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Effect of biomethanated distillery spentwash and pressmud biocompost on microbial and enzyme dynamics in soil

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ABSTRACT

The effect of different levels of biomethanated distillery spentwash and pressmud biocompost application on soil microbial and enzymatic activity was examined through a field experiment. The field experiment was conducted using Groundnut (*Arachis hypogaea* L.) as a test crop at farms of M/S. Bhavani distilleries and chemicals Ltd., T.Pudur, Thimiri, Vellore District. The results of the study showed that the microbial population and enzymatic activities of the soil were substantially increased throughout the crop growth period due to spentwash and bio-compost application. The highest microbial population and enzyme activities were recorded with presown application of BDS at the rate of 100 $m^3 ha^{-1}$ along with RDF- NP. The utilization of spentwash at an optimum level of 100 $m^3 ha^{-1}$ soil will increase the activities of soil microbes and enzymes thus enhancing the fertility status besides paving an eco-friendly approach for the disposal of the spentwash.

KEYWORDS

Biomethanated distillery spentwash;
Pressmud biocompost;
Microbial population;
Enzyme activities.

INTRODUCTION

Distillery spentwash is a liquid waste discharged from the distillery industry and 14-15 L of spentwash is produced for every litre of alcohol production. The raw spentwash obtained after distillation of alcohol contains very high BOD, COD and solids. It is subjected to biomethanation process where 80 per cent of BOD reduction and energy production are obtained. The effluent discharged after biomethanation process is known as Biomethanated Distillery Spentwash (BDS). The Biomethanated Distillery Spentwash (BDS) is effective organic liquid manure derived from sugar industry waste materials. The BDS contains large amount of organic carbon, K, Ca, Mg, Cl and SO_4 and moderate amounts of N and P and traces of Zn, Cu, Fe and Mn. Therefore, upon field application, it enhances the biological properties and enzyme activities of soils and thus influences the fertility of soil significantly. The addition of organic matter through BDS may be favourable for microorganisms and enzymes in soils[1]. Observed that the spentwash at 250 $m^3 ha^{-1}$ rate stimulated the soil microorganism and increased the dehydrogenase activity in soil[2]. Reported that the soil enzyme activities were maintained with 50 times diluted spentwash irrigation, but the phosphatase enzyme activity was not suppressed by the undiluted spentwash irrigation which might be due to the presence of copious quatity of phos-

phate in the spentwash[3]. Reported that the application of distillery wastewater to a field soil at doses equivalent to 40, 80 and 160 $m^3 ha^{-1}$ of irrigation increased soil microbial biomass and dehydrogenase activity. The spentwash addition increased the activity of phosphatase, dehydrogenase and urease enzymes in dry land black and red soils especially at levels of 125 $m^3 ha^{-1}$[4]. The present study was undertaken with a view to studying the effect of distillery wastes *viz.*, BDS and pressmud biocompost application on microbial population dynamics and enzyme activities of soil under field condition.

MATERIALS AND METHODS

A field experiment was conducted at Research and Development Farm, M/s. Bhavani Distilleries and Chemicals Limited, T.Pudur, Thimiri, Arcot taluk, Vellore district, Tamil Nadu in randomized block design with three replications using groundnut (*Arachis hypogaea*) var. TMV 7 as a test crop. The experimental field was laid out and the calculated quantity of BDS (TABLE 1) was uniformly applied in each plot as per the treatment details given below. Then, the soil was ploughed at 10 days interval for two times providing better soil aeration and consequent reduction of BOD level in the soil-water system. Biocompost (TABLE 2) was incorporated in the respective treatments at the time of last ploughing.

