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Original Research Article

Effect of Sugarcane Industry Solid Waste on Major and Secondary Nutrients Status of Soil

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A B S T R A C T

The effect of sugarcane pressmud and bio compost along with NPK at varied levels on finger millet was studied in a field experiment conducted during *kharif* 2017 at the research block of M/s Sri Chamundeshwari Sugars Ltd, Bharathi Nagar, Maddur taluk, Mandya District, located in Southern Dry Zone of Karnataka. The experiment was laid out in randomized complete block design with eight treatments replicated thrice. The results showed that application of RDF + pressmud 10 t ha^{-1} significantly increased soil physical properties like MWHC (37.46 %) and decreased bulk density (1.39 Mg m^{-3}) as compared to control. Chemical properties like pH, EC, OC, nutrients NPK, Ca, Mg, S and micronutrients increased and the nutrient content and uptake (major, secondary and micro nutrients) by finger millet was high in treatment (T_3) RDF + bio compost 10 t ha^{-1}. The plant height, number of tillers per hill, grain yield (3625 kg ha^{-1}) and straw yield (6363 kg ha^{-1}) of finger millet increased significantly on application of (T_3) RDF + bio compost 10 t ha^{-1} as compared to control. In conclusion application of sugarcane pressmud or bio compost @ 10 t ha^{-1} along with recommended NPK would be the nutrient recommendation for finger millet in Southern Dry Zone of Karnataka.

Keywords

Pressmud, Biocompost, FYM, Soil, Nutrients

Introduction

The loss of soil fertility, in many developing countries due to continuous nutrient depletion by crops without adequate replenishment poses an immediate threat to food and environmental securities. On an average, 49% of Indian soils have been found deficient in Zn, 15% in Fe, 3% in Cu, 5% in Mn, 33% in B and 13% in Mo (Singh, 2001). The problem of imbalance fertilizer uses in case ofprimary, secondary and micronutrients is even worse wherein theuse is much less compared to crop requirement. So, we have to narrow down this nutrient use ratio in order to sustain the crop productivity (Tewatia, 2007; Sharma, 2011). Use of fertilizers alone in the intensive cropping system creates infertility and unfavourable physical, chemical and biological conditions of soil. The gradually deteriorating soil health can be mitigated by use of organic sources. Total estimated available nutrient value of organic resources in India is 12.80 Mt but the present utilization is about 3.75 Mt (Bhattacharyya, 2007) which may be utilized for filling about 25% nutrient needs of Indian agriculture. Results indicated that the application of organic manures (15, 7.5 and 5 tha-1 year-1 of FYM, pressmud, poultry manure, respectively) in conjunction with recommended dose of N increased productivities in different cropping systems and maintained soil fertility (Antil and Narwal, 2007). Application of 15 t FYM or 7.5 t pressmud or 5 t poultry manure ha^{-1} year^{-1} with or without NP fertilizers could not sustain the initial level of N but in case of P, K and micronutrients (Zn, Mn, Fe and Cu) can be maintained through (Antil and Singh, 2007; Antil and Narwal, 2007). These results indicated that fertilizer-N cannot be saved with the application of organic manures but the application of P, K and micronutrients fertilizers can be avoided. The availability of FYM is limited in India; therefore, some other sources of organics have to be sourced and they increased the OC and nutrients content of soil (Antil, 2012). The residual effect of pressmud on groundnut has been shown higher than that of FYM (Ghosh *et al.*, 2005). Sheeba and Chellamuthu (2000) observed that the continued application of varying quantities of inorganic fertilizers and their combinations with FYM over 22 years did not alter the soil pH appreciably. The results of the long-term fertilizer experiments on sorghum-sunflower cropping sequence indicated significant decrease in pH and decline in values of soil EC where N was applied through organic sources (Mairan *et al.*, 2005).

The farm yard manure and pressmud are the effective source of plant nutrients at lower chemical fertilizer application (Dang and Verma, 1996; More, 1994; Singh *et al.*, 1998). An amount of 25-50% of available nitrogen was obtained from the FYM (Singh *et al.*, 1998). However, nutrient supplying capacity of FYM is restricted in the winter season (Singh *et al.*, 1983). The application of 20 tha^{-1} pressmud saved 25% of the recommended fertilizers. The pressmud application showed significant residual effects on the succeeding crops (Jurwarkar *et al.*, 1993).

