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REGULAR ARTICLE

EFFECT OF SUGAR FACTORY DISTILLERY SPENT WASH (DSW) ON THE GROWTH PATTERN OF SUGARCANE (*SACCHARUM OFFICINARUM*) CROP

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SUMMARY

Distillery spent wash is a rich source of organic matter and nutrients like nitrogen, phosphorus, potassium, calcium and sulfur. In addition, it contains sufficient amount of micro-nutrients such as iron, zinc, copper, manganese, boron, and molybdenum. A field experiment was conducted with different dilutions of distillery spent wash using sugar cane (*Saccharum officinarum*) variety Co1274 as test crop. The experiment was formulated with four treatments (25%, 50%, 75% and 100%) with three replicates, with a set of control for comparison. The growth parameters like height of the plant, length of the leaves, breadth of the leaves, girth of the stem, leaf area index, number of leaves per plant, no. of tillers per plant etc of the plant enhanced with increase in concentration of distillery spent wash up-to 75%. But in 100% concentration of distillery spent wash all the growth parameters showing a declining trend from the control. This increase in the parameters is statistically significant.

Key words: Distillery Spent Wash (DSW), Plant Height, Stem Girth, Leaf Area Index

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1. 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 cheap source for production of alcohol in distilleries by fermentation method [1]. For the production of 1 litre of alcohol 3-10 kgs of molasses are utilized [2]. A 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 [3]. 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 [4]. 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. Diluted spent wash could be used for irrigation purpose with out adversely affecting soil fertility [5,6], seed germination crop productivity [7]. Diluted spent wash increases the growth of shoot length, leaf number/plant, leaf area and chlorophyll content of peas [8]. Increased concentration of spent wash causes decreased seed germination, seedling growth and chlorophyll content in sunflower (*Helianthus annus*) and the spent wash can be safely used for irrigation purpose at lower concentration [9,7]. The spent wash could be used as a complement to mineral fertiliser to

sugarcane [10]. Mineralization of organic material as well as the nutrient present in spent wash was responsible for increase amount of plant nutrients.

Sugar cane (*Saccharum officinarum*) has world wide significance as a major source of food (i.e sugar) and a large amount of by-products which are economically more viable. Through large no of experiments it has been found that spent wash is very useful in increasing the yield of several crops and improving the soil characteristics like pH, Ec and nutrient availability [3]. However the effect of raw distillery spent wash in different concentration on the growth parameters, sugarcane production, soil fertility status and ground water quality are lacking in the state of Orissa. The present study aims to evaluate the effect of raw spent wash of sugar factory distillery on the growth of sugarcane at Aska of Ganjam district of Orissa, India.

2. Materials and Methods

The distillery spent wash samples were collected from the Aska co-operative sugar Industries, Ltd, Ganjam district, Orissa. The spent wash was collected in polycarboryl container; properly sealed and stored at 4°c for further analysis. The physico-chemical properties were analysed by standard methods of APHA [11] (Table 1). Raw effluents were freshly diluted viz. 25, 50, 75, 100% v/v with water for experimental studies.

Table 1

Chemical Composition of Distillery Spent Wash	
Chemical Parameters	Mgl^{-1}
pH	7.23
Electrical Conductivity(μs)	28700
Total Solids	35340
Total Dissolved Solids	27240
Total Suspended Solids	9980
Settleable Solids	9860
COD	30520
BOD	15300
Carbonate	Negligible
Bicarbonate	12200
Total Phosphorus	28.36
Total Potassium	6500
Calcium	920
Magnesium	753.25
Sulphate	5100
Sodium	420
Chlorides	5626
Iron	6.3
Manganese	1429
Zinc	1.09
Copper	0.265
Cadmium	0.036
Lead	0.19

Chemical Composition of Distillery Spent Wash	
Chromium	0.067
Nickel	0.145
Ammonical Nitrogen	636.25
Total Phosphorus	29.28
Total Potassium	7300
Sulphur	75.6

The soil samples from the experimental site was collected at 25cm depth, air dried, powdered and analyzed for physico-chemical properties. The physical properties like soil pH was estimated by pH meter and chemical characteristic was determined by following the methods given by Chapman, 1976 [12] and Wilde et al., 1979 [13] and presented in Table -2.

