digested spentwash application increased soil concentration of most elements (Scandaliaris et al. 1987, Sweeny & Graetz 1991). It was found that addition of spentwash decreased the pH and EC of soil. There were significant changes in exchangeable K, Ca and Mg, and the DTPA extractable Fe, Zn and Mn contents of soil significantly increased at all stages of crop growth treated with diluted spentwash (Pawar et al. 1992). Irrigation with diluted distillery wastewater along with gypsum and press mud reduced the exchangeable Na and increased the available N, P and K and exchangeable Ca and Mg contents. The soil organic carbon, N, P and K contents were increased significantly with increase in the number of pre-sowing distillery effluent irrigation (Anil Kumar 1995). There was buildup of soil fertility with effluent application particularly soil organic carbon and K status. Further, with increase in the amount of effluent added, there was an increase in pH, EC, available N, P and K. It was found that in red soil with wheat as test crop, employing different effluent dilution levels (1:5, 1:10, 1:25 and 1:50) in comparison with undiluted effluent and freshwater, available N, P, K, Zn, Cu and Mn contents in soil decreased with increased dilution levels (Sukanya & Meli 2004). The application of distillery spentwash for three years to evaluate the effect on soil properties in deep black soil was found that the organic carbon and EC of the surface soil increased significantly with application of spentwash but the soil pH was not affected (Hati et al. 2005). However, not much information is available on the impact of diluted distillery spentwash such as 33% and 50% on soil characteristics in first time treated soil and application of spentwash in different intervals of short time. Therefore, the present investigation was carried out to study the impact of distillery spentwash against raw water treatment.

MATERIALS AND METHODS

The investigation was carried out during December 2006 to February 2008 at the field of Chamundi Distilleries Pvt. Ltd., Maliyur, Mysore district, Karnataka. The PTSW, 33% and 50% spentwash were collected and the physical and chemical parameters, and amount of nitrogen (N), potassium (K), phosphorus (P) and sulphur (S) were analysed using standard procedures. Plot 1 (untreated) and Plot 2 (one time treated) (each area of 10 × 10 feet) were treated with raw water, 33% and 50% spentwash with some vegetables plants as test crops. After harvesting the test crops, the soil was ploughed and exposed to sunlight for one month. Composite soil samples were collected in the month of February 2007 from the experimental site at 25 cm depth. After the application of primarily treated distillery spentwash on the soil at different intervals of time, the soils were also ploughed and exposed to sunlight. The soil samples were collected during December 2006 (Sample 1), March 2007 (Sample 2), June 2007 (Sample 3), September 2007 (Sample 4) and February 2008 (Sample 5). All the soil samples were air dried, powdered and analysed for physical-chemical characteristics using standard procedures.

RESULTS AND DISCUSSION

Table 1 revealed the changes in the values of parameters in PTSW, 33% and 50% spentwash. It was found that all the parameters were decreased in the case of 33% spentwash as compared with PTSW and 50% spentwash. However, the application of 33% and 50% spentwash to the soil samples increased most of the parameters.

The impact of diluted spentwash compared with raw water in first time treated (Plot 1) and second time treated (Plot 2) soils were studied and are shown in Table 2. It was found that the pH and EC values increased with the application of 50%, and 33% spentwash treatment in both plots 1 and

Table 1: Chemical composition of the distillery spentwash.

Chemical parameters	Units	PTSW	50% SW	33% SW
pH	-	7.36	7.36	7.24
Electrical conductivity	µS	28800	19660	10020
Total solids	mg/L	46140	26170	20870
Total dissolved solids	mg/L	35160	16060	10140
Total suspended solids	mg/L	10540	5680	4380
Settleable solids	mg/L	10070	4340	3010
COD	mg/L	40530	18316	10228
BOD	mg/L	16200	7818	4800
Carbonate	mg/L	Nil	Nil	Nil
Bicarbonate	mg/L	13100	7400	4200
Total phosphorus	mg/L	30.26	12.20	6.79
Total potassium	mg/L	7200	3700	2400
Calcium	mg/L	940	600.0	380.0
Magnesium	mg/L	1652.16	884.16	542.22
Sulphur	mg/L	74.8	35.0	22.6
Sodium	mg/L	480	260	240
Chlorides	mg/L	5964	3272	3164
Iron	mg/L	9.2	6.40	5.20
Manganese	mg/L	1424	724	368
Zinc	mg/L	1.28	0.72	0.41
Copper	mg/L	0.276	0.134	0.074
Cadmium	mg/L	0.039	0.021	0.010
Lead	mg/L	0.16	0.09	0.06
Chromium	mg/L	0.066	0.032	0.014
Nickel	mg/L	0.165	0.084	0.040
Ammonical nitrogen	mg/L	743.68	345.24	276.64

