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Effect of raw and post bio-methanated spent wash bio-compost on the growth, yield quality of seasonal sugarcane chemical properties of sodic soil

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Summary

A field experiment was conducted at Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth Rahuri, dist- Ahmednagar (M.S.) with raw and post bio-methanated spent wash for preparation of bio-compost from the different organic sources like press mud cake, baggasse, sugarcane trash, farm waste like pearl millet straw, chickpea straw and wheat cut straw etc. and seasonal sugarcane crop (*Saccharum officinarum*) variety Co 86032 was planted with sixteen treatments, three replications in sodic soil. Absolute control, farm yard manure and vermicompost treatments were taken for comparison with bio-composts. The growth parameters like height of the plant, girth of the stem, number of tillers etc. as well as yield , quality of sugarcane and soil chemical properties etc. were found significantly higher in the post bio-methanated bio-compost treatment as compared to the raw spent wash bio-compost treatment under sodic soil condition.

Key words : Spent wash, Post bio-methanated, Farm yard manure, Pearl millet, Vermicompost

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Introduction

India is a major producer of sugar in the world and contributes substantially to economic development. The waste products like bagasses and molasses from the sugar factory are also economically more important. Bagasse is used in the production of paper, electricity and also as a fuel in boilers. Molasses is the cheapest source for production of alcohol in distilleries by fermentation method for the production of 1 litre of alcohol 3-10 kg of molasses are utilized. Large network of distilleries has been established in India to utilize molasses, which are regarded as one of the most polluting agro-based industries emitting huge quantities of distillery spent wash (DSW). It is a dark coloured, acidic, high biological oxygen demand (BOD) and chemical oxygen demand (COD) liquid consisting of biodegradable organic and inorganic constituents, which can not be disposed directly into water bodies. But the land application of spent wash offer benefits of water pollution control and utilization for agricultural production. The utilization of industrial waste as soil amendment has generated interest in recent times. The waste water produced continuously could cater the needs of irrigated crops. Thus, this will not only prevent waste from being an environmental hazard but also serves as an additional potential source of fertilizer for agricultural use.

Looking to the availability of different nutrients in spent wash and its importance as a amendment for reclamation of sodic soil, bio-compost was prepared from different waste organic sources may be farm waste like pearl millet straw, wheat straw, chickpea straw, sugarcane trash, etc. and industrial waste like, baggasse, press mud cake, etc. Heap method for preparation of compost was used. Well decomposed bio-compost were used prior to one month before planting of suru sugarcane.

Resource and Research Methods

The field experiment was conducted at farm of central campus, Post Graduate Institute, MPKV, Rahuri on vertisols. The initially soil was clay in texture with pH (8.82), EC (1.12 dSm^{-1}) and slightly moderate in organic carbon (0.37 %) nitrogen (153 kg ha^{-1}) and phosphorus (7.60 kg ha^{-1}) and very high in potassium (390 kg ha^{-1}). DTPA micronutrient were found higher of values *i.e*. Fe (4.1 mg kg^{-1}), Mn (9.72 mg kg^{-1}), Zn (0.39 mg kg^{-1}) and Cu (0.88 mg kg^{-1}) etc. The experiment was laid out in Randomized Block Design with sixteen treatments and three replications. Suru sugarcane variety CO.86032 was grown at the net spacing 2.70 x 3.20 m^2

There were total sixteen treatments whish composed of T_1 - Absolute control, T_2- RSW + BC, T_3- PBSW + BC , T_4- RSW+STC, T_5-PBSW + STC , T_6- RSW +- PMC, T_7- PBSW + PMC, T_8- RSW + WSC, T_9- PBSW + WSC, T_{10}- RSW + PeBWC, T_{11}- PBSWC + PeBWC, T_{12}- RSW + CSC , T_{13}- PBSW + CSC, T_{14}- FYM (AST), T_{15}- VC RDF (AST), T_{16}- (AST). RDF 470:175:70 kg ha^{-1} N,P_2O_5 and K_2O, respectively (On the basis of AST). Two eye budded setts were soaked in solution containing 300 ml malathion + 10 g of bavistin in 100 L of water for 10 minutes The same setts were again soaked in solution containing 1.25 kg each of *Azotobacter, Azospirillum*, Acetobacter and PSB in 100 L of water for 30 minutes and used for planting.

