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Effect of sugarcane trash management techniques on soil fertility, nutrient uptake and yield of sugarcane ratoon in calcareous soil

Rajendra Bairwa, CK Jha and SK Thakur

Abstract
A field research was formulated for sugarcane (*Saccharum* spp. Hybrid complex) plant -ratoon system in calcareous soil at Crop Research Centre, RPCAU, Pusa, Bihar, to see the effect of various trash management techniques *viz.*, sugarcane trash incorporation and trash mulching treatments activated with urea, FYM, vermicompost, and trash mulching treatments inoculated with *Trichoderma* / *Azotobacter* + PSB along with control plot. RDF (170 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}) applied in all the treatments. The trash mulching treatments either activated with FYM, VC or inoculated with *Trichoderma* resulted in the significant enhancement in all the growth and yield parameters of ratoon crop and these treatment were found on par. Among treatments *Trichoderma* inoculated trash recorded highest cane yield and maximum uptake of nutrients (NPK) by ratoon crop. The various trash mulching treatments either activated with FYM, vermicompost, or inoculated with *Trichoderma*/ *Azotobacter* + PSB significantly enhance organic carbon and NPK availability in soil after ratoon harvest. The N, P and K availability in soil improved maximum to the extent of 15.45, 39.66 and 63.14 percent respectively in *Trichoderma* inoculated trash plot over control. Our findings suggest that mulching of activated / inoculated sugarcane trash @10 t ha^{-1} in plant-ratoon system has an immense potential to supply organic matter and availability of nutrient in soil with significant improvement in cane yield and uptake of nutrient by sugarcane grown in calcareous soil.

Keywords: Sugarcane trash, nutrient uptake, cane yield, soil fertility

Introduction
Sugarcane plant - ratoon system is very common in subtropical regions of India that produce sugarcane trash around 8-10 t ha^{-1}. The millable cane is being supplied to sugar mill after detrashing. It is the biggest challenge for the farmers to handle with huge amount of trash left in the field left after crop harvest. In India sugarcane trash generate about 2% of the total crop residues with a total amount of 93 Mt. The data on crop residue generated, residue surplus and burnt annually in different states of India indicates that about 140.84 Mt of crop residue are surplus and about 92.81 Mt of crop residues are being burnt across the India annually (Pandey, 2018) [6]. The large portion of the residues is burnt on-farm. Burning of residue causing pollution to the atmosphere and creating many health problems for soil and living life. Indian farmers in sub tropical region are taking only one to two ratoon crops. The continuous plant - ratoon system increased soil compaction, reduced soil fertility and cane yield. Several researchers have emphasized the benefits of predominantly agricultural techniques such as mulching of crop residue, green manuring, and agroforestry efficiently and having positive influence on crop productivity and in the maintenance of farming system sustainable under tropical and sub-tropical climatic conditions (Yadav and Yaduvanshi, 2001) [16]. Sugarcane yields in India have remained steady in recent years, and productivity has decreased due to a decrease in soil organic matter content (Singh *et al*. 2007) [17]. Sugarcane trash is supplements the plant nutrient after decomposition by microorganisms. Crop growth, plant nutrient uptake, cane yield and soil fertility was influenced by the application of *Trichoderma* inoculated trash Thakur *et al.* (2010) [11]. Many strategies, such as trash or polythene mulching and intercropping, have been widely used in north India to improve ratoon cane yields; however, little progress has been made in closing the yield gap. Organic matter in the soil is an essential component of soil fertility. The sugarcane trash has a great potential to supply organic matter and nutrients in soil (Singh *et al*, 2015) [8]. Therefore the present research was formulated to investigate the influence of various sugarcane trash management techniques on the yield and soil fertility of sugarcane plant-ratoon system grown in calcareous soil of subtropical region.

