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Effect of Different Levels of Nitrogen on the Physico-Chemical Characteristics of Pond Productivity

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ABSTRACT

The physico-chemical factors of six earthen ponds were studied at Fisheries Research Farm, University of agriculture, Faisalabad. Air temperature varied from 14.8-33 °C, while range of ponds water temperature was 14.7-35.4 °C; light penetration from 7.6-25.2 cm; pH 8.09-8.90; dissolved oxygen 8.75-13.40 mg/L; total alkalinity 330-440 mg/L; carbonates 20-80 mg/L; bicarbonates 310-370 mg/L; total hardness 180-392 mg/L; calcium 9.6-48.7 mg/L; magnesium 15.44-81.62 mg/L; nitrates 3.0-4.50 mg/L; phosphates 0.01-0.39 mg/L; total solids 959-1284 mg/L; total dissolved solids 820-1150 mg/L and planktonic biomass ranged from 90-194 mg/L.

Key Words: Temperature; Nitrogen; Productivity; Dissolved oxygen

INTRODUCTION

Aquatic resources are among the major alternatives for the production of animal protein. Fish is one of the best aquatic animals that can help in augmenting protein supply for human use. The availability of suitable food and ecological conditions for the fish in the pond are basic needs for securing high fish production and protein quality. Fertilization increases production without the rise of dietary diseases. It improves the hygienic condition of the pond and increases the primary productivity. At the same, it plays an active role in the formation of soil structure. The availability of suitable food for fish in the pond depends upon its richness with planktonic life which in turn depends upon the physico-chemical environments of the ponds. A considerable number of biotic and abiotic factors are known to influence the growth of fish (Brett, 1979). Among the abiotic factors of a fish's environment temperature has been called the ecological master factors (Brett, 1970). The heavy planltonic biomass is related with high water temperature (Vijayaraghavan, 1971; Armitage *et al.*, 1973). The paper throws light on the seasonal variations of physico-chemical variations of physico-chemical characteristics of pond productivity by the application of different level of nitrogen.

MATERIALS AND METHODS

The studies were conducted using six earthen ponds located at Fisheries Research Farm, University of Agriculture, Faisalabad. Each of the ponds has three fish species i.e *Labeo rohita, Catla catla* and *Cirrhinus mrigala* in the ratio of 40:30:30 respectively. All the ponds were fertilized with nitrophos on the basis of nitrogen contents ranging from 0.05 to 0.3% of wet body weight of fish daily. In pond (i) fertilization was done at the rate of 0.05 mg, pond (ii) 0.1 mg, pond (iii) 0.15 mg, pond (iv) 0.2 mg, pond (v) 0.25 mg and pond (vi) 0.3 mg N / 100 g of fish.

Water samples were collected in plastic bottles. Air and water temperature was recorded with the help of alcohlic thermometer, sacchi`s disc was used for determining light penetration and pH meter is used for measuring pH. Dissolved oxygen, total alkalinity, carbonates, bicarbonates, total hardness, calcium, megnesium, nitrates, phosphates, total solids, total dissolved solids and dry weight of planktonic biomass were estimated according to Boyd (1981).

RESULTS AND DISCUSSION

The changes in air temperature and that of six treated ponds of water for experimental period remained 14.8-33.0 °C, while ponds water 14.7-35.4 °C. Air temperature was lowest in January and highest in July. The water temperature showed a trend similar to that of atmospheric temperature. Such a direct relationship between atmospheric and water temperature was also recorded by Nazneen (1980). There was a minimum difference between air and water temperature during the months of October and November; this was due to increase in humidity which greatly decrease the loss of heat through evaporation. Transparency values as interpreted from sacchi`s disc ranged from 7.6-25.2 cm. The low transparency was due to increased planktonic biomass. Khatri (1985) also reported that transparency showed an inverse relationship with phytoplankton, greater the value, lower is the planktonic biomass. The pH values of all the ponds fluctuated within narrow range 8.09-8.90. It is evident from the results that pH values remained favourable for fish for most of the study period as described by Boyd (1981) and Mahboob *et al.* (1988). The pH values throughout the study period remained alkaloid (Table I).

Maximum value of dissolved oxygen was noted in winter months while minimum value 8.75-13.40 mg/L was observed during summer. The decrease in oxygen contents related to steady increase in temperature and respiration of aquatic organisms (Table II). Qadri *et al.* (1981) and Bilgrami *et al.* (1985) also reported the similar pattern of variation in the dissolved oxygen contents. Bicarbonates concentrations were higher than carbonates (carbonates 20-

Table I. Seasonal variation in physico-chemical factors under different treatments