Growth observations :

Germination percentage:

The germination count of sugarcane was taken one month after planting. The germination percentage was 80 in sodic soil. Gap filling was done in both the experiments.

Number of tillers per plant :

The number of tillers was counted at 60 and 120 days which were calculated by following formula.

$$\textbf{Tillering ratio} = \frac{\textbf{Total number of shoots} - \textbf{Number of cane of mother cane}}{\textbf{Number of mother canes}}$$

The total number of tillers from selected five clumps were counted and recorded from each plot at 120 days after planting.

Plant height :

The plant height was measured from the base of shoot to base of fully opened last leaf of the shoot. The periodical height was measured at regular intervals *viz*., 60^{th}, 120^{th}, 180^{th} day after planting and at harvest. Total height and millable cane height were recorded.

Number of millable canes :

Millable canes from each treatment were counted at harvest of sugarcane crop.

Girth of cane :

The circumference of the top, middle and bottom internodes of each cane was measured and five readings were averaged to get the girth of cane.

Yield of cane and green tops:

The canes were harvested from individual plot. After detrashing and removal of tops from plants the weight of millable canes and tops as per treatments were recorded and reported as yield of sugarcane and green tops in tonnes ha^{-1}.

Nutrient uptake :

The uptake of major nutrients like N,P,K was worked out by multiplying dry matter accumulation and with concentration of N,P and K at harvest by using the following formula:

$$\textbf{Uptake of nutrient (kg ha}^{-1}\textbf{)} = \frac{\textbf{Total dry matter x Concentration of nutrient}}{\textbf{100}}$$

Cane juice sampling :

Fresh juice samples were utilized for quality parameters. Canes were cleaned by removing dry leaves and cane top. Cane juice was extracted with the help of steel crusher. About one litre of fresh cane juice was extracted in clean plastic cans from each treatment, for quality studies.

Cane juice quality studies:

Juice was analysed in the laboratory for various quality parameters *viz.*, Brix, POL, sucrose, purity, reducing and non-reducing sugar content.

Brix :

The brix values (total soluble solids) in the juice sample was estimated by using brix hydrometer and expressed in terms of brix (corrected) after making calibration for temperature. After crushing, the filtered juice sample was taken in a 500 ml measuring cylinder and filled to the top level of the cylinder and recorded the reading of brix hydrometer in the juice. The recorded observations were calibrated for juice temperature from chart. The treatment and replication wise brix (T.S.S.) observations were recorded.

POL :

The POL (Sucrose content) values were determined by the polorimeter after clarifying the juice by using lead acetate. The sucrose content of the juice was expressed in per cent using Schmitz's conversion table.

Purity :

Purity is the ratio of sucrose content of the juice (POL) to the total soluble solids [Brix (^{0}C)]. It was worked out and expressed in per cent.

$$\text{Purity (\%)} = \frac{\text{POL (sucrose) per cent}}{\text{Brix (}^{0}\text{C)}} \times 100$$

Commercial cane sugar (CCS):

The CCS percentage was worked out from the POL (Sucrose) percentage using formula given in Schimmits conversion table.

CCS % = {S-(B-S) x 0.4} x 0.74 *

where,

S = Sucrose per cent

B = Corrected Brix

* Crushing factors of sugarcane juice crusher.

