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EFFECT OF DISTILLERY INDUSTRY BYPRODUCTS ON NUTRIENT AND ENHANCED YIELD OF CUMBU NAPIER HYBRID GRASS

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ABSTRACT

Distillery spentwash is a nutrient rich liquid organic waste obtained from molasses based distillery industries after biomethanation process and it is the carrier of huge amounts of nutrients and organic matter. A field investigation was carried out during 2009 to 2010, Research and Development Farm M/s. Bannari Amman Sugars Distillery Division Ltd, Ealur, Sathyamangalam, Erode to assess the performance of cumbu napier hybrid grass by utilizing distillery industry byproducts viz., distillery spentwash, biocompost and spentwash ash. Treatments involved are distillery spentwash @ 37.5 and 50 kilo litre per ha at full and split dose, biocompost @ 5.0 tonnes per ha and spentwash ash @ 400 kg per ha with recommended dose of fertilizers and the parameters were assessed at 12th, 26th, 39th and 52nd weeks after planting (1st, 3rd, 5th and 7th harvest). Results of the field experiment revealed that the application of spentwash @ 50 kilo litre per ha at full dose with recommend dose of nitrogen and phosphorus increased the quality parameters, nutrient parameters and green fodder yield over recommended dose of fertilizers.

INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries by fermentation method. About eight (08) liters of waste water is discharged for every lifer of ethanol production in distilleries, known as raw spentwash, is characterized by high Bio-chemical Oxygen Demand (BOD 5000-8000 mg/L), Chemical Oxygen Demand (COD 25000-30000 mg/L), highly acidic with undesirable color and foul smell which was subjected to biomethanation treatment to decrease BOD and COD and the product obtained is known as Biomethanated Distillery Spentwash (BDS). The BDS contains almost all plant nutrients, it could be used as liquid manure. Fertilizer application through irrigation water is being recommended to improve the fertilizer use efficiency (Sarayu Mohana *et al*., 2009). In India, the projected demand for fodder in 2015 is estimated to be 589 million tonnes of dry fodder and 1061 million tonnes of green fodder. However, our country faces a net deficit of 61.1 per cent green fod-

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der, 21.9 per cent dry crop residues and 64 per cent feeds (FAO, 2009). Forage crops require high amount of N and K and are the better choice towards assessing the nutrient potential of spentwash since it is rich in K and N (Galavi *et al*., 2009). Only a few research reports regarding the effect of distillery spentwash on forage crops are available. Keeping this in view, the present study was made to assess the performance of distillery industry byproducts on nutrient parameters and green fodder yield of CN hybrid grass.

MATERIALS AND METHODS

The BDS was collected from the distillery unit of M/s. Bannari Amman Sugars Ltd., Periyapuliyur, Erode district, Tamil Nadu and analyzed for its physico-chemical properties by standard procedures (APHA, 1998). Biocompost is being prepared and marketed by M/s. Bannari Amman Sugars Ltd., Ealur and analyzed for its physico - chemical properties. Spentwash ash is being produced by M/s. Bannari Amman Sugars Ltd., Distillery division, Alakangi, Nanjangud, Karnataka and analyzed for its physico - chemical properties. BDS was dark brown colour and a neutral pH (7.42) with high EC (32.5 dS m^{-1}), BOD (6,545 mg L^{-1}) and COD (34,476 mg L^{-1}). It contains highest K (8,376 mg L-1) followed by N (2,116 mg L^{-1}), Ca (2,072 mg L^{-1}), Mg (1,284 mg L^{-1}) and very low content of P (52.8 mg L^{-1}). The biocompost showed a neutral pH (7.26) and 1.74 dS m^{-1} EC with 15.42 per cent organic carbon content. Among the nutrients, the K content was highest (4.08 %), followed by Ca (3.72 %), Mg (2.46 %), P (2.06 %), Na (1.54 %) and N (1.24 %). The spentwash ash was alkaline nature (pH 8.96) with high EC (17.8 dS m^{-1}) and no organic carbon and N content. Among the nutrients, the K content was the highest (10.25 %), followed by Ca, Mg and Na (3.16, 2.54 and 0.65 %), respectively.

