https://doi.org/10.29321/MAJ.10.A02443

Madras agric J. 71. (2): 100—104 February 1984

NITROGEN AND PHOSPHORUS LEVELS IN SOILS UNDER MUNICIPAL SEWAGE EFFLUENT IRRIGATION

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Sewage irrigation continuously over a period of 25 years and 15 years significantly favoured the total, ammonical and available N content in the soil. While NH_4-N accumulation was of a higher order in sewage treated soil NO_3-N concentration was comparatively lower, irrespective of years of treatment. In 25 years sewage irrigated soils, a three fold increase in available phosphorus was observed. The concentration of total and available phosphorus decreased with depth.

Currently there is considerable interest in the use of sewage effluent for irrigation, as several benefits are associated with this method of sewage disposal. Several workers have reported that organic matter content in the soil increased due to application of sewage sludge. Ramanathan *et al.* (1977) reported that the available N content in soil irrigated with sewage water was greater than that in soil irrigated with well water. Schalscha *et al.* (1979) observed significant amounts of NO_3-N in the surface soil irrigated with untreated sewage water. Taylor *et al.* (1978) observed that addition of sewage sludge compost to soils resulted in varying amounts of extractable P.

Sewage sludge can be used to correct P deficient conditions in soils. In this investigation, attempt has been made to study the effect of continous irrigation with sewage effluent to the black soils of Tamil Nadu on the levels of nitrogen and phosphorus. A sewage farm belonging to Coimbatore Municipality has been chosen for the study.

MATERIAL AND METHODS

Nine profile pits up to a depth of 105 cm i.e. three pits each in 25 years (T1). 15 years sewage irrigated files (T2) and in the farmer's fields (without sewage irrigation-T3) Surrounding the sewage farm were dug and soil samples at the rate of seven samples per pit (0-15, 15-30, 30-45, 45-60, 60-75, 75-90 and 90-105 cm) were collected and analysed for total N (Jackson, 1973) total phosphoric acid (Pemberton, 1945), available N (Subbiah and Asija, 1956), available phosphorus (Olsen *et al.*, 1954), and from the supernatant liquid of 1 M KC1 extract, NH_4-N and NO_3-were determined as per the method described by Jackson (1973).

The sewage water samples were analysed for pH, EC, total solids, N, P and the results are present in Table 1.

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RESULTS AND DISCUSSION

Soil Nitrogen: Sewage irrigation favoured significantly the total nitrogen content of the soils. Twenty five years and 15 years sewage irrigated fields recorded 0.07 and 0.05 per cent of total nitrogen respectively which were 133 and 66 per cent increase over the fields of without sewage irrigation. Increased N accumulation consequent on sewage irrigation finds support in the work of Keefer *et al.* (1976). This may be probably due to the large additions of organic matter to the soil which in turn might have increased the soil total nitrogen. The depthwise data indicated that 0-15 cm surface soil had the highest total nitrogen and the same progressively decreased with depth. The interaction between depth and time was also significant (Table 2).

Ammonical nitrogen content ranged from 23.10 to 33.44 ppm (Table 4). Sewage irrigation over 25 years significantly recorded higher values as compared to others. The ammoniacal N content was observed to decrease with depth. A plausible explanation for the increase in the NH_4-N content could be that the NH_4-N present in the sewage might have been absorbed by the soil colloids upon the addition of sewage wastes to soil with subsequent leaching with water. A similar observation was made by Lance and Whisler (1972). Ammoniacal nitrogen was correlated positively with total nitrogen (r values for T1 and T2: 0.88**; 0.89**).

While NH_4-N accumulation was of a higher order in sewage treated soil' NO_3-N concentration was comparatively low, irrespective of the years of treatment (Taylor *et al.*, 1978 and Soon *et al.*, 1978). The treatments T1 and T2 showed an increase of 28 and 13 per cent of NO_3-N respectively over T3. Signifying the trend that successive additions of sewage might have favoured the accumulation of NO_3-N which other wise seldom occurs in soils. The increase in NO_3-N content could be well attributed to the increased microbial mineralisation of organic N and due to oxidation of NH_4-H to NO_3-N The content of NO_3-N was higher in the third layer (30-45 cm) in all the treatments. This may be attributed to the favourable nitrification processes and the nitrate so formed might have subsequenty leahed down to the lower layers of soil along with the percolating water. This is in agreement with Schalscha (1979).

The highest available nitrogen was found in T1, which may probably be due to high organic matter addition and microbial activities. It is pertinent to state from the work of Ramanathan *et al.*, (1977) that sewage irrigation influenced the availability of nitrogen in soil.

