Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Effects of Sustainable Trash Management on Soil Health and Economic Profitability of Sugarcane in Calcareous Soil

Rajendra Bairwa
Jagannath University Jaipur
Chandan Kumar Jha
Dr. Rajendra Prasad Central Agriculture University
Shoji Lal Bairwa
Bihar Agricultural University
Hanuman Singh Jatav
hanumaniasbhu@gmail.com

Sri Karan Narendra Agriculture University, Jobner
Mamta Mamta
Indian Agricultural Research Institute
Deen Dayal Bairwa
Jagannath University Jaipur
Satyesh Raj Anand
Jagannath University Jaipur
Harkesh Kumar Balai
Jagannath University Jaipur
Manish Bairwa
Dr. Rajendra Prasad Central Agriculture University

Research Article

Keywords: Soil health, Carbon stock, Mulching, Benefit-cost ratio, Nutrient Balance

Posted Date: September 29th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10802400/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations:
No competing interests reported.

Tables are available in the Supplementary Files section

Effects of Sustainable Trash Management on Soil Health and Economic Profitability of Sugarcane in Calcareous Soil

Rajendra Bairwa[1], Chandan Kumar Jha[2], Shoji Lal Bairwa[3], Hanuman Singh Jatav[5]*, Mamta Mamta[4], Deen Dayal Bairwa[1], Satyesh Raj Anand[1], Harkesh Kumar Balai[1], Manish Bairwa[2]

[1]Faculty of Agriculture, Jagannath University, Chaksu, Jaipur, Rajasthan, India
[2]Department of Soil Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India-848125
[3]Department of Agricultural Economics, Bihar Agricultural University, Sabour, India
[4]Department of Soil Science and Agricultural Chemistry, ICAR-Indian Agriculture Research Institute, Pusa, New Delhi, India
[5*]Department of Soil Science and Agricultural Chemistry, Sri Karan Narendra Agriculture University, Jobner, India

Corresponding Author: Email- hanumaniasbhu@gmail.com

Abstract

This study, conducted in the subtropical region (Bihar), India in the year 2020-2022 to explores the influence of various trash management practices on soil health, nutrient balance and economics under sugarcane (CoP 2061) plant and ratoon systems. The experiment included treatments such as trash mulching with inoculation with *Trichoderma viride*, alongside the use of organics like farmyard manure (FYM) and vermicompost. The results revealed that trash mulching, particularly when combined with *Trichoderma*, significantly improved cane yield, with increases of up to 26.30% in plant crops and 32.83% in ratoon crops compared to control. These practices also enhanced soil health, as evidenced by higher soil organic carbon, nutrient availability, physical environment of soil. The economic analysis revealed that trash treatments led to a higher benefit-cost (B:C) ratio for plant (1.89) and ratoon (2.20), making them a sustainable option. The positive balance of available-NP was recorded in both plant and ratoon crop, while potassium (K) was negatively balanced in control plot for plant (-13.56 kg ha^{-1}) and ratoon (-12.79 kg ha^{-1}) crop.

Keywords: Soil health, Carbon stock, Mulching, Benefit-cost ratio, Nutrient Balance

Introduction

Yield of trash (Dry leave and top of sugarcane crop) is an associate with millable cane and it produces (8-12 t ha^{-1}) after detrashing practice of millable cane over the one crop season. This is the biggest challenge for the farmers to handle huge amounts of trash left in the field after crop harvest. The large portion of the residues is burnt on-farm by the farmers despite of banned by Indian government. Most of the farmers burned it in open fields which deteriorating the soil health and caused severe air pollution and greenhouse gases release to

