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Effect of Aeration on Mineralization of Organic Nitrogen in Brackishwater Fishpond Soil

A.N. MOHANTY*

Puri Research Centre
C.I.B.A., Puri-752002
Orissa, India

Abstract - The mineralization of organic nitrogen at different salinity levels of brackishwater fishpond soils upon addition of cowdung was studied under laboratory conditions at ambient temperature 28.8-30.6°C over 120 days. Upon aeration, percentage gains in mineralized nitrogen at 0.5, 10, 20 and 30 ppt salinity ranged between 26.1 and 28.5% and were not significantly different. However, the rate of mineraliza-tion was slower at higher salinities.

Aeration is an important management practice in shrimp farming. Aeration not only maintains optimum levels of dissolved oxygen but also minimizes renewal of water (Aquacop 1985; Kungvankij 1985). Rajyalakshmi et al. (1988), for example, recommended aeration for closed brackishwater ponds with dense shrimp populations in fringe areas of the Chilka Lagoon for enhancing production. In India, brackishwater ponds are generally low in organic carbon con-tent (Chattopadhyay and Mandal 1980a) and raw cowdung is com-monly used as a source of organic manure to increase natural pro-ductivity (Chattapadhyay and Mandal 1982). As information regarding chemical changes occurring in the brackishwater environment due to aeration is limited, an attempt has been made to investigate the rate of mineralization of both native and added organic nitrogen due to aeration under experimental conditions.

Soil was collected from the Mudiratha shrimp culture farm pond located in the northeastern sector of Chilka Lagoon (Orissa). It was air-dried, powdered and passed through a 40-mesh sieve. The soil was sandy loam, low in organic carbon and nitrogen (Table 1).

Ten-gram samples of soil were transferred to 56 long (25-cm) glass tubes, moistened with distilled water and maintained in the

*Present address: Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar - 751002, Orissa, India.

Table 1. Physicochemical properties of shrimp farm soil from Chilka Lagoon.

Sand	72%	Total nitrogen	0.041%
Silt	19%	Organic nitrogen	0.026%
Clay	9%	Calcium carbonate	4.250%
pH	7.70%	Electrical conductivity	8.86 millimhos$\cdot$cm^{-1}
Organic carbon	0.398%	C/N ratio	9.71

laboratory for two days. The tubes were then arranged in eight sets of seven tubes each. The sets were further classified into two groups of four sets each and the tubes of one set of each group were then provided with 100 ml sodium chloride solution of 0, 10, 20 and 30 ppt. concentrations, respectively. The tubes were wrapped with thick black paper to avoid photosynthetic activities and kept in a dark corner of the laboratory for 30 days to attain equilibrium between soil and sodium chloride solutions. Evaporation, if any, was compensated by addition of small quantities of distilled water. At the end of 30 days, 0.5 g fresh cowdung with an estimated nitrogen content of 0.391 per cent was added to each tube. One group was kept without aeration while the other was aerated on alternate days for 15 minutes at the soil-water interphase with the aid of an aquarium aerator. Ammoniacal and nitrate nitrogen were estimated prior to addition of cowdung and also after 15, 30, 45, 60, 90 and 120 days of incubation (Table 2).

Standard methods by Piper (1950) and Jackson (1967) were followed for analysis of soil, while APHA (1971) was followed for water analysis. The ambient water temperature of the tubes ranged between 28.8 and 30.6°C.

The amount of NH_4-N in the water phase increased up to the 30th day of incubation and declined slowly thereafter with the progress of incubation period (Table 2). Higher salinities did not seem to influence much in the above trend. A similar trend was observed in the soil phase, except in the control where maximum mineralized NH_4-N was recorded on the 15th day of incubation. In contrast, on the decomposition of cowdung with and without aeration in freshwater, Ghosh and Mohanty (1981) observed a maximum level of NH_4-N on the seventh day of incubation which indicates a slower rate of mineralization in brackishwater environment.

The NH_4-N concentration remained always higher in soils than the water phase. It may be presumed that a large portion of NH_4-N remained absorbed in soil under the prevailing reduced conditions

Table 2. Mineralization of organic nitrogen with and without aeration at different salinity levels.

