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Effect of Trash Management of Sugarcane on Soil Organic Carbon Buildup and Sustaining Yields of Successive Ratoon Crop in Khammam District of Telangana

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***Abstract*:** A field study was conducted to assess the impact of sugarcane trash, a crop residue constituting 10-20% of the weight of cane harvested was either burnt, removed, retained and shredding as mulch in two successive ratoon crops in Khammam District of Telangana during 2017-2020. Within two years trash shredding and retaining as mulch increased the soil organic carbon by 0.06% and 0.09%, while trash burning decreased by 0.06% in two successive ratoon crops. Trash shredding recorded the highest values of number of tillers (95.7 and 97.8 thousand per ha), cane height (214.7 and 216.8 cm), no of inter nodes (25.4 and 25.8), the cane girth (3.4 and 3.5 cm), average cane weight (1.53 and 1.55 kg), no of millable canes (78,436 and 79,543 per ha) and cane yield (120.5 and 123.8 t/ha). However, trash retained practice was at par with trash shredding. The lowest number of tillers (87.3 and 83.2 thousand per ha), cane height (207.0 and 201.3 cm), no of inter nodes (23.2 and 22.2), cane girth (2.8 and 2.6 cm), average cane weight (1.46 and 1.44 kg), no of millable canes (75,648 and 72,874 per ha) and cane yield (105.4 t/ha) were recorded with trash burnt practice in second ratoon crop. Trash shredding practice was found as best practice among all the trash management practices in sugarcane crop.

***Keywords*:** Bulk density, Organic carbon, Sugarcane, Trash shredding

In the conventional practice, the sugarcane trash after harvesting is usually burnt in the field which ultimately leads to loss of nutrients, degrades soil fertility and the environment. High C: N ratio, high fibre content and lack of proper composting techniques prolong the decomposition of trash in the field. Besides the loss of organic matter and plant nutrients, burning of crop residues results in increase of atmospheric pollution due to the emission of toxic gases like methane and carbon dioxide. Surface organic mulch such as sugarcane trash is used to conserve soil moisture, moderating soil temperature extremes, checking weed growth and adding organic matter to soils (Malik 2014). Thereby organic mulches create better physical. Chemical and biological environment of soils and in turn, improves crop productivity. Crop residues incorporation in soil is very important source of organic manure. Sugarcane produces nearly 10-12 tones dry leaves (trash) per hectare per year. The trash contains appreciable amount of NPK and other micro and secondary nutrients. In situ trash management can be a good alternative option to mitigate these problems. Similarly, the mechanical handling and incorporation of trash will help to enhance crop yield and improve soil health. The objective of this study was to find out the impact of trash management strategies on the cane yield, organic carbon and bulk density of the soil.

MATERIAL AND METHODS

The adoptive research was conducted at farmer's field during 2017- 2020 with plant crop and two ratoon crops in five locations viz., Rajeswaripuram ($17^0.82^1$ 16 N $80^0.26^1$ 22 E), Chennaram ($17^0.106^1$19 N $80^0.81^1$16 E), Kalluru ($17^0.102^1$42 N $80^0.854^1$ 26 E), Kothuru ($17^0.82^1$ 23 N $80^0.36^1$ 48 E) and Pynampalli ($17^0.84^1$ 32 N $80^0.36^1$ 57 E) with four treatments replicated five times in a randomized block design. The soil was sandy loam with a pH of 7.38; organic C, 0.54%; available N, 240 kg/ha; P, 48 kg/ha; and K, 300 kg ha^{-1}. The sugarcane crop (Co 86032) was planted under 90 cm spacing on 21 April, 2017 and harvested on 20 February, 2018. Subsequently, two ratoon crops were raised in succession with the above-mentioned trash management practices. Recommended dose of fertilizers, i.e., 280:60:120 kg N: P_2O_5: K_2 O/ha was adopted. Full dose of P was applied in furrows before planting and N and K were applied in two splits in plant crop as well as ratoon crops, and irrigated the main crop through furrow method and flood irrigation to the ratoon crop. During the experimentation, irrigation scheduling was done once in 8, 10, and 15 days at germination (up to 35 DAP), tillering (36-100 DAP), grand growth (101- 270 DAP) and maturity (271 days onward) stages of the cane, respectively. At harvest, number of millable canes (NMC), cane height, cane girth, single cane

weight, cane yield was recorded. After harvest of the crops, soil samples were analyzed for organic carbon (Walkley and Black 1934), available N with alkaline $KMnO_4$ method (Subbaiah and Asija 1956), 1 N NH_4OAc-extractable K (Hanway and Heidal 1952) and 0.5 M $NaHCO_3$ (pH 8.5)-extractable P (Olsen et al 1954). Bulk density was measured by a core sampler (Blake and Hartge 1986).

RESULTS AND DISCUSSION

Growth attributes: Growth attributes of sugarcane were significantly influenced by trash management practices. Significantly higher number of tillers (95.7 and 97.8 thousand per ha), cane height (214.7 and 216.8 cm) and inter nodes (25.4 and 25.8) were recorded with trash shredding practice over trash burnt and trash removal followed by trash retained practice in both ratoon crops. It might be improved the soil fertility with obvious increase of organic matter, as well as decrease in pH of the soil through humification with trash shredding practice over all the practices. The results of the present experiment corroborated with the findings Ahmed et al (2014) and Suma et al (2015). The lowest growth attributes were recorded under trash burnt practice over all the treatments. The lowest number of tillers (87.3 and 83.2 thousand per ha) counted at 120 days after planting (DAP) as well as cane height (207.0 and 201.3 cm) and no of inter nodes (23.2 and 22.2) were recorded under trash burnt practice after successive two ratoon crops due to loss of soil fertility by decrease of microfauna activity in the soil with limited moisture conservation, loss of organic carbon by the increase of soil temperature with burnt of trash in the field similar reports were confirmed by Flavio et al (2013) and Henrique et al (2013).