global warming. The subtropical region of India (Uttar Pradesh, Bihar, Haryana and Punjab) covered 55 % of total sugarcane area. However, the yield sugarcane is low in subtropic region might be due to short growing season, high temperature gap among seasons, plant protection problems, floods and water logging which leads to very poor ratoons. The productivity of subtropic region around 60 tonnes per hectare. However, there is considerable potential to be exploited [1]. The ratoon crop covers half of sugarcane area in India nevertheless it contributes 25-30 % of the total cane production. This reducing of yields in third or forward ratoons due to decline in soil fertility [2]. The addition of organics and inorganics significantly improved the economic yield of sugarcane main crop and its ratoons [3]. The higher shoot populations, leaf area index, dry matter production (DMP), number of millable cane, cane and sugar yield of ratoon and soil organic carbon (SOC) content at harvest and higher net returns also observed the lowering weed density, weed dry weight and bulk density of soil due trash mulching with various agronomic practices [4]. Nowadays the sugarcane production potential decreasing may be due to deteriorating in soil health of India's subtropical region. The declining in cane yield has been reported from last decade in India due to reduce the soil organic matter [5], [6]. The mulching of trash can be used as nutrient supplements for the maintaining of soil health and production potential of crop. The management of trash as mulching or incorporation [7], mulching with *Trichoderma* [8], [9]. and mulching with *Trichoderma* + FYM [10], [9]. Improved soil health, soil fertility, economic production of cane (Cane and sugar yield) under sugarcane based cropping system. While trash burning observed that losses more than 70 % of nutrients [11]. Trash mulching has become a common practice in sugarcane ratoon. It has been observed to be conserves soil moisture, reduces soil erosion, controls weed growth and improved in Soil carbon (soil health) after decomposition [12]. Trash mulching similarly offers shelter to soil microorganisms [13], responsible for bio-decomposition/ nutrient mineralization. Thus, trash regulates the rhizospheric environment through enhanced soil health parameters, soil moisture and ultimately improves crop growth and yields [14], [15], [16], [17]. The effect of sugar wastes on maize growth, yield and uptake of macronutrient (NPK) [18]. The influence of organics significantly improved nutrient uptake [19]. The combined action of organic (FYM) and chemical fertilizer treatment under plant - ratoon system and they were in opinion that increased yield contributing attributes, cane yield and sugar yield due to use of organic with inorganic nutrient source in combination under sugarcane production system [14]. Whereas, the incorporation of *Trichoderma* treated trash enhanced the uptake of most vital nutrients i.e. N, P and K uptake by sugarcane [20]. The application of organics and

Trichoderma viride in mung bean intercrop (1:2) reported the maximum nutrient uptake, yield and net profit and B:C ratio [21]. Several researchers have been emphasized on the benefits of crop residue/trash mulching for increasing crop productivity and maintaining the sustainability of farming systems in tropical and sub-tropical climatic conditions [22]. Trash treated with *Trichoderma* degraded fast and quickly released nutrients and improved biological activity and fertility status of soil [16]. In according to above fact this present experiment has been carried out with aim to investigate the influence of trash management on sugarcane production potential, soil health and nutrient balance in soil under plant and ratoon system in Calcareous soil.

The profile of experimental site

The average annual rainfall was 1537 mm and 1909 mm during the plant and ratoon crop season, respectively. This research was planned at experimental site situated on the bank of the river *Burhi-Gandak* in the Samstipur, district of Bihar (India). Its coordinates were 25.58° N, 85.40° E, and its site comes under *Ustic* moisture regime subtropical climatic region of India. The experimental soil had sandy-loam textural class [23]. The analysis of initial soil indicates slightly alkaline in nature (8.67) [23] with medium EC (0.49 dSm^{-1}) [23], free $CaCO_3$ (31.62 %) [23], low organic carbon (4.60 g kg^{-1}) [24], medium in available N [25], P [26] and K [23] (224, 10 and 97 kg ha^{-1}, respectively). The applied sugarcane trash, farmyard manure and vermicompost were contained C/N ratio 79.84, 25.58 and 20.60, respectively. Prior to the start of the plant crop experiment, the initial and after harvest of main and ratoon crop surface soil samples were collected and analysed for various soil characteristics.

Experimental Details

The above research work was planned and conducted in RBD with 8 treatments and 3 replications. The treatments included control (RDF), trash mulching alone, trash mulching with urea (25 kg N ha^{-1}), FYM (5 t ha^{-1}), VC (2.5 t ha^{-1}), *Trichoderma viride* (500 gm t^{-1} of trash), *Azotobacter*+ phosphorus solubilizing bacteria (5 kg ha^{-1}) and trash incorporation. The methods of trash treatment employed in both main and ratoon crop of sugarcane () (CoP 2061). The experiment was carried out for the main sugarcane crop in 2020–2021 and the ratoon crop in 2021–2022. Trash was collected from Crop Research Centre, RPCAU, Pusa for main crop, while plant crop generated trash was used as *in situ* for ratoon crops. The Department of Plant Pathology, RPCAU, Pusa provided *Trichoderma* culture (*10^8 – 10^9 cfu g^{-1} of culture*), which was used to inoculate the trash.

