over NPK alone and high yield targets recorded higher critical levels. The reduction of fertilizer N, P_2O_5 and K_2O requirements under IPNS was of higher magnitude which in turn would have led to attaining the critical levels well in advance as compared to that of NPK alone.

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Research Notes

Impact of treated paper mill effluent irrigation on quality of soil and ground water

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The paper and pulp industry is classified as a highly water intensive one and it also forms a major polluter of soil and water resources. In order to utilize the enormous quantity of treated effluent, the bagasse based paper mill has established an Treated Effluent Water Lift Irrigation Society (TEWLIS) and has continously used the treated effluent water in the erstwhile drylands of rainfed regions in Pugalur taluk of Karur district, Tamil Nadu for agriculture since 1994. The treated paper mill effluent contains nutrients that enhance the plant growth but also has other toxic materials too.

A systematic study was conducted during 1996 and 1997 to assess the impact of continuous effluent irrigation on soil and ground water in TEWLIS area. The soil and ground water samples were collected periodically once in three months, at 17 bench marked sites, selected randomly within the ayacut area irrigated with treated paper mill effluent since 1994. Three sites were selected in Cauvery water irrigated areas, which were taken as control. Water samples collected from the wells were kept in freezer at 4°C to avoid microbial activity whereas the soil samples were dried in shade and processed for chemical analysis as per standard procedure (Jackson, 1973).

The analytical data on various chemical parameters on soil and ground water as influenced by the paper mill effluent and cauvery water (control) irrigation, over four year period is presented in Table 1. It is evident that continuous irrigation with treated paper mill effluent had increased the soil pH, electrical conductivity (EC), organic carbon (OC), available NPK, exchangeable sodium percentage (ESP), exchangeable Na, Ca, K except Mg which was higher in cauvery river water irrigated soils. The soil EC and ESP were increased by 94 and 127 per cent due to effluent irrigation over control. The increase of soluble salt content in soil under effluent irrigation could be ascribed to the salt content of the treated effluent. An increasing trend on soil EC, OC and available NPK and exchangeable cations and ESP due to continous paper mill effluent irrigation over a period of 15 years has been reported by Palaniswami and Sree Ramulu (1994). The bacteria, fungi and actinomycetes populations of the soil were also increased due to continuous effluent irrigation.

The ground waters within the effluent irrigated areas had less pH but high EC, total hardness, carbonates, bicarbonates, chlorides sulphates, sodium, calcium, magnesium, potassium

Table 1. Effect of treated paper mill effluent on soil and ground water quality

Properties	Paper mill effluent irrigated (mean of 17 observations)			Cauvery water irrigated area (mean of 3 observations)		
	Oct. 96	Jan. 97	April 97	Oct. 96	Jan. 97	April 97
Soil						
pH	8.28	8.35	8.40	8.23	8.32	8.37
EC (dSm^{-1})	1.26	1.36	1.40	0.61	0.74	0.73
OC (per cent)	0.58	0.61	0.63	0.50	0.52	0.54
$KMnO_4$ - N (kg^{-1})	85.29	89.66	95.38	80.70	84.13	90.77
Olsen's - P (kg^{-1})	13.84	14.26	14.61	9.53	10.00	10.47
NH_4OA_c - K (kg^{-1})	241	348	363	339	340	356
Exch.Na (C mol (p^+) kg^{-1})	8.13	8.87	9.85	3.35	3.52	3.70
Exch.Ca (C mol (p^+) kg^{-1})	11.62	11.86	12.63	9.56	9.67	12.22
Exch.Mg (C mol (p^+) kg^{-1})	7.81	8.40	9.23	13.03	13.57	13.20
Exch.K (C mol (p^+) kg^{-1})	0.67	0.75	0.82	0.36	0.39	0.45
ESP	28.33	29.45	30.25	12.87	13.09	12.75
Ground water						
pH	8.12	8.24	8.30	8.51	8.65	8.53
EC (dSm^{-1})	1.95	2.06	2.19	0.65	0.72	0.52
Total hardness (mg l^{-1})	549	567	585	244	252	236
Carbonates (mg l^{-1})	44.4	48.5	51.8	33.0	36.0	36.0
Bicarbonates	333	344	350	315	324	325
Chlorides (mg l^{-1})	745	763	685	124	130	61
Sulphates (mg l^{-1})	668	681	787	264	273	272
Sodium (mg l^{-1})	173	183	191	77	84	69
Sodium per cent	46.51	46.80	45.37	39.64	39.88	40.33
Potential salinity (m.e. l^{-1})	27.99	28.63	27.43	6.25	6.51	4.55
SAR	3.23	3.36	3.47	1.80	2.06	1.77
RSC (m.e.l^{-1})	-4.11	-4.09	-4.13	-0.53	-0.57	0.90

sodium per cent, SAR and RSC than that of cauvery river water. The EC and SAR values increased 2 to 3 times within four years of continuous effluent irrigation while the increase was marginal with respect to per cent sodium. High sodium, calcium, magnesium and potassium in the effluent through leaching and infiltration might have contaminated the ground waters. The potential salinity of the ground waters in effluent irrigated filed was increased three tiems over control and the values crossed the safer limits in many places indicating that the ground water was polluted with chlorides and sulphates. The salinity was due to accumulation of chlorides and sulphates through effluent irrigation. The SAR values of ground water samples were well within the safer limit and the RSC of ground water fell under safe category (<1.25). The RSC values were negative in most of the cases since calcium and magnesium were higher than carbonate and bicarbonate. The ground water could be used for irrigation in light textured soils with proper drainage facilities.

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