Several studies have indicated that long-term and balanced application of chemical fertilizers and organic manure can generally improve soil quality than any of these applied alone (Rudrappa *et al.*, 2006; Manna *et al.*, 2007; Fan *et al.*, 2008). An attempt was made to utilize pressmud and biocompost along with FYM, as nutrient source on finger millet and to study their effect on crop performance, changes in soil nutrient status.

Materials and Methods

A field experiment was conducted to investigate the *"*Effect of sugar industry solid wastes on soil properties, growth and yield of finger millet*"* was carried out at M/s Sri Chamundeshwari Sugars Ltd., Bharathinagar, Maddur taluk, Mandya District located in Southern Dry Zone of Karnataka which falls under Southern Dry Zone of Karnataka and is situated at 12° 36' North latitude 77° 4' East longitude and at an altitude of 662 meters above mean sea level. The experimental site is located at a distance of 25 km from V.C. Farm, Mandya. In randomized block designwith three replications using ragiverity GPU-28 (*finger millet*) as a test crop.The experiment was laid out in Randomized Complete Block Design (RCBD) and replicated thrice. Imposition of treatments Pressmud, biocompost and well decomposed FYM were applied three weeks prior to transplanting of finger millet seedlings as per treatments. The required quantity of fertilizers as per treatment was added, 50 per cent N and 100 per cent P & K was added as basal dose. The remaining N dose was added three weeks later. The treatment details consists that T_1 (Absolute control), T_2 (RDF +pressmud 10 t ha^{-1}), T_3 (RDF + biocompost 10 t ha^{-1}), T_4 (50% RDF + 50% N through pressmud), T_5 (50 % RDF + 50% N through biocompost), T_6 (75 % RDF + 25 % N through pressmud), T_7 (75 % RDF + 25 % N through biocompost), T_8 (POP (RDF + FYM)

Major and secondary Nutrient analysis

The effect of application of varied levels of pressmud and bio compost on physical and chemical properties of soil was determined at three intervals 30, 60 DAT and at the harvest. Soil samples collected from each plot were air dried, passed through 2 mm sieve and analysed for major and secondary Nutrient

Statistical analysis and interpretation of data

The analyses and interpretation of the data was done adopting Fisher's method and variance technique as given by Gomez and Gomez (1984). The level of significance used in 'F' and 't' test was 5 % probability and wherever 'F' test was found significant, the 't' test was performed to estimate critical differences among various treatments.

Results and Discussion

Available nitrogen

Application of different levels of pressmud and bio compost along with RDF and FYM increased the soil available nitrogen with increases in quantity at 30 and 60 DAT (Table 1).

The soil available nitrogen differed significantly with application of pressmud and bio-compost. Treatment (T_3), RDF + bio-compost @ 10 t ha^{-1} recorded significantly higher available nitrogen at 30 DAT (509.7 kg ha^{-1}), 60 DAT (495.5 kg ha^{-1}) and at harvest (309.30 kg ha^{-1}) but it was on par with (T_2) RDF + pressmud @ 10 t ha^{-1} (501.7, 489.8 and 294.1 kg ha^{-1} at 30 DAT, 60 DAT and at harvest, respectively) and (T_8) RDF + FYM @ 10 t ha^{-1} (504.1, 471.1 and 286.0 kg ha^{-1} at 30 DAT, 60 DAT and at harvest, respectively). Significantly lower available nitrogen was recorded in (T_1) control (422.1, 372.9 and 275.6 kgha^{-1}at 30 DAT, 60 DAT and at harvest, respectively).

Increased application of pressmud and bio-compost increased the soil available nutrients at different stages of crop growth which might be due to release of nutrients coinciding with the crop demand. During initial stages inorganic fertilizer supplements crop N demand during the later stages mineralization of organic nutrients (Pressmud and bio compost) may synchronize the release of N for crop which helps the growth and development (Tiwari *et al.*, 2002, Walia *et al.*, 2010 and Shriram Patil, 2014).

Available phosphorus

Application of different levels of pressmud and bio compost along with RDF and FYM increased the soil available phosphorus with increase in quantity at 30 and 60 DAT (Table 2).

