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Nutrient content and uptake by maize (*Zea mays* L.) crop due to application of distillery spentwash R O reject

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Abstract
A field experiment was conducted during *kharif* 2013 to see the effect of this distillery spentwash R O reject application on nutrient content and uptake by maize (*Zea mays* L.) crop. The experiment consisted 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 significantly increased the nitrogen (1.48 and 0.69%), phosphorus (0.44 and 0.26%), potassium (0.63 and 1.97%) and other nutrient elements in both grain and stover, respectively compared to all other treatments. Significantly higher uptake of nitrogen, phosphorus, potassium (126.2, 40.5 and 192.3 kg ha^{-1}, respectively) and other nutrient elements were recorded in treatment received 150% N through distillery spentwash (DSW) R O reject. Significantly lower values of nutrient content and uptake were recorded in treatment receiving RDF only. It is concluded that application of distillery spentwash (DSW) R O reject resulted in increased nutrient content and uptake of maize.

Keywords: Distillery, Nitrogen, Phosphorus, Potassium, R O reject, Uptake

Introduction
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 by fermentation of diluted molasses by employing different microbial strains. Spentwash is a dark brown coloured liquid with an unpleasant odour of burnt sugar. The dark brown colour of raw spentwash is due to the presence of melanoidin of cane molasses which is not decomposed effectively by yeast and methane bacteria in its activated sludge process.
The disposal of distillery effluent is of serious concern due to its large volume as well as due to its high BOD and COD. The effluent doesn't contain any toxic metals as it is a waste from plant based sugar mills; rather it contains major and micro-nutrients which are helpful for sustaining the soil fertility and the yield of crops. 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.
It is a well-known fact that availability of organic manures is very much limited in the present day agriculture. Therefore, the application of nutrients needs to be increased to keep the soil fertile and to make agriculture sustainable, but the cost of inorganic fertilizer is increasing. It is said that nutrient supplying capacity of soil declines steadily under intensive cropping system. 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. So by keeping this in mind we made an effort to see the effect of this distillery spentwash R O reject on nutrient content and uptake by maize (*Zea mays* L.) crop and the results are presented in this paper.

Material 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 (India) during *kharif* 2013. 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.

Table 1: Initial soil characteristics of the experimental site.

Soil Properties	Values	Soil Properties	Values
pH	6.48	Calcium (me/100g)	3.6
EC (dsm^{-1})	0.14	Magnesium (me/100g)	2.4
CEC [cmol (p^+) kg^{-1}]	8.9	Sulphur (ppm)	19.10
Organic carbon (%)	0.55	Iron (ppm)	21.28
Av. Nitrogen (kg ha^{-1})	248.37	Zinc (ppm)	0.38
Av. Phosphorus (kg ha^{-1})	22.69	Manganese (ppm)	23.20
Av. Potassium (kg ha^{-1})	652.51	Copper (ppm)	0.60

Farm yard manure (7 t ha^{-1}) was applied three weeks before sowing of the maize crop. The experiment consisted of seven treatments laid out in Randomized Complete Block Design with three replications. Recommended dose of fertilizer: 100:50:25 kg N: P_2O_5: K_2O ha^{-1} was given. The spacing was maintained at 60 cm X 30 cm and NAH-1137 (HEMA) is a 120 days duration maize variety was used. 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. After the harvest of the maize crop, the grain and stover samples were collected and subjected for analysis following standard procedures.

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

Parameters	Values	Parameters	Values
Colour	Dark brown	Calcium (mg L^{-1})	1932
pH	7.29	Magnesium (mg L^{-1})	1202.4
EC (dsm^{-1})	44	Sulphur (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		

The experiment consisted of 7 treatments *viz.*, T_1: RDF only; T_2: RDF + FYM; T_3: 50% N through DSW R.O. Reject + 50%N through fertilizer; T_4: 75% N through DSW R.O. Reject + 25%N through fertilizer; T_5: 100% N through DSW R.O. Reject; T_6: 125% N through DSW R.O. Reject; and T_7: 150% N through DSW R.O. Reject.

