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Effect of *in situ* recycling of sugarcane crop residue and its industrial wastes on yield and quality of sugarcane and soil sustainability in Inceptisol

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Abstract
A field experiment was conducted at Central Sugarcane Research Station, Padegaon Farm Tal Phaltan Dist Satara (M.S.) during 2015-16 to 2018-19 as a one plant cane and its three successive ratoon with object of to assess the effect of recycling of sugarcane crop residues and it's industrial wastes on yield, quality and nutrient uptake of sugarcane, study the soil properties as influenced by decomposition of sugarcane crop residues and it's industrial wastes, to assess the changes in soil organic carbon as influenced by various treatments of in situ decomposition of sugarcane crop residues and industrial wastes and to assess the possibility of saving of chemical fertilizers.The experimental results recorded and mentioned during harvest of second ratoon. It consists of main plot treatment as sugarcane crop residue and industrial wastes management with sub plot treatment comprising fertilizer levels. In *situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash + bagasse ash recorded significantly higher cane yield, CCS yield and number of millable canes per hectare also improved physico chemical properties of soil. However, effect of fertilizer levels results showed that the fertilizer level receiving 100 % recommended dose of fertilizers recorded significantly higher cane yield, CCS yield and number of millable canes and it was at par with 75 % recommended dose of fertilizers. While in terms of soil chemical parameters showed significant results for organic carbon, available nitrogen, available phosphorus and available potassium as compared to soil initial status. The higher gross and net return were observed in the *In situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash + bagasse ash (Rs.2,72,857 and Rs.2,02,815) with higher benefit cost ratio (2.90). The 100 % recommended dose of fertilizer recorded significantly higher gross and net return (Rs.2,78,614 and Rs.2,00,093) with higher benefit cost ratio (2.55). Thus, result shows that recycling of sugarcane crop residue and industrial wastes along with 100% or 75 % recommended dose of fertilizers found to be better for enhance farmers income as well as improves soil health.

Keywords: In *situ* trash management, Sugarcane industrial waste, recycling of sugarcane crop residue, pressmud compost, Post biomethanated spent wash and bagasse ash

Introduction

Global sugarcane industry is facing and will continue to face many challenges. Currently, it is sandwiched between increasing cost of production and decreasing yields. Sugarcane crop requires large quantity of chemical fertilizers as it remains in the field for longer period. Due to indiscriminate use of water and fertilizers, continuous growing of sugarcane after sugarcane, the fertility and productivity of soil is depleting, and also the prices of chemical fertilizers are increasing. Under these circumstances, it is essential to make use of available organic wastes to improve soil health as well as nutrient status of sugarcane soils so as to increase yield. Generally, cane trash contains 68% organic matter, 0.42% N, 0.15% P, 0.57% K, 0.48% Ca and 0.12% Mg, besides 25.7, 2045, 236.4 and 16.8 ppm Zn, Fe, Mn and Ca, respectively. (Srivastava *et al.* 1992). Trash can also be utilized as organic mulch which conserves soil moisture, reduces the impact of moisture stress, moderates soil temperature, improves germination, checks weed growth and aids in better tiller survival. It is estimated that 8-10 t ha^{-1} of dry cane trash breaks down over about one year to form 2.5 t of organic matter (Calcino *et al.* 2000) [1]. At Coimbatore, soil temperature was reduced by 2.1ºC under trash cover, creating more favorable environment for crop growth (Sundara 1998) [8]. The mulched trash can be incorporated into soil by earthing-up in both plant and ratoon crops.

Sugarcane upon harvest leaves behind 8 to 10 tonnes of sugarcane trash, 4 to 5 tonnes of stubbles along with root mass, 4 to 5 tonnes of press mud cake and about 12,000 to 16,000 liters of biomethanated spent wash from one hectare area. Besides the loss of organic matter and plant nutrients, burning of crop residues results in atmospheric pollution due to the emission of toxic gases like methane and carbon dioxide.*In situ* trash management can be a good alternative option to mitigate these problems.