Treatment	Water (ppm)		No. of days after treatment						
	Soil (mg/100 g)		0	15	30	45	60	90	120
Control	Water	NH_4-N	0.90	6.22	6.85	4.05	3.92	3.19	2.31
		NO_3-N	0.70	2.95	3.21	3.16	2.67	2.17	1.67
	Soil	NH_4-N	1.19	15.48	14.49	8.32	8.40	6.62	5.24
		NO_3-N	0.41	3.68	3.91	2.95	2.21	2.04	1.32
		Total-N	3.20	28.33	28.46	18.48	17.20	14.02	10.54
Control with aeration	Water	NH_4-N	0.95	8.92	9.37	4.91	5.61	3.86	3.12
		NO_3-N	0.70	4.82	4.97	4.49	4.91	4.61	3.86
	Soil	NH_4-N	1.13	18.05	14.50	10.02	10.19	7.08	6.17
		NO_3-N	0.43	3.95	4.21	3.50	4.33	3.18	2.67
		Total-N	3.21	35.74	33.05	22.92	25.04	18.73	15.82
10 ppt	Water	NH_4-N	1.01	4.91	6.17	5.70	4.00	3.37	2.18
		NO_3-N	0.67	2.48	3.07	2.90	2.95	2.45	2.18
	Soil	NH_4-N	1.16	10.44	12.45	10.35	7.90	6.13	5.85
		NO_3-N	0.46	2.65	4.40	3.02	1.96	2.32	2.18
		Total-N	3.30	20.48	26.09	21.97	16.81	14.27	12.39
10 ppt with aeration	Water	NH_4-N	0.95	5.87	8.36	6.45	5.96	3.51	2.32
		NO_3-N	0.70	3.42	4.51	4.91	4.40	3.85	2.11
	Soil	NH_4-N	1.22	14.07	15.55	11.83	10.85	7.48	5.85
		NO_3-N	0.41	3.28	4.48	4.33	4.05	4.02	2.98
		Total-N	3.28	26.64	32.90	27.52	25.26	18.86	13.26

Continued

Table 2. Continued

Treatment	Water (ppm)		No. of days after treatment						
	Soil (mg/100 g)		0	15	30	45	60	90	120
20 ppt	Water	NH_4-N	0.92	4.02	6.08	5.89	4.24	3.16	2.37
		NO_3-N	0.67	2.87	2.95	3.12	3.08	2.67	1.88
	Soil	NH_4-N	1.27	9.45	11.90	10.85	7.13	6.24	4.97
		NO_3-N	0.41	2.37	3.95	3.33	2.18	2.32	2.63
		Total-N	3.27	18.71	24.88	23.19	16.63	14.39	11.85
20 ppt with aeration	Water	NH_4-N	0.95	5.18	7.62	6.85	6.08	4.87	2.09
		NO_3-N	0.64	3.63	3.44	5.02	4.29	3.43	2.87
	Soil	NH_4-N	1.62	14.45	15.80	12.08	8.45	6.90	4.18
		NO_3-N	0.46	3.16	4.96	4.02	4.82	3.42	2.37
		Total-N	3.67	26.42	31.82	27.97	23.64	18.62	11.51
30 ppt	Water	NH_4-N	0.90	4.33	6.08	5.80	4.12	3.44	2.18
		NO_3-N	0.67	2.18	2.62	3.07	3.37	2.81	2.23
	Soil	NH_4-N	1.25	9.45	12.15	10.07	7.46	5.73	5.14
		NO_3-N	0.41	2.45	4.07	3.37	2.37	2.65	2.42
		Total-N	3.23	18.41	24.92	22.31	17.32	14.63	11.97
30 ppt with aeration	Water	NH_4-N	0.95	5.45	5.88	7.13	5.89	4.47	2.45
		NO_3-N	0.59	3.28	4.07	4.89	4.33	3.35	2.35
	Soil	NH_4-N	1.27	14.36	13.35	12.94	10.98	7.03	5.12
		NO_3-N	0.41	3.08	4.62	3.86	4.33	3.18	2.62
		Total-N	3.22	26.17	27.92	28.82	25.53	18.03	12.54

Table 3. Average mineralized nitrogen values over a period of 120 days experimentation with and without aeration.

Salinity (ppt)	Without aeration (mg ± SD)	With aeration (mg ± SD)	Gain over aeration (%)
0.5	17.18 ± 9.15	22.07 ± 10.98	28.46
10.0	16.47 ± 7.46	21.10 ± 10.10	28.11
20.0	16.13 ± 7.30	20.52 ± 9.97	27.22
30.0	16.11 ± 7.17	20.32 ± 9.57	26.13

restricting bacterial oxidation of NH_4-N to NO_3-N. It was also observed that beyond the 30th day, the rate of decrease in NH_4-N levels declined more slowly at higher salinity levels, possibly indicating slower rate of mineralization as well as higher replacement of exchangeable NH^+_4 by Na^+ ions in the soil phase.

The quantitative changes in NO_3-N in both soil and water phases under varying salinities followed the same pattern as that of NH_4-N, but the quantitative changers were smaller. Chattopadhyay and Mandal (1980a, 1980b) also observed the amount of NO_3-N to be lower than that of NH_4-N in brackishwater environments and attributed this to the prevailing anaerobic conditions. The present data also showed that the level of NO_3-N was comparatively higher in aerated tubes indicating the beneficial effects of aeration.

In general, it was observed that total mineralization was unaffected by increase in water salinity levels (Table 3). A t-test of the data showed no significant difference in mineralization gain between the treatments.

However, due to the slower rate of mineralization of organic matter in more saline pond water, organic manures should be added one month before stocking, or use well decomposed organic manures (Chattopadhyay and Mandal 1980b).

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