Statistical analysis

The data collected were analyzed statistically following the procedure as described by Panse and Sukhatme (1967)[8]. The level of significance used in 'F' and 't' test was *P=0.05*. Critical differences were calculated using the 't' test wherever 'F' test was significant.

Results and discussion

Effect of distillery spentwash R O reject application on nutrient content of maize crop

The results related to average concentration of nitrogen, phosphorus and potassium in maize grain and stover varied significantly due to one time application of distillery spentwash R O reject at harvest (Table 3). Significantly higher average concentration of nitrogen, phosphorus and potassium in maize grain were observed with the treatment receiving 150% N through distillery spentwash R.O. reject (T_7) (1.48%, 0.44% and 0.63%, respectively) compared to all the other treatments followed by treatment with application of 125% N through distillery spentwash R.O. reject (T_6) (1.40%, 0.39% and 0.60%, respectively). The treatments T_3 (1.25%, 0.38% and 0.52%, respectively) and T_4 (1.26%, 0.36% and 0.53%, respectively) were found on par with each other. The lowest N, P and K (1.18%, 0.28% and 0.43%, respectively) content was recorded by the treatment receiving RDF only (T_1).

Table 3: Effect of application of distillery spent wash R. O. reject on total nitrogen, phosphorus and potassium content of maize.

Treatments	Grain			Stover		
	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)
T_1	1.18	0.28	0.43	0.48	0.22	1.19
T_2	1.39	0.38	0.49	0.64	0.23	1.51
T_3	1.25	0.38	0.52	0.46	0.23	1.10
T_4	1.26	0.36	0.53	0.61	0.25	1.46
T_5	1.38	0.38	0.56	0.58	0.24	1.54
T_6	1.40	0.39	0.60	0.65	0.24	1.54
T_7	1.48	0.44	0.63	0.69	0.26	1.97
SEm±	0.03	0.01	0.01	0.02	0.004	0.10
CD at 5 %	0.08	0.03	0.03	0.06	0.011	0.31
CV (%)	3.15	5.59	2.73	6.31	2.56	11.67

Significantly higher average concentration of nitrogen, phosphorus and potassium in maize stover (Table 3) were observed with the treatment receiving 150% N through distillery spentwash R.O. reject (T_7) (0.69%, 0.26% and 1.97%, respectively) compared to all other treatments followed by treatment receiving 125% N through distillery spentwash R.O. reject (T_6) (0.65%, 0.24% and 1.54%, respectively), T_5 (0.58%, 0.24% and 1.54%, respectively) and T_2 (RDF + FYM) (0.64%, 0.23% and 1.51%, respectively). The treatment receiving RDF only (T_1) recorded lowest N, P and K (0.48%, 0.22% and 1.19%, respectively).

The data pertaining to average concentration of Ca, Mg and S in maize grain and stover differed significantly due to one time application of distillery spentwash R O reject at harvest (Table 4). The concentration of Ca, Mg and S in maize grain was found higher in treatment receiving 150% N through

distillery spentwash R.O. reject (T_7) (0.33%, 0.16% and 0.19%, respectively) than other treatments followed by treatment receiving 125% N through distillery spentwash R.O. reject (T_6) (0.30%, 0.14% and 0.17%, respectively). The treatments T_2 (0.28%, 0.12% and 0.16%, respectively), T_3 (0.29%, 0.13% and 0.15%, respectively), T_4 (0.27%, 0.12% and 0.15% respectively) and T_5 (0.27%, 0.10% and 0.15%, respectively) were found on par with each other.

Table 4: Effect of application of distillery spent wash R. O. reject on calcium, magnesium and sulphur content of maize.

