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Growth, yield and quality of sugarcane as influenced by sugarcane trash management

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Abstract
A field experiment was conducted to study effect of trash burning, mulching and trash incorporation by trash shredder on growth, yield and quality of sugarcane during 2017-18 and 2018-19 at Agricultural Research Station, Perumallapalle, ANGRAU, Andhra Pradesh. The experiment consists of 4 treatments *viz*., control, burning of trash, mulching of trash and trash spreading by trash shredder. Recommended dose of fertilizers (224-112-112 kg N-P_2O_{5-} $_2O$ ha^{-1} for plant crop and 336-112-112 kg N-P_2O_5-K_2O ha^{-1}, respectively for ratoon crop) were applied to all treatments. Data on tillers ha^{-1-}, shoot population ha^{-1} and number of millable canes (NMC) ha^{-1} yield attributes *viz.*, cane length and girth, juice quality parameters like sucrose, CCS and purity, cane yield, CCS yield were recorded in all treatments. Results revealed that significantly the highest cane yield (124 t ha^{-1}) was recorded with application of trash spreading by trash shredder followed by trash mulching (119 t ha^{-1}). Similar trend was followed in cane length also. Significant improvement in tillers, NMC was observed with application of trash by the trash shredder. Significantly the highest CCS yield (15.78 t ha^{-1}) was recorded with application of trash by trash shredder followed by trash mulching (15.18 t ha^{-1}).

Keywords: sugarcane, cane trash, growth, yield and quality.

Introduction
The main advantages of organic mulches like cane trash and straw mulches are organic matter and nutrient supply not only for plants but also for soil organisms. Retention of sugarcane residue (sugarcane trash) in the field potentially has several effects both positive and negative. Burning can be detrimental to soil structure and nutrient availability due to the loss of soil organic matter. Retention of unburned residues can increase nutrient conservation, reduce weed growth and conserve soil moisture. Substantial losses of C and N due to sugarcane residue burning have been reported by Suma and Savitha, 2015 [12]. Fire may play a role in controlling insect populations and diseases (Niveta *et al*., 2014) [8]. However, the retained mulch makes tillages operations more difficult, interferes with fertilizer and herbicide applications and immobilizes nitrogen and phosphorus. Furrow irrigation is more difficult when residues remain on the soil surface.

Management of residue (cane trash) after harvest will the impact on subsequent sugarcane crop. In high rainfall areas the trash can be left on the surface since it decomposes quickly. Incorporation of the cane trash is difficult and energy intensive. Residues left on the surface have been found to improve organic matter content and soil moisture holding capacity in long term compared to incorporation. Chapping the cane trash / residue into finer particles and soil incorporation have been found to increase decomposition rates and increase cane yields (Mendoza *et al*, 2001) [5].

Most of the farmers in Chittoor district of Andhra Pradesh irrigate the sugarcane crop by flood method. Under this situations, it becomes difficult to irrigate the crop. Hence if the trash can be convened into small pieces by trash shredder, it helps for easy incorporation into soil and fast decomposition when compared to mulching with sugarcane trash. The present investigation aimed to study effect of method of trash application on soil fertility, yield and quality of sugarcane.

Material & Methods
To study the effect of trash burning, mulching and trash incorporation by trash shredder on growth, yield and quality of sugarcane crop, a field experiment was conducted during 2017-18 and 2018-19 at Agricultural Research Station, Perumallapalle, ANGRAU, Andhra Pradesh.

The experiment consists of 4 treatments *viz.*, control, Burning of trash, Trash mulching and Trash incorporation by trash shredder and replicated five times. Recommended dose of fertilizers (224-112-112 kg $N\text{-}P_2O_5\text{-}K_2O$ ha^{-1}) were applied to plant crop. Entire dose of phosphorus and potassium was applied as basal. Nitrogen was applied in two equal splits at 45 and 90 days after planting (DAP). Ratoon crop was fertilized with recommended dose of 336-12-112 Kg $N\text{-}P_2O_5$ - K_2O ha^{-1}, respectively. Experimental site was neutral in reaction, non saline nature, low in organic carbon content, available nitrogen, medium in phosphorus, high in available potassium and sufficient in DTPA extractable Fe, Mn, Zn and Cu. Initial soil properties of experimental site was given in table 1. Trash mulching was done by spreading the trash on the soil surface in inter row spaces. Trash was completely removed from control treatment. Trash which was left in field after harvest is burnt in trash burning treatment. Trash was spreading in inter row spaces and run the trash shredder for easy incorporation and fast decomposition in trash incorporation by trash shredder treatment. Ratoon crop was fertilized with recommended dose of fertilizers $N\text{-}P_2O_5$ and K_2O @ 336-112-112 Kg ha^{-1} through urea, single super phosphate and muriate of potash respectively. Half of the nitrogen and entire phosphorus and potassium were applied as side dressing in furrows opened manually just after hoeing in inter row space while remaining half of nitrogen was top dressed at 45 day after ratooning. Data on yield, yield attributing characters and juice quality parameters *viz*., sucrose (%), CCS (%), purity (%) and CCS yield (t ha^{-1}) were recorded at harvest. Total soluble solids were measured by using Brix hydrometer with the method given by Meade and Chen (1977) [4] and the reading was corrected to temperature by referring the tables. The data was statistically analyzed by the method outlined by Panse and Sukhatme (1985) [9] by using SPSS 20.

