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Soil fertility management in fodder cultivated area through sewage water irrigation

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Abstract : Field experiments were conducted at AC & RI, Madurai to study the effect of sewage effluent on nutrient availability in soils besides improving the fodder yield and quality of bajra napier hybrid grass (BN 2) . Field experiments were conducted in a spilt plot design with two irrigation sources *viz.*, ordinary water (I_1) and sewage effluent (I_2) as main plots and four N leves *viz., 0,* 50, 75 and 100 kg N ha^{-1} as sub plot treatments with three replications. BN 2 grass was grown as a test crop. The analyses of sewage effluent collected at periodic intervals showed that the sewage effluent was alkaline in reaction (pH : 8.3), non-saline (EC: 1.1-1.5 dSm^{-1}). The total N, P, K, Ca and Mg contents ranged from 220-700 ppm, 3-14 ppm, 16-268 ppm, 18-292 ppm and 19-134 ppm, respectively. The micronutrients like Zn, Cu, Mn and Fe ranged from traces - 0.18, traces- 0.06, 0.03- 0.21 and traces-12.84 ppm respectively. The heavy metals like selenium and cadmium were absent whereas lead, chromium and nickel were present in trace amounts. The bacterial, fungi and actinomycetes population in sewage water were 3.55 x 10^{7}ml^{-1}, 2.68 x 10^{3}ml^{-1} and 5.55 x 10^{3}ml^{-1}, respectively. Periodic soil samples were taken after 2nd, 4th and 8th cuts during first year and after 4th and 8th cuts during second year. Addition of increased levels of N increased the available N content in soil. Irrigation with sewage effluent increased the organic carbon content (0.96%) compared to ordinary water (0.65%). A built up in soil available N, K and organic carbon content was observed due to sewage effluent irrigation. *(Key words : Bajra Napier Hybrid Grass, Sewage effluent, Nutrient availability, Organic carbon, Micro nutrients)*

Growing fodder crops using waste water and effluents is gaining commercial importance. The commercial fodder production invariably invites heavy applications of nitrogenous fertilizers to enhance productivity. In addition to large amount of certain plant nutrients, organic matter and heavy loads of microorganisms, such waste waters may also contain appreciable amounts of micronutrients (Fe, Mn, Cu and Zn) and heavy metals (Ni, Cr, Cd, Pb, Se etc...) depending on their source. Their possible potential pollution hazards on soil, environment and fodder require evaluation for long term monitoring purposes. Keeping this in view, the present investigation was carried out to assess the fertility built up in fodder cultivated area through sewage water irrigation.

Materials and Methods

Field experiments were conducted during 1992-93 to study the effect of sewage effluent

Table 1. Characteristics of the experimental site soil

Characteristics	Value	
	0-15 cm	15-30 cm
Coarse sand (%)	34.50	37.41
Fine sand (%)	23.40	20.40
Silt (%)	18.70	17.90
Clay (%)	20.5	20.48
Texture	Sandy clay loam	Sandy clay loam
pH (1:2)	7.80	7.40
EC (1:2) (dSm^{-1})	0.60	0.63
Organic carbon (%)	0.86	0.26
Available N (kg ha^{-1})	263.4	194.4
Available P (kg ha^{-1})	16.70	14.90
Available K (kg ha^{-1})	348.5	329.50
Available Cu (ppm)	1.04	0.96
Available Zn (ppm)	1.50	0.88
Available Mn (ppm)	14.60	15.20
Available Fe (ppm)	17.04	15.14

on nutrient availability in soils besides improving the fodder yield and quality of BN 2 grass. The experiment was conducted in a split plot design with two irrigation sources *viz.*, ordinary water (I_1) and sewage effluent (I_2) as main plots and four N levels *viz.* 0, 50, 75 and 100 kg N ha^{-1} as sub plot treatments with three replications. The characteristics of the soil used for this study is furnished in Table 1. The experimental soil was non saline (0.60 dSm^{-1}) and alkaline in reaction (pH, 7.8) low in available N, medium in available P and high in available K content. All the micronutrients were in sufficient range.