Treatments	Grain			Stover		
	Calcium (%)	Magnesium (%)	Sulphur (%)	Calcium (%)	Magnesium (%)	Sulphur (%)
T_1	0.25	0.07	0.15	0.18	0.07	0.14
T_2	0.28	0.12	0.16	0.22	0.10	0.15
T_3	0.29	0.13	0.15	0.24	0.09	0.25
T_4	0.27	0.12	0.15	0.27	0.11	0.17
T_5	0.27	0.10	0.15	0.28	0.12	0.16
T_6	0.30	0.14	0.17	0.30	0.13	0.26
T_7	0.33	0.16	0.19	0.32	0.14	0.24
SEm±	0.006	0.01	0.006	0.003	0.013	0.012
CD at 5 %	0.019	0.03	0.018	0.008	0.039	0.036
CV (%)	3.79	16.39	6.43	1.77	20.12	10.39

The concentration of Ca, Mg and S in maize stover (Table 4) was found higher in treatment with application of 150% N through distillery spentwash R.O. reject (T_7) (0.32%, 0.14% and 0.24%, respectively) followed by treatment receiving 125% N through distillery spentwash R.O. reject (T_6) (0.30%, 0.13% and 0.26%, respectively). The lowest concentration of Ca, Mg and S in both grain (0.25%, 0.07% and 0.15%, respectively) and stover (0.18%, 0.07% and 0.14%, respectively) was recorded in treatment receiving RDF only (T_1).

The results related to average concentration of Fe, Zn, Cu and Mn in maize as influenced by one time application of distillery spentwash R O reject at harvest are presented in Table 5. Significantly higher concentrations of Mn, Cu and Zn by maize grain were observed with the treatment receiving 150% N through distillery spentwash R.O. reject (T_7) (120.40, 25.73 and 32.27 ppm, respectively). Iron content was found higher in T_4 (75% N through DSW R.O. reject + 25%N through fertilizer) (1656.27ppm). The lowest concentration of Fe, Zn, Cu and Mn (1080.67, 20.73, 8.33 and 57.87 ppm, respectively) was recorded in treatment receiving RDF only (T_1).

Table 5: Effect of application of distillery spent wash R. O. reject on micronutrient content of maize.

Treatments	Grain					Stover				
	Fe(ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)
T_1	108.07	57.9	20.7	8.3	7.70	92.77	124.5	14.6	13.3	6.67
T_2	135.47	98.1	22.7	11.1	9.20	134.77	174.3	27.6	22.3	8.47
T_3	133.44	53.20	16.8	8.8	8.80	133.55	184.7	19.0	17.9	9.20
T_4	165.63	110.9	21.4	21.6	9.47	134.08	166.0	31.6	19.3	8.60
T_5	132.47	82.4	27.7	13.7	8.37	135.70	156.6	40.0	20.5	6.60
T_6	158.48	97.6	24.3	17.1	10.27	134.44	160.2	20.4	21.5	8.33
T_7	153.88	120.4	32.3	25.7	12.40	143.86	187.5	25.9	22.8	10.20
SEm±	5.51	10.85	2.05	2.74	0.56	3.83	5.84	2.10	1.78	0.49
CD at 5 %	16.97	33.42	6.32	8.44	1.72	11.79	17.99	6.47	5.49	1.53
CV (%)	6.76	21.19	14.99	31.26	10.22	5.10	6.14	14.21	15.68	10.36

The higher concentration of Fe, Mn, Cu and B in maize stover was recorded in treatment receiving 150% N through distillery spentwash R.O. reject (T_7) (1438.5, 187.5 and 22.8 ppm, respectively) (Table 5). Significantly higher content of Zn was recorded in T_5 (100% N through DSW R.O. reject) (40.0 ppm). Significantly lower content of Fe, Mn, Zn, Cu and B were recorded in RDF only (T_1) (928.9, 124.5, 14.6, 13.3, 10.20 and 6.67, ppm respectively).

Effect of distillery spentwash R O reject application on nutrient uptake by maize crop

