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Effect of Spent Wash on Soil Properties And Plant Nutrient Composition at Various Distances From The Effluent Stream

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ABSTRACT

Effect of spent wash on soil properties and nutrient status of index leaves at different distances from effluent steam were studied at there locations *viz;* Naidupeta, Chittoor and Renigunta distillery units around Tirupathi, A.P. The soil properties like EC. Organic carbon, available N, P, K and S , exchangeable Ca and Mg and DTPA extractable Zn, Fe, Mn and Cu were significantly more in the immediate vicinity of the effluent stream and decreased significantly with an increase in distance from the effluent stream. The adverse effects of spent wash was continued mainly upto 10 m, 50 m, and 10 m at Naidupeta, Chittoor and Renigunta, respectively. The index leaves of plants grown under polluted environment, were having slightly higher N, P, K, Ca, Mg, S, Zn, Fe, Mn and Cu contents as compared to the plants grown under normal environmental condition.

Key words : Plant nutrient composition, Soil properties, Spent wash.

India is a major producer of sugar and sugar industry is mushrooming, as a result of which large quantities of molasses is produced every day. This by - product is used as a feed stock in distillery units for producing ethyl alcohol for industrial and potable uses. These distillery units are also considered important due to growing requirement of alcohol in energy sector. However, their environmental significance is assessed as pollutional units, generating large volume of foul smelling dark coloured waste water known as spent wash. This spent wash is either disposed on land or in surface water which results in polluting the land, water and atmosphere. In Andhra Pradesh, there are about 24 distilleries with total installed capacity 1.24 lakh kilo litres of alcohol per annum. Distillery units in Naidupeta, Chittoor and Renigunta located around Tirupati, Andhra Pradesh, India are producing alcohol using molasses as a raw material. The spent wash is being discharged into a stream for more than 18 years which is flowing about 2 kms down ward into a river. This spent wash through hydrologic cycle recharges adjoining wells and also often it is being used along with well water for irrigating crops on farms located near distilleries by farmer. Keeping above facts in view the present investigation was under taken to assess the effect of spent wash on soil properties and nutrient content of index leaves in there distillery unit areas around Tirupati, Andhra Pradesh viz; Naidupeta, Chittoor and Renigunta.

MATERIAL AND METHODS

Empee distilliery of Naidupeta, Sreenivasa distillery of Chittoor and OR distillery of Renigunta are situated around Tirupati of Andhra Pradesh. These distillery units were discharging their waste water (spent wash) of varying quality into a main drain which flows along the agricultural fields. The drain carrying the spent wash is not well maintained and it usually spreads over the neighboring agricultural fields and wells. Occasionally spent wash is also used by farmers for irrigation. In view of this, the soil samples along with well water were collected from the fields adjoining the three distillery effluent streams *viz;* Naidupeta, Chittoor and Renigunta at different lateral distances viz; 0 m (adjoining the effluent stream) 10, 50, 100, 150, 200, 250, 300, 350,400, 450 and 500 m away from the effluent stream at each location and the soil samples were collected at 0-15, 15-30 and 30-45 cms depth. Soil samples were also collected from non-polluted area (2 km away from the effluent stream) at each location to serve as control for the purpose of comparison.

Soil samples were analyzed for pH, EC, OC, available N, P,K,S, exchangeable Ca, Mg and DTPA extractable Zn, Fe, Mn, and Cu as per the standard methods. The fresh surface soil samples were used for assessing the microbial population as per the method outlined by Waksman and Fred (1992). Index leaf samples of chilli, paddy, ragi and sugarcane grown at different distances from the effluent stream were randomly collected at different lateral distances from the effluent stream, whereas in Renigunta area there was no crop at the time of sampling upto ½ km away from the effluent stream. Index leaf samples were also collected from non polluted area to serve as control. N, P, K, Ca, Mg, S, Zn, Fe, Mn and Cu were estimated in plant samples by following the standard procedures.