The cane yield (t/ha) was multiplied by the CCS percent (commercial cane sugar percentage) as follows: $Yield\ of\ sugar\ (t/ha) = \frac{CCS\ \% \times Yield\ of\ cane\ (\frac{t}{ha})}{100}$

The cane samples (Whole cane) have been collected at the harvest time and cane juice was extracted by using the power crusher and pol (sucrose) content of juice was assessed as per the protocol [27]. CCS was computed from the Brix and pol measurements.

CCS (%) = [S - 0.4 (B-S)] x 0.73

An economical assessment was computed based on the treatment for main and ratoon crop of sugarcane.

Sampling and analysis of soil

An initial soil sample was taken during the beginning of the experiment and soil samples were also collected treatment wise at the harvest of sugarcane ratoon crop (0 to 15 cm soil depth). The bulk density was determined using fresh core soil samples [27]. The wet oxidation method was used to measure the amount of soil oxidizable organic carbon [24]. The methodology used for available-N [25], available phosphorus [26] and available-K [23]. The balance sheet was prepared for both plant and ratoon crops. To ascertain the statistical significance of treatments, analysis of variance (ANOVA) was performed and the least significant difference (LSD) at the 5 % level of significance was applied for testing variation among treatment mean value.

Results and Discussion

Soil Health

Soil organic carbon (4.53 – 6.93 g kg^{-1}) improved significantly due application of sugarcane trash management (Table 1). The soil organic carbon stock varied from 14.70 – 20.76 Mg ha-1 after harvest of ratoon. The various trash mulching treatments (T_2-T_8) significantly influenced soil available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) content after harvest of ratoon crop (Table 1). A significant improvement was recorded similar trend for soil organic carbon stock [34], [35], [36].

The BD of soil significantly reduced (Table 1) after harvest of ratoon crop as compared to no trash. The lowest BD was measured in T_4 (1.41 Mg m^{-3}) and T_6 (1.41 Mg m^{-3}) treatments receiving trash mulching (10 t ha^{-1}) treated with FYM and *Trichoderma*. In case of surface soil layer, the soil penetration resistance mean value varied from 1.26 – 1.40 MPa while in sub-surface it varied from 3.68-4.09 MPa after harvest of ratoon. The lowest penetration

resistance was recorded in T6 in surface (1.26 MPa) and sub-surface (3.68 MPa) receiving trash mulching inoculated with *Trichoderma*. In general, soil strength increases from surface to sub-surface soil (Table 1). The WHC varied (36.43- 44.94 %) significantly due to different trash mulching management practices. The highest percentage of macro aggregate recorded in T_6 (63.30 %) followed by T_4 (60.41 %), T_5 (59.38 %), T_7 (59.13 %), T_3 (59.08 %), T_8 (57.60 %), T_2 (55.61 %) and lowest in control (45.34 %). After 2 years, the *Trichoderma* inoculated trash mulching treatment showed significantly superior as compared other treatments (Table 1). The trash mulching treatments significantly enhanced the SMBC by 139.47 % over the no trash (Control) after two crop cycles (Table 1) [31], [32], [33]**.**

Uptake of NPK

The uptake of nitrogen, phosphorus and potassium by sugarcane crop improved significantly changed from 213.47 – 282.40 kg N ha^{-1} after ratoon harvest (Figure 1). Among the trash applied treatments, nitrogen uptake recorded highest in T_6 (282.40 kg ha^{-1}). The P-uptake from the soil was influenced ranged from 15.21 – 20.57 kg ha^{-1}. Nevertheless, the potassium uptake by ratoon was significantly more in trash treatments as compared to control (Figure 1). The K-uptake ranged from 165.35– 246.34 kg ha^{-1} at harvest stage of ratoon. The uptake of macronutrients (NPK) increased significantly due to increased concentration of nutrients in plant due to higher availability of NPK in soil. In addition, higher accumulation of biomass as reflected from dry matter production in trash treated treatments uptakes more nutrient. Similar effects of trash or organics addition on uptake nutrients also reported by [20], [29], [6], [30], [37].