The results on total uptake of nitrogen, phosphorus and potassium by maize varied significantly due to one time application of distillery spentwash R O reject at harvest (Table 6). Significantly higher total uptake of nitrogen, phosphorus and potassium by maize were observed with the treatment receiving 150% N through distillery spentwash R.O. reject (T_7) (126.2, 40.5 and 192.3 kg ha^{-1}, respectively) compared to all the other treatments followed by T_6 (125% N through distillery spentwash R.O. reject) (111.7, 35.3 and 142.7 kg ha^{-1}, respectively) and T_2 (RDF + FYM) (103.7, 32.07 and 123.3 kg ha^{-1}, respectively). The treatments T_4 (75% N through DSW R.O. reject + 25%N through fertilizer) (88.6, 28.5 and 117.6 kg ha^{-1}, respectively) and T_5 (100% N through DSW R.O. reject) (93.5, 28.6 and 128.1 kg ha^{-1}, respectively) were found to be on par with each other. The lowest uptake of nitrogen, phosphorus and potassium was recorded in treatment receiving RDF only (T_1) (66.0, 20.1 and 83.6 kg ha^{-1}, respectively).

Table 6: Effect of application of distillery spent wash R. O. reject on uptake of nitrogen, phosphorus and potassium by maize.

Treatments	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
T_1	37.5	28.5	66.0	8.9	13.2	20.1	13.7	69.9	83.6
T_2	60.8	42.9	103.7	16.4	15.7	32.1	21.4	101.9	123.3
T_3	47.1	32.7	79.8	14.2	16.2	30.4	19.6	78.8	98.3
T_4	48.2	40.4	88.6	13.7	16.9	28.5	20.3	97.3	117.6
T_5	53.4	40.2	93.6	14.6	16.4	28.6	21.6	106.5	128.1
T_6	62.9	48.9	111.7	17.3	17.9	35.3	27.0	115.7	142.7
T_7	68.9	57.2	126.2	20.5	21.2	40.5	29.2	163.1	192.3
SEm±	0.95	1.42		0.51	0.24		0.35	6.79	
CD at 5 %	2.91	4.37		1.56	0.75		1.08	20.95	
CV (%)	3.02	5.91		5.82	2.49		2.78	11.24	

The highest nitrogen uptake in the treatment receiving 150% N through distillery spentwash R.O. reject (T_7) may be due to more availability of soil available nitrogen with higher rate of application of distillery spentwash R O reject. Total uptake of nitrogen by maize increased with increasing quantity of distillery spentwash R O reject based on N levels. Chidankumar and Chandraraju (2008) [4] and Malagi *et al* (2013) [7] outlined similar results in case of sugarcane. Highest nitrogen uptake was in treatments receiving distillery spentwash R O reject compared to other treatments. Doddamani *et al*. (2011) [5] reported that the uptake of N, P, K and other nutrients were increased in maize due to application of distillery spentwash.

Decomposition of high organic matter load applied through spentwash helped in availability of phosphorus due to solubilising effect of certain organic acids and carbon dioxide produced during decomposition. The organic forms of phosphorus present in the raw spentwash upon decomposition in the soil will contribute for higher available phosphorus and more crop uptake. At higher N/P ratio, better utilization of applied P in the presence of higher N must have contributed for more P uptake. Vinod and Chopra (2013) [11] reported similar results indicating that the application of distillery spentwash increased the uptake of N, P and K by crops. The increased uptake of K by maize crop might be due to higher quantity of K in distillery spentwash R O reject (11887 mg L^{-1}). Similar findings were outlined by Chandraju *et al.* (2011) [2] and Sukanya and meli (2004) [10].

The data pertaining to total uptake of Ca, Mg and S by maize differed significantly due to one time application of distillery spentwash R O reject at harvest (Table 7). Application of 150% N through distillery spentwash R.O. reject (T_7) recorded significantly higher uptake of Ca, Mg and S (41.9, 19.2 and 28.6 kg ha^{-1}, respectively) compared to other treatments followed by treatment receiving 125% N through distillery spentwash R.O. reject (T_6) (36.0, 15.9 and 27.0 kg ha^{-1}, respectively).

Table 7: Effect of application of distillery spent wash R. O. reject on uptake of calcium, magnesium and sulphur by maize.