Yield attributes: The yield attributes of sugarcane were significantly influenced by trash management practices. The cane girth (3.4 and 3.5 cm), average cane weight (1.53 and 1.55 kg) and no of millable canes (78,436 and 79,543 thousand per ha) was significantly improved with trash shredding practice over trash burnt and trash removed practices. Improvement in soil fertility due to trash shredding might have been responsible for such an effect and also improve the availability of nutrients from soil to the successive ratoon crops through fast decomposition of trash by shredding into small pieces in the field, as well as Increase in NMC and cane yield in trash shredding plot were attributed to higher soil moisture content and reduction in soil temperature then followed by trash retained practice shown better performance over trash burnt and trash removed practices. Similar trend was observed by Graham et al (2000) and Ridge (2003) and Munoz-Arboleda et al (2011). The lowest yield attributes, average cane girth (2.8 and 2.6 cm), average cane weight (1.46 and 1.44 kg) and no of millable canes (75,648 and 72,874 thousand per ha) were observed with trash burnt due to decreased availability of nutrients by poor organic matter content of the soil as well as less biological activity of microorganisms in soil with burning of trash increased the soil temperature Kumar et al (2015) and Carvalho et al 2017).

Table 1. Effects of different trash management practices on growth attributes after successive harvests of sugarcane in a ratoon system

Treatment	Tillers count (“000/ha)			Cane height (cm)			No. of internodes		
	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2
T_1-Trash burnt	85.4	87.3	83.2	204.6	207.0	201.3	22.5	23.2	22.2
T_2-Trash removed	85.4	88.4	85.5	204.6	208.2	202.5	22.5	23.3	22.5
T_3-Trash retained	85.4	91.4	92.1	204.6	210.5	212.6	22.5	24.3	24.4
T_4-Trash shredding	85.4	95.7	97.8	204.6	214.7	216.8	22.5	25.4	25.8
C.D (p=0.05)	-	4.4	7.4	-	6.6	12.0	-	2.0	3.1

Table 2. Effects of different trash management practices on yield attributes after successive harvests of sugarcane in a ratoon system

Treatment	Cane girth (cm)			Average cane weight (kg)			Number of millable cane (NMC/ha)		
	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2
T_1-Trash burnt	2.9	2.8	2.6	1.45	1.46	1.44	73,675	75,648	72,874
T_2-Trash removed	2.9	2.9	2.7	1.45	1.47	1.45	74,675	75,458	73,921
T_3-Trash retained	2.9	3.0	3.1	1.45	1.48	1.49	74,675	76,412	76,712
T_4-Trash shredding	2.9	3.4	3.5	1.45	1.53	1.55	74,675	78,436	79,543
C.D (p=0.05)	-	0.42	0.6	-	0.06	0.08	-	2938	4812

Table 3. Effects of different trash management practices on cane yield, soil organic carbon content and bulk density after successive harvests of sugarcane in a ratoon system

Treatment	Cane yield t/ha			Organic carbon content (%)			Soil bulk density (g cm-^{3})		
	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2	Plant crop	Ratoon 1	Ratoon 2
T_1-Trash burnt	108.6	110.7	105.4	0.54	0.52	0.48	1.43	1.50	1.55
T_2-Trash removed	108.6	111.4	107.5	0.54	0.56	0.52	1.43	1.47	1.50
T_3-Trash retained	108.6	113.8	114.6	0.54	0.58	0.60	1.43	1.43	1.39
T_4-Trash shredding	108.6	120.5	123.8	0.54	0.60	0.63	1.43	1.40	1.35
C.D (p=0.05)	-	4.2	7.0	-	0.04	0.06	-	0.04	0.06

Yield, soil organic carbon and bulk density: Trash shredding and retaining as mulch each year in the ratoon crop for two years increased the soil organic carbon by 0.06% and 0.09%, while trash burning decreased it by 0.06% (Table 3). Trash shredding and retained conserved soil moisture and regulated soil temperature which might create a congenial, edaphic environment for accelerated activity of soil microorganisms which in turn would have enhanced decomposition of root residues and trash. The trash burning not only destroyed the littered residues in the field but also sterilized the top soil, thus killing the microbes which are responsible for decomposing root residues left under the soil. The bulk density of the soil (1.50 to 1.55 g cm^{-3}) and (1.47 to 1.50 g cm^{-3}) increased, after successive harvests of the crop, in plots with trash burning and removal, but decreased where trash shredded and retained (Table 3). Dahiya et al. (2003) and De Cerqueira et al (2018) also reported a decline in soil organic matter with an increase in soil bulk density. Yadav et al. (2009), Tayade et al (2016) and De Aquinoa et al (2017) observed higher organic carbon and nitrogen contents in the soil after trash incorporation than in the trash burnt soil. Cane yield (120.5 and 123.88 t/ha) of all the ratoon crops significantly increased in plots where trash shredded followed by trash retained as mulch, compared to plots with trash burning and removal it might be conservation of soil moisture and nutrients in the soil by incorporation of sugarcane trash through shredding into small pieces added the organic matter, increased the nutrient status and availability in the soil, similar results were confirmed by Mathew and Varughese (2005) and Muñoz-Arboleda and Quintero-Duran (2011).

CONCLUSION

Trash shredding practice was showed significantly better performance in terms of growth and yield attributes of sugarcane over trash burnt and trash removal practices. The majority of the farmers were realized and obtained significantly higher cane yield (120.5 and 123.8 t/ha) in addition to that added more organic carbon (0.54 to 0.63%) in the soil due to incorporation of trash in the soil with trash shredder in Khammam district, Telangana state of India.

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