Balance of NPK

The trash mulching treatments improved positive (+) balance of available nitrogen (N), being highest in T_6 and lowest in control. However, positive (+) balance of available phosphorus (P), presence highest in T_7 and lowest in control (Figure 2). It might be due to increased available-NP in soil due to decomposition of treated trash. However, potassium (K) was negatively balanced in control plot (-12.02 kg K_2O ha^{-1}), while it balanced positively in trash treatments either mulching (T_2-T_7) or incorporation (T_8) after harvest of ratoon), depicted in figure 2. It might be due to less availability of K in control plot after ratoon harvest. The luxury consumption of K may be also the reason for higher uptake of K by sugarcane. The results followed the agreements with [29], [14], [5], [38].

Cane yield and economics

The plant and ratoon cane yield which significantly improved due to trash application (Table 2). The yield of cane increased minimum by 13.28 % in T_2 (Trash mulching alone) and maximum by 26.30 % in T_6 in plant crop. The cane yield increased maximum to the tune of 32.83 % in T_6 followed T_4 (24.37 %) receiving trash mulching activated with FYM over the control. The results agreed with [8], [10], [13], [39].

B:C ratio

The B:C ratio increased significantly ($p<0.05$) in trash mulching treatments, activated/inoculated and its direct incorporation into soil under sugarcane plant and ratoon trash mulching cropping system (Table 2). The addition of trash (T_2) was inferior in terms of B:C ratio. However, all the trash treatments were found on par with each other. The higher B:C ratio in trash activated/inoculated treatments owing to the low cost of cultivation and high gross return due to higher yield in both plant and ratoon crops. The similar findings have been reported by [28], [3], [20].

Conclusion

The study highlights the significant benefits of trash mulching management on sugarcane growth, yield and soil health. While treatments, particularly trash mulching with *Trichoderma*, significantly increased tiller count, cane length, and yield in ratoon crops. Soil health also improved, with notable improvements in organic carbon, bulk density, water holding capacity and microbial biomass carbon. The findings emphasize the effectiveness of trash mulching management with organic and microbial treatments for boosting sugarcane productivity and soil sustainability.

Acknowledgement

I would like to express my special thanks and gratitude to Director of Sugarcane Research Institute and Head of the Department of Soil Science, RPCAU, Pusa, who gave me the facility to do this wonderful research work.

Conflict of Interest

We, the authors, declare that we have no conflict of interest presenting of data in current research study.

Data availability

Yes, all data generated and analysed in this study and available from the corresponding author on reasonable request.

Funding: This research did not receive any specific funds.

Ethics and consent to participate: Not applicable

Plant material:

"The sugarcane plant material (*Saccharum officinarum* L.) variety CoP 2061 used in this study was cultivated under field conditions and was not collected from the wild. The cultivation, collection and use of plant material complied with applicable local and national guidelines and regulations. No specific permission or licence was required for the use of the cultivated plant material in this study."

