS at 750 kg ha^{-1}. Higher N (2.28 %), P (0.42 %) and K (2.60 %) content in above ground dry matter of finger millet

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was recorded with the application of RDF + EPS @ 750 kg ha^{-1}. Higher N (468.61 mg pot^{-1}), P (86.32 mg pot^{-1}) and K (535.40 mg pot^{-1}) uptake in above ground dry matter of finger millet was observed with the application of EPS at 750 kg ha^{-1} along with RDF as compared to other levels of EPS.

Keywords: Enriched phosphatic sludge; finger millet; growth and nutrient uptake.

1. INTRODUCTION

Under the present trend of exploitative agriculture, inherent soil fertility can no longer be maintained on a sustainable basis. The nutrient supplying capacity of soil declines steadily under continuous and intensive cropping systems. The use of optimum levels of N, P and K has failed to maintain yield levels, probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil due to insufficient application of organic sources to soil. Apart from the fertility and productivity issues, use of chemical fertilizers alone cause environmental hazards, farmers are not offer application of chemical fertilizer due to their high costs and scarcity during peak season. Hence there is a need to look for additional or alternative means of providing nutrients to be explored. In this context, the by-products or wastes of different industries which are rich in essential nutrients and low in heavy metals are the most viable choice as the use of such materials in crop production solves their problem coincidently. The first one is their deprival problem and secondly to improve soil properties. Application of compost made from industrial or municipal wastes could be the most economical and attractive methods of solving twin problems of waste disposal and the necessity to increase the organic matter content of soils [1].

Composting or enrichment of industrial solid waste is most viable options considering the demand for organic sources of nutrients. Scientists have prepared a vemicompost using sludge from paper mill that is rich in humic content, nitrogen and phosphorus and low in heavy metal contents [2]. The compost prepared using industrial wastes or enrichment or altering the composition of solid waste by adding material of different properties serves as a rich source of organic carbon, N, P, K and micronutrients (Fe, Mn, Zn and Cu) and reduced the bioavailability of toxic heavy metals [3]. In this context we are conducting pot experiment using EPS which was by product of ortho-phospharic manufacturing plant located at Karwar, Karnatak (India) owned by Aditya birla chemicals, pvt. limited. After generating raw sludge from industry, it was enriched with press mud, plant growth hormones, sea weed extract and humic acid. This raw sludge was enriched in order to improve physico - chemical properties of EPS so that it can be congenial for soil application. With an objective to study the impact of EPS on crop growth, dry matter production and major nutrient uptake of finger millet crop after 60 days of sowing, a pot culture study was under taken at green house.

2. MATERIALS AND METHODS

Two pot culture experiments were conducted in the greenhouse using sandy loam textured soil. The bulk soil was collected from 0 to 15 cm depth of a agroforestry field belonging to the Eastern dry zone of Karnataka, India situated at UAS, GKVK, Bangalore with latitude of 13 07 77^0 N and longitude of 77^0 58 05^0 E and receives annual rainfall of 1140 mm. Physico-chemical properties of soil are given in Table 1. This study was conducted in the greenhouse of University of Agricultural Sciences, Bangalore. The study included five levels of EPS (125, 250, 500, 750 and 1000 kg ha^{-1}) applied at the time of sowing along with RDF. Twelve treatments were replicated thrice using CRD during the year 2017. Each plastic pot was filled with 5 kg of soil and a calculated quantity of EPS, FYM and fertilizers was applied, mixed properly, before sowing of finger millet. Treatment details for pot experiment: T_1: Absolute Control, T_2: RDF+FYM, T_3: RDF+ EPS at 125 kg ha^{-1}, T_4: RDF+ EPS at 250 kg ha^{-1}, T_5: RDF+ EPS at 500 kg ha^{-1}, T_6: RDF+ EPS at 750 kg ha^{-1}, T_7: RDF+ EPS at 1000 kg ha^{-1}, T_8: Balanced RDF + EPS at 125 kg ha^{-1}, T_9: Balanced RDF + EPS at 250 kg ha^{-1}, T_{10}: Balanced RDF + EPS at 500 kg ha^{-1}, T_{11}: Balanced RDF + EPS at 750 kg ha^{-1} and T_{12}: Balanced RDF + EPS at 1000 kg ha^{-1}.

