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Effect of One Time Application of Distillery Spentwash R O Reject on Soil Properties

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Abstract Spentwash is a dark brown colored liquid with an unpleasant odor of burnt sugar, it contains major and micro-nutrients which are helpful for sustaining the soil fertility and the yield of crops. A field experiment was conducted in red sandy clay loam soil in the farmer's field near J. P. Distileries Pvt. Ltd. Heggadathihalli village, Kunigal taluk, Tumkur district, situated in the southern dry zone (Zone-6) of Karnataka during *kharif* 2013. The experiment consists of seven treatments laid out in randomized complete block design with three replications. The experimental results indicated that the application of 150% N through distillery spentwash (DSW) R O reject increased the soil properties like pH (6.71), EC (0.55 dSm^{-1}), OC (0.83%), available N (283.7 kg ha^{-1}), P (24. 1 kg ha^{-1}), K (1213.5 kg ha^{-1}), secondary and micronutrients compared to all other treatments. Significantly lower values of soil properties were recorded in treatment receiving RDF only.

Keywords Distillery, R O reject, Nitrogen, Enzymes.

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Introduction

Under the present trend of exploitative agriculture in India, inherent soil fertility can no longer be maintained on the sustainable basis. It is said that nutrient supplying capacity of soil declines steadily under intensive cropping system. The use of optimum levels of N, P and K failed to maintain yield levels probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil. Apart from the fertility and productivity issues, use of chemical fertilizers is also becoming more and more difficult for the farmers due to their high costs and scarcity during peak season. On the other hand during recent years, sugar industries are producing large amount of waste products some of which are rich sources of macro, micro and secondary nutrients.

Distilleries are one of the most important agro based industries in India producing alcohol from molasses, which is a by-product of sugar factories. More than 90% of ethanol in India is mainly produced

Table 1. Initial soil characteristics of the experimental site.

Soil properties	Values
Physical properties	
Sand (%)	53.10
Silt (%)	25.89
Clay (%)	21.02
Textural class	Sandy clay loam
Chemical properties	
pH	6.48
EC (dsm^{-1})	0.14
CEC [cmol (p^+) kg^{-1}]	8.9
Organic carbon (%)	0.55
Av Nitrogen (kg ha^{-1})	248.37
Av Phosphorus (kg ha^{-1})	22.69
Av Potassium (kg ha^{-1})	652.51
Calcium (me/100 g)	3.6
Magnesium (me/100 g)	2.4
Sulfur (ppm)	19.10
Iron (ppm)	21.28
Zinc (ppm)	0.38
Manganese (ppm)	23.20
Copper (ppm)	0.60
Boron (ppm)	0.18
Biological properties	
Dehydrogenase activity (µg TPF g^{-1} of soil hr^{-1})	3.8
Urease activity (µg NH_4-N g^{-1} dry soil hr^{-1})	32.4
Phosphatase activity (µg P-NPP g^{-1} of dry soil hr^{-1})	14.2

Table 2. Physico-chemical characteristics of distillery spentwash R O reject.

Parameters	Values	Parameters	Values
Color	Dark brown	Calcium (mg L^{-1})	1932
pH	7.29	Magnesium (mg L^{-1})	1202.4
EC (dsm^{-1})	44	Sulfur (mg L^{-1})	430.01
Organic carbon (%)	0.9	Iron (mg L^{-1})	48.66
Total suspended solids (mg L^{-1})	37100	Zinc (mg L^{-1})	5.12
Total dissolved solids (mg L^{-1})	48000	Manganese (mg L^{-1})	6.98
BOD (mg L^{-1})	53560	Copper (mg L^{-1})	4.5
COD (mg L^{-1})	87280	Boron (mg L^{-1})	26.4
Nitrogen (%)	0.18	Chlorides (mg L^{-1})	7139.1
Phosphorus (mg L^{-1})	450.2	Bicarbonates (mg L^{-1})	86.7
Potassium (mg L^{-1})	11887		

by fermentation of diluted molasses by employing different microbial strains. For every liter of alcohol produced, 12–15 liters of spentwash is generated. In India, nearly 30–40 billion liters of spentwash is generated annually from 319 distilleries while producing 3 billion liters of alcohol. In Karnataka, there are 29 distilleries with an annual installed capacity of 64.12 million liters of alcohol.

The effluent contains high potassium (1.3%), sulfur (0.4%) and appreciable amounts of nitrogen (0.2%) and acts as a slow release fertilizer being mostly in the colloidal form. Moreover, it contains large amount of calcium, copper, manganese, zinc and a substantial quantity of organic matter essential for soil health. So it can be applied directly to the land as irrigation water as it helps in restoring and maintaining soil fertility, increasing soil micro flora, improving physical and chemical properties of the soil leading to better water retaining capacity of the soil.