Clinical Trial Registration: Not Applicable

Consent to Publish: Not Applicable

References

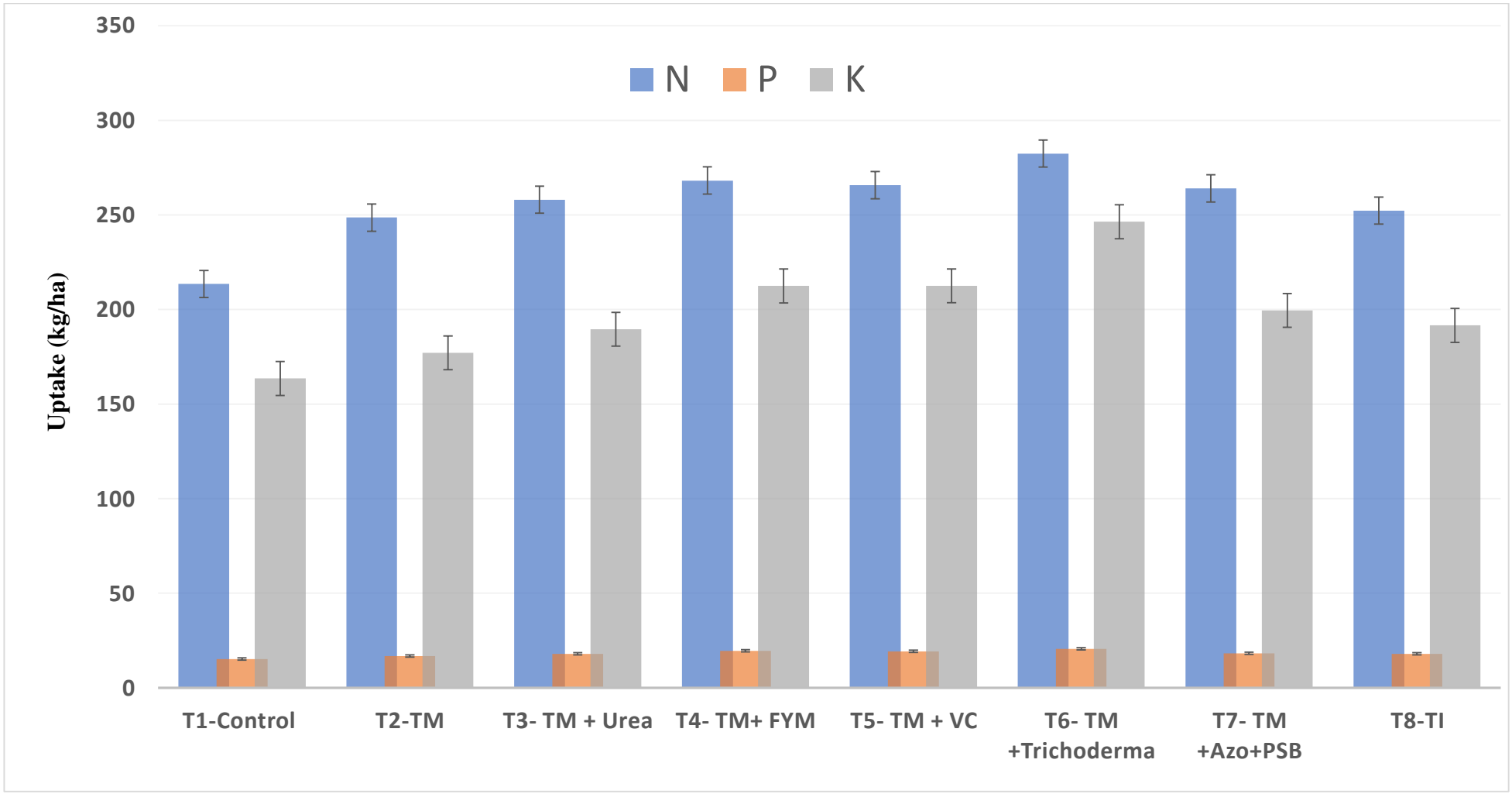
1. National Food Security and Nutrition Mission (NFSNM). (2025). Crops and Seed Division, Operational Guidelines, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, Krishi Bhavan, New Delhi, India.
2. Hunsigi, G. 2001. Ratoon management. In: Sugarcane in agriculture and industry. Prism Books, Bangalore, p. 217.
3. Srivastava, T.K., Singh, K.P. and Yadav, R.L. (2012). Sugarcane productivity, soil health and nitrogen use dynamics in a bio-nutrition based multi-ratooning system under Indian sub-tropics. *International sugar journal*. **114**(1364): 584-589.
4. Singh, V., Srivastava, A., Singh, R.K. and Savita, U.S. (2011). Effect of tillage practices and residue management on soil quality and crop yield under maize (*Zea mays*)-Based cropping system in Mollisol. *Indian Journal of Agricultural Sciences*. **81**(11): 10-19.
5. Singh, G., Jalota, S.K. and Singh, Y. (2007a). Manuring and residue management effects on physical properties of a soil under the rice–wheat system in Punjab, India. *Soil and Tillage Research*. **94(1):** 229-238.
6. Singh, K.P., Suman, A., Singh, P. N. and Lal, M. (2007b). Yield and soil nutrient balance of a sugarcane plant–ratoon system with conventional and organic nutrient management in sub-tropical India. Nutrient Cycling in Agroecosystems. 79(3): 209-219.
7. Shukla, S. K., Jaiswal, V. P., Sharma, L., Tiwari, R., Pathak, A. D., Gaur, A., and Srivastava, A. (2022). Trash management and Trichoderma harzianum influencing photosynthesis, soil carbon sequestration, and growth and yield of sugarcane ratoon in subtropical India. *European Journal of Agronomy*, **141**:126631.
8. Jaiswal, V. P., Shukla, S. K., Sharma, L., and Pathak, A. D. (2023). Crop residue recycling affecting carbon sequestration, nutrients availability and crop yields in rice-wheat and sugarcane-ratoon-wheat system. Sugar Tech, 25(1), 119-140.
9. Bairwa, R., Jha, C. K., Thakur, S. K., Mamta, Roy, D. K., and Brajendra. (2023). Carbon pools and indices under activated trash treatments in sugarcane plant-ratoon system grown in calcareous soil of subtropics. Sugar Tech, 25(6), 1433-1444.