Methods and Materials

The present research on sugarcane (*Saccharum* spp. Hybrid complex) plant – ratoon cropping system was formulated in calcareous soil at Crop Research Centre, RPCAU, Pusa, Bihar, to see the effect of various trash management techniques *viz.,* sugarcane trash incorporation and trash mulching treatments activated with urea, FYM, vermicompost, and trash mulching treatments inoculated with *Trichoderm* / *Azotobacter* + PSB along with control plot. The experiment was formulated in randomised block design under Ph.D. research programme. The altitude of experimental farm was 52.0 m above mean sea level and located 25.58° N, latitude 85.40° E longitude. The experimental site having subtropical climate and Ustic moisture regime. During crop growth period, in the year 2020-2021, the average annual rainfall was1883.60 mm and mean annual temperature was 29.90 (Maximum) and 19.3 °C (Minimum). The treatments consisted of various trash management techniques *viz.*, trash incorporation, trash mulching treatments activated with starter dose of urea (25 kg N ha^{-1}), FYM (@ 5 t ha^{-1}), vermicompost (@ 2.5 t ha^{-1}), and trash mulching treatments inoculated with *Trichoderma* (@ 500 g t^{-1} of trash along with slurry of 200 kg FYM) / *Azotobacter* + PSB (@ 5 kg ha^{-1} along with slurry of 200 kg FYM) with control plot. The sugarcane trash was applied @ 10 t ha^{-1}. The sugarcane mid-late variety CoP 2061 was planted in spring 2020 and rationing was done in February, 2021. The sugarcane trash was mulched between the plant to plant row spaces of 90 cm and trash was activated with urea, FYM, vermicompost, and inoculated with *Trichoderma*/ *Azotobacter* + PSB as per technical plan of the experiment. The fertilizer dose of 170 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} were applied in all the treatments based on the recommendations for ratoon crop. During the crop growth period all the recommended agronomic package and practices were adopted for sugarcane crop. At the initiation of the experiment, an initial surface soil sample was collected from experimental area. The treatment wise soil samples were also collected from various plots following the harvest of the sugarcane ratoon crop. The representative homogeneous soil samples was analyzed for pH and EC in 1:2 soil water suspension (Jackson, 1967), organic carbon was by rapid titration method (Walkey and Black., 1934) [13], alkaline permanganate method for estimation of N availability (Subbiah and Asijia., 1956) [10], double beam spectrophotometer using olsen extract for available P (Olsen *et al.,* 1954) and IN ammonium actate extractable available K was using flame photometer (Hanway and Heidel, 1952) [15]. At maturity stage (270 days after planting) whole cane plant was uprooted, dried and processed for analysis using standard procedure. For this purpose plant samples were digested and analysed for N, P, and K (Jackson, 1978). Based on the concentration of nutrients present in plant samples, uptake of nutrients (N, P, K) by the sugarcane ratoon crop was calculated by multiplying the plant concentration of N, P, K with the plant dry matter yield. The data were analysed statistically for testing differences between treatments means at the 5% level of significance.

Result and Discussion

Growth and yield parameters

The data on ratoon crop (Table-1) revealed that various trash management techniques significantly increased numbers of tillers, plant height, cane length and cane yield in trash mulching treatments as compared to no trash (Control). However, the effect of trash management treatments was found non-significant on cane girth and single cane weight. The mean dry matter production (26.95- 33.18 t ha^{-1}) and cane yield (57.20-70.29 t ha^{-1}) varied significantly among treatments. The trash mulching treatments either activated with FYM, VC or inoculation of trash with *Trichoderma* resulted in the significant enhancement in all the growth and yield parameters of ratoon crop and found on par with each other. The *Trichoderma* inoculated trash mulching treatment recorded maximum growth and yield of ratoon with increment in yield to the tune of 22.88 percent. These results are in conformity with the findings of Thakur *et al.* (2010) [11] and Umesh *et al*. (2014) [12]. The trash mulching inoculated with *Trichoderma* or activated with FYM and VC might be improved soil physical environment viz., soil moisture retention, arresting of weeds and maintained soil temperature for the root proliferation and better plant growth resulted in enhancement in growth and yield parameters of sugarcane crop. Graham *et al.* (2000) [2] and Singh *et al*. (2011) [9] also observed similar findings.