Treatments	Calcium (kg ha^{-1})			Magnesium (kg ha^{-1})			Sulphur (kg ha^{-1})		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
T_1	7.9	10.8	18.7	2.4	2.4	4.8	4.8	8.3	13.1
T_2	12.4	15.1	27.4	5.4	6.9	12.3	7.1	10.0	17.1
T_3	10.9	17.4	28.4	4.9	5.5	10.4	5.8	17.6	23.4
T_4	10.4	17.8	28.2	4.5	7.4	11.8	5.7	11.7	17.4
T_5	10.6	19.6	30.2	3.9	8.6	12.5	5.9	11.3	17.2
T_6	13.5	22.6	36.0	6.4	9.5	15.9	7.5	19.6	27.0
T_7	15.2	26.8	41.9	7.6	11.6	19.2	8.6	19.9	28.6
SEm±	0.26	0.19		0.48	0.74		0.26	0.92	
CD at 5 %	0.79	0.58		1.47	2.28		0.79	2.83	
CV (%)	3.85	1.76		16.37	17.29		6.84	11.31	

The treatments receiving 75% N through DSW R.O. reject + 25% N through fertilizer (T_4) (11.8 and 17.4 kg ha^{-1}, respectively) and 100% N through DSW R.O. reject (T_5) (12.5 and 17.2 kg ha^{-1}, respectively) were on par with each other with respect to Mg and S. Significantly lower uptake of Ca, Mg and S was recorded by treatment RDF only (T_1) (9.08, 4.79 and 13.06 kg ha^{-1}, respectively).

Higher uptake of Ca and Mg might be due to the presence of appreciable amount of Ca (1932 mg L^{-1}) and Mg (1202.4 mg L^{-1}) in the spentwash and this enhanced the crop uptake and assimilation. Treatments with high K content due to spentwash application might have enhanced the Ca uptake. Ashutosh Sharma (2013) [1] revealed that crop responded well due to application of spentwash which increased the uptake of nutreints including secondary and micronutrients. The increase in sulphur uptake might be due to the presence of appreciable quantity of sulphur in spentwash (430.0 mg L^{-1}), which might have enhanced the S uptake. This may be due to greater uptake of N and P by crop which might have induced the uptake of sulphur. These results were in accordance with results of Chidankumar *et al.* (2010) [3].

Table 8: Effect of application of distillery spent wash R. O. reject on uptake of micronutrients by maize.

Treatments	Fe (g ha^{-1})			Mn (g ha^{-1})			Zn (g ha^{-1})			Cu (g ha^{-1})		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
T_1	343.9	545.5	889.4	184.1	732.3	916.4	65.9	85.9	151.8	26.5	78.4	104.9
T_2	590.7	906.9	1497.6	427.6	1173.2	1600.7	98.8	185.8	284.6	48.3	150.3	198.6
T_3	504.9	956.2	1461.1	201.3	1322.3	1523.6	63.6	136.0	199.6	33.3	127.9	161.3
T_4	631.2	895.7	1526.9	422.8	1108.9	1531.7	81.6	211.1	292.6	82.3	128.8	211.1
T_5	511.5	940.4	1451.9	318.2	1084.9	1403.0	106.8	277.2	384.0	52.8	142.3	195.1
T_6	710.6	1012.3	1722.9	437.6	1206.3	1643.9	109.1	153.6	262.7	76.5	161.9	238.5
T_7	717.1	1191.2	1908.2	561.1	1552.8	2113.9	150.4	214.7	365.1	119.9	189.1	309.0
SEm±	21.25	26.89		41.83	40.35		8.64	14.13		11.33	12.17	
CD at 5 %	65.48	82.88		128.88	124.32		26.62	43.54		34.89	37.51	
CV (%)	6.43	5.06		19.87	5.98		15.49	13.55		31.23	15.08	

The data on to total uptake of Fe, Zn, Cu and Mn by maize varied significantly due to one time application of distillery spentwash R O reject at harvest (Table 8). Significantly higher uptake of Fe, Mn and Cu was recorded in treatment T_7 (150% N through distillery spentwash R.O. reject) (19081.8, 2113.9 and 309.0 g ha^{-1}, respectively). Higher uptake of Zn (384.0 g ha^{-1}) was observed in treatment receiving 100% N through DSW R.O. reject (T_5). Lower uptake of Fe, Mn, Zn and Cu was observed in treatment RDF only (T_1) (8900.4, 916.4, 151.8 and 104.9 g ha^{-1}, respectively). Micronutrient uptake was found to be highest in distillery spentwash R O reject applied plots. This might be due to the presence of appreciable quantities of these micronutrients in distillery spentwash. Similar results were reported by Kavitha *et al.* (2008) [6].