10. Suma, R. and Savitha, C.M. (2015). Integrated sugarcane trash management: A novel technology for sustaining soil health and sugarcane yield. *Advances in Crop Science and Technology*. **3**(1): 1-4.
11. Mitchell, R.D., Thorburn, P.J. and Larsen, P. (2000). Quantifying the loss of nutrients from the immediate area when sugarcane residues are burnt. In Proceedings of the 2000 Conference of the Australian Society of Sugar Cane Technologists held at Bundaberg, Queensland, Australia, 2-5 May 2000. PK Editorial Services. pp. 206-211.
12. Surendran, U., Ramesh, V., Jayakumar, M., Marimuthu, S., and Sridevi, G. (2016). Improved sugarcane productivity with tillage and trash management practices in semi arid tropical agro ecosystem in India. *Soil and Tillage Research*, *158*, 10-21.
13. Yadav, R.L., Shukla, S.K., Suman, A. and Singh, P.N. (2009). *Trichoderma* inoculation and trash management effects on soil microbial biomass, soil respiration, nutrient uptake and yield of ratoon sugarcane under subtropical conditions. *Biology and Fertility of soils.***45**(5): 461-468.
14. Shukla, S.K., Suman, A., Singh, A.K., Yadav, R.L. and Lal, M. (2007). Organic nutrition for sustaining soil health, improving rhizospheric environment, and sugarcane yield in India. Hartsburg Claus T., editor. Sugar Beet Crops: Growth, Fertilization and Yield. USA: Nova Science Publishers Inc. pp.1-29.
15. Shukla, S.K., Singh, P.N., Chauhan, R.S. and Yadav, R.L. (2012). Recycling of organic wastes amended with *Trichoderma* and *Gluconacetobacter* for sustenance in soil health and sugarcane ratoon yield in Udic Ustochrept. *Communications in soil science and plant analysis*. **43**(7): 1073-1097.
16. Shukla, S.K., Yadav, R.L., Awasthi, S.K. and Gaur, A. (2017a). Soil microbial biomass nitrogen, in situ respiration and crop yield influenced by deep tillage, moisture regimes and N nutrition in sugarcane-based system in subtropical India. *Sugar Tech*. **19**(2): 125-135.
17. Shukla, S.K., Shee, S., Maity, S.K., Solomon, S., Awasthi, S.K., Gaur, A. and Jaiswal, V.P. (2017b). Soil carbon sequestration and crop yields in rice–wheat and sugarcane–ratoon–wheat cropping systems through crop residue management and inoculation of Trichoderma viride in subtropical India. *Sugar Tech.* **19**(4): 347-358.
18. Venkatakrishnan, D., Rajkumar, K., Elayaraja, D., Manivannan, R., Senthilvalavan, P., Manimaran, S. and Ravichandran, S. (2020). Effect of nutrient management on yield and uptake of maize. *Plant Archives*. **2**(2): 4544-4546.
19. Sinha, S.K., Kumar, V. and Jha, C.K. (2017). Effect of integrated use of bio-compost and nitrogen on productivity and soil properties of sugarcane plant–ratoon system in calcareous soil. *Sugar Tech*. **19**(5): 485-491.
20. Thakur, S.K., Jha, C.K., Kumari, G. and Singh, V.P. (2010). Effect of Trichoderma inoculated trash, nitrogen level and bio-fertilizer on performance of sugarcane (Saccharum officinarum) in calcareous soils of Bihar. *Indian Journal of Agronomy*. **55**(4): 55-58.
21. Srivastava, T.K., Singh, K.P., Menhilal, Suman, A. and Kumar, P. (2008). Productivity and profitability of sugarcane (Saccharum spp. complex hybrid) in

