

Influences of distillery industry by products on productivity of cumbu napier hybrid grass [CO (CN) 4] under irrigated condition

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A field experiment was conducted during 2009 to 2011 at Research and Development farm, M/s. Bannari Amman Sugars Distillery Division Ltd., Ealur, 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 l 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 1st, 3rd, 5th and 7th harvests. Results of the field experiment revealed that the application of distillery spentwash @ 50 kilo l per ha at full dose with recommend dose of nitrogen and phosphorus increased all the parameters and reduced the biochemical parameters over recommended dose of fertilizers.

Key words : Distillery spentwash, Biocompost, Spentwash ash, Crude protein, Cellulose

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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) litres of waste water is discharged for every litre 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 fodder, 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 (Latha, 2008). Keeping this in view, the present study was made to assess the performance of distillery industry byproducts on growth and quality of cumbu napier hybrid grass.

RESEARCH METHODOLOGY

Collection and characterization of distillery industry byproducts :

The BDS was collected from the distillery unit of M/s. Bannari Amman Sugars Ltd., Periyapuliur, 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.

Field experimental details :

The field experiment was conducted during 2009 to 2010, Research and Development Farm, M/s. Bannari Amman Sugars Distillery Division Ltd., Ealur, Erode, Tamil Nadu to find out the effect of BDS, biocompost and spentwash ash along with inorganic fertilizers using Cumbu Napier hybrid grass [CO (CN) 4] as test crop has been tried. The experiment was laid out in Randomized Block Design with three replications. The treatment consisted of T₁ - Recommended dose of NPK (RD), T₂ - Biocompost @ 2.5 t ha⁻¹ + RD of NP, T₃ - Spentwash ash @ 400 kg ha⁻¹ + RD of NP, T₄ - BDS @ 37.5 kilo l ha⁻¹ at full dose + RD of NP, T₅ - BDS @ 37.5 kilo l ha⁻¹ at split dose (basal 40 % and 10 % after each cutting) + RD of NP, T₆ - BDS @ 50 kilo l ha⁻¹ at full dose + RD of NP, T₇ - BDS @ 50 kilo l ha⁻¹ at split dose + RD of NP.

Application of amendments :

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 as basal. Recommended dose of nitrogen at 150 kg ha⁻¹ as urea, phosphorus at 50 kg ha⁻¹ as single super phosphate and potassium at 50 kg ha⁻¹ as muriate of potash was applied as per the treatment. The first harvest was done on 90th 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 ha⁻¹.

Collection and analysis of plant samples :

The plant samples were collected from the field at 12th, 26th, 39th and 52nd weeks after planting (WAP) coinciding 1st, 3rd, 5th and 7th harvests and the growth parameters *viz.*, plant height, number of tillers hill⁻¹, leaf length and leaf stem ratio were measured and sample were dried in hot air oven at 65°C to determine the moisture percentage. Crude protein content was derived by multiplication of total nitrogen with a factor 6.25 and was expressed as percentage (Humphries 1956), chlorophyll content was estimated by adopting the procedure of Yoshida *et al.* (1971), soluble protein content was determined by the procedure described by Lowry *et al.* (1951). The cellulose content was estimated by adopting the method of Updegraph (1969), hemicellulose content was estimated by the method described by Goering and Vansoest (1975) and lignin content was estimated by following the method of Chesson (1978). Each harvest was made at above ground level in each plot and the total green biomass was weighed and expressed in t ha⁻¹. The four harvest values were cumulated and mean value is presented in tables. The data were analyzed statistically and the treatment means were compared using LSD at 5 % probability (Panse and Sukhatme, 1985).