Table 2

Properties of the soil of the experimental site, Aska, Ganjam (Orissa)	
Nutrients	ppm
pH (1:2) solution	6.7
Organic Carbon (%)	9.37
Available Nitrogen	354
Available Phosphorus	125
Available Potassium	78
Calcium	142
Magnesium	225
Sodium	85
Available Sulphur	232
Iron	190
Manganese	200
Copper	4

The field experiment was conducted with different doses of raw distillery spent wash using co 1274 sugarcane variety as test crop. The experimental field was divided into three sets of five equal parts of size 500cm length & 300cm breadth each. Before plantation the land was ploughed, labelled and divided into ridges and furrows with uniform distance. The sugarcane test crop was collected from the local farmers for planting. The setts were treated with Bovistin and planted in the experimental field. After plantation, with regular watering (once in a week) the plants are allowed to grow for three months. After three months different growth parameters were recorded and then the fields were treated with different doses of distillery spent wash. Out of the three sets five fields, one set was kept as control without any treatment, the rest four sets of plots were treated with 25,50,75,100% concentration of distillery spent wash. All the fields except the control were treated with different concentration of the distillery spent wash on every month and the fields were irrigated with water on every week.

Biometric observation were made by randomly selecting five plants in the net plot area of individual treatments on every month.

The growth parameters like height of the plant, leaf length,leaf breath, stem girth, leaf area index, no. leaves per plant and no. of tillers/plant were recorded as per the standard procedure and the mean values obtained were expressed as the SI system of units.

3. Results and Discussion

The experimental field soil was sandy loam in texture which was almost neutral pH (6.7). The organic carbon content was moderate (6.4). The fertility status of the soil reveal low available nitrogen, medium phosphorous and potassium content. The characteristic of distillery spent wash is presented in Table 1.

It is dark brown in colour with unpleasant odour of burnt sugar. The brown colour could be ascribed to the presence of melanoidin, the reaction products of sugar amine condensation [14]. The unpleasant odour is due the presence of skatole, indole and other sulphur compounds which are not effectively decomposed by yeast or methane bacteria [15,16]. The pH of the effluent was 7.2 and the EC was high. The potassium salts were mainly responsible for increasing the EC of the effluent [17]. Among the nutrients, potassium was present in larger amount than nitrogen and phosphorous in general. Distillery spent was contained large amount of potassium and sulphate, followed by nitrogen and phosphorous [18].The calcium content was higher than magnesium content. The presence of calcium in considerable amounts make the spent wash a potential amendment in reclaiming the sodic soils [19]. The BOD and COD content is very high. This may be due to the soluble form of organic matter present in it [1]. Very high concentration of chlorine, bicarbonate and sulphate were observed. Similar findings were given by [20].

The data presented in Table 3(1-VII) dipicted the plant height, leaf length, leaf breadth, stem girth, number of leaves/plant, number of tillers/plant and leaf area index of sugarcane crop at different stages of growth. It was found that different growth parameters showed an increasing tendency from the control upto the concentration of 75% of distillery spent wash, but at 100%, all the parameters declined as compared to control.

Different concentration distillery spent wash application caused a significant increase in average height of the plants, length of leaves, breadth of leaves, leaf area index, girth of stem and the parameters like number of leaves/plant, number of tillers/plant, the increase is non significant. The result are presented in Table 3 (I-VII)

Table-3 I. Effect of distillery spent wash on the height of the plant (cm)

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	194.96 ± 0.96	193.52 ± 1.92	192.88 ± 4.63	192.96 ± 3.58	193.46 ± 2.19	0.4	N.S
120	244.12 ± 3.82	245.88 ± 3.44	246.02 ± 4.14	261.28 ± 1.55	242.62 ± 3.17	30.05	3.36
150	264.96 ± 3.98	271.46 ± 4.49	278.42 ± 2.89	281.86 ± 2.82	261.4 ± 3.40	33.1	4.45
180	285.38 ± 4.12	296.38 ± 3.78	300.46 ± 3.00	312.96 ± 2.30	277.52 ± 4.98	65.93	4.99

Table-3 II. Effect of distillery spent wash on the leaf length of the plant (cm)

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	150.122 ± 6.603	150.312 ± 2.350	149.856 ± 4.222	149.786 ± 5.798	150.598 ± 6.935	0.02	N.S
120	166.938 ± 3.813	171.322 ± 2.537	172.714 ± 3.175	175.348 ± 3.482	150.338 ± 2.977	47.81	4.26
150	172.628 ± 2.712	180.724 ± 1.406	184.016 ± 2.980	186.272 ± 4.829	171.406 ± 2.110	24.37	4.01
180	180.442 ± 3.248	192.008 ± 2.715	200.372 ± 1.669	204.584 ± 2.768	177.574 ± 4.726	69.66	4.21

Table-3 III. Effect of distillery spent wash on the breadth of the leaves of the plant (cm)

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	4.87 ± 0.430	4.71 ±0.310	4.45 ±0.333	4.35 ±0.116	4.66 ±0.256	2.32	N.S
120	5.30 ± 0.354	5.75 ±0.528	5.76 ±0.739	6.10 ±0.157	4.73 ±0.434	6.0	0.638
150	5.86 ± 0.346	6.29 ±0.382	6.52 ±0.376	7.05 ±0.291	5.11 ±0.678	13.98	0.576
180	6.21 ± 0.298	6.50 ±0.352	6.75 ±0.525	7.12 ±0.373	5.55 ±0.516	9.86	0.559