PTSW→Primary treated spentwash; 50% SW→50% distillery spentwash; 33% SW→33% distillery spentwash

2 than raw water. In both the plots an increased uptake of organic carbon, available N, P, K, and S, and exchangeable Ca, Mg, Na and DTPA Fe, Mn, Cu and Zn were observed with the application of diluted spentwash compared with water. However, uptake of available P and DTPA Fe and Zn were remarkably influenced by the application of 50% spentwash than 33% spentwash and improved uptake of the organic carbon, available N, P, K and S, and exchangeable Ca, Mg, Na and DTPA Mn and Cu were observed in the case of 33% than 50% spentwash.

The impact of application of primarily treated distillery spentwash (PTSW) on soil characteristics was studied and as shown in Table 3. It was found that pH value increased with increased number of applications of spentwash, but the decreased value was observed in the fourth time treatment. EC value of the soil increased with application of spentwash up to second time treatment and decreased value was observed in the third treatment which further increased with fourth time application. Increased value of soil organic carbon was noticed with the application of spentwash. It was found that the uptake of available potassium and exchangeable calcium, magnesium and DTPA copper and available sulphur increased with the application of spentwash. The uptake of available nitrogen, phosphorus and DTPA iron, manganese and zinc increased in the first time treatment, and decreased value was observed in the second treatment but the values increased further with the application of spentwash.

CONCLUSION

It was noticed that the nutrient uptake in soils was largely influenced by distillery spentwash treatment in case of the both 33% and 50% diluted distillery spentwash than raw water. 33% distillery spentwash treatment shows more uptake of nutrients than 50% diluted spentwash in first time treated and second time treated soils. This could be due to the efficient absorption of nutrients by soil at high dilution. The application of PTSW to soils improved most of the nutrients. Hence, spentwash can be used to increase the fertility of soils without any adverse effects.

ACKNOWLEDGEMENT

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Table 2: Chemical characteristics experimental soil.

Chemical Parameters	Units %	Plot 1			Plot 2		
		RW	50% SW	33% SW	RW	50% SW	33% SW
Coarse sand	%	9.68	10.20	9.68	11.23	11.36	11.46
Fine sand	%	42.36	38.80	40.64	42.64	39.48	40.72
Silt	%	24.27	26.44	25.26	26.84	27.46	27.38
Clay	%	23.69	24.56	24.42	19.29	20.68	20.44
pH (1:2 solution)	-	8.07	8.33	8.29	8.07	8.41	8.21
Electrical conductivity	µS	2660	5760	3310	932	4451	2360
Organic carbon	%	1.09	1.21	1.28	1.16	1.78	1.89
Available nitrogen	ppm	140	380	440	120	240	230
Available phosphorus	ppm	130	170	140	120	250	230
Available potassium	ppm	60	70	85	110	128	140
Exchangeable calcium	ppm	140	160	190	178	180	190
Exchangeable magnesium	ppm	180	190	220	245	260	270
Exchangeable sodium	ppm	110	130	140	130	160	165
Available sulphur	ppm	160	210	240	129	140	185
DTPA iron	ppm	190	240	210	165	180	170
DTPA manganese	ppm	220	260	280	215	265	280
DTPA copper	ppm	6	7	9	5	6.9	8
DTPA zinc	ppm	55	70	60	45	90	80

Plot 1: One time treated soil; Plot 2: second time treated soil; RW→Raw water; 50% SW→50% distillery spentwash; 33% SW→33% distillery spentwash

Table 3: Characteristics of experimental soil.

