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Impact of enriched bio digested bone sludge compost on the yield and economics of sugarcane

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Abstract
A field experiment was conducted at farmer's field in Varagurpettai village of Chidambaram taluk, Cuddalore district to study the effect of utilization of bone sludge, by-product of ossein industry as manure on the yield and economics of sugarcane during February 2021 – February 2022. The results of the present study revealed that the yield of sugarcane was favourably influenced by the use of bone sludge compost. Application of bone sludge compost at the rate of 5 t ha^{-1} + pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers recorded the highest cane yield of 185.12 kg ha^{-1} and registered a maximum return $rupee^{-1}$ invested value of 4.15. Considering the results of the present investigation it can be concluded that application of bone sludge compost @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers registered the highest yield and return $rupee^{-1}$ invested value in sugarcane.

Keywords: Economics, sugarcane, bone sludge and return $rupee^{-1}$ invested

Introduction
Sugarcane is one of the most important commercial crops of our country and it is a natural renewable agricultural resource that provides sugar, bio-fuel, fibre and manure besides many by-products producing nearly 15% and 25% of global sugar and sugarcane respectively (Abhishek *et al*., 2020) [1]. In India, sugarcane is grown under diverse agro climatic situations covering an area of 4.86 m ha producing 399 million tonnes of sugarcane with an annual productivity of 82 t ha^{-1} (Directorate of Economics and Statistics, 2020) [2].
The uncontrolled disposal of the industrial waste is hazardous to mankind as well as soil health on which the whole plant kingdom thrives on. Therefore, avenues are being searched to recycle these wastes in such a way that they are useful to the environment including soil.
The challenge is to properly incorporate these wastes in a controlled management programme so that the applied wastes do not contribute to the problem of pollution (Sivakumar, 2020) [7].
Recycling of industrial wastes originating from agriculture and non-agricultural related fields are finding acceptance for recycling in agriculture because they have soil ameliorative properties, acting as a source of plant nutrients, capable of improving the fertilizer use efficiency and help the indigenously available resources by acting as a low-cost input in agriculture (Kapse *et al*., 2017) [5]. To explore the potentiality of sustainable use of organic and inorganic nutrient sources, there is an urgent need to test locally available alternative sources of energy such as bone sludge compost, pressmud compost, and poultry manure compost for increasing production of sugarcane and soil health as well. Hence, with the raising apprehension on soil conservation and health in the context of depleting traditional organic manures, efforts are required to exploit the potentiality of easily available sources of organics effectively. Therefore, an experiment was carried out at Varagurpettai village to study the effect of using various combination of organic and inorganic sources of nutrients to increase crop productivity.

Materials and Methods
The experiment was conducted at farmer's field in Varagurpettai village of Chidambaram taluk, Cuddalore district. The location is geographically situated at 11º24' N latitude and 79º44' E longitude at an altitude of + 5.79 m above mean sea level. The soil of the experimental field is classified as *Udic chromustert* (clay) according to FAO / UNESCO (1974). The initial analysis of the experimental soil revealed that heavy clay with neutral in reaction (pH = 7.2), with low soluble salts (EC = 0.33 dS m^{-1}), low in available N (231 kg ha^{-1}), medium in available P_2O_5 (20.80 kg ha^{-1}) and high in available K_2O (290 kg ha^{-1}).

The experiment was laid out in randomized block design with 3 replications. There were altogether 10 treatments *viz.*, T_1 - Bone sludge compost @ 2.5 t ha^{-1} + balance N and K through fertilizers, T_2 - Bone sludge compost @ 5 t ha^{-1} + balance N and K through fertilizers, T_3 - Bone sludge compost @ 7.5 t ha^{-1} + balance N and K through fertilizers, T_4 - Bone sludge compost @ 10 t ha^{-1} + balance N and K through fertilizers, T_5 - BSC @ 2.5 t ha^{-1} + Poultry manure compost @ 2.5 t ha^{-1} + balance N and K through fertilizers, T_6 - BSC @ 2.5 t ha^{-1} + Pressmud compost @ 2.5 t ha^{-1} + balance N and K through fertilizers, T_7 - Pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers, T_8 - BSC @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers,
T_9 - FYM @ 12.5 t ha^{-1} + Recommended NPK ha^{-1} (Traditional farmers practice) and T_{10} - Control (No nutrient supply). Sugarcane variety CO 11015 was chosen for the study. Bone sludge compost, Pressmud compost, Poultry manure compost, Farm yard manure and chemical fertilizers were applied in the respective plots as per the treatment schedule. Pressmud compost, poultry manure compost and FYM were obtained from farm unit of Department of Agronomy, Faculty of agriculture, Annamalai University, Annamalai Nagar. Bone sludge compost used in this study was obtained from Pioneer Jellice India Pvt. Ltd., Cuddalore. The recommended set of good agricultural practices for cane was adopted and the cane was harvested. All the recorded data were analyzed statistically with analysis of variance using Agres software with a critical difference at 0.05 level of probability.