Materials and Methods

A field experiment was conducted in the farmer's field near J. P. Distilleries Pvt. Ltd. Heggadathihalli village, Kunigal taluk, Tumkur district, situated in the southern dry zone (Zone-6) of Karnataka during *kharif* 2013 to study the effect of distillery spentwash R O reject on soil properties. The soil of the experimental site was sandy clay loam in texture belong to the order *Alfisol*. The initial soil properties of the experimental site are given in Table 1.

Farm yard manure was applied three weeks before sowing of the crop. The experiment consists of seven treatments laid out in randomized complete block design with three replications. Recommended dose of fertilizers: 100:50:25 kg N: P_2O_5: K_2O ha^{-1}. The spacing was maintained at 60 cm × 30 cm and NAH-1137 (HEMA) is a 120 days duration variety was used as a test crop. The distillery spentwash R O reject was applied one month prior to sowing. The chemical composition of distillery spentwash R O reject is given in Table 2. Soil sampling was done after the harvest of the crop and subjected for analysis of different nutrient composition following the standard procedures.

The experiment consisted of 7 treatments viz.,

Table 3. Soil properties at harvest as influenced by one time application of distillery spentwash R O rejecr.

Treat-ments	pH	EC (dSm^{-1})	Organic carbon (%)	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T_1	5.36	0.12	0.51	193.6	10.6	588.5
T_2	5.65	0.12	0.61	211.3	17.9	638.1
T_3	5.86	0.38	0.66	187.9	10.9	741.6
T_4	5.97	0.42	0.69	179.6	19.1	893.1
T_5	6.37	0.46	0.76	207.1	12.9	1005.3
T_6	6.39	0.51	0.78	245.3	18.3	1150.7
T_7	6.71	0.55	0.83	283.7	24.1	1213.5
SEm±	0.18	0.004	0.003	11.58	2.35	26.54
CD at 5%	0.56	0.013	0.010	35.67	7.23	81.79
CV (%)	5.18	2.04	0.79	9.30	25.01	5.17

T_1: RDF only, T_2 : $RDF_{:}$ + FYM, T_3: 50% N through DSW RO Reject + 50% N through fertilizer, T_4: 75% N through DSW RO Reject + 25% N through fertilizer, T_5: 100% N through DSW R.O. Reject, T_6 : 125% N through DSW RO Reject and T_7: 150% N through DSW RO Reject.

Results and Discussion

Physico-chemical properties

pH

The pH was increased in treatment receiving 150% N through DSW RO reject (6.71) followed by 125% N through DSW RO reject (6.39). The addition of basic cations like Ca from spentwash might have increased the pH. Similar results were reported earlier [1]. Lower pH value was recorded in RDF only (T_1) (5.36).

Electrical conductivity

Significantly higher EC (0.55 dSm^{-1}) was recorded in treatment receiving 150% N through DSW RO reject, followed by treatment receiving 125% N through DSW RO reject (0.51 dSm^{-1}). This increase was quite expected as the distillery spentwash RO reject had an EC of 44 dSm^{-1} due to heavy load of salts. Increase in EC after distillery effluent application was also reported earlier [2]. However, RDF only recorded significantly lower EC (0.12 dSm^{-1}).

Organic carbon (OC)

Significantly higher OC content (0.83%) was recorded with treatment receiving 150% N through DSW RO reject which was followed by treatment receiving 125% N through DSW RO reject (0.78%). Whereas, significantly OC content (0.51%) was recorded in RDF only. The spentwash with high BOD and organic carbon content enriches the soil with organic matter. The decomposition and humification of the organic matter in soil supplied through distillery effluent, in turn increased the soil organic carbon. Similar results were reported earlier [3].

Available major nutrients

Nitrogen

The soil nitrogen content was found increased in treatment receiving 150% N through DSW RO reject (283.7 kg ha^{-1}) (Table 3). The higher rate of mineralization and release of N from soil and high nitrogen content of spentwash could have contributed for increase in the available N content of the soil. These results are in accordance with earlier findings [4, 5]. Lower nitrogen content was recorded in RDF only (193.6).

Phosphorus:

Significantly higher phosphorus content (24.1 kg ha^{-1}) was recorded in treatment receiving 150% N through DSW RO reject. A significant increase in available P in the soil due to the addition of P and HCO_3 through distillery spentwash and production of organic acids would have helped in the solubility of the native soil P. However, RDF only recorded significantly lower phosphorus content (10.6 kg ha^{-1}).