The analyses of sewage effluent collected at periodic intervals showed that the sewage effluent was alkaline in reaction (pH: 8.3), non-saline (EC : 1.1-1.5 dSm^{-1}). The total N, P, K, Ca and Mg contents ranged from 220-700 ppm, 3-14 ppm, 16-268 ppm, 18-292 ppm and 19-134 ppm, respectively. The micronutrients like Zn, Cu, Mn and Fe ranged from traces-0.18, traces -0.06, 0.03 -0.21 and traces- 12.84 ppm, respectively. The heavy metals like selenium and cadmium were absent. Whereas lead, chromium and nickel were present in trace amounts. The bacterial, fungi and actinomycetes population in sewage water were 3.55 x $10^7 ml^{-1}$, 2.68 x $10^3 ml^{-1}$ and 5.5 x $10^3 ml^{-1}$, respectively. The BN 2 grass was grown as a test crop for two years. Periodic soil samples were taken after 2^{nd}, 4^{th} and 8^{th} cuts during first year and after 4^{th} and 8^{th} cuts during second year.

The pH and EC of sewage effluent as well as initial soil were analysed using pH meter and electrical conductivity bridge respectively by the method of Jackson (1973). The total N in sewage effluent was estimated by the Kjeldahl method (Piper, 1966), total P by vanadomolylbdate method (Jackson, 1973), total Ca and Mg by versenate titremetry (Jackson, 1973), micronutrients *viz.*, Fe, Cu, Mn and Zn by Atomic Absorption Spectrophotometer (Lindsay and Norwell, 1978). The soil was analysed for available N by alkaline permanganate method (Subbaiah and Asija, 1956), available P by Olsen's method (Olsen and Watanabe, 1956), available K by neutral N NH_4OAC method (Stanford and English 1949), organic carbon by chromic acid wet oxidation method (Walkley and Black, 1934) and available micronutrients (Fe, Mn, Cu and Zn) by DTPA extract method in AAS (Jackson, 1973).

Results and Discussion

Nitrogen Availability

The available N content in the soil (after 2^{nd}, 4^{th} and 8^{th} cut during the first year and after 4^{th} and 8^{th} cut in the second year) was presented in Table 2. The available N content of the soil ranged from 177 to 391 kg ha^{-1}.

Table 2. Effect of N levels and irrigation source on available N status of the soil (kg ha^{-1}) (Mean of three replications)

N levels (kg ha^{-1})	First year									Second year					
	2ndcut			4th cut			8th cut			4th cut			8th cut		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
0	198	250	224	196	177	187	231	176	204	277	278	278	299	320	310
50	225	227	226	237	223	230	284	244	264	342	315	329	292	314	303
75	252	246	249	269	225	247	255	249	252	348	331	340	306	322	314
100	227	242	235	271	269	270	271	268	270	342	391	367	325	361	343
Mean	226	241	-	243	224	-	260	234	-	327	329	-	306	329	-
	SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)	
I	21.22	NS		9.66	NS		26.65	NS		9.03	NS		20.61	NS	
N	27.80	NS		28.54	NS		22.82	49.7		22.76	49.60		13.29	28.96	
I x N	38.96	NS		40.70	NS		32.27	NS		32.39	NS		18.79	NS	

Table 3. Effect of N levels and irrigation sources on available P status of the soil (kg ha^{-1}) (Mean of three replications)

