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Effect of bone sludge a by-product of ossein industry on the economics of ragi cultivation

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Abstract
Field experiment was conducted at Annamalai University Experimental Farm, Annamalainagar to study the effect of utilization of bone sludge, by-product of ossein industry as manure on the yield and economics of ragi cultivation during April – August 2017. The experiment was laid out in randomized block design with eleven treatments and replicated thrice. The results of the present investigation revealed that the yield components of ragi viz., number of ear heads m^{-2}, number of fingers ear^{-1}, and number of grains ear $head^{-1}$, thousand grain weight, grain yield and straw yield were favourably influenced by the use of bone sludge. Application of bone sludge at the rate of 10 t ha^{-1} + recommended NPK recorded the highest grain yield of 3584 kg ha^{-1} and registered a maximum benefit cost ratio of 1.95. This was followed by the integrated application of bone sludge at the rate of 7.5 t ha^{-1} + recommended NPK with a benefit cost ratio of 1.87.

Keywords: Bone sludge, ossein industry, dicalcium phosphate and alternate source

Introduction
The uncontrolled disposal of the industrial waste is hazardous to mankind as well as soil health on which the whole plant kingdom thrives on. The exponential increase in industrialization is not only consuming large areas of agricultural land but simultaneously causing serious environmental degradation. Therefore avenues are being searched to recycle this waste. Industry waste originating from agriculture 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 (Sudhakar, 2007) [5]. The challenge is to properly incorporate the disposal of the wastes in a controlled management program so that the applied wastes do not contribute to the problem of pollution.
Ossein and Dicalcium phosphate are manufactured from animal crushed bones by M/S Pioneer Miyagi Chemicals (p) Ltd, Cuddalore in a joint venture with a Japanese firm. The bone sludge are suspended bone particles in the bone washings which are filtered and sun dried. This bone sludge contains considerable quantity of macro and micro nutrients and hence has a great scope for being used as manure for agricultural and horticultural crops.
Soil acts as a sink for extremely poisonous (Cd, As, Cr and Hg) moderately poisonous (Pb, Ni, Mo and F) and low poisonous (B, Co, Mn and Zn) constituents of the wastes produced by the industries. The challenge is to properly incorporate the disposal of the wastes in a controlled management program so that the applied wastes do not contribute to the problem of pollution. The bone sludges were found to be rich in various nutrients and hence considered the possibility for use in agriculture as manure **(**Vennila and Savithiri, 1998) [7].
In recent years, with decreasing soil fertility, the use of organic manure industrial sludge can be considered as an alternate source of organic manure which now deserves greater attention than ever before (Anu lavanya, 2005) [1]. In this context, the present investigation was undertaken to develop a system based nutrient management practice for ragi by utilizing bone sludge from M/s Pioneer Miyagi Chemicals Private Limited to augment ragi productivity.

Materials and Methods
The experiment was conducted in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The geographical location of Annamalai Nagar is 11º24' N latitude and 79º44' E longitude at an altitude of 5.74m 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 = 7.5),

with low soluble salts (EC = 0.33 dSm^{-1} medium in available N (215.35 kg ha $^{-1}$), low in available P_2O_5 (19.85 kg ha $^{-1}$) and high in available K_2O (291.70 kg ha $^{-1}$). The experiment was laid out in randomized block design with three replications. The experiment comprised of eleven treatments viz., T1 – Bone sludge @ 2.5 t/ha, T2 – Bone sludge @ 5.0 t/ha, T3 – Bone sludge @ 7.5 t/ha, T4 – Bone sludge @ 10.0 t/ha, T5 – Bone sludge @ 2.5 t/ha + Recommended NPK, T6 – Bone sludge @ 5.0 t/ha + Recommended NPK, T7 – Bone sludge @ 7.5 t/ha + Recommended NPK, T8 – Bone sludge @ 10.0 t/ha + Recommended NPK, T9 – Farm Yard Manure @ 12.5 t/ha, T10 – Farm Yard Manure @ 12.5 t/ha + Recommended NPK, T11 – control (no manures). Ragi variety Co.13 was chosen as test crop for the investigation. Bone sludge, obtained from M/S Pioneer Miyagi Chemicals Ltd., Cuddalore, Tamilnadu was applied 10 days before sowing evenly over the respective plots as per the treatment schedule. The nutrient content of industrial wastes viz., pressmud compost and bone sludge are N-3.73% and 2%, P-3.64% and 9.92% and K- 2.36% and 0.36% respectively. The recommended package of practices was followed and the crop was harvested. For the estimation of dry matter production, five plants were removed randomly at harvest stage. These samples were first air dried in shade and then oven dried at 80 ± 5°C till a constant weight was obtained and the weight was recorded. The mean dry weight was expressed in kg ha $^{-1}$. The yields and economic analysis of each treatment were recorded separately and analyzed statistically with Analysis of Variance.