Parameters	Units	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Coarse sand	%	53.3	10.94	9.82	9.87	9.85
Fine sand	%	26.2	42.86	40.70	40.65	40.72
Silt	%	8.2	26.32	25.48	25.53	25.77
Clay	%	12.3	19.88	24.00	23.95	23.66
Taxonomic name	-	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf
Textural class	-	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam
pH (1:2 soln.)	%	7.86	8.15	8.44	8.56	8.41
Electrical conductivity	µS	443	451	544	532	540
Organic carbon	%	0.38	0.93	1.21	1.35	1.77
Available nitrogen	ppm	386.8	460	380	396	402
Available phosphorus	ppm	32.54	180	160	180	202
Available potassium	ppm	56.5	65	95	102	113
Exchangeable calcium	ppm	140	150	175	179	185
Exchangeable magnesium	ppm	187	190	265	268	276
Exchangeable sodium	ppm	38	180	120	122	125
Available sulphur	ppm	225	230	325	329	337
DTPA iron	ppm	200	240	220	221	232
DTPA manganese	ppm	232	260	220	225	230
DTPA copper	ppm	3.10	8	7	9	12
DTPA zinc	ppm	50	65	62	65	66

Sample 1→Untreated soil; Sample 2→One time treated soil; Sample 3→Second time treated soil; Sample 4→Third time treated soil; Sample 5→Fourth time treated soil

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Original Research Paper

Investigation of Impact of Distillery Spentwash on Soil Characteristics

S. Chandraju, H. C. Basavaraju* and C. S. Chidankumar**
Department of Studies in Sugar Technology, Sir M.V. P.G. Centre, University of Mysore, Tubinakere, Mandya-571402, Karnataka
*Department of Chemistry, Jnana Vikas Institute of Technology, Bidadi-562109, Karnataka
**Department of Chemistry, Bharathi College, Bharathi Nagar-571 422, Karnataka

Key Words:
Distillery spentwash
Application of spentwash
Soil characteristics
Soil Nutrients
Uptake of nutrients

ABSTRACT

A field investigation was carried out during 2007-2008 to study the impact of use of primarily treated distillery spentwash (PTSW) and diluted distillery spentwash (50% and 33%) on sandy loam soil physico-chemical characteristics. Impact of distillery spentwash on soil characteristics like pH, electrical conductivity, total organic carbon, available nitrogen (N), phosphorus (P), potassium (K), exchangeable calcium (Ca), magnesium (Mg), sodium (Na), available sulphur (S), iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were studied at different intervals of time. Long-term application of distillery spentwash proved useful in significantly increasing most of the characteristics. The nutrient availability, viz., N, P, K, Zn, Cu, Fe and Mn contents in soil was significantly higher with decreased dilution. The impact of distillery spentwash on physical and chemical characteristics of sandy loam soil was studied and it was found that application of distillery spentwash improves the nutrient status of soil.

INTRODUCTION

Disposal of distillery spentwash is practised as an alternative for reducing pollution as its application in agricultural fields improves all the factors involved in soil fertility. Spentwash is produced as wastewater in distillery during manufacture of ethanol, but it contains valuable recyclable substances to produce plant biomass by improving the nutrient status of soil. The addition of distillery slops and molasses to column of saline sodic soil changes hydraulic conductivity, aggregate stability and improvement in infiltration rate (Escolar 1963). The physical properties of soil like water retention, hydraulic conductivity and water stable aggregates were adversely affected with irrigation of distillery effluent (Jadav & Sawant 1975). The addition of spentwash without dilution was very effective in increasing the water intake rate of sodic calcareous soil, and application of spentwash followed by irrigation rather than dilution of spentwash at the time of its application was very effective in reclamation of sodic soil (Singh et al. 1980). The pH values of soil decreased with increased levels of spentwash, but electrical conductivity values increased with increased levels of spentwash (Patil et al. 2000). Increased potassium content in soil was observed when soil was treated with spentwash (Dongal & Savant 1978). It was found that application of vinasse for 20 years was benefited in terms of pH increase, higher potassium, calcium, magnesium and greater cation exchange capacity (CEC) (Orland et al. 1985). The application of spentwash to soil increased the soil nitrate-N availability, EC and interchangeable potassium, and the addition of distillery spentwash regardless of rate, raised the soil pH owing to increase in soil K, Ca, Mg and Na contents, and digested spentwash application increased soil concentration of most elements (Scandaliaris et al. 1987, Sweeny & Graetz 1991). It was found that addition of spentwash decreased the pH and EC of soil. There were significant changes in exchangeable K, Ca and Mg, and the DTPA extractable Fe, Zn and Mn contents of soil significantly increased at all stages of crop growth treated with diluted spentwash (Pawar et al. 1992). Irrigation with diluted distillery wastewater along with gypsum and press mud reduced the exchangeable Na and increased the available N, P and K and exchangeable Ca and Mg contents. The soil organic carbon, N, P and K contents were increased significantly with increase in the number of pre-sowing distillery effluent irrigation (Anil Kumar 1995). There was buildup of soil fertility with effluent application particularly soil organic carbon and K status. Further, with increase in the amount of effluent added, there was an increase in pH, EC, available N, P and K. It was found that in red soil with wheat as test crop, employing different effluent dilution levels (1:5, 1:10, 1:25 and 1:50) in comparison with undiluted effluent and freshwater, available N, P, K, Zn, Cu and Mn contents in soil decreased with increased dilution levels (Sukanya & Meli 2004). The application of distillery spentwash for three years to evaluate the effect on soil properties in deep black soil was found that the organic carbon and EC of the surface soil increased significantly with application of spentwash but the soil pH was not affected (Hati et al. 2005). However, not much information is available on the impact of diluted distillery spentwash such as 33% and 50% on soil characteristics in first time treated soil and application of spentwash in different intervals of short time. Therefore, the present investigation was carried out to study the impact of distillery spentwash against raw water treatment.