The field experiment was conducted during 2009 to 2010 at Ealur, Erode, Tamil Nadu. The location comes under the soil series of Irugur with the subgroup of Typic Ustorthent under the soil order Entisol. The soil texture of the experimental site was sandy loam, neutral pH (7.24), non saline (0.28 dS m^{-1}) and rich in organic carbon (3.56 g kg^{-1}). With regard to nutrient status, the soil was low in N (118.5 kg ha^{-1}), medium in P (19.2 kg ha^{-1}) and high in K (248 kg ha^{-1}). Different doses of BDS, biocompost and spentwash ash along with inorganic fertilizers using cumbu napier hybrid CO (CN) 4 as test crop has been tried. The experiment was laid out in Randomized Block Design with three replications; 40,000 two budded stem cuttings ha^{-1} was used with the spacing of 50 x 50 cm. The treatment consisted of T_1 - Recommended dose of NPK (RD), T_2 - Biocompost @ 2.5 t ha^{-1} + RD of NP, T_3 - Spentwash ash @ 400 kg ha^{-1} + RD of NP, T_4 - BDS @ 37.5 kilo l ha-1 at full dose + RD of NP, T_5 - BDS @ 37.5 kilo l ha^{-1} at split dose (basal 40 % and 10 % after each harvest) + RD of NP, T6 - BDS @ 50 kilo l ha-1 at full dose + RD of NP, T_7 - BDS @ 50 kilo l ha^{-1} at split dose + RD of NP. Spentwash was applied as per the treatment and incorporated into the soil at 30 days before planting in order to reduce the BOD and COD. Biocompost and spentwash ash were applied at basal. Recommended dose of nitrogen @ 150 kg/ha as urea, phosphorus @ 50 kg/ha as single super phosphate and potassium @ 40 kg ha^{-1} as muriate of potash was applied as per the treatment. The first harvest was scheduled on 90th DAP (Days After Planting), the crop was allowed for ratooning at 45 days intervals by supplementing N as top dress at the rate of 75 kg N ha^{-1}.

The plant samples collected from the field at 12th, 26th, 39th and 52nd WAP coinciding 1st, 3rd, 5th and 7th harvest were dried in hot air oven at 65oC to determine the moisture percentage. The total chlorophyll and carotenoid content were estimated by adopting the procedure of Yoshida *et al.* (1971), reducing sugars content was determined by somogyi method (Nelson, 1944), soluble protein content was determined by the procedure described by Lowry *et al.* (1951). The oven dried samples were powdered in Wiley mill attached with stainless steel blades and analyzed for its nutrient content by adopting the standard methods. The four harvest values were cumulated and mean value was presented in Tables. Each harvesting was made at above the ground level in each plot and the total green biomass was weighed and expressed in t ha 1. The data were analyzed statistically and the treatment means were compared using LSD technique at 5 % probability (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

BDS and biocompost applied plots showed there was improvement in nutrient status of N, P, K, pH, EC, and OC compared to initial status of soil (Table 1).

Application of BDS and biocompost on CN hybrid grass had significant influence on the physiological parameters viz., total chlorophyll, carotenoid, reducing sugar and soluble protein compared to spentwash

Table 1. Effect of distillery industry byproducts on initial and after harvest of CN hybrid grass