3. RESULTS AND DISCUSSION

A pot culture experiment was conducted to know the effect of different levels of EPS application on growth (plant height, number of leaves and dry matter production) of finger millet crop grown under controlled conditions. (Table 2).

Table 1. Initial physico chemical characteristics of soil used for pot culture study

Soil parameters	Values
Particle size distribution	
Sand (%)	65.50
Silt (%)	18.57
Clay (%)	15.75
Soil texture	Sandy loam
pH (1: 2.5 water)	5.29
EC (dS m^{-1})	0.14
OC (g kg^{-1})	5.38
Available N (kg ha^{-1})	149.68
Available P2O5 (kg ha^{-1})	32.53
Available K2O (kg ha^{-1})	154.97
Available S (mg kg^{-1})	13.11
Exchangeable Ca (C mol (P^+) kg^{-1})	4.84
Exchangeable Mg (C mol (P^+) kg^{-1})	1.69
DTPA-extractable Fe (mg kg^{-1})	17.01
DTPA-extractable Cu (mg kg^{-1})	0.61
DTPA-extractable Mn (mg kg^{-1})	15.39
DTPA-extractable Zn (mg kg^{-1})	1.25

The plant height was significantly influenced by different levels of EPS. Application of higher levels of EPS increased the plant height during all the stages of plant growth and maximum plant height was recorded at 60 DAS. Application of EPS at750 kg ha^{-1} showed significantly higher plant height during all the plant growth stages. Application of EPS at750 kg ha^{-1} recorded higher plant height of 19.8, 28.3 and 45.0 cm at 20, 40 and 60 DAS, respectively and was on par with the treatment T_7 which received EPS at1000 kg ha^{-1}(19.6, 27.1 and 44.0 cm) at 20, 40 and 60 DAS, respectively. Application of EPS at750 kg ha^{-1} recorded higher number of leaves to an extent of 9.0 and 13.0 at 40 and 60 DAS respectively and significantly higher than control.

Higher plant height and number of leaves was observed in the treatment which received RDF+ EPS at 750 kg ha^{-1}. An organic component in the EPS helps in the binding of the nutrients and increases the availability of nutrients to the plants. Enriched phosphatic sludge also contains the plant growth promoting hormones which stimulated the growth and development of the crop. Similar results were reported [4]. They also observed increase in shoot characteristics of lettuce due to auxins content in seaweed extracts which have an effective role in cell division and enlargement. These results are also in conformity with scientists who reported that sea weed extracts contains plant nutrients, phyto harmones, amino acids and antibiotic substances which enhances plant height, root volume and biomass accumulation [5].

The increase in plant height in maize under greenhouse conditions might be associated with desirable effects of pressmud (PM) on soil chemical, biological and physical properties [6]. Addition of PM increases soil organic matter (SOM), moisture holding capacity [7] and concentrations of N, P, K, Cu, Zn, Fe and Mn [8] and the scientists reported that nutrients certainly promote the growth of plant [9].

The results on shoot and root dry matter (g pot^{-1}) as influenced by different levels of EPS. Increase in levels of EPS application, significantly increased the shoot and root dry matter of finger millet. Maximum shoot (20.47 g pot^{-1}) and root dry matter (10.10 g pot^{-1}) of finger millet was recorded with addition of EPS at 750 kg ha^{-1}. In case of root dry matter (9.9 g pot^{-1}), addition of EPS at 750 kg ha^{-1} was on par with application of EPS at 1000 kg ha^{-1}. Minimum shoot (10.85 g pot^{-1}) and root (5.30 g pot^{-1}) dry weight was recorded in control.

Increase in dry matter yield of finger millet with increasing levels of EPS application might be due to the presence of high organic matter content and also enrichment of sludge with sea weed extracts. Similar results were observed by Use of sea weed extracts improved the growth and yield in black gram. Sea weed extracts helps in proliferating root development and enhance root to shoot ratio [5].

The perusal of result presented in Table 3 revealed that the content and uptake of N, P and K by finger millet was significantly higher with the application of different levels of enriched phosphatic sludge.