Commercial cane sugar yield :

The yield of commercial cane sugar was calculated based on commercial cane sugar percentage and the cane yield and expressed in tones ha^{-1}.

$$\text{CCS yield (t ha}^{-1}\text{)} = \frac{\text{Cane yield t ha}^{-1}}{100} \times \text{CCS (\%)}$$

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of spent wash bio-compost application on sugarcane growth:

The data in respect of effect of spent wash bio-compost on growth parameters of sugarcane are presented in Table 1.

The application of spent wash compost significantly increased tillering ratio at 120 days over control, RDF, FYM and vermicompost. The tillering ratio under sodic soil ranged from 2.80 (vermicompost) to 3.39 (PBSW + CSC). The effects of application of spent wash bio-compost prepared from chickpea straw and press mud cake were comparable in respect of tillering ratio. The effect of either raw spent wash or post bio-methanated spent wash was found comparable.

The use of spent wash for sugarcane enhanced the tillering ratio and growth of sugarcane was also reported by Ghugare (1994).

The application of PBSW + CSC showed highest cane height (250 cm) followed by PBSW + PMC (248.33 cm) but highest cane girth (8.96 cm) was observed in PBSW+PMC followed by PBSW + CSC (8.95 cm) over control.

The number of millable canes under sodic soil condition ranged from 58.40 x10^3 ha^{-1} (A.C.) to 66.92 x10^3 ha^{-1} (PBSW + CSC). The application of spent wash bio-compost significantly increased number of millable canes over control and RDF. Use of raw spent wash compost significantly decreased the number of millable canes over the use of bio-compost prepared from post bio-methanated spent wash. The use of PBSW+CSC significantly increased the number of millable canes as compared to other bio-compost and manures. The number of millable canes increased due to application of spent wash compost was also reported by Ghugare (1994).

In general, the effect of application of post bio-methanated compost and chickpea compost comparatively showed better growth parameters in respect of tillering ratio, cane height, cane girth and number of millable canes under normal and sodic soil conditions. This could be due to improvement in chemical properties of soil which reflected in enhancing the soil fertility status and bio-availability of plant nutrients to

Table 1 : Effect of spent wash bio-compost application on growth characters of *Suru* sugarcane in sodic soil

Sr. No.	Treatments	Tillering ratio		Cane height	Girth	No. of millable canes(000 ha^{-1})
		60	120	----------cm---		
		---------DAS------		-------------At harvest--------		
1.	AC	1.80	2.87	212.67	8.07	58.40
2.	RSW+BC	2.33	3.20	242.00	8.67	59.31
3.	PBSW+BC	2.33	3.27	244.33	8.68	60.85
4.	RSW+STC	2.30	3.29	241.00	8.69	61.26
5.	PBSW+STC	2.33	3.27	242.33	8.75	62.85
6.	RSW+PMC	2.37	3.30	244.00	8.93	66.67
7.	PBSW+PMC	2.43	3.37	248.33	8.96	66.64
8.	RSW+WSC	2.37	3.30	246.00	8.83	65.43
9.	PBSW+WSC	2.33	3.27	242.00	8.85	66.70
10.	RSW+PeBWC	2.30	3.31	242.67	8.87	65.01
11.	PBSWC+PeBWC	2.33	3.30	242.67	8.89	66.87
12.	RSW+CSC	2.33	3.32	246.00	8.95	66.37
13.	PBSW+CSC	2.43	3.39	250.00	8.95	66.92
14.	FYM (AST)	1.93	2.93	240.67	8.65	61.74
15.	VC (AST)	2.10	2.80	241.00	8.69	61.00
16.	RDF (AST)	2.17	3.05	218.33	8.67	59.81
	S.E. ±	1.87	0.87	0.19	0.32	0.01
	C.D. (P=0.05)	NS	2.51	0.53	0.92	0.03

NS= Non-significant

Table 2 : Effect of spent wash bio-compost application on cane and top yield (t ha^{-1}) of *Suru* sugarcane

