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Impact of enriched bio digested bone sludge compost on the growth and yield of rice (*Oryza sativa* L.)

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ABSTRACT

Rice serves as the primary staple food in Asia. Indiscriminate and unbalanced use of chemical fertilizers not only exhausts the inherent nutrient levels in the soil but also leads to significant environmental harm, including the emission of greenhouse gases, acidification, and eutrophication. This poses a substantial threat to the sustainability of rice cultivation. Employing a combined approach of organic manures alongside chemical fertilizers emerges as a preferable solution to mitigate the adverse impacts linked with the exclusive use of chemical fertilizers. Therefore, acknowledging the complementary role of organic supplements to chemical fertilizers is crucial for maintaining soil health and ensuring the optimal yield potential in rice production. Therefore, field experiment was conducted at Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar during the cropping year of 2022, to find out the effect of utilization of bone sludge, by-product of ossein industry as manure with other organic manures viz., bone sludge compost, pressmud compost, poultry manure compost, goat manure compost and farmyard manure on the growth and yield of rice. The results of the experiment revealed that among the different treatments tested, application of bone sludge compost @ 5 t/ha + Pressmud compost @ 5 t/ha along with balance N and K through fertilizers (T_4) excelled all treatments and gave significantly higher grain yield of 6170 kg/ha when compared to other treatments. Considering the results of the present investigation, it can be concluded that application of bone sludge compost @ 5 t/ha + Pressmud compost @ 5 t/ha along with balance N and K through fertilizers registered highest values in growth parameters, yield attributes and yield of rice.

Key words: *Bone sludge, Compost, Goat manure, Poultry manure, Pressmud, Farmyard manure*

Introduction

Rice (*Oryza sativa*) serves as a fundamental food source for approximately half of the global population (Jhon and Babu, 2021). Globally rice is cultivated over an area of 162 million hectares with an annual production of around 700 million tonnes with an average productivity of 4.3 tonnes ha^{-1}. In India, rice is cultivated in an area of 48.53 million hectares with a production of 112.18 million tonnes and an average productivity of 2.31 tonnes ha^{-1}. In Tamil Nadu, rice is cultivated in an area of 2.2 million hectares with a production of 8.65 million tonnes and productivity of 3.93 t ha^{-1} (Directorate of Economics and Statistics, 2021). As a consequence of urbanization and industrialization, the existing 170

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million hectares of cultivable land may not be entirely accessible, potentially decreasing to 100 million hectares by 2025. India needs to exert considerable effort to achieve a twofold increase in its food grain production from the current quantity of 297.5 million tonnes recorded in 2019-20. Withdrawal of nutrients from the soil resulting in poor soil fertility besides, deterioration of soil health and degradation of land (Jagadeesha *et al*., 2020).

The declining trend of total production from the same land and diminishing response to applied fertilizer nutrients are due to imbalanced, inappropriate and indiscriminate use of chemical fertilizers leading to heavy capacity of soil, pollution of water resources and chemical contaminations of food grains (Shova Akter *et al*., 2023).

Sustainable production could be achieved only when factors leading to continued maintenance of soil health are taken care of. Hence, the complimentary role of organics as supplements to chemical fertilizers is important for keeping the soil health in order to harness the potential yield in rice (Lency, 2001). Under these circumstances, more emphasis is now being given on integration of inorganic and organics including crop residues, agro-based industrial wastes and by-products to improve the soil productivity (Mohana Sundar and Saravana Perumal, 2021). Besides improving nutrient status of soils, it also helps in improving physical, chemical and biological properties of soil towards betterment of soil quality, and permeability which increases fertilizer use efficiency due to higher addition of humus (Pankaj Singh and Awadhesh Kumar Singh, 2022).

Recycling of industrial wastes originating from agriculture and non-agricultural related fields is finding acceptance for soil amelioration, acting as a source of plant nutrients capable of improving the fertilizer use efficiency and helping the indigenously available resources by acting as a low-cost input in agriculture for profitable crop production (Sadh *et al*., 2018). Pressmud compost, a significant by-product of the sugar industry, comprises essential macro and micronutrients. It is utilized to enhance soil nutrient levels, providing nitrogen (N) and phosphorus (P) to improve the overall nutrient status of the soil and increase the availability of micro-nutrients in agricultural systems (Krishnaveni *et al*., 2020). Bone sludge, a by-product of the ossein industry, consists of suspended bone particles in the washings of bones. These particles are filtered, sun-dried, and contain a significant amount of both macro and micro-nutrients.