Increase in N (2.28 %), P (0.42 %) and K (2.60 %) content in above ground dry matter of finger millet was recorded with the application of EPS at 750 kg ha^{-1} and was on par with the treatment T_5, T_7 and T_2 which received EPS at 500 kg ha^{-1}, at 1000 kg ha^{-1} and RDF+ FYM, respectively. In case of phosphorus and potassium, treatment T_6 recorded higher content followed by the treatment T_5, T_7 and T_2 which received EPS at500 kg ha^{-1}, at 1000 kg ha^{-1} and RDF + FYM, respectively. Lower N (2.02 %), P (0.32 %) and K (1.62 %) concentration was recorded in control. Higher N (468.61 mg pot^{-1}), P (86.32 mg pot^{-1}) and K (535.40 mg pot^{-1}) uptake in above ground dry matter of finger millet was observed with the

Table 2. Effect of different levels of enriched phosphatic sludge (EPS) on plant height, number of leaves, shoot and root dry matter (g pot^{-1}) of finger millet under different growth stages

Treatment	Plant height (cm)			Number of leaves		Shoot dry matter	Root dry matter
	20 DAS	40 DAS	60 DAS	40 DAS	60 DAS	----------(g pot^{-1})----------	
T_1 - Absolute Control	11.30	18.10	32.40	5.67	7.67	10.85	5.30
T_2 - RDF+FYM	18.20	27.00	44.30	8.00	9.67	19.37	9.00
T_3 - RDF+ EPS at125 kg ha^{-1}	15.40	22.30	36.40	7.67	10.00	16.22	8.30
T_4 -RDF + EPS at 250 kg ha^{-1}	16.80	23.70	37.70	8.00	10.33	17.70	8.70
T_5 – RDF + EPS at500 kg ha^{-1}	18.60	25.50	40.40	8.33	10.33	18.03	8.80
T_6 – RDF + EPS at750 kg ha^{-1}	19.80	28.30	45.00	9.00	11.00	20.47	10.10
T_7 – RDF + EPS at1000 kg ha^{-1}	19.60	27.10	44.00	8.67	10.67	19.50	9.90
T_8 - Balanced RDF + EPS at125 kg ha^{-1}	14.60	21.40	35.30	8.33	10.00	16.05	8.10
T_9 - Balanced RDF + EPS at250 kg ha^{-1}	14.90	21.80	37.00	7.33	9.67	16.79	8.40
T_{10} - Balanced RDF + EPS at 500 kg ha^{-1}	15.30	22.20	38.40	8.67	10.33	17.42	8.50
T_{11} - Balanced RDF + EPS at750 kg ha^{-1}	15.80	22.70	39.40	7.33	10.33	17.70	8.70
T_{12} - Balanced RDF + EPS at1000 kg ha^{-1}	16.30	23.20	40.00	7.33	9.33	18.00	9.00
S.Em±	0.36	0.47	0.68	0.47	0.37	0.27	0.13
CD at 5 %	1.06	1.33	1.99	1.37	1.08	0.80	0.40

Table 3. Effect of different levels of enriched phosphatic sludge (EPS) on NPK content (%) and uptake (mg pot^{-1}) of above ground dry matter by finger millet

Treatments	N	P	K	N	P	K
	----------%----------			----------(mg pot^{-1})----------		
T_1 - Absolute Control	2.02	0.32	1.62	219.67	34.80	176.20
T_2 - RDF+FYM	2.26	0.39	2.49	439.61	75.86	483.70
T_3 - RDF+ EPS at125 kg ha^{-1}	2.12	0.34	1.94	323.95	51.95	253.30
T_4 -RDF + EPS at 250 kg ha^{-1}	2.16	0.36	2.28	383.74	63.96	406.80
T_5 – RDF + EPS at500 kg ha^{-1}	2.20	0.38	2.04	398.24	68.79	370.10
T_6 – RDF + EPS at750 kg ha^{-1}	2.28	0.42	2.60	468.61	86.32	535.40
T_7 – RDF + EPS at1000 kg ha^{-1}	2.24	0.40	2.47	438.58	78.32	482.80
T_8 - Balanced RDF + EPS at125 kg ha^{-1}	2.14	0.33	1.86	344.21	53.08	299.30
T_9 - Balanced RDF + EPS at250 kg ha^{-1}	2.04	0.35	2.21	343.92	59.01	372.20
T_{10} - Balanced RDF + EPS at 500 kg ha^{-1}	2.06	0.37	2.20	360.36	64.72	396.90
T_{11} - Balanced RDF + EPS at750 kg ha^{-1}	2.14	0.38	2.19	380.19	67.51	389.70
T_{12} - Balanced RDF + EPS at1000 kg ha^{-1}	2.16	0.38	2.12	390.27	68.66	383.50
S.Em±	0.03	0.01	0.03	12.11	2.09	11.83
CD at 5 %	0.10	0.02	0.10	35.34	6.11	34.53