The soil available phosphorus differed significantly with application of pressmud and bio-compost. Treatment (T_3) RDF + bio-compost @ 10 t ha^{-1} recorded significantly higher available phosphorus at 30 DAT (197.57 kg ha^{-1}), 60 DAT (170.88 kg ha^{-1}) and at harvest (141.47 kg ha^{-1}) which was on par with (T_2) RDF + pressmud @ 10 t ha^{-1} (195.54, 166.58and 136.88 kg ha^{-1} at 30, 60 DAT and at harvest, respectively. (T_8) RDF + FYM @ 10 t ha^{-1} (190.54, 166.17 and 136.88 kg ha^{-1} at 30, 60 DAT and at harvest, respectively). Significantly lower available phosphorus was recorded in control (T_1) 130.23,103.78 and 90.85 kg ha^{-1} at 30, 60 DAT and at harvest, respectively.

The increase in available-P content of soil is mainly attributed to the increase in the organic carbon content of soil and on its decomposition results in release of organic acids which facilitates P solubilization. In addition, roots release exudates which convert inorganically bound P into available form. The favorable effect of pressmud and bio compost on P availability is ascribed to its effect on biotic activity and P release *via* biotic activity. Yadvinder Singh *et al.,* (2008) concluded that application of 60 kg N ha^{-1} along with pressmud cake (5 t ha^{-1}) increased available P contents in soil under rice-wheat cropping system. Md Zahangir Hossain *et al.,* (2016) reported that pressmud and molasses contain different nutrients and can be substituted for phosphatic fertilizers, in crop production, it increases soil availability of P for agricultural crops

Similar results were observed by Yaduvanshi and Yadav (1996), Deshmukh *et al.,* (2012) observed that application of sludge at the rate of 10 t ha^{-1} increased the availability of N, P and K. Borkar *et al.,* (1991) reported that the application of organic manure reduced the phosphorus fixation in the soil and increased the microbial activity, thus making it more available to the plant

Available potassium

Application of different levels of pressmud and bio compost along with RDF and FYM increased soil available potassium with increase in doses of organics at 30 and 60 DAT (Table 3).

The soil available potassium differed significantly with application of pressmud and bio-compost. Treatment (T_3) RDF + bio compost @ 10 t ha^{-1} recorded significantly higher available potassium at 30 DAT (397.81 kg ha^{-1}), 60 DAT (291.24 kg ha^{-1}) and at harvest (217.68 kg ha^{-1}) but was on par with (T_2) RDF + pressmud @ 10 t ha^{-1} (361.76, 283.04 and 200.84 kg ha^{-1} at 30, 60 DAT and at harvest, respectively) and (T_8) RDF + FYM @ 10 t ha^{-1} (360.53, 283.96 and 200.21 kg ha^{-1} at 30, 60 DAT and at harvest, respectively). Significantly lower available potassium was recorded in control (T_1) 304.71,253.92 and 173.04 kg ha^{-1} at 30, 60 DAT and at harvest, respectively.

Increase in K may be explained by the release of K from the applied organic matter on mineralization and from K bearing minerals. Higher available potassium was recorded in pressmud treated plots as pressmud is a rich source of potassium. Increased availability of K on pressmud application to sugarcane was reported by Rama Lakshmi *et al.,* (2011). Singh *et al.,* (2015) reported that organics were superior in improving available K. Higher available potassium in the soil test based nutrient application along with organic manures might be due to balanced supply of potassium from inorganics and organics.

Calcium and Magnesium

The data pertaining to the exchangeable calcium, magnesium and sulphur status of soil as influenced by pressmud and bio compost are presented in (Table 4)

Significant increase in the content of exchangeable calcium was observed due to application of pressmud and bio compost at different intervals (Table 12). The initial content was 7.00 cmol [p+] kg^{-1}. At 30 days all the treatments recorded significantly higher Ca than control. The treatments T_2 (RDF + pressmud @ 10 t ha^{-1}) 13.67 and T_3 (RDF + bio compost @ 10 t ha^{-1}) 12.33 c mol [p+] kg^{-1} of exchangeable calcium which was higher compared to control. A similar trend was observed at 60 days and at harvest.