Organic fertilizers such as pressmud compost, poultry manure compost, goat manure compost, bone sludge compost and farmyard manure are highly effective. They contain substantial quantities of nitrogen, phosphorus, potassium, and essential nutrients. These organic fertilizers show great promise in reversing the deterioration of soil health and enhancing productivity by addressing marginal nutrient deficiencies (Imran khan *et al*., 2022). Hence, the present investigation was carried out to develop an efficient using bio digested bone sludge compost practice for rice using with locally available organic sources along with inorganic fertilizers to augment productivity of rice.

Materials and Methods

The field experiment was conducted in Q block of experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The soil of the experimental field is classified as *Udicchromustert* (clay) according to FAO (1974). The initial analysis of the experimental soil revealed that heavy clay was neutral in reaction (pH = 7.6), with low soluble salts (EC = 0.33 ds/m), medium in available N (230 kg/ ha), low in available P2O5 (21 kg/ha) and high in available K_2O (280 kg/ha).

The experiment was laid out in randomized block design with three replications. The experiment comprised eight treatments viz., T_1– Bone sludge compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers, T_2– Bone sludge compost @ 2.5 t ha^{-1} + Pressmud Compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers, T_3 – Bone sludge compost @ 2.5 t ha^{-1} + Poultry manure compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers, T_4 – Bone sludge compost @ 5 t ha^{-1} + Pressmud Compost @ 5 t ha^{-1} + Balance N and K through fertilizers, T_5 – Bone sludge compost @ 5 t ha^{-1} + Poultry manure compost @ 5 t ha^{-1}+ Balance N and K through fertilizers, T_6– Bone sludge compost @ 5 t ha^{-1} + Goat manure compost @ 5 t ha^{-1} + Balance N and K through fertilizers, T_7– FYM @ 12.5 t ha^{-1} + Recommended NPK ha^{-1} and T_8– Control (No nutrient supply). Rice variety ADT43 was chosen as test crop for the investigation bone sludge compost, pressmud compost, poultry manure compost, goat manure compost and FYM 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. Annamalai University, Annamalai Nagar. Bone sludge compost used in this study was obtained from Pioneer Jellice India Pvt. Ltd., Cuddalore. The nutrient content of organic manure composts viz., Bone sludge N–2.10%, P–9.96%, K–0.38%, pressmud compost N– 2.63%, P–2.54%, K–2.36%, goat manure compost N–1.50%, P–0.40%, K–0.37%, poultry manure compost N–2.20%, P–1.40%, K–1.20% and FYM N–0.58%, P–0.27%, K–0.60%, respectively. The recommended package of practices was followed, and the crop was harvested. For recording plant height and for estimation of dry matter production, five plants were randomly removed 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. 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

Growth Characters

The growth components of rice viz., plant height and dry matter production were significantly influenced by the application of bio digested bone sludge compost (Table 1). Among the different treatments studied, application of bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha along with Balance N and K through fertilizers (T_4) significantly registered the highest plant height of 96.46 cm. This phenomenon may be attributed to the impact of bone sludge and pressmud compost on lowland rice soils, leading to the release of NH_4^+ nitrogen into the rice rhizosphere. Consequently, the rice plants exhibit increased nitrogen uptake, supported by the nitrogen supplied from pressmud compost, meeting the nutrient demands throughout the plant's growth stages. As a result, optimal vegetative growth ensues, resulting in maximum plant height. This is in agreement with the findings of Sultana *et al*. (2021).

Application of bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha along with Balance N

Table 1. Effect of bio digested bone sludge compost on growth characters and yield of rice at harvesting stage

Treatments	Plant height at harvest (cm)	Dry matter production ($kgha^{-1}$)	No. of productive tillers m^{-2}	No. of filled Grains $panicle^{-1}$	Grain yield ($kgha^{-1}$)	Straw yield ($kgha^{-1}$)
T_1 - Bone sludge compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	84.11	11754	354	82.70	4011	6675
T_2 - Bone sludge compost @ 2.5 t ha^{-1} + Pressmud Compost @2.5 t ha^{-1} + Balance N and K through fertilizers	89.10	13470	415	89.20	4906	7340
T_3 - Bone sludge compost @ 2.5 t ha ^{1} + Poultry manure compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	86.62	12596	385	86.00	4461	6990
T_4 - Bone sludge compost @ 5 t ha^{-1} + Pressmud Compost @ 5 t ha^{-1} + Balance N and K through fertilizers	96.46	15884	491	98.00	6170	8270
T_5 - Bone sludge compost @ 5 t ha^{-1} + Poultry manure compost @ 5 t ha^{-1}+ Balance N and K through fertilizers	94.01	15112	468	95.20	5769	7970
T_6 - Bone sludge compost @ 5 t ha^{-1} + Goat manure compost @ 5 t ha^{-1} + Balance N and K through fertilizers	91.55	14304	443	92.30	5344	7660
T_7 - FYM @ 12.5t ha^{-1} + Recommended NPK ha^{-1}	83.92	11424	342	80.50	3861	6525
T_8 - Control (No nutrient supply)	81.44	9736	307	76.70	2861	5990
CD (p=0.05)	2.43	324	13	2.60	180	210
SEm±	0.81	108	4.33	0.86	60	70