RESULTS AND DISCUSSION

pH ,EC and Organic carbon

Data revealed that (Table1,2&3), there was no appreciable change in the soil reaction but the soluble salt content was significantly higher in the immediate neighborhood of the effluent stream in all the there places studied as compared to that of normal soil. The EC ranged from 0.40 to 2.76, 0.41 to 2.86 and 0.47 to 1.45 dSm^{-1} ,respectively in the soils of Naidupeta, Chittoor and Renigunta as compared to 0.42, 0.36 and 0.33 dSm^{-1} , respectively in the normal soil under non polluting environment. The EC in the surface layers was higher and decreased significantly with depth and with an increase in distance from effluent stream. The influence of spent wash was maximum at Chittoor up to a lateral distance of 100 m distance from the effluent stream. The variation in the spread of the salts at the three locations might be attributed to EC of spent wash and also due to the variations in slope, nature of the soil and management practices followed by the farmers around effluent stream. EC was higher in surface layers as compared to sub- surface layers. This might be due to higher accumulation of slats in the surface layers because of more evaporation losses under tropical climatic conditions. Same trend of accumulation of salts in the soils nearer to the effluent steam was also reported by Joshi *et al.,* (1996) and Pathak *et al.,* (1998).

The organic carbon content varied significantly with distance and depths at all three places. Nearer to the effluent stream OC was higher and decreased significantly with increasing distance from the effluent stream .Organic carbon content ranged from 0.21 to 1.95, 0.23 to 2.15 and 0.23 to 1.43 per cent in the soils of Naidupeta, Chittoor and Renigunta as compared to 0.30, 0.27 and 0.24 per cent respectively in the normal soil under non-polluting environment. Environmental conditions nearer to the effluent stream like high EC, high moisture content *etc*. might have adversely influenced the activity of microflora which might have resulted in less decomposition of organic matter that lead to its accumulation in the soils adjacent to the effluent stream. The increase in organic carbon content in the soil might also be due to addition of organic matter through the spent wash which was a plant extract derived from the molasses. Similar results were also reported by Pathak *et al.,* (1998). Organic carbon content more in surface soil followed sub – soil. It decreased from 0.61 to 0.33,0.68 to 0.44 and 0.55 to 0.39 per cent at Naidupeta, Chittoor and Renigunta, respectively from the top to 45 cm depth. This might be due to accumulation of organic compounds at the surface and depends on rate of application of organic residues by the farmer in surrounding areas of the effluent streams.

Macro and Secondary nutrients

Macro and secondary nutrient (N, P, K, Ca, Mg and S) of soils varied significantly by the distance of sampling from the effluent stream and depth of soil at all the three places (Table 1,2&3).Their accumulation was more in the soils adjacent to the effluent stream and decreased gradually with increase in lateral distance and vertical depth. This increase is due to higher amount of nutrients in spent wash and the ferilizer practices adopted by the farmers in adjacent areas of the effluent streams. Increased soil N, P, K, Ca, Mg and S under polluting environment was also reported by Kalyalvizhi *et al* ., (2000). The availability of Potassium was highest followed by available P and available N. Batranou *et al.,* (1989) reported that potassium is the component supplied in large quantities by minery and distillery effluent. There was significant increase in available P values compared to control. The effluents being acidic in nature, might have solubilized the native P in soil there by increased the available P in the soil. Similar findings were also reportedly kalyalvizhi *et al.,* (2000).

Available micronutrients

Available micronutrient viz; Zn, Fe, Mn and Cu were significantly influenced by the distance of sampling from the effluent stream and depth of soil at all the three locations studied (Table1,2&3). In general the available micronutrients were significantly higher in soils in immediate neighborhood of effluent stream as compared to soils away form the stream. The higher amount of micronutrients in the soils adjacent to the stream was mainly due to the presence of considerable amount of micronutrients in the effluents and also the presence of higher amount of organic carbon in the adjacent soils of the effluent steam. Accumulation of DTPA extractable micronutrients in soils adjacent to sun paper mills Ltd of Charanmahadevi of Tamilnadu was reported by Srinivasachari *et al.,* (1999).