MATERIALS AND METHODS

The investigation was carried out during December 2006 to February 2008 at the field of Chamundi Distilleries Pvt. Ltd., Maliyur, Mysore district, Karnataka. The PTSW, 33% and 50% spentwash were collected and the physical and chemical parameters, and amount of nitrogen (N), potassium (K), phosphorus (P) and sulphur (S) were analysed using standard procedures. Plot 1 (untreated) and Plot 2 (one time treated) (each area of 10 × 10 feet) were treated with raw water, 33% and 50% spentwash with some vegetables plants as test crops. After harvesting the test crops, the soil was ploughed and exposed to sunlight for one month. Composite soil samples were collected in the month of February 2007 from the experimental site at 25 cm depth. After the application of primarily treated distillery spentwash on the soil at different intervals of time, the soils were also ploughed and exposed to sunlight. The soil samples were collected during December 2006 (Sample 1), March 2007 (Sample 2), June 2007 (Sample 3), September 2007 (Sample 4) and February 2008 (Sample 5). All the soil samples were air dried, powdered and analysed for physical-chemical characteristics using standard procedures.

RESULTS AND DISCUSSION

Table 1 revealed the changes in the values of parameters in PTSW, 33% and 50% spentwash. It was found that all the parameters were decreased in the case of 33% spentwash as compared with PTSW and 50% spentwash. However, the application of 33% and 50% spentwash to the soil samples increased most of the parameters.

The impact of diluted spentwash compared with raw water in first time treated (Plot 1) and second time treated (Plot 2) soils were studied and are shown in Table 2. It was found that the pH and EC values increased with the application of 50%, and 33% spentwash treatment in both plots 1 and

Table 1: Chemical composition of the distillery spentwash.

Chemical parameters	Units	PTSW	50% SW	33% SW
pH	-	7.36	7.36	7.24
Electrical conductivity	μS	28800	19660	10020
Total solids	mg/L	46140	26170	20870
Total dissolved solids	mg/L	35160	16060	10140
Total suspended solids	mg/L	10540	5680	4380
Settleable solids	mg/L	10070	4340	3010
COD	mg/L	40530	18316	10228
BOD	mg/L	16200	7818	4800
Carbonate	mg/L	Nil	Nil	Nil
Bicarbonate	mg/L	13100	7400	4200
Total phosphorus	mg/L	30.26	12.20	6.79
Total potassium	mg/L	7200	3700	2400
Calcium	mg/L	940	600.0	380.0
Magnesium	mg/L	1652.16	884.16	542.22
Sulphur	mg/L	74.8	35.0	22.6
Sodium	mg/L	480	260	240
Chlorides	mg/L	5964	3272	3164
Iron	mg/L	9.2	6.40	5.20
Manganese	mg/L	1424	724	368
Zinc	mg/L	1.28	0.72	0.41
Copper	mg/L	0.276	0.134	0.074
Cadmium	mg/L	0.039	0.021	0.010
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Chromium	mg/L	0.066	0.032	0.014
Nickel	mg/L	0.165	0.084	0.040
Ammonical nitrogen	mg/L	743.68	345.24	276.64

PTSW→Primary treated spentwash; 50% SW→50% distillery spentwash; 33% SW→33% distillery spentwash

2 than raw water. In both the plots an increased uptake of organic carbon, available N, P, K, and S, and exchangeable Ca, Mg, Na and DTPA Fe, Mn, Cu and Zn were observed with the application of diluted spentwash compared with water. However, uptake of available P and DTPA Fe and Zn were remarkably influenced by the application of 50% spentwash than 33% spentwash and improved uptake of the organic carbon, available N, P, K and S, and exchangeable Ca, Mg, Na and DTPA Mn and Cu were observed in the case of 33% than 50% spentwash.