Results and Discussion

Cane yield (t ha^{-1})

The cane yield was significantly influenced by bio digested bone sludge compost application.

Among the treatments tested, the highest cane yield of 185.12 t ha^{-1} was recorded in the treatment T_8 (Bone sludge compost @ 5 t ha^{-1} + pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers). The higher cane yield might be due to the slow release and continuous availability of nutrients from bone sludge and pressmud compost which relatively added large amount of macro and micro nutrients especially P, Ca and Mg which involved in enzyme activities and impart physio-chemical and biological activities of soil resulting in more photosynthates assimilation and subsequent conversion of assimilates into yield attributes in larger fraction which in turn appreciably improved the number of millable cane population, single cane weight leading to higher cane yields. Similar findings of balanced supply of nutrients by integrating organics with inorganics for better growth, yield attributes and yield of cane were with the results of the study of Joginder *et al.* (2019) [4] and Abhishek *et al.* (2020) [1].

Economics

Application of bone sludge compost @ 5 t ha^{-1} + pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers (T_8) registered the higher gross return, net return and the return rupee^{-1} invested. The higher return rupee^{-1} invested might be due to maximum yield. Similar results were also noticed by Sriram (2015) [8] who concluded that higher return rupee^{-1} invested was achieved by introducing organic manures in reducing the purchase cost of high analyzed fertilizer inputs. The treatment control recorded the lower return rupee^{-1} invested. These results are in line with the findings of Keerthana (2021) [6].

Table 1: Effect of bio digested bone sludge compost on cane yield (t ha^{-1})

Treatments	Cane yield (t ha^{-1})
T_1 - Bone Sludge Compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	120.39
T_2- Bone Sludge Compost @ 5 t ha^{-1} +Balance N and K through fertilizers	130.66
T_3- Bone Sludge Compost @ 7.5 t ha^{-1} +Balance N and K through fertilizers	154.92
T_4 - Bone Sludge Compost @ 10 t ha^{-1} + Balance N and K through fertilizers	163.73
T_5 - Bone Sludge Compost @ 2.5 t ha^{-1} + Poultry manure compost@ 2.5 t ha^{-1} + Balance N and K through fertilizers	168.60
T_6 - Bone Sludge Compost @ 2.5 t ha^{-1} + Pressmud compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	176.97
T_7 - Pressmud compost @ 5 t ha^{-1} +Balance N and K through fertilizers	145.79
T_8 - Bone Sludge Compost @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers	185.12
T_9- Traditional farmers practice FYM @ 12.5 t ha^{-1} +Recommended NPK ha^{-1}	105.64
T_{10} - Control (No nutrient supply)	56.50
S.Em(±)	2.70
CD (P=0.05)	8.07

Table 2: Effect of bio digested bone sludge compost on economics of sugarcane

Treatments	Total cost of cultivation (₹ ha^{-1})	Gross income (₹ ha^{-1})	Net income (₹ ha^{-1})	Return rupee^{-1} invested
T_1 - Bone Sludge Compost (BSC) @ 2.5 t ha^{-1} + Balance N and K through fertilizers	124078	421365	297287	3.39
T_2- Bone Sludge Compost (BSC) @ 5 t ha^{-1} + Balance N and K through fertilizers	129508	457310	327802	3.53
T_3- Bone Sludge Compost (BSC) @ 7.5 t ha^{-1} + Balance N and K through fertilizers	143333	542220	398887	3.78
T_4 - Bone Sludge Compost (BSC) @ 10 t ha^{-1} + Balance N and K through fertilizers	147888	573055	423167	3.87
T_5 - BSC @ 2.5 t ha^{-1} + Poultry manure compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	151415	590100	436685	3.89
T_6 - BSC @ 2.5 t ha^{-1} + Pressmud compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	154463	619395	463213	4.00
T_7 - Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers	132997	510265	377268	3.83
T_8 - BSC @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers	156078	647920	489842	4.15
T_9- Traditional farmers practice FYM @ 12.5 t ha^{-1} + Recommended NPK ha^{-1}	124285	369740	245455	2.97
T_{10} -Control (No nutrient supply)	79491	156390	76899	1.91

Conclusion

Based on the results of the present investigation, it could be concluded that application of bone sludge at the rate of 5 t ha^{-1} + pressmud compost @ 5 t ha^{-1} + balance N and K through fertilizers recorded the highest cane yield of 185.12 kg ha^{-1} and registered a maximum return $rupee^{-1}$ invested value of 4.15. Hence, bone sludge is a realistic organic alternative which is agronomically efficient, ecologically desirable and economically viable which paves way for realization of higher returns from sugarcane without affecting the soil health.

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