Table-3 IV. Effect of distillery spent wash on the stem girth of the plant (cm)

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	4.25 ± 0.56	4.46 ±0.54	4.62 ±0.60	4.60 ±0.28	4.58 ±0.52	0.44	N.S
120	5.13 0.23	5.18 ±0.29	5.48 ±0.30	5.87 ±0.15	4.96 ± 0.18	11.28	0.316
150	6.01 ± 0.64	6.12 ±0.58	6.46 ±0.40	6.63 ±0.44	5.54 ± 0.35	2.54	0.703
180	7.08 ± 0.25	7.09 ±0.71	7.46 ±0.69	7.74 ±0.48	6.47 ± 0.48	3.77	0.725

Table-3 V. Effect of distillery spent wash on the leaf area index of the plant

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	4.73 ± 0.662	4.74 ± 0.55	4.68 ± 0.80	4.26 ±0.422	4.46 ±0.771	0.54	N.S
120	6.97 ± 0.628	8.1 ±0.868	8.10 ±0.794	9.16 ± 1.12	5.46 ±0.562	14.77	1.08
150	9.01 ± 1.376	10.51 ±1.472	10.154 ±1.582	12.65 ±2.143	7.4 ±0.951	7.8	2.05
180	11.012 ± 0.95	12.27 ±1.731	13.44 ± 0.9	15.03 ±0.867	9.28 ±0.418	7.9	1.06

Table-3 VI. Effect of distillery spent wash on the no. of leaves/plant

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	15.4 ± 1.14	16.0 ±1.58	17.4 ±2.30	15.6 ±1.14	15.0 ± 1.58	1.65	N.S
120	18.8 ± 1.30	19.6 ±0.55	19.6 ±2.07	20.4 ±2.07	18.4 ± 2.07	1.02	N.S
150	21.2 ±2.59	21.8 ±2.17	22.4 ±2.07	23.0 ±3.87	20.2 ± 1.30	0.9	N.S
180	22.8 ± 1.79	23.4 ±2.70	24.0 ±2.35	24.6 ±1.14	22.6 ±2.07	0.8	N.S

Table-3 VII. Effect of distillery spent wash on the no. of tillers/plant

Days after plantation	Control A	Treated with different conc. of DSW				F Value	LSD (0.05)P
		B (25%)	C (50%)	D (75%)	E (100%)		
90	3.8 ± 1.30	4.0 ±1.87	4.2 ±0.84	4.0 ±1.41	3.4 ± 0.89	0.26	N.S
120	4.0 ± 1.85	5.2 ±1.30	4.6 ±2.70	5.0 ± 2.0	2.6 ± 1.14	1.63	N.S
150	3.2 ± 1.30	5.0 ±0.71	5.8 ±1.92	7.2 ±1.30	4.6 ± 1.52	5.53	1.85
180	5.4 ± 2.07	7.2 ±3.11	7.8 ±2.77	4.8 ±1.92	7.8 ± 2.77	1.42	N.S

Height of the test crop increases from 285.38 cm to 312.96 cm, the length of the leaves increases from 180.44cm to 204.58 cm, the breadth increases from 6.21 cm to 7.12 cm, the leaf area index increases from 11.012 to 15.03, the girth of the stem increase from 7.08cm to 7.74cm in 90 days which are statistically significant.

It was noticed that the growth rate was high in case of 75% spent wash, moderate in 50%, low at 25% of spent wash and lowest in the control. The plants are able to absorb maximum amount of nutrients from the soil and spent wash resulting increase in good growth. This concludes that, the raw spent wash can be conveniently used for cultivation of sugarcane without external (either organic or inorganic fertilizer) and this will help in the economy of farmers.

The distillery spent wash is essentially a plant extract and contain high level of plant nutrients which were made available to the plants, thus resulting in better growth, development and yield of the crop. Similar effects with the usage of distillery effluent were also reported by Nandy et al 2008[1] in rice, Ramana et al 2000 [7] in maize. Rajannan et al1998 [21] reported that fertigation of distillery spent wash 40 to 50 times dilution increased the yield of sugarcane, banana and rice. Rajannan et al[21] also reported that high manurial potential of distillery spent wash increases the leaf area, chlorophyll content and thus resulting in high dry matter production of maize.The decling tendency of growth parameters in higher concentration may also be due to the presence of higher amount of organic matter, BOD which leads to depletion of O_2 and accumulation of CO_2 in the soil.

From this investigation it could be concluded that application of distillery spent wash upto 75% concentration can be utilized for the cultivation of sugarcane.

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