Sr. No.	Treatments	Sodic soil	
		Cane yield	Top yield
1.	AC	51.22	4.89
2.	RSW+BC	68.17	6.52
3.	PBSW+BC	69.83	6.68
4.	RSW+STC	64.86	6.20
5.	PBSW+STC	66.27	6.34
6.	RSW+PMC	83.15	7.95
7.	PBSW+PMC	87.20	8.34
8.	RSW+WSC	67.67	6.47
9.	PBSW+WSC	67.83	6.49
10.	RSW+PeBWC	67.70	6.50
11.	PBSWC+PeBWC	67.95	6.49
12.	RSW+CSC	77.34	7.39
13.	PBSW+CSC	80.80	7.73
14.	FYM (AST)	65.18	6.23
15.	VC (AST)	65.19	6.24
16.	RDF (AST)	60.28	5.71
	S.E. ±	0.99	0.10
	C.D. (P=0.05)	2.86	0.27

sugarcane for its growth.

The data in respect of effect of application of spent wash bio-compost on cane and top yield of sugarcane in sodic soil are presented in Table 2.

The data on cane yield as influenced by use of different bio-compost prepared from raw and post bio-methanated spent wash are depicted in Table 2. The cane yield was significantly superior in all bio-compost treated plots over control and RDF. The cane yield obtained from compost prepared from press mud cake, chickpea and bagasse by use of raw and post bio-methanated spent wash showed significantly higher cane yield over use of FYM and vermicompost. Among the all treatments, use of post bio-methanated + PMC compost showed highest cane yield (87.20 t $^{-1}$) over raw spent wash (83.15 t ha^{-1}). Similar trend was also noticed for bio-compost prepared from chickpea straw, where the use of raw spent wash showed comparatively lower cane yield (77.34 t ha^{-1}) over the use of post bio-methanated spent wash (80.80 t ha^{-1}). However, the effect of raw spent wash and post bio-methanated spent wash was at par in the other crop residues *viz.*, baggasse, wheat straw, sugarcane trash and pearl millet straw etc.

Effect of spent wash bio-compost on cane top yield of sugarcane :

The top yield of sugarcane ranged from 4.89 to 8.34 t ha^{-1}. The bio-compost prepared from post bio-methanated spent wash and PMC showed significantly highest top yield (8.34 t ha^{-1}) followed by raw spent wash + PMC bio-compost (7.95 t ha^{-1}) and post bio-methanated spent wash + chickpea straw bio-compost (7.73 t ha^{-1}). These treatments were significantly superior over FYM and vermicompost. The other crop residue bio-compost showed comparable effects as that of FYM and vermicompost under sodic soil condition.

Thus, the yield parameters clearly indicate that the significant response for increase in yields due to application of bio-compost prepared from spent wash. Among the treatments the use of PBSW+PMC showed significantly highest cane and top yield under normal and sodic soil condition over RDF, FYM and vermicompost indicating superiority of use of spent wash bio-compost prepared from PBSW+PMC for enhancing bio-availability of plant nutrients and improvement in physico-chemical and biological and enzymatic activities in pedo environment which ultimately reflected in enhancing the soil fertility, the nutrient uptake and growth parameters

Table 3 : Effect of spent wash bio-compost application on sugarcane juice quality under sodic condition