N levels (kg ha^{-1})	First year									Second year					
	2ndcut			4th cut			8th cut			4th cut			8th cut		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
0	17.8	15.3	16.6	19.7	16.5	18.1	6.0	3.7	4.9	16.32	10.92	13.62	20.27	19.00	19.64
50	20.5	19.0	19.8	23.2	18.6	20.9	6.0	5.2	5.6	25.09	11.44	18.27	17.99	16.95	17.47
75	18.6	18.3	18.5	16.9	24.5	20.7	9.3	8.9	9.1	22.62	21.94	22.28	30.02	31.25	30.64
100	24.5	21.3	22.9	18.2	22.8	20.5	14.9	8.2	11.6	26.49	17.36	21.93	29.10	19.62	24.36
Mean	20.4	18.5	-	19.5	20.6	-	9.1	6.5	-	22.63	15.42		24.35	21.70	
	SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)	
I	1.28	NS		2.55	NS		2.09	NS		0.31	1.33		6.57	NS	
N	2.20	NS		2.73	NS		1.35	2.93		5.99	NS		4.56	NS	
I x N	2.98	NS		4.21	NS		2.66	NS		8.48	NS		6.45	NS	

Sewage water irrigation had no significant influence in increasing the available N content in soil during the first year as well as in the second year experiment. Addition of different N levels showed a significant response in increasing the available N content in soil in the post harvest soil samples (after 8th cut) of the first year and second year and also after 4th cut in the second year. Addition of N @ 100 kg ha^{-1} recorded maximum available N content in soil compared to control. Ramanathan *et al.* (1977) reported that the available N content in the soil irrigated with sewage was greater than that in soil irrigated with well water. The combined application of organic manure (FYM) and fertilizer (Urea) in 50:50 ratio @ 100 kg N ha^{-1} along with 80 kg P_2O_5 ha^{-1} increased not only available nutrients (N and P) but also forage yield of oats and its quality (Tripathi and Hazra, 1996).

Phosphorus Availability

There was a built up in available P content in soil after 2nd and 4th cut in the first year and after 4th and 8th cut in the second year irrespective of sources of irrigation. Basal application of P_2O_5 @ 50 kg ha^{-1} has sustained the fertility status of available P in soil in the first year as well as in the second year except in the post harvest soil sample (after 8th cut) in the first year. The reason for the reduction in available P content was mainly due to the utilization of P by the forage grass throughout the year. Sewage water irrigation had significantly reduced the available P content in soil (15.4 kg ha^{-1}) compared to ordinary water (22.6 kg ha^{-1}) during the 2nd year field experiment. Where as irrigation showed a non significant response in available P content of the soil during the first year (Table 3). Similar to this findings Kardos and Hook (1976) found no significant increase in Bray-P in the 30 to 60 cm zone in a sewage effluent treated soil (nine years of treatment). Whereas other studies showed a positive response to sewage water irrigation. Irrigation with sewage water increased phosphorus content compared to soil irrigated with well water (Day and Strohlein, 1972). Similar results were also reported by Bennet *et al.*, (1973) and Ramanathan *et al.* (1977). Addition of N had no significant effect in influencing the available P status of soil except in the first year post harvest soil wherein application of N @ 75 and 100 kg ha^{-1} had significantly increased the available P content of the soil (9.1 and 11.6 kg ha^{-1} respectively).

Table 4. Effect of N levels and irrigation sources on available K status of the soil (kg/ha^{-1}) (Mean of three replications)

N levels (kg ha^{-1})	First year									Second year					
	2nd cut			4th cut			8th cut			4th cut			8th cut		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
0	392	769	581	235	483	359	463	429	446	235	683	459	214	459	337
50	455	709	582	306	698	502	545	500	523	433	769	601	426	564	495
75	457	859	658	325	720	523	444	493	469	407	806	607	313	605	459
100	437	937	687	310	736	523	567	687	627	508	967	738	433	612	523
Mean	435	819	-	294	659	-	505	527	-	396	806	-	347	560	-
	SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)		SE_d	CD (5%)	
I	71.18	306		78.36	337		78.92	NS		122.9	NS		60.38	NS	
N	53.50	NS		76.01	NS		58.14	127		67.24	146.5		64.18	NS	
I x N	75.67	NS		107.5	NS		82.22	NS		95.09	NS		90.76	NS	

Table 5. Effect of N levels and irrigation sources on organic carbon content (%) in post harvest soil samples.