and K through fertilizers (T_4) significantly recorded the highest dry matter production of 15884 kg/ha at harvest. This might be due to the simultaneous use of synthetic fertilizers and organic manure likely contributed to a consistent and harmonized supply of both inherent and externally applied nutrients. This, in turn, could have prolonged the leaf area duration, allowing rice plants to enhance their photosynthetic rate and consequently increase dry matter accumulation. Additionally, this practice might have enhanced soil aggregation and nutrient availability, fostering favorable soil conditions. Consequently, heightened physiological processes such as increased photosynthesis and improved light interception likely led to greater vegetative growth and dry matter production in the plants Similar findings were reported by Stepien *et al*. (2021).

Higher dry matter production was due to the higher leaf dry weight and stem dry weight recorded at different stages. This had provided more photosynthetically active leaf area resulting in higher dry matter production.

Yield Attributes

The yield attributes of rice viz., number of productive tillers/m² and number of filled grains/panicle were favourably influenced by the bio digested bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha along with Balance N and K through fertilizers (Table 1). Maximum number of productive tillers (491/m²) and number of filled grains/panicle (98.00) were registered under the application of bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha along with Balance N and K through fertilizers (T_4). It was followed by the application of bone sludge compost @ 5 t/ha + poultry manure compost @ 5 t/ha along with Balance N and K through fertilizers (T_4). The treatment with control (no nutrient supply) (T_8) registered the minimum number of tillers (307/m2) and filled grains/panicle 76.70).

The utilization of industrial waste like bone sludge and pressmud compost, rich in both macro and micronutrients, contributed to soil enrichment when combined with inorganic fertilizers, including NO3, PO4, Ca, K, Mg, S, and other essential nutrients readily absorbable by plants. This resulted in an increased number of tillers due to improved soil nutritional status. This is in concomitance with the findings of Arunkumar *et al*. (2018) and Shobeka Devi and Sivakumar (2022). The simultaneous use of inorganic fertilizers and organic manure likely facilitated a consistent nutrient supply throughout the various growth stages of rice. This practice may have also enhanced the availability of both macro and micronutrients, leading to increased nutrient uptake and better translocation of photosynthates from source to sink, ultimately resulting in a higher number of filled grains per panicle. These findings conform with the earlier reports of Rahman and Barmon (2019).

Yield

Bio digested bone sludge compost significantly influenced the grain and straw yield of rice (Table 1). Application of bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha along with Balance N and K through fertilizers (T_4) significantly registered the highest grain yield of 5792 kg/ha and straw yield of 8270 kg/ha. It was followed by application of bone sludge compost @ 5 t/ha + poultry manure compost @ 5 t/ha along with Balance N and K through fertilizers recorded with a grain yield of 5769 kg/ha and straw yield of 7970 kg/ha. Treatment with control (no nutrient supply) (T_8) registered the minimum grain yield of 2861 kg/ha and straw yield of 5990 kg/ha. The increase in grain yield could be attributed to the superior characteristics contributing to yield in bio digested bone sludge compost. This approach ensures the provision of essential nutrients in well-balanced proportions, promoting the optimal growth of rice. This might be due to the slow and steady release of nutrients by bone sludge compost and pressmud compost that provided nutrients such as available nitrogen, soluble K, exchangeable Ca, Mg and P that could be readily taken by the plants in balanced manner (Sarkar *et al*., 2021) and Mohanasundar and Saravana perumal (2021).

Moreover, the application of bone sludge and pressmud composts significantly contributed a substantial quantity of macro and micronutrients, particularly phosphorus, calcium, and magnesium. These nutrients play crucial roles in enzyme activities and influence the physiochemical and biological activities of the soil, leading to increased assimilation of photosynthates. This, in turn, promotes the conversion of assimilates into yield-enhancing attributes in a larger proportion, ultimately resulting in higher grain and straw yields. Similar findings of balanced supply of nutrients by combining organics with inorganics for better growth, yield attributes and yield of rice are in agreement with the results of the study of Ajay Kumar and Sivakumar (2020)

Conclusion

Based on the present investigation, it could be concluded that application of bone sludge compost @ 5 t/ha + Pressmud compost @ 5 t/ha along with balance N and K through fertilizers holds promise in enhancing crop yield in rice which is the felt need of present-day agriculture. 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 rice without affecting the soil health.