Initial soil nutrient status	pH	EC	OC	Available nutrient (kg ha^{-1})		
		(dS m^{-1})	(g kg^{-1})	N	P_2O_5	K_2O
	7.24	0.28	3.56	118.5	22.3	228
Treatments	pH	EC (dS m^{-1})	OC (g kg^{-1})	Available nutrient (kg ha^{-1}) N	P_2O_5	K_2O
T_1 - Recommended dose of fertilizers	7.27	0.25	3.41	118	20.6	216
T_2 - Biocompost @ 2.5 t ha^{-1} + RD of NP	7.35	0.32	3.79	147	28.6	277
T_3 - Spentwash ash @ 400 kg ha^{-1} + RD of NP	7.28	0.28	3.44	121	21.0	233
T_4 - BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP	7.38	0.37	3.88	162	25.1	307
T_5 - BDS @ 37.5 kilo l ha^{-1} at split dose + RD of NP	7.25	0.33	3.62	136	23.0	341
T_6 - BDS @ 50 kilo l ha^{-1} at full dose + RD of NP	7.41	0.43	3.97	157	24.2	326
T_7 - BDS @ 50 kilo l ha^{-1} at split dose + RD of NP	7.28	0.36	3.74	140	23.7	367

Table 2. Effect of BDS, biocompost and spentwash ash on physiological parameters of CN hybrid grass

Treatments	Total chlorophyll (mg/g)	Carotenoid (mg/g)	Reducing sugar (%)	Soluble protein (mg/g)
T_1 - Recommended dose of fertilizers	2.64	0.41	0.45	24.8
T_2 - Biocompost @ 2.5 t ha^{-1}+ RD of NP	2.95	0.50	0.53	26.2
T_3 - Spentwash ash @ 400 kg ha^{-1} + RD of NP	2.77	0.44	0.47	25.2
T_4 - BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP	3.01	0.51	0.54	26.7
T_5 - BDS @ 37.5 kilo l ha^{-1} at split dose + RD of NP	2.82	0.45	0.49	25.9
T_6 - BDS @ 50 kilo l ha^{-1} at full dose + RD of NP	3.10	0.53	0.56	27.2
T_7 - BDS @ 50 kilo l ha^{-1} at split dose + RD of NP	2.85	0.47	0.50	26.1
CD (0.05)	0.10	0.03	0.02	0.52

ash and RD (Table 2). Among the treatments, BDS @ 50 kilo l ha^{-1} at full dose + RD of NP registered the highest total chlorophyll (3.10 mg g^{-1}), carotenoid (0.53 mg/g), reducing sugar (0.56 %) and soluble protein (27.2 mg g^{-1}) which was on par with BDS @ 37.5 kilo l ha^{-1} at full doses + RD of NP and the lowest was recorded by RD which was on par with spentwash ash @ 400 kg ha^{-1} + RD of NP. The productivity of crop depends on photosynthesis and partitioning of assimilates to the economically important parts. An increased content of total chlorophyll and carotenoid was due to the application of BDS. This reflected the high manurial potential of the distillery effluents (Sivasankari, 2009). Plant cells might have retained higher water potential with the application of BDS which might have prevented protein degradation metabolism and enhanced the soluble protein synthesis by activating enzyme activity (Koach and Mengel, 1977).

Application of BDS and biocompost had significantly influenced the nutrient parameters of CN hybrid grass compared to recommended dose of fertilizer and spentwash ash (Table 3). Among the treatments, BDS @ 50 kilo l ha^{-1} at full dose + RD of NP registered the highest nutrient content viz., 1.71, 2.86, 0.48, 0.62 and 0.51 per cent of N, K, Na, Ca and Mg respectively and which was on par with BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP. In phosphorus, biocompost @ 2.5 t ha^{-1} + RD of NP recorded the highest content of 0.37 per cent which was on par with BDS @ 50 kilo l ha^{-1} at full dose + RD of NP and BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP. The recommended dose of fertilizers recorded the lowest nutrient content viz., 1.55, 0.31, 2.56, 0.37, 0.50 and 0.40 per cent of N, P, K, Na, Ca and Mg respectively and it was which was on par with spentwash ash @ 400 kg ha^{-1} + RD of NP and BDS @ 37.5 kilo l ha^{-1} at split dose + RD of NP and BDS @ 50 kilo l ha^{-1} at split dose + RD of NP. This increased nutrients uptake due to more absorption of nutrients by the crop, supplied through nutrient rich BDS and biocompost. These results corroborates with the findings of Vijayakumar (2006)