N levels (kg ha^{-1})	I Year (after 8[th] cut)			II year (after 8[th] cut)		
	I_1	I_2	Mean	I_1	I_2	Mean
0	0.85	0.87	0.86	0.58	0.70	0.64
50	0.84	0.90	0.87	0.78	0.88	0.83
75	0.68	1.20	0.94	0.64	1.20	0.92
100	0.50	1.09	0.80	0.60	1.11	0.86
Mean	0.72	1.02	-	0.65	0.97	-
	SE_d	CD (5%)		SE_d	CD (5%	
I	0.020	0.085		0.023	0.097	
N	0.024	0.052		0.019	0.041	
I at N	0.035	0.099		0.032	0.104	
N at I	0.034	0.073		0.027	0.059	

Potassium Availability

Irrigation with sewage effluent significantly increased the available K content over ordinary water irrigation in the first year (after 2[nd] and 4[th] cuts). Application of N at different levels had significantly increased the available K content of the soil in the post harvest soil samples (after 8[th] cut) in the first year and after 4[th] cut in the second year. Addition of 100 kg N ha^{-1} showed increased available K content in the soil (627 kg ha^{-1}-I year and 738 kg ha^{-1} -II year) (Table 4). Increase in N, P and K content in the soil due to sewage water irrigation was reported by Klimo and Fekete (1990). Similar results were also reported by Maiti *et al.* (1992) and Ramanathan *et al.* (1977). Investigation by Hortenstine (1974) revealed that irrigation with sewage effluent increased the K content from 0.05 ppm to 14 ppm in the soil.

Organic Carbon Content

In the present study the organic carbon content showed conspicuous difference with different irrigation sources. A marked increased in soil organic matter was observed with the sewage water irrigation. Sewage water irrigation had increased the organic carbon content of the soil (1.02 and 0.97%) compared to ordinary water (0.72 and 0.65%) during the first year as well as in the second year experiment respectively (Table 5). This might be due to the continuous irrigation of the fields with these water which contained large quantities of organic matter. Similar change in the trend and magnitude in organic matter content of soil was reported by Cooker *et al.* (1987) and Smith *et al.*, (1989).

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Efficient utilization of sewage water for improving the forage yield and quality of bajra-napier hybrid grass

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Abstract : Field experiments were conducted at Agricultural College and Research Institute, Madurai to compare the effect of sewage effluent on yield and quality of Bajra Napier hybrid grass with two irrigation sources *viz.,* ordinary water (I_1) and sewage effluent (I_2) as main plots and four N levels *viz., 0,* 50, 75 and 100 kg N ha^{-1} as sub plot treatment in a split plot design with three replications. BN 2 grass was grown as a test crop. Among the different levels of N, application of 100 kg N ha^{-1} recorded the highest green fodder (303 t ha^{-1}), dry matter (61 t ha^{-1}) and crude protein (5.26 t ha^{-1}) yield. Sewage effluent irrigation increased the green fodder, dry fodder and crude protein yield. The interaction effect between sewage effluent irrigation and N showed that 100 kg N ha^{-1} with sewage effluent irrigation recorded the highest green fodder yield of 357 t ha^{-1}, dry matter yield of 72 t ha^{-1} and crude protein yield of 6.37 t ha^{-1}. Sewage water irrigation showed increased total K, Ca, Fe, Mn and Zn content in BN 2 grass. The oxalic acid content was within the safe limit at all the levels of N tried (2.04-2.08%) and with sewage effluent irrigation (2.14-2.61%). A decrease in crude fibre content was observed due to the increased addition of N at both the source of irrigation because of involvement of N in protein synthesis and consequent reduction in carbohydrate, ultimately leading to better digestibility of the grass. ***(Key words : Bajra Napier hybrid grass, Sewage Effluent, Drymatter, Crude protein, Crudefibre, Oxalic acid)***