Treatments

T_1 : RDF- NPK (17: 34: 54 kg of N: P_2O_5: K_2O ha^{-1})

T_2 : Application of biocompost @ 2.5 t ha^{-1} + RDF-NPK

T_3 : Application of biocompost @ 5 t ha^{-1} + RDF- NPK

T_4 : Pre-sown application of BDS @ 100 $m^3 ha^{-1}$ + RDF- NP alone

T_5 : Pre-sown application of BDS @ 10 $m^3 ha^{-1}$ (=100 % RDF- N) + balance P through inorganic fertilizer

T_6 : Pre-sown application of BDS @ 20 $m^3 ha^{-1}$ (=200 % RDF- N) + balance P through inorganic fertilizer

T_7 : Pre-sown application of BDS @ 30 $m^3 ha^{-1}$ (=300 % RDF- N) + balance P through inorganic fertilizer

T_8 : Pre-sown application of BDS @ 40 $m^3 ha^{-1}$ (=400 % RDF- N) + balance P through inorganic fertilizer

T_9 : Post-sown application of BDS @ 10 $m^3 ha^{-1}$ (=100 % RDF- N) on 30 DAS + balance P through inorganic fertilizer

T_{10} : Post-sown application of BDS @ 20 $m^3 ha^{-1}$ (=200 % RDF- N) on 30 DAS + balance P through inorganic fertilizer

(RDF- Recommended Dose of Fertilizer)

On 30th day of BDS application, the individual plot was formed with flat beds and ground nut seeds were sown by adopting the spacing of 30 cm x 10 cm. All cultural practices including gap filling, thinning, weeding, plant protection measures and other cultural practices were done as per Tamil Nadu Agricultural University recommendations.

TABLE 1 : Characteristics of biomethanated distillery spentwash

S.No	Parameters	BDS
	Physical properties	
1	Colour	Dark brown
2	Odour	Unpleasant
3	Total dissolved solids (mg L^{-1})	42300
4	Total suspended solids (mg L^{-1})	6100
5	Total solids (mg L^{-1})	48400
	Physico-chemical properties	
6	pH	7.57
7	EC (dSm^{-1})	33.45
8	BOD (mg L^{-1})	11400
9	COD (mg L^{-1})	42800
10	Organic carbon (mg L^{-1})	25200
11	Nitrogen (mg L^{-1})	1700
12	Phosphorus (mg L^{-1})	248
13	Potassium (mg L^{-1})	10680
14	Sodium (mg L^{-1})	480
15	Calcium (mg L^{-1})	2120
16	Magnesium (mg L^{-1})	1680
17	Chloride (mg L^{-1})	9050
18	Bicarbonate (mg L^{-1})	3470
19	Carbonate (mg L^{-1})	Absent
20	Sulphate (mg L^{-1})	2950
21	Copper (mg L^{-1})	3.9
22	Manganese (mg L^{-1})	7.2
23	Iron (mg L^{-1})	51.4
24	Zinc (mg L^{-1})	6.4
	Biological properties	
25	Bacteria (x 10^6 CFU ml^{-1})	21
26	Fungi (x 10^4 CFU ml^{-1})	11
27	Actinomycetes (x 10^2 CFU ml^{-1})	3

TABLE 2 : Characteristics of biocompost

S. No.	Parameters	Values
	Physico-chemical properties	
1	pH	7.50
2	EC (dSm^{-1})	8.80
3	Organic carbon (%)	24.80
4	Total nitrogen (%)	1.54
5	Total phosphorous (%)	1.08
6	Total potassium (%)	2.95
7	Total calcium (%)	3.20
8	Total magnesium (%)	2.00
9	Sodium (%)	1.05
10	C/N ratio	16.10
11	Copper (mg kg^{-1})	45
12	Zinc (mg kg^{-1})	105
13	Iron (mg kg^{-1})	2000
14	Manganese (mg kg^{-1})	190
	Biological properties	
15	Bacteria ($x10^6$ CFU g^{-1})	31
16	Fungi ($x10^4$ CFU g^{-1})	17
17	Actinomycetes ($x10^3$ CFU g^{-1})	11

Collection and analysis of soil samples

Soil samples were collected at the time of sowing (S_1), 30 DAS (S_2), 60 DAS (S_3) and after the harvest of groundnut (S_4) and the number of fungi, bacteria and actinomycetes colonies were assessed by plating dilution technique[5]. The activities of urease, phosphatase and dehydrogenase enzymes were assayed as per the standard procedures[6].