Nutrient composition of index leaves

Nutrient composition of index leaves (Table 4) indicates that the index leaves of plants grown under polluted environment were having slightly

Table 1. Effect of spent wash on soil parameters at various distances from the effluent stream and at different depths of soil at Naidupeta.

Distance (m)	pH	EC (dSm^{-1})	O.C (%)	N ($kgha^{-1}$)	P_2O_5 ($kgha^{-1}$)	K_2O ($kgha^{-1}$)	Ca(cmol (p^+)kg^{-1})	Mg (cmol (p^+)kg^{-1})	S ($kgha^{-1}$)	Zn ($mgkg^{-1}$)	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
0	6.6	2.76	1.95	770.51	26.23	914.92	12.23	3.54	68.72	0.98	26.05	13.56	2.48
10	7.7	1.35	0.68	270.02	14.51	325.65	7.86	2.38	42.35	0.72	18.34	12.92	1.92
50	7.7	0.83	0.38	263.43	13.82	186.33	9.12	1.99	27.11	0.56	13.32	12.42	1.86
100	7.8	0.74	0.33	206.78	12.96	227.14	8.88	1.63	23.63	0.64	14.92	12.00	1.72
150	7.8	1.03	0.44	289.80	12.73	150.12	8.41	1.86	28.88	0.73	14.56	11.24	1.55
200	7.6	0.55	0.26	262.07	11.45	136.58	7.89	1.38	27.16	0.42	12.14	10.82	1.76
250	7.8	0.84	0.23	270.85	10.69	180.27	7.24	1.42	23.21	0.66	11.92	10.36	1.48
300	7.7	0.95	0.25	262.13	9.73	140.76	8.87	1.73	20.83	0.43	12.36	9.82	0.88
350	7.5	0.75	0.26	252.43	9.02	148.35	7.64	1.51	23.72	0.56	10.32	9.34	0.94
400	7.6	0.54	0.21	204.51	7.20	140.43	7.42	1.25	20.45	0.48	9.98	9.78	0.78
450	7.8	0.50	0.42	200.50	8.81	130.42	7.73	1.34	19.74	0.53	8.44	8.00	0.86
500	7.7	0.40	0.38	196.87	8.10	120.68	6.98	1.16	18.27	0.39	9.12	7.55	0.78
Mean	7.6	0.94	0.48	287.49	12.10	233.47	8.36	1.93	28.67	0.52	14.21	11.45	1.48
Control	7.6	0.42	0.30	186.07	8.26	131.83	7.01	1.22	21.23	0.38	7.78	9.02	0.68
CD5%	0.1	0.09	0.06	16.03	0.93	6.99	0.70	0.81	1.70	0.09	0.34	0.37	0.19
Depth of Soil (cm)													
0-15	7.60	1.10	0.61	371.42	18.24	322.94	11.24	3.07	39.08	0.78	17.86	16.46	1.78
15-30	7.70	0.85	0.47	241.36	10.09	210.32	7.51	1.21	26.00	0.56	12.38	9.92	1.32
30-45	7.80	0.76	0.33	178.78	6.62	143.71	5.81	0.72	16.92	0.38	8.12	5.66	1.00
CD5%	0.07	0.04	0.05	7.70	0.45	3.36	0.33	0.09	0.81	0.05	0.16	0.18	0.09

Table 2. Effect of spent wash on soil parameters at various distances from the effluent stream and at different depths of soil at Chittor