relation to organic nutrition under different cropping systems. *Indian Journal of Agronomy*. **53**(4): 310-330.
22. Yadav, D. V. and Yaduvanshi, N. P. S. (2001). Integration of green manure intercropping and fertilizer-N for yield and juice quality and better soil conditions in sugarcane grown after mustard and wheat in different plant arrangements. *The Journal of Agricultural Science*, *136*(2), 199-205.
23. Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi.
24. Walkley, A. and Black, C.A. (1934). An experimentation of digestion method for determining soil organic matter and proposed modification of chronic acid method. *Soil Science*. **37:** 29-38.
25. Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the determination of available nitrogen in soils. *Current Science*. **25**: 259-60.
26. Olsen, S. R. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture.
27. Spencer, G.L and Meade, G.P. (1964). Sugarcane hand book. John Wiley and Sons. London.
28. Srivastava, T.K., Singh, K.P., Singh, P., Suman, A., Singh, S.R., Verma, R.R., Singh, V.K. and Singh, R.K. (2018). Effect of bio-manures on soil quality, cane productivity and soil carbon sequestration under long-term sugarcane (Saccharum officinarum) plant - ratoon system in Indian sub-tropics. *Indian Journal of Agricultural Sciences*. **88**(11): 1696-1703.
29. Majeed, A., Rashid, I., Niaz, A., Ditta, A., Sameen, A., Al-Huqail, A.A. and Siddiqui, M.H. (2022). Balanced Use of Zn, Cu, Fe, and B Improves the Yield and Sucrose Contents of Sugarcane Juice Cultivated in Sandy Clay Loam Soil. *Agronomy*. **12**(3): 696.
30. Jha, C.K., Sinha, S.K. and Thakur, S.K. (2017). Enhancing soil fertility, nutrient uptake and sugarcane productivity through integrated use of Fe and organics in sub-tropical system. *Indian Journal of Ecology*. **44**(5): 521-525.
31. Bairwa, R., Chattopadhyaya, N., Mandal, N., and Singh, M. (2021). Phosphorus solubilization under organic and inorganic sources of P in red and alluvial soils and estimation of phosphorus solubilizing power. Journal of the Indian Society of Soil Science, 69(4), 440-450.
32. Thakur, S.K. and Jha, C.K. (2011). Integrated effect of nutrients on yield, uptake and juice quality of Sugarcane. *Indian Agriculturist*. **55**(3and4): 157-162.
33. Thakur, S.K., Alam, M. and Singh, V.P. (2012). Effect of different levels of NPK and compost on performance of sugarcane in calcareous soils of Bihar. Abstract published in 2nd International Conference on Agrochemicals Protecting Crop, Health and Nature Environment- Role of Chemistry for Sustainable Agriculture at IARI, New Delhi from 15-18 Feb., 2012. pp. 288.
34. Bairwa, R., Chattopadhyaya, N., Mandal, N., Singh, M., Mamta, and Meena, P. (2025). Phosphorus Availability from Rock Phosphates and Adsorption-Desorption Phenomenon in Red and Alluvial Soil as Affected by Phosphorus Solubilizing