application of EPS at 750 kg ha^{-1} along with RDF as compared to other levels of EPS.

The concentration and uptake of NPK increased with increase in the application of EPS. This might be due to the presence of high amount of phosphorus and appreciable amounts of N and K in EPS. Sludge was enriched with press mud which contains appreciable amounts of organic matter, macro and micro nutrients which resulted in the improvement in the soil N, P and K concentrations and resulted in the higher uptake of N, P and K by finger millet. These results were in conformity with [10] and [8] and scientists reported that soil N, P and K concentrations improved by the addition of press mud (PM) promoted their uptake by maize crop. The PM contains high organic matter and N which could have increased the N uptake. An increase in plant N and P concentrations with PM application particularly in the first 45 days of growth of maize under pot culture conditions [11].

4. CONCLUSION

Application of EPS at 750 kg ha^{-1} along with RDF significantly increased the plant height, number of leaves and dry matter production during all the stages of plant growth. Higher N, P and K and Ca, Mg and S uptake was noticed in treatment T_6 which received RDF + EPS at 750 kg ha^{-1}.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chen Y, Avnimelech Y. The role of organic matter in modern agriculture. Developments Plant and Soil Sciences. 1986;25:456-482.
2. Elivira C, Sampedro L, Benitez E, Noales RJ. Waste treatment and disposal. 1998;63(3):205-11.
3. Mirbagheri SA, Hosseini SN. Pilot plant investigation on petrochemical wastewater treatment for the removal of copper and chromium with the objective of reuse. Desalination. 2004;171(1):85– 93.
4. Gollan JR, Wright JT. Limited grazing pressure by native herbivores on the invasive seaweed caulerpa Taxi folia in a temperate. Australia Estuary Marine and Fresh water Res. 2006;57(7):685-694.
5. Pramanick B, Koushik Brahmachari, Arup Ghosh, Zodape ST. Effect of seaweed saps derived from two marine algae *Kappaphycus* and *Gracilaria* on growth and yield improvement of black gram. Indian J. Geo-Marine Sci. 2016;45(6):789-794.
6. Chand M, Abrol IP, Bhumbla DR. A comparison of the effect of eight amendments on soil properties and crop growth in a highly sodic soil. Indian J. Agricl. Sci. 1977;47:348-354.
7. Gaikwad SS, Puranik RB, Deshmukh SD. Dynamics of soil microbial population and nutrient availability as influenced by application of press mud cake in an Entisol. J. Soils and Crops. 1996;6(1):82-85.
8. Rangaraj T, Somasundaram E, Amanullah MM, Thirumurgan V, Ramesh S, Ravi S., Effect of agro-industrial wastes on soil properties and yield of irrigated finger millet (*Eleusine coracana* L. Gaertn) in coastal soils. Res. J. Agricl. And Biological Sci. 2007;3(3):153-156.
9. Elsayed MT, Babiker MH, Abdelmalik ME, Mukhtar ON, Montange D. Impact of filter mud application on the germination of sugarcane and small-seeded plants and on soil and sugarcane nitrogen contents. Bioresource Tech. 2008;99:4164-4168.
10. Singh H, Singh Y, Vashist KK. Evaluation of pressmud cake as source of phosphorus for rice-wheat rotation. J. Sustainable Agricl. 2005;26(4):5-21.
11. Deshmukh VL, Kaswala RR, Patil RG. Kaswala AR. Effect of different sludges materials on physico-chemical properties of vertisol. J. Maharashtra Agricl. Univ. 2004;29(1):9-11.

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