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Influence of Sewage Wastes Addition on the Soil Characteristics: IV. Composition of Leachate Fraction*

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Laboratory experiments conducted to determine the effect of different levels (0, 40, 80, 120 and 160 t/ha) of sludge and liquid (50 per cent diluted and undiluted) sewage on the composition of leachate collected for 90 days from four soils of Tamilnadu revealed a significant effect on nutrient concentration in the leachate. The concentration of various nutrients in the leachate was maximum in treatment with 160 tons sludge/ha. Water leaching caused a slight increase in the concentration of these irons in the leachate fractions.

Increased urpanization has produced massive increases in municipal wastes. It has been estimated that a potential for the production of 18 million tonnes of manure in an year from these wastes exists, generating an income of Rs. 100 crores. Stewart *et al.* (1975) reported that application of sewage sludge to a loamy soil at 2.5 and 5.0 cm per ha had resulted in significant increases in soil NO_3-N in the 0 to 90 cm soil profile. Lance *et al.* (1976) reported that the NO_3-N concentration of water collected from soil columns with a low infiltration rate (15 cm/day) was consistently around 5 ppm with little evidence of a nitrate peak, whereas the water from columns with a 50 cm/day infiltration rate had a peak NO_3-N concentration of 70 to 80 ppm. Lund *et al.* (1976) observed that soils beneath sludge ponds were enriched in total N to a depth 4 and 8 m. Concentration of NH_4-N considerably in excess of control has observed to depths of 4 m, demonstrating the movement of substantial amounts of NH_4-N in soil below sewage waste water ponds. Concentration of NO_3-N in excess amount was observed in situation where samples were collected at 8.5 to 12.0 m. In view of the interest in land disposal of liquid sludge and the increasing concern regarding environmental quality, an investigation was conducted to determine the effect of sewage application on soil and leachate composition. In this paper the influence of sewages addition on the leachate composition collected from four soils viz. black, red, alluvial and laterite soils, have been reported.

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MATERIAL AND METHODS

Laboratory experiments were conducted using glass columns 40 cm in length and 9 cm in diameter. Before inserting the glass columns over porcelain funnels, two sheets of Whatman No. 1 filter paper were put on the funnel to prevent the soil particles moving down the column through the pores. Then two kg of soil passed through a 2 mm sieve was uniformly backed in the glass columns. There were seven such columns for each soil. Dried solid sludge (Table III) got from Tamilnadu Agricultural University domestic sewage pond was added at different (0, 40, 80, 120 and 160 tonnes / ha) levels which correspond to the treatments T_0, T_1, T_2, T_3 and T_4 and then the soil culumns leached with 25 ml of distilled water added every day. Such additions were condinued for three months. For the treatments T_3 and T_6 involving liquid sewage (Table III) the total quantity required to irrigate a three months old crop (40 cm) was calculated and this was equally divided for 90 days. The columns were saturated with water to field capacity to start with and in order to prevent evoporation loss the columns as well as jars were covered with polythene sheet. The leachate collected over the 90 day period was analysed for macro-and micronutrients. N, P, K, Ca, Mg and Na were analysed as per the methods descriped by Jackson (1967). Fe, Ca, Mn and Zn were estimated in the atomic apsorption spectrophotometer using the appropriate cathode lamp.

RESULTS AND DISCUSSION

The treatment effect (Table I) on micronutrient concentration in the leachate fraction was observed to be significant. Its concentration in the leachate was maximum in T_4 (160 t/ha solid sludge) treatment. High concentration of iron in leachate was noticed in T_4 (160 t/ha solid sludge) treatment. With increasing level of sludge addition, a larger proportion of iron passed into the leachate. The concentration of manganese, zinc and copper also showed a similar trend. Hence it is likely that micronutrients would be leached to the lower layers with heavy addition of sludge and only deep rooted crops could derive the benefit. Similar result was reported by Peterson and Gschwind (1974).

The leachates of the control column also reflected the presence of micronutrient cations indicating the possibility of these micronutrients moving down to lower layers due to irrigation. This could be ascribed to the formation of water soluble complexes with various organic compounds that are present in the soil or added through the application of sewage wastes. The concentrations of Fe, Mn and Zn were higher in the leachate collected from laterite soil than those from other soils. Laterite soil was open textured and would have facilitated the translocation of water

TABLE 1 Concentration in ppm Micronutrients in the Leachates of Soil Columns Treated with Sewage Wastes