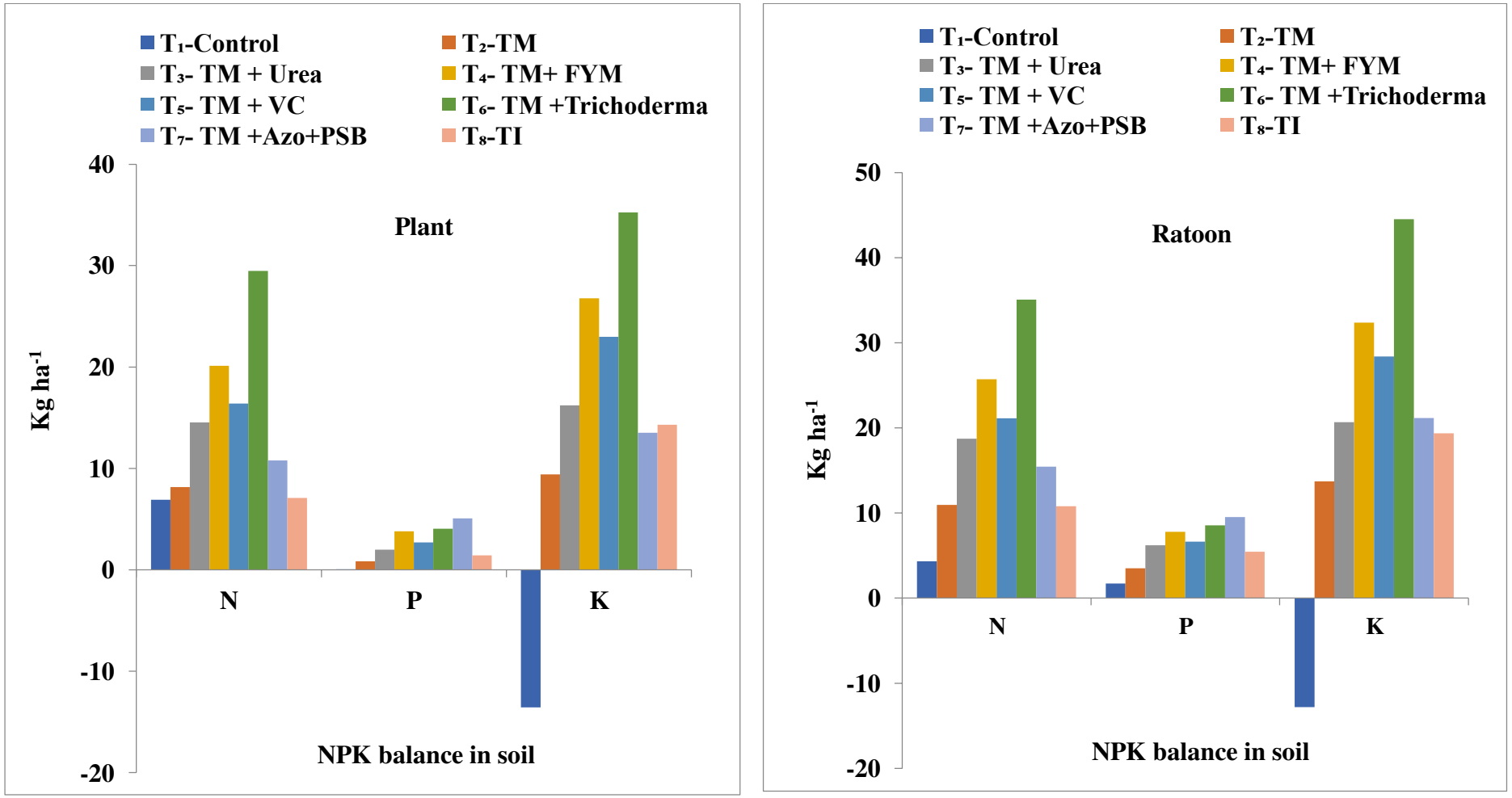
Bacteria (PSB), FYM and Vermicompost Application. Communications in Soil Science and Plant Analysis, 56(4), 602-616.

35. Minhas, Y.J., Baloch, L.M. and Minhas, S. (2013). Effect of trash mulch and N levels on cane yield and recovery of sugarcane variety Thatta-10. *Pakistan Sugar Journal*. **28**(1): 17-22.
36. Bairwa, R., Jha, C. K., and Thakur, S. K. (2022). Effect of sugarcane trash management techniques on soil fertility, nutrient uptake and yield of sugarcane ratoon in calcareous soil. The Pharma Innovation, 11(5), 1538-1541.
37. Kumar, S., Chand, G., Mandal, D., Kumar, A. and Kumar, S. (2015). Effect of trash mulching on quantitative and qualitative parameters of sugarcane. *Ecology, Environment and Conservation*. **21**: 141-143.
38. Bairwa, R., Jha, C. K., Thakur, S. K., and Kumar, V. (2022). Soil health, Cane Productivity and Juice quality Improvement through Sugarcane trash Management in Plant-ratoon system grown in Calcareous soil. Biological Forum An International Journal (Vol. 14, No. 2, pp. 1091-1094).
39. Blake, G.R. and Hartge, K.H. (1986). Peterson, RG, and LD Calvin. 1986. Bulk density Chapter 13 pp. 363-376. Klute, A. Methods of soil analysis. Part, 1.



[Control- No trash, TM-Trash mulching (@10 t ha^{-1}), FYM-Farmyard manure, VC-Vermicompost, Azo- *Azotobacter*, PSB-Phosphorus solubilising bacteria, TI-Trash incorporation]

Figure 1: Effect of trash mulching treatments on nutrient uptake by ratoon crop.



[Control- No trash, TM-Trash mulching (@10 t ha^{-1}), FYM-Farmyard manure, VC-Vermicompost, Azo- *Azotobacter*, PSB-Phosphorus solubilising bacteria, TI-Trash incorporation]

Figure 2: NPK balance in soil after harvest of sugarcane plant and ratoon crop.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tablef.docx