Table 1: Initial soil properties of experimental field

Particulars	Value
Soil pH	7.27
Soil EC (dS m^{-1})	0.396
Organic carbon (%)	0.47
Available N (kg ha^{-1})	259
Available P (kg ha^{-1})	46.32
Available K (kg ha^{-1})	277
DTPA extractable Fe (mg/kg)	9.12
DTPA extractable Mn (mg/kg)	4.76
DTPA extractable Zn (mg/kg)	0.88
DTPA extractable Cu (mg/kg)	3.17

Results & Discussion

Growth and yield attributes

Data presented in table 2 indicate that there was significant improvement in number of tillers at 90 days after planting, shoot population at 180 days after planting as well as number of millable canes with application of trash by trash shredder. During 2017-18, spreading of trash by trash shredder significantly increase number of tillers from 104527 in control to 116100 ha^{-1} with trash shredder which was at par with trash mulching (113024 ha^{-1}). In case of number of millable canes (NMC) where significantly the highest MMC were recorded with trash spreading by shredder (98524 ha^{-1}) followed by trash mulching (95748 ha^{-1}). The lowest NMC was recorded in control (88127ha^{-1}). Similar trends were observed in 2018-19. Application of trash by trash shredder plays an important role in improving organic matter content after fast decomposition of trash which inturn helps in improving physical properties leads to proliferation of roots. More nutrient uptake causes more number of tillers. Increase the organize matter also help in increasing nutrient use efficiency and also improving conversion efficiency of tillers to NMC (Munoz and Quintero, 2011) [6].

Table 2: Effect of trash application on growth and dry matter production of sugarcane

Treatments	2017-18			2018-19		
	Tillers at 90 DAP	Shoot population at 180 DAP	NMC at harvest	Tiller at 90 DAP	Shoot population at 180 DAP	NMC at harvest
T1 - Control	104527^{c}	93561^{d}	88122^{d}	100335^{c}	95245^{d}	86012^{c}
T2 – Burning of trash	109105^{b}	96239^{c}	93178^{c}	104150^{b}	100256^{c}	89952^{c}
T3 – Trash mulching	113024^{ab}	107444^{b}	95748^{ab}	109755^{a}	103694^{b}	94105^{b}
T4 – Trash spreading by trash shredder	116100^{a}	110251^{a}	98524^{a}	111389^{a}	105783^{a}	98502^{a}
Treatments	*	*	*	*	*	*
p-value	0.039	0.047	0.041	0.028	0.040	0.035

Cane length was significantly influenced by treatment in plant crop and ratoon crop (Table 3 and 4). Significantly the highest cane length was noticed with trash spreading by trash shredder (279 and 268 cm, respectively) followed by trash applied as mulch (253 and 248 cm, respectively) and the lowest cane length was recorded in control (207 and 223 cm, respectively). The highest cane length with trash spreading by trash shredder might be due to sufficient supply of macro and micronutrients after decomposition of trash. The nutrients like nitrogen, calcium and zinc *etc* are helpful or involved in vigorous growth, cell elongation and cell division thus enhanced crop growth led to more cane length. Similar results were reported by Mathew and Varughese (2005) [3]. Cane girth was not significantly influenced by application of trash in different methods during both the years.

Table 3: Effect of trash application on yield and quality of sugarcane (2017-18)

Treatments	Cane Yield (t ha^{-1})	CCS Yield (t ha^{-1})	Cane Length (cm)	Cane Girth (cm)	Sucrose (%)	CCS (%)	Purity (%)	B:C ratio
T1 – Control	111^{b}	13.26^{d}	207^{d}	2.77^{c}	17.04^{b}	11.95^{b}	91.12	1.10
T2 – Burning of trash	113^{b}	14.65^{c}	239^{c}	2.94^{b}	18.51^{a}	12.97^{a}	95.48	1.12
T3 – Trash mulching	116^{a}	15.45^{b}	253^{b}	3.03^{a}	18.72^{a}	13.30^{a}	90.93	1.20
T4 – Trash spreading by trash shredder	122^{a}	16.20^{a}	279^{a}	3.07^{a}	18.93^{a}	13.33^{a}	91.89	1.29
Treatments	*	**	**	**	**	*	N.S.	
P value	0.03	0.000	0.000	0.000	0.000	0.01	0.30	

Table 4: Effect of trash application on yield and quality of sugarcane (2018-19)