Now a days the CPCB has banned the soil application of spent wash by imposing gazette, however only utilization of spent wash in the composting process is possible. There is no any concrete recommendation for management of sugarcane crop residue and industrial waste after harvest of sugarcane ratoon crop.

With the above facts and views, it is felt need to develop economically viable *in situ* bio-conservation technique for holistic recycling of available sugarcane crop residues and industrial wastes to ascertain C sequestration in improving sugarcane productivity and soil health.

Materials and Methods

The study on *In situ* recycling of sugarcane crop residue and its industrial wastes on sugarcane yield and soil sustainability in Inceptisol was conducted in preseasonal sugarcane October, 2015 (Plant cane) with its three successive rattons up to February, 2020 (3rd ratoon) at Central Sugarcane Research Station Farm in Split Plot design with three replications. In this experiment Green manure- preseasonal sugarcane – sugarcane ratoon crop sequence was taken. The two eye budded sugarcane setts of variety CoM 0265 under wide row spacing 120 cm apart 15 cm distance between two setts with recommended dose of fertilizer 340:170:170 (Plant Cane) and 250:115:115 (Ratoon) N, P_2O_5 and K_2O kg ha^{-1}. All necessary cultural, planting and irrigation practices were followed during field experimentation.

The seven treatments imposed included in main plot as sugarcane crop residue and industrial wastes management as T_1:Burning of sugarcane trash (Farmers practice–I), T_2: Removal of stubbles as farmers practice (Farmers practice-II), T_3:In *situ* decomposition of sugarcane crop residues by recommended decomposition practice, T_4:In *situ* recycling of sugarcane crop residues + Post biomethanated spent wash, T_5:In *situ* recycling of sugarcane crop residues + pressmud compost, T_6:In *situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent was hand T_7:In *situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash+ Bagasse ash. While sub plot treatment comprises four recommended dose of fertilizer level treatments including F_0: Without fertilizers, F_1: 50 % recommended dose of fertilizers, F_3: 75 % recommended dose of fertilizers and F_4: 100 % recommended dose of fertilizers.

The quantity of sugarcane crop residues viz. sugarcane trash and stubbles and industrial wastes viz., pressmud compost, post biomethanated spent wash and bagasse ash generated from harvested sugarcane ratoon field is utilized for conduct of experiment. The main plot treatments are imposed after harvest of previous sugarcane ratoon crop. After three months in situ decomposition of sugarcane residues the sub plot treatments are superimposed without disturbing the original layout to sugarcane plant cane and subsequent ratoons. Recommended sugarcane crop residue decomposition practice: 1 tonne sugarcane crop residues + 8 kg urea + 10 kg SSP + 1 kg decomposing culture. Application of decomposing culture which consists of Trichoderma hergiunum, Trichoderma viride, Penecillium digitatum, Chetomium spp. having viable cell count 10^{-7} used @ 1 kg + 8 kg urea + 10 kg SSP for one tonne sugarcane crop residues to the treatment T_3 to T_7.

Quantity of applied sugarcane crop residues and industrial wastes per hectare

Sr. No.	Particular	Quantity (ha^{-1})
1	Sugarcane trash	12 tonne
2	Sugarcane Stubble	3.39 tonne
3	Pressmud compost	2.26 tonne
4	Post biomethanated spent wash (PBSW)	13,560 liter
5	Bagasse ash	339 kg

The soil of the experimental site was Inceptisol and initial status of second ratoon was soil pH 7.52, E.C.0.39 dS m^{-1}, organic carbon 0.66 %, soil available nitrogen 213.67 kg ha^{-1}, phosphorus 36.15 kg ha^{-1}, potassium 316.69 kg ha^{-1}, respectively and soil physico parameters like bulk density 1.35 Mgm^{-3}, porosity 48.95 % and maximum water holding capacity were 59.54 %.

Statistical analysis of the sugarcane data was worked out as per the method described by Panse and Sukhatme (1967) [4].