Distance (m)	pH	EC (dSm^{-1})	O.C (%)	N ($kgha^{-1}$)	P_2O_5 ($kgha^{-1}$)	K_2O ($kgha^{-1}$)	Ca(cmol $(p^+)kg^{-1}$)	Mg (cmol $(p^+)kg^{-1}$)	S ($kgha^{-1}$)	Zn ($mgkg^{-1}$)	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
0	6.4	2.86	2.15	617.53	30.26	1137.69	18.95	4.02	70.53	1.26	33.56	20.96	3.50
10	6.6	1.90	0.88	430.04	17.47	428.81	12.08	3.03	39.08	0.78	22.64	18.02	2.88
50	7.3	1.52	0.71	342.33	14.63	328.15	10.72	2.15	36.05	0.62	17.92	16.96	2.14
100	7.7	1.67	0.68	344.37	12.38	298.94	9.76	1.64	33.31	0.63	15.64	15.62	1.96
150	7.8	1.38	0.43	271.04	8.42	182.33	10.35	1.91	30.14	0.58	14.22	13.12	1.38
200	7.8	1.07	0.23	323.81	8.04	149.96	8.33	1.48	29.73	0.64	13.02	10.94	0.76
250	7.9	0.62	0.26	262.20	11.15	154.95	8.12	1.53	25.72	0.68	12.16	9.92	0.88
300	7.6	0.45	0.23	309.83	10.01	144.74	7.38	1.06	28.68	0.56	12.22	9.66	0.74
350	7.8	0.41	0.27	220.21	8.93	157.90	8.17	1.82	26.11	0.52	11.86	9.55	0.78
400	7.8	0.45	0.32	183.07	7.68	154.82	7.76	1.46	20.05	0.58	10.66	8.86	0.66
450	7.7	0.52	0.36	190.07	8.64	165.63	7.54	1.54	18.42	0.62	8.02	8.32	0.76
500	7.7	0.52	0.42	191.42	7.52	145.86	7.33	1.45	17.78	0.68	8.98	8.76	0.82
Mean	7.5	1.11	0.58	307.16	12.09	287.48	9.71	0.92	31.30	0.73	15.82	13.29	1.51
Control	7.6	0.36	0.27	182.73	6.63	161.96	10.32	1.53	19.71	0.71	7.02	8.34	0.56
CD5%	0.18	0.09	0.06	23.71	0.97	11.10	0.34	0.13	1.51	0.11	0.36	0.20	0.13
Depth of Soil (cm)													
0-15	7.5	1.51	0.68	446.50	18.20	437.16	14.89	3.24	44.21	0.89	19.02	18.28	1.84
15-30	7.6	0.90	0.54	267.82	10.31	252.84	8.93	1.53	28.94	0.64	12.62	11.48	1.26
30-45	7.8	0.75	0.44	178.48	7.09	166.62	5.86	0.86	16.96	0.58	11.24	7.12	0.82
CD5%	0.08	0.04	0.03	11.39	0.46	5.33	0.16	0.06	0.71	0.05	0.17	0.10	0.06

Table 3. Effect of spent wash on soil parameters at various distances from the effluent stream and at different depths of soil at Renigunta

Distance (m)	pH	EC (dSm^{-1})	O.C (%)	N ($kgha^{-1}$)	P_2O_5 ($kgha^{-1}$)	K_2O ($kgha^{-1}$)	Ca(cmol ($p^{+)}kg^{-1}$)	Mg (cmol ($p^{+)}kg^{-1}$)	S ($kgha^{-1}$)	Zn ($mgkg^{-1}$)	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
0	6.7	1.45	1.43	756.53	29.64	57.94	11.93	3.73	59.28	1.14	16.68	13.76	1.68
10	7.7	0.90	0.64	422.34	15.95	269.66	7.96	2.42	37.01	0.70	12.98	10.32	0.96
50	7.7	0.72	0.58	383.81	10.62	207.38	8.49	2.56	24.96	0.52	13.56	11.46	0.58
100	7.6	0.57	0.45	226.82	12.77	197.12	10.12	2.75	22.97	0.60	14.02	10.92	0.78
150	7.7	0.50	0.42	245.04	12.12	174.81	7.95	2.32	23.83	0.44	12.26	9.95	0.82
200	7.8	0.56	0.40	211.23	11.00	196.30	7.28	2.67	19.55	0.76	8.22	9.46	0.96
250	7.8	0.54	0.37	219.34	9.03	166.39	7.67	2.52	20.01	0.34	9.48	9.32	0.78
300	7.8	0.47	0.34	212.42	8.24	135.97	7.55	2.63	19.34	0.55	9.92	9.78	0.64
350	7.9	0.57	0.36	208.44	9.73	152.25	6.33	2.02	18.83	0.50	8.78	8.38	0.68
400	7.8	0.51	0.31	196.07	8.17	131.12	5.88	2.81	18.12	0.42	6.82	8.88	0.76
450	7.8	0.49	0.33	194.03	7.69	144.20	5.91	2.37	19.21	0.36	6.26	8.56	0.88
500	7.9	0.47	0.23	208.31	7.25	126.15	5.66	2.13	18.43	0.30	6.98	8.22	0.86
Mean	7.7	0.65	0.49	290.37	11.85	200.77	7.73	2.58	25.13	0.57	11.08	10.70	0.94
Control	7.6	0.33	0.24	197.14	7.54	120.03	9.23	2.84	20.06	0.48	5.58	7.92	0.58
CD5%	0.14	0.06	0.04	14.19	1.28	8.68	0.30	0.18	1.35	0.10	0.21	0.23	0.14
Depth of Soil (cm)													
0-15	7.6	0.68	0.55	369.21	17.46	292.60	12.32	4.01	33.54	0.72	15.06	14.48	1.24
15-30	7.7	0.64	0.47	267.93	10.47	197.31	7.84	2.59	23.10	0.58	9.28	9.34	0.72
30-45	7.7	0.55	0.39	212.49	6.82	121.28	3.20	1.52	16.43	0.44	5.74	5.78	0.42
CD5%	0.06	0.03	0.02	6.81	0.61	4.17	0.14	0.08	0.65	0.05	0.10	0.11	0.07