Table 3. Effect of BDS, biocompost and spentwash ash on macro and micro nutrient content (%) of CN hybrid grass

Treatments	N	P	K	Na	Ca	Mg	Fe	Cu	Zn	Mn
T_1 - Recommended dose of fertilizers	1.55	0.31	2.56	0.37	0.50	0.40	257	11.3	22.1	14.4
T_2 - Biocompost @ 2.5 t ha^{-1} + RD of NP	1.67	0.37	2.76	0.45	0.59	0.48	267	13.0	26.3	17.5
T_3 - Spentwash ash @ 400 kg ha^{-1} + RD of NP	1.56	0.32	2.67	0.40	0.54	0.43	262	11.9	24.0	16.1
T_4 - BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP	1.69	0.35	2.80	0.46	0.60	0.49	270	13.3	27.0	18.0
T_5 - BDS @ 37.5 kilo l ha^{-1} at split dose + RD of NP	1.59	0.33	2.70	0.42	0.56	0.45	265	12.4	24.7	16.6
T_6 - BDS @ 50 kilo l ha^{-1} at full dose + RD of NP	1.71	0.36	2.86	0.48	0.62	0.51	273	13.7	27.8	18.4
T_7 - BDS @ 50 kilo l ha^{-1} at split dose + RD of NP	1.59	0.33	2.72	0.42	0.56	0.46	264	12.5	25.5	16.8
CD (0.05)	0.04	0.02	0.08	0.02	0.02	0.02	3.47	0.44	0.73	0.66

Table 4. Influence of BDS, biocompost and spentwash ash on economics of CN hybrid grass

Treatments	Total cost (Rs.)	Total return (Rs.)	Net return (Rs.)	BC ratio
T_1 - Recommended dose of fertilizers	74196	257600	183404	3.47
T_2 - Biocompost @ 2.5 t ha^{-1} + RD of NP	102161	286300	184139	2.80
T_3 - Spentwash ash @ 400 kg ha^{-1} + RD of NP	76961	267400	190439	3.47
T_4 - BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP	73861	291200	217339	3.94
T_5 - BDS @ 37.5 kilo l ha^{-1} at split dose + RD of NP	73861	275800	201939	3.73
T_6 - BDS @ 50 kilo l ha^{-1} at full dose + RD of NP	73861	295400	221539	4.00
T_7 - BDS @ 50 kilo l ha^{-1} at split dose + RD of NP	73861	277900	204039	3.76

and Suganya (2008). Effluent has a rich source of organics, which may be beneficial to micro flora besides acting as slow nutrient releaser. Significant improvement was observed in the cations of Ca, Mg, Na and K content by the crop in BDS and biocompost applied treatments. Such improvements were possibly due to the enhanced biomass of the crop thereby increased the uptake of cations (Hati *et al.*, 2007). Similar to macro nutrients, BDS and biocompost had significant influence on the micro nutrients compared to recommended dose of fertilizer and spentwash ash (Table 3). Among the treatments, BDS @ 50 kilo l ha^{-1} at full dose + RD of NP registered the highest Fe, Cu, Zn and Mn content of 273, 13.7, 27.8 and 18.4 mg kg^{-1} respectively and the lowest micro nutrient content (Fe -257 mg kg^{-1}, Cu - 11.3 mg kg^{-1}, Zn -22.1 mg $kg^{-1}$and Mn -14.4 mg kg^{-1}) was recorded by recommended dose of fertilizer. This might be due to that high micro nutrient content with effluent application. This is in line with findings of Bhalerao *et al*., (2006) and Madhumitadas *et al*., (2010).