There was no significant difference among the treatments with respect to exchangeable magnesium content of soil at 30, 60 DAT and at harvest of finger millet (Table 12). However, T_2 showed higher magnesium content at different intervals (6.73, 5.17 and

3.00 c mol (p^+) kg^{-1}) and all other treatments received different doses of pressmud and bio compost along with chemical fertilizers increases the magnesium content of soil as compare to control (T_1).

Exchangeable Ca increased with application of treatments but was significant on application of pressmud while synthetic fertilizer also increases the concentration of Ca and Mg but was not significant as compared to pressmud treatments (Sarwar *et al.,* 2008). The higher quantity of soluble Ca and Mg was recorded in treatment receiving higher rates of pressmud and gypsum. In this context application of organic amendments resulted in increased in Ca in soil solution due to formation of organic acids (Wong *et al.,* 2009). In addition, organic matter has increased the Ca & Mg content of the soil due to the action of dissolved CO_2 and organic acids on native $CaCO_3$ of the soil (Ahmed *et al.,* 1988). Similar results were obtained by Dotaniya *et al.,* (2016) on addition pressmud @ 5 t ha^{-1} which results in higher exchangeable calcium and magnesium content of soil compared to FYM @ 10 t ha^{-1}.

Table.1 Effect of varied levels of sugarcane pressmud and bio compost on available nitrogen status of soil at different intervals

Treatments		**Available N (kg ha ^{1})**		
		30 DAT	**60 DAT**	**At harvest**
T_1	Absolute control	422.1	372.9	275.6
T_2	RDF + pressmud@ 10 t ha^{-1}	501.9	489.8	294.1
T_3	RDF + bio compost @ 10 t ha^{-1}	509.7	495.5	309.3
T_4	50% RDF + 50% N through pressmud	483.1	451.2	256.0
T_5	50 % RDF + 50% N through bio compost	478.7	455.6	253.0
T_6	75 % RDF + 25 % N through pressmud	448.2	450.4	253.9
T_7	75 % RDF + 25 % N through bio compost	454.8	448.6	248.1
T_8	POP (RDF + FYM)	504.1	471.1	285.9
	S. Em. ±	**4.59**	**12.12**	**8.76**
	CD @ 5%	**13.95**	**36.76**	**26.56**
	Initial value	420.29		

Table.2 Effect of varied levels of sugarcane pressmud and bio compost on available phosphorus content of soil at different intervals

Treatments		Available P_2O_5 (kg ha^{-1})		
		30 DAT	**60 DAT**	**At harvest**
T_1	Absolute control	130.23	103.78	90.85
T_2	RDF + pressmud@ 10 t ha^{-1}	195.54	166.58	136.88
T_3	RDF + bio compost @ 10 t ha^{-1}	197.57	170.88	141.47
T_4	50% RDF + 50 % N through pressmud	171.80	141.51	111.88
T_5	50 % RDF + 50% N through bio compost	164.21	140.10	115.74
T_6	75 % RDF + 25 % N through pressmud	171.20	139.17	115.21
T_7	75 % RDF + 25 % N through bio compost	180.94	139.51	107.54
T_8	POP (RDF + FYM)	190.54	166.17	136.88
	S. Em. ±	**2.37**	**1.90**	**3.07**
	CD @ 5%	**7.21**	**5.78**	**9.32**
	Initial value	140.29		

Table.3 Effect of varied levels of sugarcane pressmud and bio compost on available potassium content of soil at different intervals

Treatments		Available K_2O (kg ha^{-1})		
		30 DAT	**60 DAT**	**At harvest**
T_1	Absolute control	304.71	253.92	173.04
T_2	RDF + pressmud @ 10 t ha^{-1}	361.76	283.04	200.84
T_3	RDF + bio compost @ 10 t ha^{-1}	397.81	291.24	217.68
T_4	50% RDF + 50% N through pressmud	341.95	266.48	161.32
T_5	50 % RDF + 50% N through bio compost	344.56	263.68	186.48
T_6	75 % RDF + 25 % N through pressmud	339.04	219.80	162.20
T_7	75 % RDF + 25 % N through bio compost	331.03	214.80	157.60
T_8	POP (RDF + FYM)	360.56	283.96	200.21
	S. Em. ±	**15.99**	**7.24**	**6.45**
	CD @ 5%	**48.52**	**21.97**	**19.57**
	Initial value	310.82		