Table 4: Effect of spent wash on nutrient concentration of crops at various distances from the effluent stream at Naidupeta and Chittor.

Distance (m)		N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Zn ($mgkg^{-1}$)	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
Naidupeta											
50-250	Sugarcane	1.98-2.34	0.14-0.18	1.39-1.65	0.26-0.35	0.16-0.28	0.10-0.16	27.7-41.5	153-165	39-41.1	4.3-8.80
300	Chillies	2.28	0.18	1.98	0.95	0.26	0.31	39.0	249.5	52.5	6.80
350-500	Sugarcane	1.88-2.06	0.12-0.16	1.46-1.66	0.20-0.26	0.14-0.18	0.12-0.16	26.0-28.6	110-156	37-39	4.90-5.80
Control	Sugarcane	1.98	0.15	1.48	0.25	0.17	0.14	26.8	150.2	37.8	5.20
Chittor											
50-100	Paddy	2.12-2.47	0.14-0.18	1.84-1.98	1.08-1.18	0.22-0.28	0.18-0.23	28.3-29.5	129-135.5	166-168.5	4.90-5.80
250	Chillies	2.21	0.11	2.01	1.04	0.28	0.35	38.5	238.0	58.5	6.60
400	Ragi	1.77	0.12	1.78	0.81	0.20	0.21	26.5	131.0	168.5	4.40
450	Paddy	2.28	0.10	1.75	0.98	0.21	0.19	26.4	128.6	161.4	4.80
Control	Paddy	2.14	0.13	1.74	1.01	0.22	0.18	27.5	130.8	162.5	4.60

higher N, P, K, Ca, Mg, S, Zn, Fe, Mn and Cu contents as compared to the plants gown under normal condition. The nutrient values obtained from the index leaves of sugarcane, rice, chillies and ragi revealed that these were not much influenced by the effluent stream at all three locatins. The results of soil analysis indicated that the effect of spent wash was only up to10 m, 50 m, and 10 m distance from the effluent stream at Naidupeta, Chittor and Renigunta, respectively. The effect of spent wash on crops raised beyond 50 m distance from the effluent stream was negligible when compared to 0 m distance. It indicates that the variation in concentration of nutrients might be due to variation in fertilizer practices followed by the farmers around the effluent streams.

The results of the present study clearly indicated that there was deterioration in the quality of soil through high salt accumulation in adjoining areas of effluent streams. At the same time the effluents act as a source of plant nutrients to improve the soil fertility status. Hence, the research efforts have to be strengthened in order to overcome the disadvantages so that the spent wash would become more economical and socially acceptable source of nutrients and in turn the soil productivity would be improved.

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