The application of BDS and biocompost had significant influence in increasing the total green fodder yield when compared to RD and spentwash ash (Fig. 1). The BDS @ 50 kilo l ha^{-1} at full dose + RD of NP (422 t ha-1) was recorded the highest yield which was on par with BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP (416 t ha^{-1}). All the harvest, RD showed the lowest yield (416 t ha^{-1}) which was on par with spentwash ash @ 400 kg ha^{-1} + RD of NP. The reason might be due to the favourable effect of organic matter and nutrients in distillery wastes which improved the soil fertility status and physical environment and might have promoted better germination, root proliferation, nutrient and water uptake by the crops (Hati et al., 2007; Banulekha, 2007). Similar result was also obtained from the present study.

The treatment, BDS @ 50 kilo l ha^{-1} at full dose + RD of NP recorded the highest benefit cost ratio and net profit followed by BDS @ 37.5 kilo l ha^{-1} at full dose + RD of NP respectively compared to recommended dose of fertilizer (Table 4). The results revealed that the farmers could get a promising economic return in the distillery spentwash wastewater compared recommended dose of fertilizer, where the application of distillery spentwash is free of cost for neighbouring farmers on demand. Hence, basal application of BDS method could be adopted for better returns.

From the present investigation, it could be concluded that the application of BDS @ 50 kilo l ha^{-1} at full dose + RD of NP increased the nutrient parameters and these highly correlated with green fodder

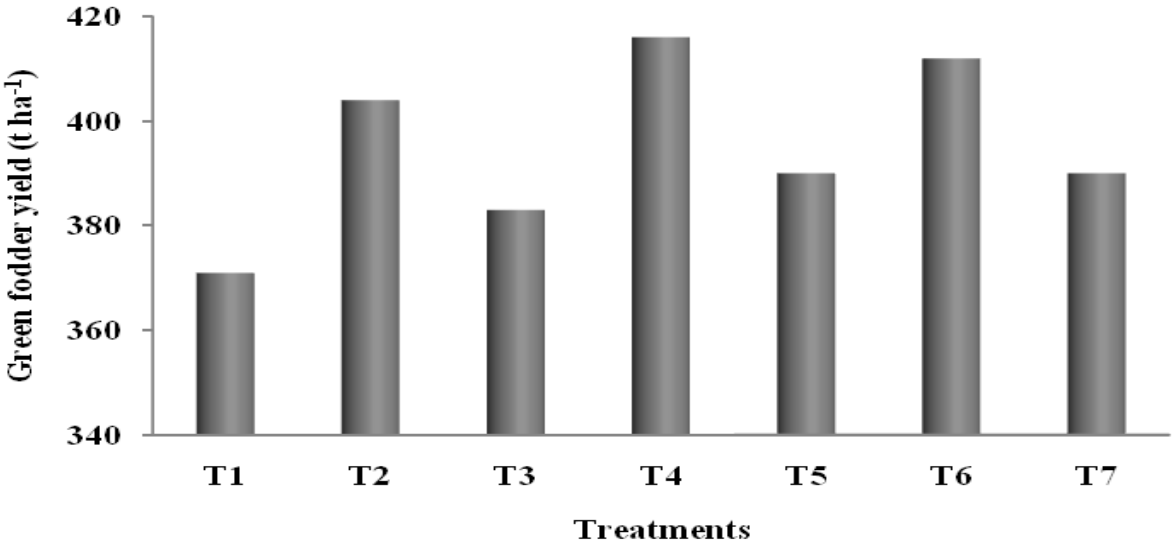

Fig. 1 Effect of BDS, biocompost and spentwash ash on green fodder yield (t ha^{-1}) of CN hybrid grass. T_1-T_7 treatments as detailed in materials and methods.

yield of CN hybrid grass. Distillery spentwash from sugar mills hitherto considered as factory waste could be used as a source of nutrients to CN hybrid grass. However, the level of application should be within the prescribed limit to avoid development of soil salinity in the long run and it did not affect the ground water quality.

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