Irrespective of the treatments of distillery spentwash R O reject, nutrient uptake was comparatively high in spentwash treatments. This could be attributed to the fact that the distillery spentwash R O reject provides all the essential nutrients in sufficient quantities for better uptake. Highest nutrient uptake in distillery spentwash R O reject applied treatments might be attributed to favorable soil physical and chemical conditions that might have increased the availability of nutrients with application of distillery spentwash R O reject which has high organic load. The increase in uptake of nutrients may also be due to higher nutrient content coupled with better vegetative growth in these treatments.

Grain and stover yield of maize crop

Figure 1 shows the grain and stover yield of maize due to effect different treatments. The results showed that higher grain (46.6 q ha^{-1}) and stover yield (82.8 q ha^{-1}) were recorded in treatment receiving 150% N through distillery spentwash R.O. reject (T_7) followed by the treatment with application of 125% N through distillery spentwash R.O. reject (T_6) (44.8 and 75.3 q ha^{-1} grain and stover yield, respectively) and treatment T_2 (RDF + FYM) (43.6 and 67.3 q ha^{-1} grain and stover yield, respectively). The treatments T_3 (37.8 and 71.6 q ha^{-1} grain and stover yield, respectively), T_4 (38.1 and 66.8 q ha^{-1} grain and stover yield, respectively) and T_5 (38.6 and 69.3 q ha^{-1} grain and stover yield, respectively) were found on par with each other. The treatment receiving RDF only (T_1) recorded significantly lower grain (31.82 q ha^{-1}) and stover yield (58.8 q ha^{-1}) (Fig. 1).

Distillery spentwash R O reject application has resulted in higher grain yield mainly due to its nutritional effects. Application of distillery spentwash R O reject was found more effective in increasing the stover yield. The reason for increased stover yield in distillery spentwash R O reject applied plots might be due to higher soil available nitrogen in these plots. Addition of more nutrients through distillery spentwash R O reject resulted in the higher grain and stover yield of maize.

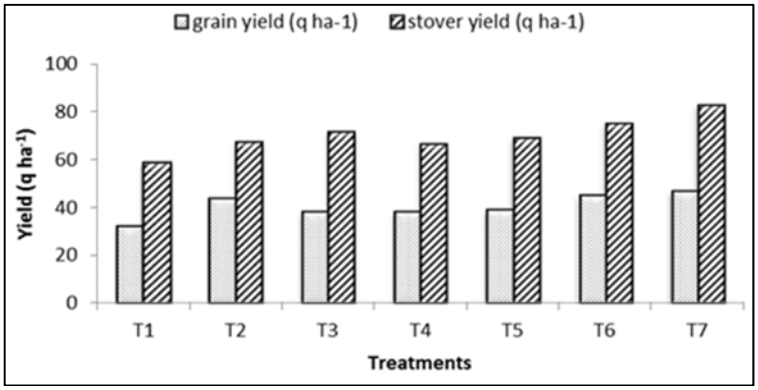

Fig. 1: Effect of distillery spentwash R. O. reject application on grain and stover yield of maize.

Higher grain and stover yield in maize could be attributed to better uptake of essential nutrients and their translocation. The increase in yield was also reported by Suganya and Rajannan (2009) [9].

Conclusion

The distillery spentwash R O reject is waste water discharged by distilleries can be utilized as a source of nutrients as it contains high amounts of essential nutrients. Application of distillery spentwash R.O. reject to soil resulted in increased nutrient content in grain as well as in stover of maize. The uptake of major, secondary and micronutrients by maize crop was increased with quantity of spentwash applied. The increased nutrient uptake resulted in increased grain and stover yield of maize. It is concluded that, application of distillery spentwash R O reject helps in adding nutrients to

soil thereby increasing nutrient content and economic produce of the crop.

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