Results and Discussion

Yield

Integrated use of inorganic and organic sources of nutrients significantly influenced the grain yield and straw yield of ragi (Table 1). Among the various integrated use of inorganic and organic sources of plant nutrient tested, combined application of recommended dose of fertilizers along with organic manure bone sludge @ 10t ha^{-1} (T_8) significantly registered the highest grain yield of 3584 kg ha $^{-1}$ and straw yield of 6455 kg ha $^{-1}$. It was followed by application of bone sludge @ 7.5 t ha^{-1} (T_7), application of FYM @10 t ha^{-1} recommended dose of fertilizers (T_{10}) which were on par among themselves. Control (T_{11}) recorded the lowest grain yield of 1517 kg ha^{-1}.

The increase in grain yield might be due to superior yield attributing characters under integrated nutrient management treatment which received the essential nutrient at balanced proportion for better growth of ragi (Mohandoss and Appavu, 2000) [3].

The better performance of ragi might be due to higher solubility of nutrients and concomitant increased uptake of nutrients and cumulative effect of bone sludge which increased yield attributes. Higher availability of nutrients because of favorable effect of organic and inorganic sources might have improved the physiological and metabolic functions inside the plant body which in turn laid down the foundation for higher yield in rice. The present findings are in agreement with the earlier reports of Thiyageswari and Rani Perumal, 2000 [6].

Table 1: Effect of integrated nutrient management on the yields (kg ha^{-1}) of ragi

Treatments	Grain yield(kg ha^{-1})	Straw yield(kg ha^{-1})
T_1 – Bone sludge @ 2.5 t/ha	1825	3514
T_2 – Bone sludge @ 5.0 t/ha	2187	4148
T_3 – Bone sludge @ 7.5 t/ha	2384	4480
T_4 – Bone sludge @ 10.0 t/ha	2574	4797
T_5 – Bon9775e sludge @ 2.5 t/ha + Recommended NPK	2792	5165
T_6 - Bone sludge @ 5.0 t/ha + Recommended NPK	3001	5505
T_7 – Bone sludge @ 7.5 t/ha + Recommended NPK	3275	5940
T_8 – Bone sludge @ 10.0 t/ha + Recommended NPK	3584	6455
T_9 – Farm Yard Manure @ 12.5 t/ha	2012	3847
T_{10} – Farm Yard Manure @ 12.5 t/ha + Recommended NPK	3203	5830
T_{11} – control (no manures)	1517	3944
S.Ed	85.00	106.5
C.D (p = 0.05)	170.0	213.0

Economic Analysis of Ragi

Among the various integrated use of inorganic and organic sources of plant nutrient tested, combined application of recommended dose of fertilizers along with organic manure bone sludge @ 10t ha^{-1} (T_8) significantly registered the highest gross return of Rs. 21504/- and net return of Rs. 10490/- with a highest return per rupee invested of 1.95. This was followed by the integrated application of bone sludge at the rate of 7.5 t ha^{-1} + recommended NPK which registered a gross return of Rs. 19650/- and net return of Rs. 9136/- with a return per rupee invested of 1.87. The minimum gross return of Rs. 9102/- and net return of Rs. 1588/- with a return per rupee invested of 1.21 was registered with the control (Table 2). Rangesh kumar (2016) [4] also confirmative with these findings of higher return per rupee invested in ragi by integrated usage of organic manures with inorganic manures.

Table 2: Effect of integrated nutrient management on the economics (kg ha^{-1}) of ragi

Treatment	Grain yield kg ha^{-1}	Straw yield kg ha^{-1}	Cost of cultivation Rs. ha^{-1}	Gross Income Rs. ha^{-1}	Net Income Rs. ha^{-1}	Return per rupee invested
T1	1825	3514	8014	10950	2916	1.37
T2	2187	4148	8514	13122	4608	1.54
T3	2384	4480	9014	14304	5290	1.59
T4	2574	4797	9514	15444	5930	1.62
T5	2792	5165	9814	16752	7238	1.71
T6	3001	5505	10104	18006	7992	1.80
T7	3275	5940	10504	19650	9136	1.87
T8	3584	6455	11014	21504	10490	1.95

T9	2012	3847	8764	12072	3308	1.38
T10	3203	5830	10264	19218	8954	1.87
T11	1517	3944	7514	9102	1588	1.21

Conclusion

From the results of the present investigation it could be concluded that in ragi application of bone sludge @ 10 t ha^{-1} along with recommended NPK holds promise as on efficient integrated nutrient management system for not only enhancing crop yields in ragi but also registering a highest benefit cost ratio of 1.95 a felt need of the present day agriculture. The bone sludge, an industrial by-product is found to be environmentally safe as it has not caused any phyto toxicity to the crops, particularly in ragi. 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 ragi without affecting the soil health.

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