Sr. No.	Treatments	Brix	Purity (%)	CCS	Sucrose (%)	Reducing sugar	CCS (t ha^{-1})
		Per cent					
1.	AC	22.85	90.34	12.78	20.38	0.20	6.53
2.	RSW+BC	22.64	91.81	13.10	20.82	0.24	8.92
3.	PBSW+BC	22.70	86.21	11.99	19.57	0.24	8.36
4.	RSW+STC	23.38	90.31	13.44	20.63	0.26	8.64
5.	PBSW+STC	22.81	89.69	12.60	20.19	0.26	8.34
6.	RSW+PMC	23.07	91.51	13.34	20.59	0.28	11.08
7.	PBSW+PMC	21.84	90.80	12.27	19.40	0.27	10.69
8.	RSW+WSC	22.91	91.91	13.30	20.94	0.25	8.99
9.	PBSW+WSC	21.53	93.81	12.55	19.65	0.25	8.50
10.	RSW+PeBWC	21.81	89.74	12.58	19.71	0.27	8.51
11.	PBSWC+PeBWC	22.07	87.77	12.03	18.73	0.25	8.17
12.	RSW+CSC	22.10	90.13	12.67	20.10	0.26	9.80
13.	PBSW+CSC	22.21	88.90	12.31	19.38	0.26	9.94
14.	FYM (AST)	23.24	91.31	13.31	20.92	0.25	8.67
15.	VC (AST)	22.30	91.26	12.66	19.71	0.24	8.34
16.	RDF (AST)	22.27	88.96	12.34	19.61	0.22	7.43
	S.E. ±	1.87	0.87	0.19	0.32	0.01	0.14
	C.D. (P=0.05)	NS	2.51	0.53	0.92	0.03	0.41

NS= Non-significant

of sugarcane under sodic soil. The application of spent wash/ spent wash compost improved the crop yields, physico-chemical, biological properties and enzymatic activities were also reported by Dongale and Sawant (1978) for sorghum, Pande and Sinha (1988) for cane stalk yield, Jadhav and Savant (1975) for *Adsali* sugarcane, Shinde *et al*. (1993) and Zalawadia and Raman (1994) for sorghum yield and Rajukannu (2001) for rice in sodic soil.

Therefore, these results are in accordance with the use of spent wash bio-compost/ spent wash also showed ameliorating effects on sodic soil were also reported by several workers (Mahimaraja and Nanthi, 2004; Sen, 2003 and Kaushik *et al.,* 2005).

Effects of application of spent wash bio-compost on juice quality of sugaracane :

The data on effect of application of spent wash bio-compost on brix, purity, CCS, sucrose, reducing sugar under sodic soil condition are depicted in Table 3.

Juice quality :

The purity per cent ranged from 86.21 (PBSW +BC) to 93.81 per cent (PBSW+WSC). Whereas, CCS percentage ranged from 11.99 per cent (PBSW + BC) to 13.44 per cent (RSW + STC). The highest content of sucrose was noticed in treatment RSW + WSC (20.94 %). The CCS yield ranged from 6.53 (control) to 11.08 t ha^{-1} (RSW + PMC) followed by (PBSW + PMC) 10.69 t ha^{-1}. The bio-compost prepared from press mud cake and chickpea straw showed comparatively higher CCS yield over RDF, FYM and vermicompost.

These results are in conformity with the findings of Ghugare (1994) and Bhalerao *et al.* (2006), where the application of spent wash/ spent wash compost increased in CCS per cent and CCS yield (t ha^{-1}) which could be attributed due to increase in yield, sucrose content, P and K availability, uptake over control and RDF.

Effect of spent wash bio-compost on chemical properties of sodic soil :

The effect of spent wash biocompost on chemical properties of sodic soil are depicted in Table 4.

The application of spent wash bio-composts resulted in significant decrease in pH over control and RDF. The application of PBSW + chickpea straw compost showed

Table 4 : Effect of spent wash bio-compost application on chemical properties of soil after harvest of *Suru* sugarcane in sodic soil