Soil Phosphorus: Superiority of sewage irrigation on total and available phosphorus status of soil was well brought out (Table 3). Mention may be made on available phosphorus status of 25 years sewage irrigated soils (T1) where a three fold increase in available phosphorus status was registered. This could be attibute to the increased phosphorus content in the sewage wastes which in turn could have caused a marked increased in the availability of phosphorus in the soils of sewage farm. This becomes obvious in the context of work carried out by Milne and Graveland (1972). Subbiah (1976) and Rajarajan (1978) that sewage incorporation resulted in the higher availability of phosphorus. The concentrations of total and available phosphorus decreased with depth. This might be due to high iron and manganese contents in the lower layers of the sewage amended soils which could have rendered phosphorus unavailable. Total phosphorus was correlated positively with available phosphrous ($r=0.61^{**}$ for T1 and $r=0.83^{**}$ for T2).

The investigation revealed that sewage effluent irrigation to the fields was found to increase the total, ammoniacal and available nitrogen and also total and available phosphorus contents of soil. The concentration of total and available phosphorus was found to decrease with depth.

The first author is grateful to the Tamil Nadu Agricultural University for according permission to publish data which formed part of M. Sc. (Ag.) thesis.

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Table 1 : Composition of sewage water.

Particulars	December, 1979		May, 1980	
	Influent to sewage farm after settlement and digestion	Effluent from the sewage farm	Influent to sewage farm after settlement and digestion	Effluent from the sewage farm
Total solids (mg/lit)	2110	1570	2010	1360
pH	7.5	7.8	7.2	7.5
EC (m. mhos/cm)	1.2	0.65	1.0	0.70
a) Total nitrogen (mg/lit)	91.8	58.8	8.14	59 3
b) Ammoniacal N (mg/lit)	76.3	43.0	69.3	41.7
c) Nitrate N (mg/lit)	0 8	—	1.0	—
Biological oxygen demand (mg/lit)	51.5	187	510	205
Total phosphorus (mg/lit)	37.5	25	41.5	20.1
Total potassium (mg/lit)	17.0	5.5	21.3	6.5

Table 2. Effect of continuous sewage irrigation on total, available, ammoniacal and nitrate nitrogn content of soil (mean values).

Profile depth (cm)	Total nitrogen (%)				Available Nitrogen (ppm)				Ammoniacal Nitrogen (ppm)				Nitrate Nitrogen (ppm)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
0-15	0.23	0.13	0.07	0.14	226	140	122	163	65	37	30	44	20.50	17.70	14.00	17.40
15-30	0.10	0.08	0.05	0.08	155	125	123	[illegible]	36	29	27	30	17.80	14.00	12.30	14.70
30-45	0.04	0.03	0.03	0.03	105	90	98	98	29	26	22	26	23.10	20.50	16.60	20.07
45-60	0.03	0.02	0.03	0.03	93	82	82	86	30	22	23	25	23.00	19.60	15.10	19.23
60-75	0.03	0.02	0.02	0.02	96	48	75	70	29	20	22	23	17.30	14.00	11.90	14.40
75-90	0.03	0.02	0.02	0.02	72	53	60	62	24	19	20	21	14.40	12.30	11.10	12.60
90-105	0.03	0.02	0.02	0.02	62	47	46	52	21	15	18	19	12.20	11.60	10.40	11.40
Mean	0.07	0.05	0.03		114	84	87		33	24	23		18.33	15.67	13.06	
CD Values	(P=0.05)				(0.05)				(0.05)				(0.05)			
Time	0.004				6.18				2.93				1.89			
Depth	0.006				9.44				4.47				1.37			
Time X Depth	0.01				16.35				7.75							

T1 = Sewage irrigation (25 years), T2 = Sewage irrigation (15 years)
T3 = Without sewage irrigation (Farmers' holding)

Table 3 : Effect of continuous sewage irrigation on total and available phosphorus content of soil (Mean values)

Profile depth (cm)	Total Phosphorus (%) Sewage irrigation 25 years (T1)	Sewage irrigation 15 years (T2)	Without sewage irrigation (T3)	Mean	Available Phosphorus (ppm) Sewage irrigation 25 years (T1)	Sewage irrigation 15 years (T2)	Without sewage irrigation (T3)	Mean
0—15	0.20	0.09	0.07	0.12	9.00	7.60	6.80	7.80
15—30	0.14	0.09	0.07	0.10	9.20	2.90	1.80	4.63
30—45	0.08	0.07	0.05	0.07	6.40	2.10	1.40	3.30
45—60	0.08	0.06	0.05	0.06	5.30	1.10	0.90	2.43
60—75	0.07	0.05	0.04	0.05	2.80	1.50	0.80	1.70
75—90	0.07	0.05	0.05	0.06	2.47	1.20	0.60	1.40
90—105	0.07	0.05	0.03	0.05	2.60	1.00	0.50	1.35
Mean	0.10	0.07	0.05		5.38	2.48	1.82	
	CD Values (0.05)				*CD Values (0.05)*			
Time	0.01				2.52			
Depth	0.01				3.84			
Time x Depth	0.02				6.66			