RESEARCH FINDINGS AND ANALYSIS

The experimental findings obtained from the present study have been discussed in following heads:

Distillery industry byproducts on growth of CN hybrid grass:

Application of BDS and biocompost had significantly influenced the growth and quality parameters *viz.*, plant height, number of tillers hill⁻¹, leaf length, leaf stem ratio and crude protein of CN hybrid grass compared to RDF (Table 1). Among the treatments, BDS @ 50 kilo l ha⁻¹ at full dose + RD of NP recorded the highest plant height (355 cm), number of tillers hill⁻¹ (45.5), leaf length (100.3 cm), leaf stem ratio (0.74) and crude protein (10.69 %) which was at par with BDS @ 37.5 kilo l ha⁻¹ at full dose + RD of NP for leaf length, leaf stem

Treatments	Plant height (cm)	Number of tillers per hill	Leaf length (cm)	Leaf stem ratio	Crude protein (%)
T ₁ - Recommended dose of fertilizers (RD)	270	33.6	84.7	0.63	9.71
T ₂ - Biocompost @ 2.5 t ha ⁻¹ + RD of NP	333	42.5	94.8	0.70	10.45
T ₃ - Spentwash ash @ 400 kg ha ⁻¹ + RD of NP	293	35.9	90.1	0.67	9.69
T ₄ - BDS @ 37.5 kilo l ha ⁻¹ at full dose + RD of NP	343	43.8	96.1	0.71	10.57
T ₅ - BDS @ 37.5 kilo l ha ⁻¹ at split dose + RD of NP	307	38.5	91.7	0.68	9.94
T ₆ - BDS @ 50 kilo l ha ⁻¹ at full dose + RD of NP	355	45.5	100.3	0.74	10.69
T ₇ - BDS @ 50 kilo l ha ⁻¹ at split dose + RD of NP	312	39.1	93.0	0.69	9.97
S.E.±	3.65	1.00	2.15	0.02	0.12
C.D. (P=0.05)	7.98	2.15	4.65	0.04	0.26

ration and crude protein and RDF significantly recorded the lowest plant height (270 cm), number of tillers hill⁻¹ (33.6), leaf length (84.7 cm), leaf stem ratio (0.63) and crude protein (9.71 %). The growth attributes are genetic characters inherently built up in the plant and could be manipulated to certain extent through external factors such as availability of nutrients. There was a remarkable improvement on the growth attributes due to the BDS application. Such improvements were might be due to the addition of substantial amount of plant nutrients to guinea grass through the spentwash. The lesser improvement by split dose of spentwash compared to one time application might be due to the immobilization and slow release of nutrients. The reason attributed for the better growth parameters was due enhanced nutrient supply and also their availability coupled with good physical properties exhibited by the application of spentwash (Rath *et al.*, 2010). The highest protein content achieved with BDS might be due to that BDS is rich in N which would have contributed for better vegetative growth, green fodder yield and nutrient uptake which in turn led to increased protein content (Galavi *et al.*, 2009).

Distillery industry byproducts on quality of CN hybrid grass:

Application of BDS, biocompost and spentwash ash on CN hybrid grass had marked influence on the physiological

(total chlorophyll and soluble protein) and biochemical parameters (cellulose, hemicellulose and lignin) compared to spentwash ash and RDF (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) and soluble protein (27.2 mg g⁻¹) which was at par with BDS @ 37.5 kilo l ha⁻¹ at full dose + RD of NP and lowest was recorded by RD. The productivity of crop depends on photosynthesis and partitioning of assimilates to the economically important parts. Increased total chlorophyll content was due to the application of BDS because its high manurial potential (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 @ 50 kilo l ha⁻¹ at full dose + RD of NP significantly registered the lowest cellulose (33.3 %), hemicellulose (17.5 %) and lignin (11.53 %) and highest content of 37.5, 20.2 and 13.6 per cent was recorded by RD (Table 2). Higher nitrogen and other nutrients present in BDS increased in leaf stem ratio and forage protein enlargement and decreased the stem fibre. This could be because of the water content and carbohydrate enlargement that have eventually resulted in decrease of cellulose, hemicelluloses

