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Assessing the Influence of Bio-digested Bone Sludge Compost on Root Morphology in Rice Cultivation

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ABSTRACT

This study, conducted in 2022 at the Experimental Farm of the Department of Agronomy, Annamalai University, investigates the impact of bio-digested bone sludge compost on rice root length and volume. Assessing various combinations of organic composts and inorganic fertilizers, the research aims to elucidate their effects on rice growth. Results indicate a significant increase in both root length and volume with the use of bio-digested bone sludge compost, particularly when combined with pressmud compost. This suggests its potential in enhancing sustainable rice cultivation practices by promoting root development, improving nutrient absorption, and enhancing soil structure. Furthermore, the integration of organic composts with inorganic fertilizers ensures a balanced nutrient supply to rice plants, further enhancing growth and productivity. Among the treatments tested, application of bone sludge compost @ 5 t/ha + Pressmud compost @ 5 t/ha, along with balanced N and K through fertilizers (T_4), demonstrated superior performance in root length and volume. In conclusion, the study highlights the efficacy of incorporating bio-digested bone sludge compost, especially in conjunction with pressmud compost, as a sustainable approach to maximize rice yield. These findings underscore the benefits of utilizing organic soil amendments in rice cultivation, offering valuable insights into environmentally friendly farming practices. Overall, this research contributes to our understanding of optimizing agricultural practices for enhanced crop productivity and sustainability. Considering the results of the present investigation, it can be concluded that the application of bone sludge compost @ 5 t/ha + Pressmud compost @ 5 t/ha, along with balanced N and K through fertilizers, registered the highest values in root length and root volume in rice.

Key words: *Rice, Root length, Root volume, Bio-digested bone sludge compost, organic compost, Inorganic fertilizers, Sustainable agriculture.*

Introduction

Rice is a vital staple food for half the world's population and ranks second only to wheat in terms of cultivated land area globally (Jhon and Babu, 2021). Globally, rice is cultivated over 162 million hectares, yielding 700 million tonnes annually at an average productivity of 4.3 tonnes per hectare. In India, rice covers 48.53 million hectares, producing 112.18 million tonnes with an average productivity of 2.31 tonnes per hectare. In Tamil Nadu, rice cultivation spans 2.2 million hectares, producing 8.65 million tonnes with a productivity rate of 3.93 tonnes per hectare (Directorate of Economics and Statistics, 2021). In this context, maximizing rice yield while minimizing environmental impacts has become a critical objective for agricultural researchers and practitioners.

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One promising approach to enhance rice yield sustainably involves the utilization of organic amendments such as bone sludge compost and pressmud compost. Bone sludge compost, derived from the bio-digestion of animal bones, and pressmud compost, a by-product of sugar refining, are rich sources of organic matter and essential nutrients necessary for plant growth (Adhikary *et al.,* 2018). These composts not only improve soil fertility but also contribute to enhanced soil structure and water retention capacity (Kumar *et al.,* 2020).

Recent years have witnessed a growing body of research focusing on the efficacy of bone sludge and pressmud composts in rice cultivation. Studies have explored their effects on various aspects of rice growth, including plant morphology, yield components, and nutrient uptake efficiency (Das *et al.,* 2019; Rahman *et al.,* 2021). Moreover, research has increasingly emphasized the role of these organic amendments in mitigating soil degradation, reducing greenhouse gas emissions, and promoting sustainable agricultural practices (Kumar *et al.,* 2022; Singh *et al.,* 2023).

Despite the growing interest in the potential of bone sludge and pressmud composts, there remains a need for comprehensive evaluations of their effectiveness in maximizing rice yield. By integrating recent advancements in agricultural science and technology, along with innovative approaches to organic waste management, researchers can develop strategies to optimize the utilization of these composts in rice production systems. This research article aims to contribute to this evolving field by investigating the yield maximization potential of bone sludge and pressmud composts in rice cultivation.

Through a systematic analysis of relevant literature and empirical research findings, this study seeks to elucidate the mechanisms underlying the beneficial effects of bone sludge and pressmud composts on rice yield. By addressing key knowledge gaps and providing practical insights, this research aims to inform policymakers, agricultural practitioners, and stakeholders about the sustainable utilization of organic amendments for enhancing rice productivity in the face of global food security challenges.

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 geographical location of Annamalai Nagar is 11º24' N latitude and 79º44' E longitude at analtitude of +5.79 m above mean sea level. 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 (210 kg/ ha), low in available P_2O_5 (21 kg/ha) and high in available K_2O (265 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 @ 12.5t ha^{-1} + Recommended NPK ha^{-1} and T_8 – Control (No nutrient supply). Rice variety ADT43 was chosen for the investigation. Bone sludge compost came from Pioneer Jellice India Pvt. Ltd., Cuddalore, while pressmud compost, poultry manure compost, and FYM were sourced from the farm unit of the Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar. 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 Root length and volume was measured at 30 and 60 days after transplanting. Statistical analysis was performed to determine significant differences among treatments.