Treatments	Cane yield (t ha^{-1})	CCS yield (t ha^{-1})	Cane length (cm)	Cane girth (cm)	Sucrose (%)	CCS (%)	Purity (%)	B:C ratio
T1 – Control	113^{b}	14.48^{c}	223^{d}	2.65	16.78	11.78	91.4	1.13
T2 – Burning of trash	117^{c}	13.84^{d}	234^{c}	2.51	17.17	11.83	89.0	1.05
T3 – Trash mulching	127^{a}	14.94^{b}	248^{b}	2.76	17.36	11.77	85.0	1.15
T4 – Trash spreading by trash shedder	132^{a}	15.37^{a}	268^{a}	2.77	17.26	11.65	85.3	1.23
Treatments	**	**	**	N.S.	N.S.	N.S.	N.S.	
p value	0.002	0.000	0.000	0.000	0.78	0.99	0.17	

Cane yield

The pooled analysis of two years data in table 5 indicated that significantly the highest cane yield (124 t ha^{-1}) was obrecorded with application of trash by trash shredder followed by application of trash as mulch (119 t ha^{-1}). Trash burning treatment recorded 114 t ha^{-1} of cane yield. Application of trash by trash shredder registered 8.8% increase over control (without trash application). It could be attributed to the better availability of nutrients due to the mineralization after fast decomposition of trash applied by trash shredder and improvement in the soil physical conditions due to the addition of organic matter (Sanjeev kumar *et al*., 2015; Dahiya *et al*., 2015) [11, 1]. A low cane yield with trash mulching than trash spreading by trash shredder could be due to the fact that high C:N ratio of trash locks up substantial amount of nitrogen leading to its low availability in the soil for plant use. The yield obtained with trash burning was also significantly superior than control (without trash). Similar results were reported earlier also by Rama *et al* (2002) [10]. The higher production with trash burning was possibly due to the healthy crop stand due to the low incidence of pests and diseases and release of greater nutrients by the enhanced microbial activity in surface soil for a short period after trash burning (Joao *et al*., 2017) [2].

Juice quality

Data pertaining to juice quality parameters are presented in table 3 and 4. During 2017-18, significant difference in sucrose and CCS was observed with application of trash by different methods. Higher sucrose and CCS was noticed with trash spreading by trash shredder (18.93% and 13.33%, respectively) which was at par with trash mulching and burning of trash treatments. The lowest sucrose and CCS (17.04 and 11.95%, respectively) were noticed with control (without trash). However during 2018-19, the treatments exerted non significant influence on sucrose and CCS%. Pooled analyses data indicated that though application of trash by trash shredder recorded higher sucrose (18.50%) and CCS (12.96%) it was at par with trash mulching (18.21% of sucrose and 12.77% of CCS). The lowest sucrose (17.08%) and CCS (11.97%) were recorded with control (without trash application).

Table 5: Pooled analysis – Effect of trash application on yield and quality

Treatments	Mean cane yield (t/ha)		Mean sucrose (%)		Mean CCS (%)		Mean CCS yield (t ha^{-1})	
T1 – Control	114^{c}		17.08^{b}		11.97^{b}		13.87^{b}	
T2 – Burning of trash	114^{c}		18.03^{b}		12.73^{a}		14.22^{b}	
T3 – Trash mulching	119^{b}		18.21^{a}		12.77^{a}		14.88^{b}	
T4 – Trash spreading by trash shedder	124^{a}		18.50^{a}		12.96^{a}		15.78^{a}	
	sig	p value	sig	p value	sig	p value	sig	p value
Years	**	0.000	**	0.000	**	0.000	**	0.000
Treatments	**	0.000	**	0.000	*	0.015	*	0.019
Years*Treatments	N.S.	0.652	N.S.	0.129	N.S.	0.064	N.S.	0.091
** Significant at P = 0.01 level * Significant at P = 0.05 level								

CCS yield

During both the years CCS yield was significantly influenced by trash application. Spreading of trash by trash shredder showed significantly the highest mean CCS yield (15.78 t ha^{-1}) followed by trash mulching (14.88 t ha^{-1}). Incorporation of sugarcane trash in the soil helped to sustain sugar yields by increasing cane yield and CCS percent. (Nguyen *et al*., 1996) [7]. More quantity of potassium has been added to the sol by decomposition of sugarcane trash. It has been observed that potassium play an important role in improving available sugar in juice and its quality. A balanced application of N, P and K in time will help in getting cane of good quality.

Economics

The benefit cost ratio was higher with application of trash by trash shredder in both the years 2017-18, 2018-19 followed by

trash mulching. Trash shredders treatment showed 1.29 and 1.23 during 2017-18 and 2018-19, respectively. This might be due to higher cane yield in this treatment than others.

From this study, it was concluded that trash spreading by trash shredder significantly increased cane length, NMC, cane yield, and CCS yield over mulching, burning and without trash application.

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