Nutrient uptake

Uptake of N, P and K by ratoon crop varied significantly due to different trash management techniques (Table 2). Uptake of N (213.47 to 282.40 kg ha^{-1}), P (15.21 to 20.57 kg ha^{-1}) and K (163.55 to 246.34 kg ha^{-1}) varied significantly among the treatments. The uptake of N, P and K was found highest in *Trichoderma* inoculated trash among treatments. The improved nutrient concentration (NPK) and cane yield resulted in higher uptake of NPK in trash mulching plots. The efficient utilisation of nutrients under mulch treatments could be expected due to enlarged, more fibrous, and more active surface feeder roots caused by favourable moisture and thermal regimes, resulting in greater nutrient uptake by plants under mulch. The treatment of trash with *Trchoderma/Azotobacter*+PSB, FYM and VC induced the assimilation of nutrient by plant resulted in more uptakes. However, *Trichoderma i*noculated trash treatment recorded highest uptakes NPK by plant. These results are in agreement with Yadav *et al.* (2009) [14] and Shukla *et al.* (2009) [14].

Soil fertility

The trash management treatments significantly increased organic carbon and available nutrients (NPK) content in post harvest soil (Table 3) after two crop cycle over no trash treatment (Control). The results indicated that trash mulching activated with starter dose of N (@ 25 kg N ha^{-1}), or organics viz. FYM (@ 5 t ha^{-1}), VC (@ 2.5 t ha^{-1}) / microbial inoculated (*Trichoderma* /*Azotobacter*+PSB) was found superior over the trash incorporated plots. However incorporated of trash (@ 10 t ha^{-1}) was found beneficial as compared to no trash treatments. However, the effect of trash management treatments was found non-significant on pH and EC of soil. The mean organic carbon (4.86-7.31 g kg^{-1}) and available N (224.13-265.07 kg ha^{-1}), P_2O_5 (26.85-37.50 kg ha^{-1}) and K_2O (104.26-170.09 kg ha^{-1}) varied significantly among treatments. The trash mulching treatments either alone or activated with FYM, VC and inoculation of trash with *Trichoderma / Azotobacter*+PSB resulted in the significant improvement in fertility status of post harvest soil. The *Trichoderma* inoculated trash mulching treatment recorded improvement in terms of organic carbon and available nutrient content of soil with increase in soil organic carbon by 50 percent. The available-N was resulted in maximum

increase by15.45 percent in *Trichoderma* inoculated plot followed by 12.36 percent in FYM and 10.44% in VC activated trash treatment over the control. The P2O5 and K2O content increased maximum by 39.66 ad 63.14 percent respectively in *Trichoderma* inoculated trash plot over control. The similar findings have been reported by Chandra *et al*. (2008) [1] and Thakur *et al*. (2010) [11]. The organic carbon, available N, available P, and available K content in the soil was significantly influenced by the different techniques of trash mulching. The sugarcane trash has an immense potential to supply organic matter and nutrients in soil (Singh *et al*, 2015) [8] and its has great influence on cane yield and soil health (Jha *et al.* 2019) [4]. In addition, *Trichoderma* treated trash degraded quickly and released nutrients in soil (Shukla *et al.* 2008) [7].