The impact of application of primarily treated distillery spentwash (PTSW) on soil characteristics was studied and as shown in Table 3. It was found that pH value increased with increased number of applications of spentwash, but the decreased value was observed in the fourth time treatment. EC value of the soil increased with application of spentwash up to second time treatment and decreased value was observed in the third treatment which further increased with fourth time application. Increased value of soil organic carbon was noticed with the application of spentwash. It was found that the uptake of available potassium and exchangeable calcium, magnesium and DTPA copper and available sulphur increased with the application of spentwash. The uptake of available nitrogen, phosphorus and DTPA iron, manganese and zinc increased in the first time treatment, and decreased value was observed in the second treatment but the values increased further with the application of spentwash.

CONCLUSION

It was noticed that the nutrient uptake in soils was largely influenced by distillery spentwash treatment in case of the both 33% and 50% diluted distillery spentwash than raw water. 33% distillery spentwash treatment shows more uptake of nutrients than 50% diluted spentwash in first time treated and second time treated soils. This could be due to the efficient absorption of nutrients by soil at high dilution. The application of PTSW to soils improved most of the nutrients. Hence, spentwash can be used to increase the fertility of soils without any adverse effects.

ACKNOWLEDGEMENT

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Table 2: Chemical characteristics experimental soil.

Chemical Parameters	Units %	Plot 1			Plot 2		
		RW	50% SW	33% SW	RW	50% SW	33% SW
Coarse sand	%	9.68	10.20	9.68	11.23	11.36	11.46
Fine sand	%	42.36	38.80	40.64	42.64	39.48	40.72
Silt	%	24.27	26.44	25.26	26.84	27.46	27.38
Clay	%	23.69	24.56	24.42	19.29	20.68	20.44
pH (1:2 solution)	-	8.07	8.33	8.29	8.07	8.41	8.21
Electrical conductivity	µS	2660	5760	3310	932	4451	2360
Organic carbon	%	1.09	1.21	1.28	1.16	1.78	1.89
Available nitrogen	ppm	140	380	440	120	240	230
Available phosphorus	ppm	130	170	140	120	250	230
Available potassium	ppm	60	70	85	110	128	140
Exchangeable calcium	ppm	140	160	190	178	180	190
Exchangeable magnesium	ppm	180	190	220	245	260	270
Exchangeable sodium	ppm	110	130	140	130	160	165
Available sulphur	ppm	160	210	240	129	140	185
DTPA iron	ppm	190	240	210	165	180	170
DTPA manganese	ppm	220	260	280	215	265	280
DTPA copper	ppm	6	7	9	5	6.9	8
DTPA zinc	ppm	55	70	60	45	90	80

Plot 1: One time treated soil; Plot 2: second time treated soil; RW→Raw water; 50% SW→50% distillery spentwash; 33% SW→33% distillery spentwash

Table 3: Characteristics of experimental soil.

Parameters	Units	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Coarse sand	%	53.3	10.94	9.82	9.87	9.85
Fine sand	%	26.2	42.86	40.70	40.65	40.72
Silt	%	8.2	26.32	25.48	25.53	25.77
Clay	%	12.3	19.88	24.00	23.95	23.66
Taxonomic name	-	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf	Typic Rhodustalf
Textural class	-	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam
pH (1:2 soln.)	%	7.86	8.15	8.44	8.56	8.41
Electrical conductivity	µS	443	451	544	532	540
Organic carbon	%	0.38	0.93	1.21	1.35	1.77
Available nitrogen	ppm	386.8	460	380	396	402
Available phosphorus	ppm	32.54	180	160	180	202
Available potassium	ppm	56.5	65	95	102	113
Exchangeable calcium	ppm	140	150	175	179	185
Exchangeable magnesium	ppm	187	190	265	268	276
Exchangeable sodium	ppm	38	180	120	122	125
Available sulphur	ppm	225	230	325	329	337
DTPA iron	ppm	200	240	220	221	232
DTPA manganese	ppm	232	260	220	225	230
DTPA copper	ppm	3.10	8	7	9	12
DTPA zinc	ppm	50	65	62	65	66

Sample 1→Untreated soil; Sample 2→One time treated soil; Sample 3→Second time treated soil; Sample 4→Third time treated soil; Sample 5→Fourth time treated soil

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