RESULTS AND DISCUSSION

Soil microbial population

The impact of different concentrations of BDS and biocompost on the population of soil bacteria, fungi and actinomycetes at various sampling periods was very well pronounced compared to RDF-NPK (TABLE 3). The microbial population of bacteria, fungi and actinomycetes was mostly appeared to have increased at the initial stages and thereafter, progressively decreased with crop growth stages. The degradation of the organic matter and depletion of plant nutrients might be the reason for the reduction of microbial population. In general, the soil microbial population was increased from the initial level by the application of BDS and biocompost. BDS containing higher levels of nutrients and organic matter might be the reason for the increase in soil microbial population. Among the treatments, higher microbial population was observed in pre-sown application of BDS @ 100 $m^3 ha^{-1}$ along with RDF- NP. Mattiazo and Ada Gloria[7] who reported an increase in soil microbial activity due to oxidation of organic matter in BDS applied soil. According to[8]. BDS contains about 42.7 per cent polysaccharides which might have served as a source of carbon, sulphate for microbial proliferation[9], also lend support for the increased number of fungi, bacteria and actinomycetes owing to the addition of spentwash. The application of spentwash improved the physical and chemical properties of the soil and further increased soil microflora[10].

The results of this study are in the agreement with results obtained by[11] who stated that the addition of organic matter increased the microbial population in soil. Such effect of spentwash on the population of bacteria, fungi and actinomycetes in the soil was also reported by[3] and the results of Valliappan[12] are in good agreement with the present findings.

Soil enzymes activities

The BDS and biocompost application has increased the activities of dehydrogenase, phosphatase and urease in experimental soil (TABLE 4). At higher dose of pre-sown application of BDS (@100 $m^3 ha^{-1}$ with RDF- NP), higher activities of dehydrogenase, phosphates and urease were observed over RDF-NPK soil. The several fold increase in the activities of dehydrogenase, phosphates and urease due to BDS application might be ascribed to the addition of organic matter and essential nutrients and subsequent increase in the microbial biomass[13, 14]. Also suggested addition of organic material to soil enhanced the microbial activities which in turn favour the synthesis of various enzymes in soil. The results of this study is in close agreement with the findings of Kamalakumari and Singaram[15] who observed a strong positive relationship among the available NPK and organic carbon and enzyme activities of the soil. Kalaiselvi and Mahimairaja[16] also reported that the enzyme activi-

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TABLE 3 : Effect of biomethanated distillery spentwash (BDS) and biocompost application on soil microbial population at various stages

Treatments	Bacteria (x 10^6 CFU g^{-1} of soil)					Fungi (x 10^4 CFU g^{-1} of soil)					Actinomycetes (x 10^3 CFU g^{-1} of soil)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	16.8	16.4	15.5	14.6	15.8	17.0	15.8	13.0	10.8	14.2	7.4	7.0	6.5	5.9	6.7
T_2	23.0	21.8	20.0	19.0	21.0	21.6	20.4	19.0	16.6	19.4	12.0	10.8	10.0	8.2	10.3
T_3	26.0	24.2	23.0	21.0	23.6	24.6	22.8	20.5	19.8	21.9	13.0	12.2	10.4	9.0	11.2
T_4	30.0	27.8	26.5	23.5	27.0	32.4	30.4	25.5	23.0	27.8	14.2	13.2	11.5	9.8	12.2
T_5	19.8	19.0	18.0	17.6	18.6	20.6	18.8	16.0	14.2	17.4	10.0	9.0	8.0	7.4	8.6
T_6	20.2	19.5	18.5	17.8	19.0	22.2	21.0	18.2	16.0	19.4	10.0	9.0	8.2	7.5	8.7
T_7	22.6	21.4	20.2	18.4	20.7	22.5	21.4	19.8	17.2	20.2	11.2	10.6	9.8	9.4	10.3
T_8	25.8	24.2	22.8	20.6	23.4	25.2	23.6	21.2	19.0	22.3	11.3	10.8	9.8	9.6	10.4
T_9	16.5	15.8	22.8	19.6	18.7	9.8	20.2	21.5	18.8	17.6	7.5	10.2	9.3	7.6	8.7
T_{10}	16.6	15.9	24.6	22.5	19.9	9.9	21.0	22.6	19.2	18.2	7.4	10.6	9.8	7.8	8.9
Mean	21.7	20.6	21.2	19.5	20.8	20.6	21.5	19.7	17.5	19.8	10.4	10.3	9.3	8.2	9.6
	SEd		CD (0.05)			SEd		CD (0.05)			SEd		CD (0.05)		
T	2.61		4.86			3.08		5.72			1.68		3.12		
S	1.67		3.11			1.97		3.66			1.07		2.00		
TXS	5.23		9.72			6.15		11.44			3.35		6.24		