Table 1: Effect of trash management techniques on growth parameters, yields attributes and yield of sugarcane ratoon crop

Treatments	Tillers ($\times 10^{-3}$ ha^{-1})	Plant Height (cm)	Dry matter (t ha^{-1})	Cane Length (cm)	Cane Girth (cm)	Single Cane Weight (kg)	Cane Yield (t ha^{-1})
T_1-Control	122.00	258.31	26.95	136.14	1.99	0.638	57.20
T_2-Trash Mulching	133.69	288.53	28.31	153.18	2.03	0.652	60.61
T_3-Trash Mulching + Urea	142.05	294.90	29.89	157.44	2.13	0.666	62.27
T_4-Trash Mulching + FYM	145.03	315.63	32.10	163.66	2.14	0.699	67.41
T_5-Trash Mulching + VC	144.21	314.23	31.96	160.11	2.13	0.682	65.02
T_6-Trash Mulching+ *Trichoderma*	157.33	322.03	33.18	165.22	2.15	0.718	70.29
T_7-Trash Mulching+ Azo+PSB	143.30	312.40	31.38	159.37	2.05	0.681	64.25
T_8-Trash incorporation	139.30	310.33	30.13	158.57	2.05	0.670	62.96
SEm (±)	5.86	12.80	1.28	5.68	0.08	0.029	3.19
CD (P=0.05)	17.79	38.82	3.88	17.24	NS	NS	9.67

Note: RDF (170 kg N, 60 kg P_2O_5 and 60 kg K_2O ha $^{-1}$), Sugarcane Trash: @10 t ha^{-1}, N through urea (25 kg N ha^{-1}), FYM (5 t ha^{-1}), VC-(Vermicompost 2.5 t ha^{-1}), and *Trichoderma* (500 g t^{-1} of trash)/ *Azotobacter* + PSB (5 kg ha^{-1})

Table 2: Effect of trash management techniques on nutrient uptake by sugarcane ratoon crop

Treatments	Macronutrients (kg ha^{-1})		
	N	P	K
T_1-Control	213.47	15.21	163.55
T_2-Trash Mulching	248.57	16.81	177.07
T_3-Trash Mulching + Urea	258.05	17.97	189.54
T_4-Trash Mulching + FYM	268.18	19.58	212.46
T_5-Trash Mulching + VC	265.75	19.26	212.52
T_6-Trash Mulching+ *Trichoderma*	282.40	20.57	246.34
T_7-Trash Mulching+ Azo+PSB	264.02	18.25	199.52
T_8-Trash incorporation	252.27	17.96	191.59
SEm (±)	12.64	0.76	10.77
CD (P=0.05)	38.36	2.31	32.66

Note: RDF (170 kg N, 60 kg P_2O_5 and 60 kg K_2O ha $^{-1}$), Sugarcane Trash: @10 t ha^{-1}, Starter dose of N through urea (25 kg N ha^{-1}), FYM (5 t ha^{-1}), VC-Vermicompost 2.5 t ha^{-1}), and *Trichoderma* (500 g t^{-1} of trash)/ *Azotobacter* + PSB (5 kg ha^{-1})

Table 3: Effect of trash management techniques on soil properties and availability of nutrients after harvest of ratoon crop

Treatment	pH	EC (dSm^{-1})	OC (g kg^{-1})	Soil available nutrients (kg ha^{-1})		
				N	P_2O_5	K_2O
T_1-Control	8.73	0.39	4.86	224.13	26.85	104.26
T_2-Trash Mulching	8.65	0.40	6.26	238.13	29.64	134.29
T_3-Trash Mulching + Urea	8.60	0.41	6.53	247.33	33.88	141.46
T_4-Trash Mulching + FYM	8.41	0.45	6.92	255.73	35.25	154.26
T_5-Trash Mulching + VC	8.54	0.44	6.76	250.27	34.04	150.08
T_6-Trash Mulching+ *Trichoderma*	8.29	0.47	7.31	265.07	37.50	170.09
T_7-Trash Mulching+ Azo+PSB	8.55	0.42	6.54	244.53	33.07	145.11
T_8-Trash incorporation	8.56	0.42	6.41	238.93	32.93	140.71
SEm (±)	0.14	0.02	0.14	6.82	0.80	4.08
CD (P=0.05)	NS	NS	0.41	20.20	2.43	12.37