Conflict of Interest - None

References

Ajaykumar, R. and Sivakumar, S.D. 2020. Effect of integrated nutrient management on growth, physiological, nutrient uptake, root and yield parameters of transplanted lowland rice. *Curr. J. Appl. Sci. Tech.* 39(40): 35-43.

Arun Kumar, Meena, Ram and Yadav, Lalji and Y. Gilotia. 2018. Effect of organic and inorganic sources of nutrient on yield, yield attributes and nutrient uptake of rice CV. PRH-10. *Int. Quat. J. Life. Sci.* 9(2): 595-597.

Directorate of Economics and Statistics, 2021. Department of Agricultural Cooperation and Farmers' Welfare. Ministry of Agriculture and Farmers' Welfare, Govt. of India, Delhi, India.

FAO/UNESCO, 1974. Soil map of the world I, Legend sheet memoirs, Paris. P. 59

Imran Khan, Muhammad, A., Chattha, M.U., Skalicky, M., Bilal Chattha, M., Ahsin, M., Ayub, M. Rizwan Anwar, Soufan, W., Hassan, M.U., Rahman, M.A., Brestic, M., Zivcak, M. and El Sabagh, A. 2022. Mitigation of Salinity-Induced Oxidative Damage, Growth, and Yield Reduction in Fine Rice by Sugarcane Press Mud Application. *Front. Plant Sci.* 13: 840900.

Jagadeesha, N., Gb, S., Hosamani, V., Umesh, M. and Reddy, V. 2020. Soil properties, water use efficiency and production potential of finger millet and pigeon pea intercropping under organic production in alfisols of Karnataka. *Intl. J. Chem. Stud*. 8: 1598-1603.

Jhon, D.A. and Babu, G.R. 2021. Lessons from the aftermaths of green revolution on food system and health. *Front. Sustain. Food Syst*. 5: 644559.

Krishnaveni, A., Chinnasamy, S., Elumalai, J. and Muthaiyan, P. 2020. Sugar industry wastes as wealth of organic carbon for soil. *Environmental Factors Affecting Human Health*. Doi: 10.5772/intechopen.90661.

Lency, T. 2001. *Formulation and evaluation of organic meals from KCPL effluent slurry.* Ph. D. thesis, Kerala Agricultural University, Vellayanikara, Thrissur, Kerala, India.

Mohana Sundar, C. and Saravana Perumal, M. 2021. Comparison of different planting methods and physiological studies for yield enhancement in rice. *J. Pharmacogn. Phytochem.* 10: 1400-04.

Pankaj Singh and Singh, A.K. 2022. The effect of integrated nutrient supply on growth and yield performance of rice (*Oryza sativa L.*) crop. *J. Pharm. Innov.* 11(1): 774-776.

Prakhyath, K.M., Prakash, S.S., Honnappa, H.M., Srinivasa, N., Krishna Murthy, R. and Yogananda, S.B. 2022. Growth and development of paddy due to different amendments and nutrient management practices in sodic soil. *J. Pharm. Innov*. SP-11(1): 208-214.

Rahman, S. and Barmon, B. 2019. Greening modern rice farming using vermicompost and its impact on productivity and efficiency: An empirical analysis from Bangladesh. *Agric.* 9: 239.

Sadh, P.K., Duhan, S. and Duhan, J.S. 2018. Agro- industrial wastes and the ir utilization using solid state fermentation: A review. Bioresour. *Bioprocess***.** 5: Doi: org/10.1186/s40643-017-0187-z.

Sarkar, S.K., Paul, S.K., Saha, K.K., Artho Baroi and Abdur Rahman Sarkar Md. 2021. Impact of vermicompost based nitrogen management and plant spacing on the performance of short duration transplant Aus rice (cv. Parija). *Archives.* 6. Doi: org/ 10.26832/24566632.2021.0604017.

Shobeka Devi, S. and Sivakumar, G. 2022. Impact of integrated nutrient management in increasing the yield of rice (*Oryza sativa* L.). *Crop Research*. 57(5 and 6): 308-312.

Shova Akter, M. Kamruzzaman, M.Z. Khan and Amin, M.S. 2023. Enhanced Potassium Fertilization Improved Rice (*Oryza sativa*) Yield and Nutrient Uptake in Coastal Saline Soil of Bangladesh. 2023. *J. Soil Sci. Plant Nutri.*

Stepien, A., Wojtkowiak, K. and Kolankowska, E. 2021. Use of meat industry waste in the form of meat-and-bone meal in fertilizing maize (*Zea mays* L.) for grain. *Sustainability.* 13: 2857.

Sultana, M., Jahiruddin, M., Islam, M.R., Rahman, M.M., Abedin, M.A. and Solaiman, Z.M. 2021. Nutrient enriched municipal solid waste compost increases yield, nutrient content and balance in rice. *Sustainability*. 13.