Treatment	Micronutrient	Black soil	Red soil	Alluvial soil	Laterite soil	Treatment mean
T_0	Fe	1.75	2.85	1.30	4.35	2.56
	Mn	1.75	0.90	2.75	8.50	3.47
	Zn	0.90	2.25	3.75	6.70	3.40
	Cu	0.21	1.17	0.88	0.13	0.59
T_1	Fe	2.00	3.30	2.30	5.30	3.22
	Mn	2.70	1.30	3.30	9.10	4.10
	Zn	2 20	3.60	5.20	7.90	4.72
	Cu	0.25	1.24	1.01	0.17	0.66
T_2	Fe	2.10	3.80	3.10	6.30	3.82
	Mn	3.40	2.50	4.00	11.10	5.25
	Zn	2.75	3.80	5.70	8.30	5.13
	Cu	0.38	1.35	1.13	0.27	0.78
T_3	Fe	2.70	4.60	3.75	7.30	4.58
	Mn	4.30	2.90	4.60	12.40	6.05
	Zn	3.30	5.15	6.80	8.95	6.05
	Cu	0.40	1.43	1.26	0.32	0.85
T_4	Fe	3.10	6.10	4.40	9.10	5.67
	Mn	7.50	4.40	5.50	17.00	8.60
	Zn	4.70	6.30	5.70	9.50	7.05
	Cu	0.46	1.49	1.40	0.36	0.92
T_5	Fe	2.20	3.55	1.70	5.45	3.22
	Mn	2.50	1.50	3.30	10.70	4.50
	Zn	1.90	2.60	4.20	7.40	4.02
	Cu	0.25	1.23	1.00	0.20	0.67
T_6	Fe	2.70	4.10	2.30	6.75	3.96
	Mn	3.10	2.10	3.70	10.60	4.87
	Zn	2.60	2.60	4.95	8.00	2.25
	Cu	0.27	1.39	1.15	0.29	0.75
Soil Mean	Fe	2.36	4.04	2.69	6.36	
	Mn	3.60	2.22	3.87	11.34	
	Zn	2.62	3.75	5.47	8.10	
	Cu	0.31	1.31	1.11	0.24	

C. D. (P=0.05)

	Fe	Mn	Zn	Cu
Soil* ..	0.17	0.49	0.28	0.021
Treatment*	0.22	0.65	0.38	0.029
S×T*	0.45	1.31	N.S.	0.06

TABLE II Influence of Sewage Waste Addition on the Macronutrient Concentrations in the Leachates of Soil Columns.

S	Mean nutrient concentration (ppm)					
	N	P	K	Ca	Mg	Na
Black soil	5·61	2.63	40.28	257.85	149.92	134.7
Red soil	2.70	1.40	24.14	225.07	99.42	33.4
Alluvial soil	8.77	3.95	50.21	251.57	117.14	208.0
Laterite soil	3.02	0.97	45.78	150.00	36.07	22.0
S. E. D.	0.06	0.17	0.91	0.87	1.03	1.0
C. D. (P=0.05)	0.13	0.34	1.86	1.78	2.11	2.1

soluble complexes of Fe, Mn and Zn through the soil columns. However, the copper concentration was lower in the leachate of this soil than these of other soil leachates. This is presumably due to the retention of Cu in the laterite soil.

Macronutrient Concentration in Leachate Fraction

A comparison of analysis of different soils revealed that the leachate from alluvial soil contained higher concentration of nitrogen than those from other soils. This could be due to low retentivity of NH_4 iron by this soil. Addition of 160 t/ha of solid sludge registered higher concentration of total nitrogen in the leachate fraction of all the four soils studied. Similar observation was made by Lund *et al*. (1976).

Total phosphorus in the leachate varied considerably among the four soils studied. In the alluvial soil leachate, the concentration of P was higher than in others. This showed that the retention of P was less in this soil and hence would have allowed the free movement of P in the absence of Fe, Al and $CaCO_3$. In laterite soil P fixation would be more due to the presence of Fe and Al and so less P was leached. Addition of 160 t/ha of solid sludge registered higher concentration of P in the different leachate fractions of the soils studied. Lund *et al*. (1976) reported similar results.

The concentration of K was higher in the alluvial soil leachate compared to those from other soils. This is because of lesser retention of K by mixed type of clay minerals present

TABLE III Composition of solid and liquid sewage water.

Particulars	Solid sludge	Liquid sewage
pH	7.2	6.8
EC in m.mhos/cm	2.1	0.65
Tot N	2.92%	56 mg/l
Organic C	4.72%	—
BOD	—	210 mg/l
NH_4-N	1.98%	43 mg/l
NO_3-N	0.76%	0.8 mg/l
Total P	0.12%	0.8 mg/l
Total K	0.30%	16.0 mg/l
Total Ca	1.24%	182 mg/l
Total Mg	0.88%	56.8 mg/l
Total Na	0.09%	132 mg/l
Total solids	—	840 mg/l
Total Fe	21250.0 ppm	5 ppm
Total Mn	220.0 ppm	12.0 ppm
Total Cu	800 ppm	50 ppm
Total Zn	540.0 ppm	69.0 ppm
Available Fe	24.0 ppm	—
Available Mn	7.0 ppm	—
Available Cu	9.6 ppm	—
Available Zn	27.8 ppm	—

in this type of soil which would have resulted in greater concentrations of K in the leachate. The concentrations of Ca, Mg and Na were higher in the laachate of black soil compared to the rest. Application of 160 t/ha considerably increased the concentration of K, Ca, Mg and Na in the soils studied.

Summarising, addition of sewage wastes resulted in the significant increase in the concentrations of micro- and macronutrients in the leachates of the four soils studied and the application of high dosage of solid sludge (160 t/ha) markedly favoured the leaching and these nutrients through the soil columns. The concentrations of Fe, Mn and Zn were fairly high in the leachate of laterite soil and that of Cu was low. In the leachate of alluvial soil high concentration of N, P and K was observed. High amounts of Ca and Mg were leached from the black soil. Columns incubated with varying amounts of sewage waste.

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