Results and discussion

1. Yield and Quality parameters

The data on yield and quality parameters of second sugarcane ratoon are presented in Table 1. Effect of sugarcane crop residues and industrial wastes management showed that the treatment T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash+ bagasse ash recorded significantly higher cane yield (111.37 t ha^{-1}) and CCS yield (14.30 t ha^{-1}) however, it was at par with all the treatments except T_1, T_2 and T_3. Significantly the highest number of millable cane (66.88 '000 ha^{-1}) recorded in treatment T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash+ bagasse ash and it was at par with all the treatments except T_1 and T_2.. Numerically higher average cane weight was recorded in treatment T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash+ bagasse ash.

Effect of fertilizer levels results showed that the RDF level receiving 100 % recommended dose of fertilizers recorded significantly higher cane yield, CCS yield, number of millable cane and average cane weight (113.72 t ha^{-1}, 14.03 t ha^{-1} 66.34 000 ha^{-1} and 1.69 kg, respectively) However, it was at par with 75 % recommended dose of fertilizers level in respect to cane yield, CCS yield, number of millable cane and 75 % and 50% recommended dose of fertilizers level in respect to average cane weight.

The interactions effect between sugarcane crop residues and industrial wastes and recommended dose of fertilizers levels (Table 1 a) showed that interaction between *In situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash+ bagasse ash (T_7) and application of 100% recommended dose of fertilizer (F_3) recorded significantly the highest cane yield (118.18 t ha^{-1}) however, it was found at par interaction between T_6 x F_3, T_5 x F_3, T_4 x F_3,

T_3 x F_3, T_7 x F_2, T_6 x F_2, T_5 x F_2, T_4 x F_2, T_7 x F_1, T_6 x F_1 and T_5 x F_1.

The significantly higher CCS yield was found in *In situ* recycling of sugarcane crop residues + pressmud compost + Post biomethanated spent wash+ bagasse ash (T_7) and application of 100% recommended dose of fertilizer (F_3) (14.74 t ha^{-1}) however, it was found at par with interaction of *In* situ recycling of sugarcane crop residues + pressmud compost + PBSW (T_6), *In* situ recycling of sugarcane crop residues + pressmud compost (T_5) and *In* situ recycling of sugarcane crop residues + PBSW (T_4) with RDF level F_2 and F_1 and treatment T_6, T_5, T_4 and T_3 with RDF level F_3. These findings are in conformity with results of Phalke *et al*. (2017) [5] and Tayade (2016) [9]. While sugarcane crop residues and industrial wastes, RDF levels and their interactions were found non significant influence on juice quality parameters.

2. Soil physical properties

The data on soil physical properties of second sugarcane ratoon are presented in Table 2. Effect of sugarcane crop residues and industrial wastes management revealed that the lowest bulk density was observed in the treatment T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash + bagasse ash. The treatments T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash + bagasse ash recorded significantly higher porosity and maximum water holding capacity (51.91 % and 63.47 %) and it was at par with treatment T_6 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash (51.15 % and 62.57 %). The lowest porosity and maximum water holding capacity were recorded in the treatment T_1 receiving Burning of sugarcane trash and removal of stubbles (Farmers practice-I). *In situ* sugarcane crop residues and industrial wastes decomposition significantly improved larger macro-aggregates as compared to burning of crop residues. These results were resembled with the findings of Manna *et al.* (2007a and b) [2, 3]. While effect of fertility levels found non significant results.