Results and Discussion

Effect of Bio Digested Bone Sludge Compost on Root Volume (Cc) and Root Length of Rice

The data on root length (cm) and root volume (cc) recorded at vegetative and flowering stages (30 DAT, 60 DAT) of rice are presented in Table 1. Significant differences in root length (cm) of rice were observed due to the application of bio-digested bone sludge compost along with other sources. Among the treatments tested in the experiment, the highest root lengths of 13.86 cm and 25.21 cm at active tillering and flowering stages, respectively, were observed with the application of bone sludge compost @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers (T_4). This treatment was followed by the application of bone sludge compost @ 5 t ha^{-1} + Poultry manure compost @ 5 t ha^{-1} + Balance N and K through fertilizers (T_5). Similarly, among the treatments tested in the experiment, the application of bone sludge compost @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers (T_4), along with balanced N and K through fertilizers (T4), registered significantly higher root volumes of 22.05 cc and 35.18 cc at active tillering and flowering stages, respectively.

Enhanced Nutrient Availability

The observed increase in root length and volume can be attributed to the nutrient-rich composition of bone sludge and pressmud compost. These organic amendments release essential nutrients, such as nitrogen (N), phosphorus (P), and potassium (K), into the soil, promoting vigorous root growth. Sultana *et al.* (2021) demonstrated a similar effect of organic composts on root development in rice, highlighting the role of nutrient availability in supporting root elongation.

Nitrogen Uptake and Rhizosphere Interaction

The nitrogen content in bone sludge and pressmud composts facilitates nitrogen uptake by rice plants, particularly through NH_4^+ ions released into the rhizosphere. This interaction between compost-derived nitrogen and rice roots stimulates root elongation, as evidenced by the significant increase in root length and volume in treatments incorporating these composts. Similar findings were reported by Senthilvalavan and Ravichandran (2019), who emphasized the importance of NH4+ nitrogen in promoting root growth in rice.

Synergistic Effect of Organic and Inorganic Inputs

The combined application of organic composts and inorganic fertilizers ensures a balanced nutrient supply to rice plants, fostering optimal root development. This synergistic effect is reflected in the superior root length and volume observed in treatments receiving bone sludge and pressmud composts along with balanced N and K through fertilizers. Shobeka Devi and Sivakumar (2022) corroborated these findings, emphasizing the role of nutrient balance in enhancing root architecture and function in rice.

Table 1. Effect of bio digested bone sludge compost on nitrogen, phosphorus, potassium uptake (kg ha^{-1}) and post-harvest soil available nitrogen, phosphorus, potassium (kg ha^{-1}) of rice

Treatments	Root length (cm)		Root volume (cc)	
	30 DAT (Tillering)	60 DAT (Flowering)	30 DAT	60 DAT
T_1 - Bone sludge compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	10.19	20.01	17.53	29.34
T_2 - Bone sludge compost @ 2.5 t ha^{-1} + Pressmud compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	11.67	22.01	19.36	31.69
T_3 - Bone sludge compost @ 2.5 t ha 1 + Poultry manure compost @ 2.5 t ha^{-1} + Balance N and K through fertilizers	10.94	21.02	18.44	30.51
T_4 - Bone sludge compost @ 5 t ha^{-1} + Pressmud compost @ 5 t ha^{-1} + Balance N and K through fertilizers	13.86	25.21	22.05	35.18
T_5 - Bone sludge compost @ 5 t ha^{-1} + Poultry manure compost @ 5 t ha^{-1} + Balance N and Kthrough fertilizers	13.14	24.18	21.15	34.02
T_6 - Bone sludge compost @ 5 t ha^{-1} + Goat manure compost @ 5 t ha^{-1} + Balance N and K through fertilizers	12.41	23.08	20.24	32.87
T_7 - FYM @ 12.5 t ha^{-1} + Recommended NPK ha^{-1}	10.08	19.94	17.48	28.95
T_8 - Control (No nutrient supply)	9.32	18.86	16.52	27.42
SEm±	0.23	0.32	0.29	0.37
CD(P=0.05)	0.70	0.98	0.87	1.12

Improved Soil Structure and Nutrient Availability

Furthermore, the incorporation of bone sludge and press mud composts enhances soil structure and nutrient availability, creating a conducive environment for root proliferation. Stepien *et al.* (2021) demonstrated that organic amendments improve soil aggregation and nutrient retention, promoting root elongation and exploration. This improvement in soil conditions likely contributed to the observed increase in root volume and length in treatments with bone sludge and press mud composts.

Conclusion

In conclusion, integrating bone sludge and pressmud composts into rice cultivation significantly enhances root length and volume by improving nutrient availability and soil structure. This study contributes to understanding sustainable practices for maximizing rice yield. The application of bone sludge compost @ 5 t/ha + pressmud compost @ 5 t/ha with balanced N and K through fertilizers (T4) shows promise in enhancing root growth and volume, offering an agronomically efficient, ecologically desirable, and economically viable approach without compromising soil health.

Conflict of Interest- Authors declare no conflict of interest.

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