Sr. No.	Treatments	pH (1:2.5)	EC (dSm^{-1})	O.C. (%)	Avail. N	Avail. P	Avail. K
					-------------($kg\ ha^{-1}$)---------		
1.	AC	8.81	1.13	0.38	151	6.89	397
2.	RSW+BC	8.71	1.19	0.42	160	7.95	419
3.	PBSW+BC	8.75	1.15	0.44	166	8.30	428
4.	RSW+STC	8.70	1.19	0.40	155	7.95	418
5.	PBSW+STC	8.76	1.17	0.42	164	8.37	424
6.	RSW+PMC	8.70	1.19	0.55	158	8.55	415
7.	PBSW+PMC	8.75	1.14	0.65	167	8.85	458
8.	RSW+WSC	8.70	1.19	0.40	158	8.17	424
9.	PBSW+WSC	8.75	1.17	0.45	164	8.60	450
10.	RSW+PeBWC	8.72	1.20	0.41	162	8.65	429
11.	PBSWC+PeBWC	8.74	1.14	0.43	166	8.90	441
12.	RSW+CSC	8.70	1.19	0.60	156	8.35	430
13.	PBSW+CSC	8.74	1.15	0.69	167	8.58	438
14.	FYM	8.80	1.09	0.42	156	8.21	423
15.	VC	8.80	1.11	0.50	154	8.15	427
16.	RDF (AST)	8.80	1.10	0.42	151	8.10	435
	S.E. ±	0.01	0.01	0.01	1.93	0.16	3.36
	C.D. (P=0.05)	0.03	0.03	0.03	5.55	0.46	9.69
	Initial	8.82	1.12	0.37	153	7.60	390

lowest soil pH as compared to FYM and vermicompost. The application of RSW + STC, RSW + PMC, RSW + WCS showed significantly lowest soil pH (8.70) as compared with RDF, FYM and vermicompost. It could be due to acidic nature of raw spent wash.

Saliha (2003) reported that increase in level of the spent wash application resulted a notable decrease in the pH of soils and such effect was more pronounced in the presence of organic amendments. Decrease in soil pH might be attributed to the acidic nature of spent wash and release of organic acids during the decomposition. Similar observations were also recorded by Pawar *et al.* (1992); Chaudhary (1998); Kayalvizhi *et al.* (2001) and Khatal (2008).

The EC ranged from 1.09 dSm^{-1} (FYM) to the 1.20 dSm^{-1} (RSW+PeBWC) (Table 4). Raw spent wash bio-compost treated plots were found high in electrical conductivity as compared to PBSW, control, FYM, vermicompost and RDF treated plots. The application of spent wash resulted in increase of EC values was also reported by Joshi *et al.* (1994) Singh and Bahadur (1997); Chaudhary (1998) and Pathak *et al.* (1999).

The organic carbon content in different treatments ranged from 0.38 per cent (control) to 0.69 per cent (PBSW+ CSC). The significantly higher organic carbon content was recorded in the treatment of PBSW + CSC (0.69%) followed by PBMSW+ PMC (0.65%). The application of spent wash /spent wash compost increased the soil organic carbon was also reported by Singh (1992); Singh *et al.* (1995); Chaudhary (1998) and Pathak *et al.* (1999).

The available nitrogen in sodic soil ranged from 151 (control) to 167 kg ha^{-1} (PBSW+ PMC). The application of spent wash bio-compost showed significant improvement in available status of nitrogen as compared to RDF.

The available P ranged from 6.89 (control) to 8.90 kg ha^{-1} (PBSW+ PeBSWC). Application of bio-compost resulted in significant increase in available P status of soil over control.

The results indicate that the application of bio-compost might have increased the phosphatase activities in the soil. The similar views were also reported by Selvamurugan *et al.* (2011) for soils of Coimbatore. Similar observations were also reported by Devarajan and Oblisami (1995); Zalawadia and Raman (1994) and Chaudhary (1998).

The available K status ranged from 397 (Control) to 458 kg ha^{-1} (PBSW+PMC). The application of bio-compost significantly improved available K status of soil over control. The increase in available status could be due to presence of higher K content in spent wash.

The application of spent wash bio-compost resulted in improving the available NPK status of the soil was noticed over control and RDF. These results are in conformity with the results of Chaudhary (1998); Kayalvizhi *et al.* (2001) and Bhalerao *et al.* (2006).

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