Note: RDF (170 kg N, 60 kg P_2O_5 and 60 kg K_2O ha $^{-1}$), Sugarcane Trash: @10 t ha^{-1}, Starter dose of N through urea (25 kg N ha^{-1}), FYM (5 t ha^{-1}), VC-Vermicompost 2.5 t ha^{-1}), and *Trichoderma* (500 g t^{-1} of trash)/ *Azotobacter* + PSB (5 kg ha^{-1})

Conclusions

Sugarcane trash mulching techniques improved the plant growth parameters, dry matter production, and yield of sugarcane ratoon crop. Meanwhile, it also improved the uptakes of N, P and K by ratoon crop and fertility status of soil. Our findings suggest that mulching of activated / inoculated sugarcane trash @10 t ha^{-1} in plant – ratoon system has an immense potential to supply organic matter and availability of nutrient in soil with significant improvement in cane yield and uptake of nutrient by sugarcane grown in calcareous soil.

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References

1. Chandra R, Rana NS, Kumar S, Panwar GS. Effect of sugarcane residue and green manure practices in sugarcane-ratoon-wheat sequence on productivity, soil fertility and soil biological properties. Archives of Agronomy and Soil Science. 2008;54(6):651-664.
2. Graham MH, Haynes RJ, Meyer JH. Changes in soil fertility induced by trash retention and fertiliser applications on the long-term trash management trial at Mount Edgecombe. Proceedings of the South African Sugar Technologists Association. 2000;74:109-113.
3. Jackson ML. Soil Chemical Analysis Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
4. Jha CK, Kumar V, Thakur SK. Integrated effect of sugarcane trash mulch, pressmud and Zn nutrition on soil fertility and productivity sugarcane in calcareous soil. Journal of Agri Search, 2019;6:4-7.
5. Olsen SR, Cole CV, Frank SW, Dean LA. Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department of Agriculture Circular. No. 939, 19, 1954.
6. Pandey C. Management of Crop Residue for Sustaining Soil Fertility and Foodgrains Production in India. Acta Scientific Agriculture, 2018;3:188-195.
7. Shukla SK, Yadav RL, Suman A, Singh PN. Improving rhizospheric environment and sugarcane ratoon yield through bioagents amended farm yard manures in udic Ustochrept soil. Soil and Tillage Research. 2008;99:158-168.
8. Singh AK, Bharati RC, Chandra N, Dimree S. Integrated Nutrient Management System: Smart way to improve cane production from sugarcane ratoon. Journal of Agri Search. 2015;2(4):233-243.
9. Singh SN, Singh AK, Malik JPS, Kumar R, Sunderpal, Sharma ML. Cultural-practice packages and trash management effects on sugarcane ratoons under sub-tropical climatic conditions of India. Journal of Agricultural Science. 2011;150:237-247.
10. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956;25:259-60.
11. Thakur SK, Jha CK, Kumari G, Sing VP. Effect of *Trichoderma* inoculated trash, nitrogen level and biofertilizer on performance of sugarcane (*Saccharum officinarum*) in calcareous soils of Bihar. Indian Journal of Agronomy. 2010;55(4):308-311.
12. Umesh UN, Kumar V, Prasad RK, Singh KDN, Singh AP. Effect of integrated use of inorganic and organic materials on the distribution of different forms of nitrogen in soil and their influence on sugarcane yield and nutrient uptake. Journal of the Indian Society of Soil Science. 2014;62(3):209-215.
13. Walkley A, Black I. An examination of the different method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science. 1934;37:29-38.
14. Yadav RL, Shukla SK, Suman A, Singh PN. *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. 2009;45:461-468.
15. Hanway JJ, Heidel H. Soil analyses methods as used in Iowa state college soil testing laboratory. Iowa Agriculture. 1952;57:1-31.
16. Yadav DV, Yaduvanshi NPS. 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. Journal of Agricultural Science, Cambridge 2001;136:199-205.
17. Singh KP, Suman A, Singh PN. Improving quality of sugarcane growing soils by organic amendments under sub-tropical climatic conditions of India. Biology and Fertility of Soils. 2007;44:367-376.