3. Soil chemical properties

The data on soil chemical properties of second sugarcane ratoon are presented in Table 3. Effect of sugarcane crop residues and industrial wastes management observed that soil organic carbon content was reduced in the inorganic treatments T_1 and T_2 and it was increased in all *In situ* recycling of sugarcane crop residues and industrial waste treatments over the initial values. The treatment T_7 receiving In *situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash+ bagasse ash recorded significantly higher organic carbon (0.72 %) and it was at par with treatment T_4, T_5 and T_6. The lowest organic carbon was recorded in the treatment T_1 receiving Burning of sugarcane trash and removal of stubbles (Farmers practice –I) (0.59 %). Significantly the highest soil EC was noticed in treatment T_7 receiving *In situ* recycling of sugarcane crop residues + press-mud compost + PBSW+ bagasse ash (0.42 dSm^{-1}) however, it was found at par with treatment T_4 and T_6. The soil pH was found non significant.

The higher available nitrogen, phosphorus and potassium were recorded in treatment T_7 receiving In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ bagasse ash (252.02 kg ha^{-1}, 54.67 kg ha^{-1} and 398.26 kg ha^{-1}, respectively) and it was at par with treatment T_5 and T_6 in respect of available nitrogen and treatment T_6 in respectavailable phosphorus.

Effect of different fertilizers levels showed that the soil pH was slightly decreased in all RDF levels.The RDF level F_3 receiving 100 % recommended dose of fertilizer noticed significantly higher organic carbon, available nitrogen, available phosphorus and available potassium (0.69 %, 241.13 kg ha^{-1}, 48.75 kg ha^{-1} and 317.81 kg ha^{-1},respectively) and it was at par with RDF level F_2 in respect of soil organic carbon, available phosphorus and available potassium. The soil pH and EC were found to be non significant.

Significantly the highest soil organic carbon (0.72 %) was found in interaction of *In situ* recycling of sugarcane crop residues + pressmud compost + PBSW + bagasse ash (T_7) with application of 100% and 75 % recommended dose of fertilizer (F_3) and (F_2) however, it was found at par with all the treatments except treatment T_1 and T_2 in RDF level F_2 and F_3 and treatment T_1, T_2 and T_3 in RDF level F_1.These findings are in conformity with results of Phalke *et al*. (2017) [5], Suma and Savita (2015) [7] and Tayade (2016) [9].

4. Total nutrient uptake

The data on total nutrient uptake of second sugarcane ratoon are presented in Table 4. Effect of sugarcane crop residues and industrial wastes management analysis revealed that the highest total nitrogen, total phosphorus and total potassium uptake were observed in the treatment T_7 receiving In *situ* recycling of sugarcane crop residues + pressmud compost + post biomethanated spent wash+ bagasse ash (210.08 kg ha^{-1}, 47.61 kg ha^{-1} and 237.64 kg ha^{-1}) and it was at par with treatment T_6 receiving *In situ* recycling of sugarcane crop residue + pressmud compost + post biomethanated spent washand T_5 receiving *In situ* recycling of sugarcane crop residues + pressmud compost in respect to total phosphorus and treatment T_6 inrespect to total nitrogen.

The RDF level F_3 receiving 100 % recommended dose of fertilizer recorded significantly the highest uptake of total nitrogen, total phosphorus and total potassium (211.12 kg ha^{-1}, 46.64 kg ha^{-1} and 237.91 kg ha^{-1}, respectively). However, it was at par with RDF level F_2 receiving 75 % recommended dose of fertilizer in respect to total nitrogen and total phosphorus.

Economics

The data on economics of second sugarcane ratoon are presented in Table 5. The higher gross and net return were observed in the treatment T_7 receiving *In situ* recycling of sugarcane crop residues + pressmud compost + PBSW + bagasse ash (Rs.272857 and Rs.202815). The higher benefit cost ratio was recorded in the treatment T_7 (2.90).

The fertilizer level F_3 receiving 100 % recommended dose of fertilizer recorded significantly higher gross and net return (Rs.278614 and Rs.200093). The fertilizer level F_3 recorded higher benefit cost ratio (2.55).