S_1: At the time of sowing; S_2: 30 DAS; S_3: 60 DAS; S_4: After harvest of groundnut.

TABLE 4 : Effect of biomethanated distillery spentwash (BDS) and biocompost application on soil enzymes activities at various stages

Treatments	Dehydrogenase (µg TPF g^{-1} of dry soil h^{-1})					Phosphatase (µg p-nitrophenol g^{-1} of dry soil h^{-1})					Urease (µg NH_4-N g^{-1} of dry soil h^{-1})				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	2.42	2.48	2.18	2.15	2.31	12.20	11.00	11.80	11.21	11.55	4.80	5.40	5.60	5.40	5.30
T_2	5.12	4.85	3.60	3.45	4.26	38.00	34.30	31.10	25.50	32.23	7.75	7.30	6.25	6.26	6.89
T_3	7.20	6.60	5.80	5.10	6.18	57.80	55.10	51.60	46.20	52.68	11.80	11.20	9.60	7.80	10.10
T_4	8.20	7.86	7.10	6.40	7.39	74.00	70.80	63.50	59.80	67.03	21.80	18.50	15.40	10.28	16.50
T_5	3.75	3.25	2.90	2.42	3.08	33.40	30.30	26.80	21.20	27.93	6.40	6.00	5.84	5.50	5.94
T_6	4.20	3.80	3.34	2.84	3.55	38.00	34.00	27.40	22.20	30.40	8.20	7.46	6.40	6.00	7.02
T_7	6.90	6.58	5.52	4.90	5.98	57.40	54.00	50.60	44.00	51.50	12.80	10.98	9.70	6.60	10.02
T_8	7.12	6.35	5.68	5.00	6.04	60.20	56.00	51.40	45.10	53.18	13.05	11.00	9.80	6.80	10.16
T_9	2.40	3.36	3.58	3.20	3.14	10.61	29.70	38.40	33.80	28.13	4.70	7.80	6.10	5.65	6.06
T_{10}	2.43	3.85	4.21	3.89	3.60	10.60	34.90	41.00	35.70	30.55	4.72	9.30	8.25	7.10	7.34
Mean	4.97	4.90	4.39	3.94	4.55	39.22	41.01	39.36	34.47	38.52	9.60	9.49	8.29	6.74	8.53
	SEd		CD (0.05)			SEd		CD (0.05)			SEd		CD (0.05)		
T	1.72		3.2			4.01		7.46			2.49		4.64		
S	1.10		2.05			2.57		4.77			1.60		2.97		
TXS	3.44		6.4			8.02		14.92			4.99		9.28		

S_1: At the time of sowing; S_2: 30 DAS; S_3: 60 DAS; S_4: After harvest of groundnut.

ties were increased due to the application of BDS. The work of[3] and Murugaragavan[4], lend support for the increased activities of these soil enzymes owing to the addition of spentwash.

CONCLUSION

The results of the study concluded that application of biomethanated distillery soentwash and bio-compost

substantially increased the microbial population and enzymatic activities of the soil throughout the crop growth period. The highest microbial population and enzyme activities were recorded with pre-sown application of BDS at the rate of 100 $m^3 ha^{-1}$ with RDF- NP. The utilization of biomethanated distillery spentwash at an optimum level of 100 $m^3 ha^{-1}$ soil will increase the activities of soil microbes and enzymes thus enhancing the fertility status besides paving an eco-friendly approach for the disposal of the spentwash.

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