Table 2: Effect of distillery industry byproducts on quality of CN hybrid grass

Treatments	Total chlorophyll (mg/g)	Soluble protein (mg/g)	Cellulose (%)	Hemi cellulose (%)	Lignin (%)
T ₁ - Recommended dose of fertilizers (RD)	2.64	24.8	37.5	20.2	13.4
T ₂ - Biocompost @ 2.5 t ha ⁻¹ + RD of NP	2.95	26.2	34.9	18.4	12.4
T ₃ - Spentwash ash @ 400 kg ha ⁻¹ + RD of NP	2.77	25.2	37.1	19.9	13.3
T ₄ - BDS @ 37.5 kilo l ha ⁻¹ at full dose + RD of NP	3.01	26.7	34.2	18.1	12.2
T ₅ - BDS @ 37.5 kilo l ha ⁻¹ at split dose + RD of NP	2.82	25.9	36.3	19.3	13.0
T ₆ - BDS @ 50 kilo l ha ⁻¹ at full dose + RD of NP	3.10	27.2	33.3	17.5	11.5
T ₇ - BDS @ 50 kilo l ha ⁻¹ at split dose + RD of NP	2.85	26.1	35.1	18.8	12.6
S.E. _±	0.05	0.24	0.29	0.20	0.17
C.D. (P=0.05)	0.10	0.52	0.64	0.44	0.36

Table 3: 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 lignin (Mohammad Rusan *et al.*, 2007). High percentage of N and K in spentwash increased the N uptake and might have contributed to better effect on protein structure resulting in decreased cellulose, hemicelluloses and lignin content (Smith *et al.*, 2002).

Distillery industry byproducts on yield of CN hybrid grass :

The application of BDS had significant influence in increasing the total green fodder yield when compared to RDF and spentwash ash (Fig 1). Application of BDS @ 50 kilo l ha⁻¹ at full dose + RD of NP (422 t ha⁻¹) recorded the highest green fodder yield which was at par with BDS @ 37.5 kilo l ha⁻¹ at full dose + RD of NP (416 t ha⁻¹). Irrespective of the harvests, RDF showed the lowest total green fodder yield (368 t ha⁻¹). The reason might be due to the favourable effect of organic matter and nutrients in distillery wastes which

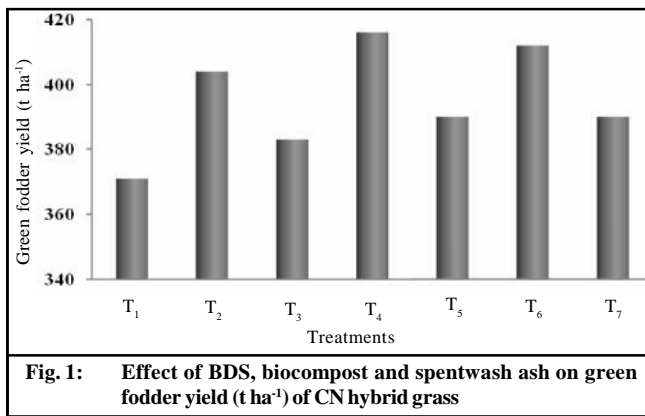


Fig. 1: Effect of BDS, biocompost and spentwash ash on green fodder yield (t ha⁻¹) of CN hybrid grass

improved the physical environment and might have promoted better germination, root proliferation, nutrient and water uptake by the crops (Hati *et al.*, 2007).

Distillery industry byproducts on economics of CN hybrid grass :

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 3). 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.

Conclusion :

From the present investigation, it could be concluded that the application of BDS @ 50 kilo l ha⁻¹ at full dose + recommended dose of NP increased the growth, quality, physiological parameters and green fodder yield and decreased the biochemical parameters. Thus, application of spentwash to the agricultural field, as an amendment, might be a viable option for the safe disposal of this kind of industrial waste with concomitant enhancement of crop growth and quality.

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