Table 1: Effect of sugarcane crop residues and industrial wastes along with different fertilizers levels on sugarcane yield and yield contributing parameters (2nd ratoon)

Treatments	Cane Yield (t ha^{-1})	CCS Yield (t ha^{-1})	NMC (000 ha^{-1})	ACW (kg)	Brix (0^0)	Sucrose (%)	Purity (%)	CCS (%)
A. Main plot treatments (Sugarcane Crop Residues and Industrial Wastes)								
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	82.93	9.79	53.48	1.53	17.92	16.60	93.77	11.80
T_2: Removal of sugarcane trash (Farmers practice –II)	86.65	10.35	55.57	1.57	18.92	16.95	92.19	11.95
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	98.75	11.85	60.69	1.61	18.63	17.08	92.58	12.00
T_4: In *situ* recycling of sugarcane crop residues + PBSW	101.25	12.30	61.50	1.64	18.83	17.06	92.65	12.15
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	103.10	12.55	63.03	1.66	18.25	17.12	94.54	12.17
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	108.89	13.46	65.53	1.67	18.46	16.66	94.03	12.36
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	111.37	14.30	66.88	1.69	18.79	17.96	95.36	12.84
SE$\pm$	3.92	0.83	2.47	0.05	0.36	0.46	1.10	0.37
CD at 5%	11.98	2.39	6.98	NS	NS	NS	NS	NS
B. Sub plot treatments (RDF Level)								
F_0: Without fertilizers	79.87	9.62	53.95	1.49	18.40	16.90	93.87	12.04
F_1: 50 % recommended dose of fertilizers	93.54	11.37	58.10	1.62	18.60	17.20	93.52	12.16
F_2: 75 % recommended dose of fertilizers	108.81	13.25	64.32	1.68	18.57	17.06	94.35	12.18
F_3: 100 % recommended dose of fertilizers	113.72	14.03	66.34	1.69	18.60	17.09	92.61	12.34
SE$\pm$	2.63	0.38	1.48	0.05	0.11	0.10	0.42	0.35
CD at 5%	7.57	1.11	4.22	0.15	NS	NS	NS	NS
C. Interactions								
SE$\pm$	4.18	0.72	0.05	4.81	0.34	0.48	1.13	0.39
CD at 5%	12.03	2.01	NS	NS	NS	NS	NS	NS
General Mean	98.99	12.07	60.67	1.62	18.54	17.06	93.59	12.18

PBSW: Post biomethanated spent wash, **NMC**: Number Millable Cane, **CCS**: Commercial Cane Sugar and **ACW**: Average Cane Weight

Table 1a: Interaction effect on cane yield (t ha^{-1}) of sugarcane ratoon(2nd ratoon)

Sub plot/Main plot	F_0: Without fertilizers	F_1: 50 % RDF	F_2: 75% RDF	F_3: 100% RDF
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	69.83	70.39	85.41	85.77
T_2: Removal of sugarcane trash (Farmers practice –II)	76.98	81.50	94.57	95.29
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	85.98	86.91	99.92	109.13
T_4: In *situ* recycling of sugarcane crop residues + PBSW	93.59	104.09	109.95	110.36
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	94.11	106.56	110.52	115.35
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	103.01	106.61	112.01	116.07
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	105.78	107.02	116.74	118.18
SE$\pm$	4.18			
CD at 5%	12.03			

Table 1b: Interaction effect on CCS yield (t ha^{-1}) of sugarcane ratoon(2nd ratoon)

Sub plot/Main plot	F_0: Without fertilizers	F_1: 50 % RDF	F_2: 75% RDF	F_3: 100% RDF
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	8.61	9.17	10.57	10.64
T_2: Removal of sugarcane trash (Farmers practice –II)	9.96	8.60	11.45	11.67
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	10.65	10.58	11.94	13.55
T_4: In *situ* recycling of sugarcane crop residues + PBSW	11.97	12.78	12.76	13.60
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	12.00	12.81	12.98	13.78
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	12.21	12.93	13.15	14.68
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	12.70	13.24	14.23	14.74
SE$\pm$	0.72			
CD at 5%	2.01			