Table.4 Effect of varied levels of sugarcane pressmud and bio compost on exchangeable calcium and magnesium at different intervals

Treatments		Ca [c mol (p^+) kg^{-1}]			Mg [c mol (p^+) kg^{-1}]		
		30 DAT	**60 DAT**	**At harvest**	**30 DAT**	**60 DAT**	**At harvest**
T_1	Absolute control	7.67	7.83	8.50	5.23	3.00	2.67
T_2	RDF + pressmud @ 10 t ha^{-1}	13.67	13.40	12.00	6.73	5.17	3.00
T_3	RDF + bio compost @ 10 t ha^{-1}	12.33	12.07	12.67	6.67	4.83	2.50
T_4	50% RDF + 50% N through pressmud	10.33	10.57	10.83	5.67	4.17	1.81
T_5	50 % RDF + 50% N through bio compost	10.83	10.00	10.33	5.50	4.17	1.67
T_6	75 % RDF + 25 % N through pressmud	10.17	10.23	10.67	5.00	4.67	1.40
T_7	75 % RDF + 25 % N through bio compost	10.83	10.00	10.83	6.00	4.00	1.67
T_8	POP (RDF + FYM)	10.00	10.40	10.83	6.17	5.00	2.33
	S. Em. ±	**0.754**	**0.765**	**0.582**	**0.564**	**0.443**	**0.375**
	CD @ 5%	**2.288**	**2.319**	**1.765**	**NS**	**NS**	**NS**
	Initial value	7.00			5.00		

Table.5 Effect of varied levels of sugarcane pressmud and bio compost on soil sulphur at different intervals

Treatments		S (mg kg^{-1})		
		30 DAT	**60 DAT**	**At harvest**
T_1	Absolute control	17.53	9.65	8.32
T_2	RDF + pressmud @ 10 t ha^{-1}	22.99	13.03	12.95
T_3	RDF + bio compost @ 10 t ha^{-1}	22.68	11.95	11.32
T_4	50% RDF + 50% N through pressmud	18.54	10.77	9.06
T_5	50 % RDF + 50% N through bio compost	18.54	10.55	10.17
T_6	75 % RDF + 25 % N through pressmud	19.82	11.31	9.32
T_7	75 % RDF + 25 % N through bio compost	20.21	10.39	9.99
T_8	POP (RDF + FYM)	20.14	10.00	9.84
	S. Em. ±	**0.82**	**0.36**	**0.56**
	CD @ 5%	**2.51**	**1.11**	**1.70**
	Initial value	18.02		

- DAT – Days after transplanting
- RDF- Recommended dose of fertilizer
- FYM- Farm yard manure
- POP- Package of practice

Sulphur

The soil sulphur differed significantly on application of pressmud and bio-compost (Table 5). Treatment (T_2) RDF + pressmud @ 10 t ha^{-1} recorded significantly higher sulphur at 30 DAT (22.99 mg kg^{-1}), 60 DAT (13.03 mg kg^{-1}) and at harvest (12.95 mg kg^{-1}) and was on par with (T_3) RDF + bio compost @ 10 t ha^{-1} (22.68, 11.95 and 11.32 mg kg^{-1} at 30, 60 DAT and at harvest, respectively). Low Sulphur content was observed in control (T_1) 17.53, 9.65 and 8.32 mg kg^{-1} at 30, 60 DAT and at harvest, respectively.

Pressmud addition resulted in maximum available S (18.56 mg kg^{-1}) as compared to FYM (15.78 mg kg^{-1}) which might be due to contribution of S from soil on microbiological oxidation (Sinha and Vipin Kumar, 2016).

Conclusion of the study is as follows

The treatment T_3 (RDF + biocompost 10 t ha^{-1}) followed by T_2 (RDF + pressmud 10 t ha^{-1}) and T_8 (RDF + FYM 10 t ha^{-1}) recorded significantly higher soil available nitrogen phosphorus and potassium compared to control.

Significantly increased exchangeable calcium, magnesium and available sulphur was recorded at different growth stages of crop T_3 (RDF + biocompost 10 t ha^{-1}) followed by T_2 (RDF + pressmud 10 t ha^{-1}) and T_8 (RDF + FYM 10 t ha^{-1}) and lower content was recorded in control.

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