Potassium

Significantly higher potassium content (1213.5 kg ha^{-1}) of soil was recorded with treatment receiving 150% N through DSW RO reject which was followed by treatment receiving 125% N through DSW RO reject (1150.7 kg ha^{-1}). Increase in soil K was due to application of spentwash which might be due to fact that K was one of the main components of spentwash

Table 4. Soil properties at harvest as influenced by one time application of distillery spentwash R O reject.

Treatments	Ca (Cmol P^+ kg^{-1})	Mg (Cmol P^+ kg^{-1})	S (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)
T_1	2.43	1.07	18.68	15.37	18.80	0.51	0.48	0.14
T_2	2.33	1.27	20.22	15.32	18.71	0.45	0.45	0.15
T_3	2.30	1.07	20.47	16.25	27.41	0.50	0.49	0.15
T_4	2.50	1.07	21.64	14.99	26.81	0.56	0.48	0.15
T_5	2.57	1.10	22.74	15.31	23.43	0.50	0.49	0.14
T_6	2.50	1.17	23.32	13.80	22.81	0.54	0.39	0.13
T_7	3.30	1.37	25.61	14.47	28.11	0.56	0.44	0.17
SEm ±	0.23	0.09	1.26	1.34	2.62	0.03	0.03	0.02
CD at 5%	NS	NS	3.88	NS	NS	NS	NS	NS
CV (%)	15.83	14.79	10.01	15.43	19.15	9.39	9.86	18.27

supplied in large quantities. These results are in agreement with earlier findings [5]. Whereas, significantly lower potassium content (588.5 kg ha^{-1}) was recorded in RDF only.

Available secondary nutrients

The exchangeable Ca and Mg contents of soil were increased significantly with application of 150% N through DSW RO reject (3.50 and 1.37 Cmol (p^+) kg^{-1}, respectively) (Table 4). This could be due to higher Ca (1932 mg L^{-1}) and Mg (1202.4 mg L^{-1}) contents in spentwash. Lower Ca and Mg contents were observed in RDF only (2.43 and 1.07 Cmol (p^+) kg^{-1}, respectively).

Table 5. Enzyme activities of soil as influenced by one time application of distillery spentwash R O reject.

Treatments	Phosphatase (µg P-NPP g^{-1} of dry soil hr^{-1})	Dehydrogenase (µg TPF g^{-1} of soil hr^{-1})	Urease (µg NH_4-N g^{-1} dry soil hr^{-1})
T_1	9.8	2.6	19.4
T_2	11.5	4.1	24.5
T_3	15.4	5.7	30.3
T_4	15.5	6.7	33.6
T_5	18.2	7.2	37.7
T_6	18.8	8.2	40.5
T_7	21.3	9.1	43.6
SEm±	0.49	0.16	0.52
CD at 5%	1.53	0.48	1.59
CV (%)	5.45	4.352	2.72

The available sulfur content of soil was found higher in treatment receiving 150% N through DSW RO reject (25.61 ppm) followed by 125% N through DSW RO reject (23.32 ppm). The increase in sulfur content of soil might be due to sulfur supplied to soil through distillery spentwash as it had good amount of sulfur (430.0 mg L^{-1}). Lower available S content was observed in RDF only (18.68 ppm). Similar results were reported earlier [1].

Available micronutrients

Effect of application of distillery spentwash R O reject on the micronutrients status of soil was found to be non-significant but irrespective of the treatments, the micronutrients contents were slightly higher in distillery spentwash RO reject applied plots. The slight increase in micronutrient contents of soil might be due to addition of micronutrients through distillery spentwash R O reject.

Enzyme activities

Application of distillery spentwash R O reject significantly increased the activities of dehydrogenase, phosphatase and urease (Table 5). Higher activities of dehydrogenase (9.1 µg TPF g^{-1} of soil hr^{-1}), phosphatase (21.3 µg P-NPP g^{-1} of dry soil hr^{-1}) and urease (43.6 µg NH_4-N g dry soil hr^{-1}) were observed in the treatment receiving 150% N through DSW RO

reject. The increase in activities of these enzymes might be due to increase in microbial population, organic carbon and availability of the essential nutrients in soil applied with distillery spentwash R O reject. Similar results were reported earlier [6]. Significantly lower activities of these enzymes (dehydrogenase: 2.6 µg TPF g^{-1} of soil hr^{-1}; phosphatase: 9.8 µg P-NPP g^{-1} of dry soil hr^{-1}; and urease: 19.4 µg NH_4-N g dry soil hr^{-1}) were recorded in treatment receiving RDF only.

Conclusion

From this study it can be concluded that soil properties were greatly influenced due to one time application of distillery spentwash R O reject. The available nutrients and enzyme activities were increased in spentwash applied plots. This clearly suggests that the distillery spentwash R O reject with high nutrient composition can be applied one time to crop fields without affecting soil health.

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