PBSW: Post biomethanated spent wash, **RDF**: Recommended Dose Fertilizer

Table 2: Effect of different treatments on soil physical properties at harvest of second sugarcane ratoon (2nd ratoon)

Treatments	Bulk density (Mg m^{-3})	Porosity (%)	Maximum water holding capacity (%)
A. Main plot treatments (Sugarcane Crop Residues and Industrial Wastes)			
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	1.40	46.56	56.27
T_2: Removal of sugarcane trash (Farmers practice –II)	1.40	46.56	57.14

T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	1.32	49.62	59.97
T_4: In *situ* recycling of sugarcane crop residues + PBSW	1.31	50.00	59.99
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	1.29	50.76	60.42
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	1.28	51.15	62.57
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	1.26	51.91	63.47
SE±	0.003	0.26	0.31
CD at 5%	0.01	0.78	0.97
B. Sub plot treatments (RDF Level)			
F_0: Without fertilizers	1.36	48.09	59.48
F_1: 50 % recommended dose of fertilizers	1.32	49.62	59.74
F_2: 75 % recommended dose of fertilizers	1.31	50.00	59.94
F_3: 100 % recommended dose of fertilizers	1.30	50.38	60.75
SE±	0.03	0.83	0.48
CD at 5%	NS	NS	NS
C. Interactions			
SE±	0.05	1.93	2.58
CD at 5%	NS	NS	NS
General Mean	1.32	49.52	59.70
Initial	*1.35*	*48.95*	*59.54*

PBSW: Post biomethanated spent wash

Table 3: Effect of different treatments on soil chemical properties at harvest of sugarcane ratoon (2nd ratoon)

Treatments	**pH (1:2.5)**	**EC (dS m^{-1})**	**Organic Carbon (%)**	**Available Nutrients (kg ha^{-1})**		
				N	**P_2O_5**	**K_2O**
A. Main plot treatments (Sugarcane Crop Residues and Industrial Wastes)						
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	7.56	0.39	0.59	171.98	24.35	208.25
T_2: Removal of sugarcane trash (Farmers practice –II)	7.56	0.40	0.60	178.14	26.47	213.57
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	7.51	0.38	0.67	219.26	37.58	303.52
T_4: In *situ* recycling of sugarcane crop residues + PBSW	7.49	0.41	0.69	227.87	41.91	349.25
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	7.49	0.40	0.70	242.78	43.27	333.11
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	7.48	0.41	0.71	250.10	51.27	370.25
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	7.48	0.42	0.72	252.02	54.67	398.26
SE±	0.03	0.003	0.01	3.12	1.28	1.59
CD at 5%	NS	0.01	0.03	9.32	3.81	4.57
B. Sub plot treatments (RDF Level)						
F_0: Without fertilizers	7.51	0.39	0.66	202.14	27.42	303.27
F_1: 50 % recommended dose of fertilizers	7.51	0.40	0.66	215.38	39.42	307.78
F_2: 75 % recommended dose of fertilizers	7.50	0.40	0.68	222.58	44.14	314.69
F_3: 100 % recommended dose of fertilizers	7.52	0.40	0.69	241.13	48.75	317.81
SE±	0.01	0.01	0.01	2.24	1.69	1.32
CD at 5%	NS	NS	0.02	6.45	4.84	3.80
C. Interactions						
SE±	0.02	0.01	0.01	5.87	2.71	4.27
CD at 5%	NS	NS	0.03	NS	NS	NS
General Mean	7.51	0.39	0.67	220.31	39.93	310.89
Initial	7.52	0.39	0.66	213.67	36.15	316.69

PBSW: Post biomethanated spent wash

Table 3a: Interaction effect on soil organic carbon (%) after harvest sugarcane ratoon (2nd ratoon)

Sub plot/Main plot	**F_0: Without fertilizers**	**F_1: 50 % RDF**	**F_2: 75% RDF**	**F_3: 100% RDF**
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	0.59	0.61	0.61	0.63
T_2: Removal of sugarcane trash (Farmers practice –II)	0.60	0.62	0.63	0.65
T_3: In*situ* decomposition of sugarcane crop residues by recommended decomposition practice	0.64	0.65	0.67	0.67
T_4: In *situ* recycling of sugarcane crop residues + PBSW	0.67	0.70	0.69	0.70
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	0.68	0.71	0.70	0.71
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	0.69	0.71	0.71	0.71
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	0.69	0.71	0.72	0.72
SE±	0.02			
CD at 5%	0.05			

PBSW: Post biomethanated spent wash, **RDF**: Recommended Dose Fertilizer

Table 4: Effect of different treatments on total nutrient uptake by sugarcane ratoon (2nd ratoon)

Treatment	Total nutrient uptake (kg ha^{-1})		
	N	P	K
A. Main plot treatments (Sugarcane Crop Residues and Industrial Wastes)			
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	156.12	26.84	162.85
T_2: Removal of sugarcane trash (Farmers practice –II)	166.83	31.49	167.95
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	191.67	40.27	207.42
T_4: In *situ* recycling of sugarcane crop residues + PBSW	195.64	42.67	215.84
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	199.67	44.57	220.59
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	205.64	46.57	232.51
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	210.08	47.61	237.64
SE±	3.78	0.99	1.38
CD at 5%	10.73	3.06	3.97
B. Sub plot treatments (RDF Level)			
F_0: Without fertilizers	159.43	29.83	166.27
F_1: 50 % recommended dose of fertilizers	180.41	38.74	194.85
F_2: 75 % recommended dose of fertilizers	206.59	44.82	226.57
F_3: 100 % recommended dose of fertilizers	211.12	46.64	237.91
SE±	2.81	0.96	1.98
CD at 5%	8.70	2.89	6.03
C. Interactions			
SE±	4.13	1.97	3.57
CD at 5%	NS	NS	NS
General Mean	189.38	40.00	206.40

PBSW: Post biomethanated spent wash, **RDF**: Recommended Dose Fertilizer

Table 5: Economics of different treatments (2nd ratoon)

Treatment	Cane Yield (t ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B : C Ratio
A. Main plot treatments(Sugarcane Crop Residues and Industrial Wastes)					
T_1: Burning of sugarcane trash and removal of stubbles (Farmers practice –I)	82.93	203179	66604	136575	2.05
T_2: Removal of sugarcane trash (Farmers practice –II)	86.65	212293	66604	145689	2.19
T_3: In *situ* decomposition of sugarcane crop residues by recommended decomposition practice	98.75	241938	68240	173697	2.55
T_4: In *situ* recycling of sugarcane crop residues + PBSW	101.25	248063	68290	179772	2.63
T_5: In *situ* recycling of sugarcane crop residues + pressmud compost	103.10	252595	69822	182773	2.62
T_6: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW	108.89	266781	69872	196908	2.82
T_7: In *situ* recycling of sugarcane crop residues + pressmud compost + PBSW+ Bagasse ash	111.37	272857	70042	202815	2.90
SE±	**3.92**				
CD at 5%	**11.98**				
B. Sub plot treatments (RDF Level)					
F_0: Without fertilizers	79.87	195682	66604	129078	1.94
F_1: 50 % recommended dose of fertilizers	93.54	229173	72601	156572	2.16
F_2: 75 % recommended dose of fertilizers	108.81	266585	75529	191056	2.53
F_3: 100 % recommended dose of fertilizers	113.72	278614	78521	200093	2.55
SE±	2.63				
CD at 5%	7.57				

PBSW: Post biomethanated spent wash, **RDF**: Recommended Dose Fertilizer

Conclusion

Application of pressmud compost @ 2.26 t ha^{-1} + 13560 L ha^{-1} of post biomethanated spent wash + 339 kg bagasse ash and 100% recommended dose of fertilizers was found beneficial for increasing sugarcane yield with maintenance of soil health. It was evident that *In situ* sugarcane trash composting had positive influence on yield of cane and soil fertility.

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