Date	Air	Water temperature °C						Light penetration (cm)						pH of the ponds					
	Tempt °C	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
2-10-96	28.5	27.1	27.2	27.25	27.5	27.8	28.2	20.1	19.3	18.7	16.8	15.9	10.4	8.75	8.45	8.20	8.40	8.45	8.43
2-11-96	21.0	20.2	20.4	20.12	20.3	20.9	20.5	12.8	13.0	17.5	16.7	11.0	15.9	8.51	8.85	8.70	8.77	8.25	8.50
2-12-96	17.3	16.0	16.3	16.4	16.5	16.8	16.9	21.4	18.9	18.7	18.0	13.1	11.0	8.32	8.55	8.40	8.78	8.65	8.60
2-1-97	14.8	14.8	14.7	14.8	14.8	14.2	14.1	22.1	21.8	12.3	18.6	13.0	10.8	8.11	8.48	8.48	8.25	8.70	8.90
2-2-97	19.5	19.0	19.1	18.1	18.0	19.4	19.8	22.0	13.9	14.7	11.2	13.8	9.4	8.09	8.50	8.50	8.48	8.72	8.70
2-3-97	23.7	22.5	22.5	22.2	22.7	22.7	22.9	20.8	18.7	14.0	20.9	8.68	9.6	8.54	8.60	8.85	8.48	8.85	8.71
2-4-97	27.0	26.5	26.4	26.0	26.4	26.9	26.5	25.2	23.4	18.9	21.6	18.7	10.0	8.25	8.65	8.65	8.65	8.45	8.85
2-5-97	29.5	28.4	28.0	28.0	28.3	29.3	29.4	20.6	20.9	19.0	22.4	18.6	7.6	8.95	8.90	8.35	8.35	8.38	8.25
2-6-97	31.4	30.7	30.3	30.3	30.9	33.1	33.1	17.8	15.8	14.9	20.1	10.9	8.05	8.70	8.77	8.48	8.25	8.42	8.35
2-7-97	33.0	32.9	32.2	32.4	32.8	35.2	35.4	16.9	15.2	10.4	9.2	8.8	7.9	8.50	8.63	8.70	8.75	8.28	8.90

Table II. Seasonal variation in physico-chemical factors under different treatments

Date	Dissolved oxygen (mg/L)						Total alkalinity (mg/L)					
	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
2-10-96	12.0	11.6	12.2	12.0	12.3	11.2	420	420	400	410	340	370
2-11-96	13.4	11.9	12.9	12.8	12.2	12.4	390	400	350	380	390	380
2-12-96	13.9	12.7	13.4	13.2	12.2	12.8	390	410	410	400	410	360
2-1-97	12.2	12.9	13.6	13.4	12.8	13.0	330	400	410	430	380	390
2-2-97	12.2	13.5	12.7	12.0	9.6	10.5	440	380	380	420	390	410
2-3-97	9.8	8.8	10.6	9.7	8.7	9.7	420	390	390	380	410	410
2-4-97	12.0	11.2	12.3	12.1	10.5	10.9	400	420	420	380	370	400
2-5-97	12.7	9.8	11.8	11.9	11.0	10.7	400	360	360	410	420	390
2-6-97	12.8	12.4	12.0	12.6	11.2	10.8	380	410	400	380	410	380
2-7-97	12.2	12.0	11.6	12.8	10.8	11.0	390	360	420	350	370	390

Table III. Seasonal variation in physico-chemical factors under different treatments

Date	Carbonate (mg/L)						Bicarbonate (mg/L)						Total hardness (mg/L)					
	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
2-10-96	60.0	50.0	40.0	60.0	40.0	50.0	360	370	360	350	300	320	180	320	380	214	235	282
2-11-96	50.0	50.0	30.0	80.0	70.0	40.0	340	350	320	300	320	340	201	275	278	209	380	260
2-12-96	40.0	70.0	50.0	40.0	50.0	40.0	350	340	360	360	360	320	200	262	280	280	290	260
2-1-97	20.0	40.0	60.0	60.0	40.0	40.0	310	360	350	370	340	350	212	320	286	240	230	200
2-2-97	40.0	20.0	40.0	20.0	20.0	50.0	400	360	340	400	370	360	260	265	360	365	370	322
2-3-97	80.0	50.0	40.0	30.0	60.0	60.0	340	340	350	350	350	350	280	365	326	305	225	392
2-4-97	60.0	60.0	50.0	40.0	30.0	30.0	340	370	370	340	340	370	320	320	320	360	260	302
2-5-97	40.0	40.0	30.0	50.0	50.0	50.0	360	320	330	360	370	340	256	260	366	265	260	284
2-6-97	60.0	60.0	50.0	60.0	70.0	60.0	320	350	350	320	340	320	286	280	284	284	210	246
2-7-97	40.0	40.0	60.0	40.0	50.0	40.0	350	320	360	310	320	350	346	260	240	254	280	272

Table IV. Seasonal variation in physico-chemical factors under different treatments

Date	Calcium (mg/L)						Magnesium (mg/L)						Nitrate (mg/L)					
	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
2-10-96	20.0	19.2	21.4	21.6	19.2	23.2	32.5	68.0	81.6	40.0	51.7	56.0	3.70	3.80	4.40	4.50	4.85	3.00
2-11-96	17.88	24.8	26.4	24.8	21.6	24.5	39.0	53.2	53.0	36.7	81.5	49.6	4.85	4.95	4.70	3.60	3.92	4.90
2-12-96	25.4	26.9	27.2	24.9	23.8	26.4	34.1	48.6	53.0	54.4	57.6	48.5	4.50	5.85	5.20	6.30	6.20	6.30
2-1-97	27.3	28.3	27.9	28.7	29.6	29.5	33.9	62.3	54.0	42.0	39.0	31.5	4.70	4.98	4.70	4.50	4.0	5.95
2-2-97	32.8	31.5	32.9	34.5	38.4	39.9	44.5	46.5	69.4	69.6	68.5	55.5	5.20	6.00	6.00	7.80	6.80	7.10
2-3-97	41.0	42.5	43.0	36.3	45.2	48.7	44.3	64.6	54.6	53.5	28.0	67.5	5.25	5.45	5.50	6.30	6.75	7.40
2-4-97	43.5	44.6	48.2	47.1	46.5	32.0	52.8	52.1	49.8	60.5	38.9	55.5	6.30	6.75	7.0	4.70	8.20	6.52
2-5-97	28.4	20.3	22.0	29.5	30.2	30.1	46.2	52.3	77.7	47.8	46.1	52.1	4.80	6.55	7.20	5.30	7.20	5.60
2-6-97	12.89	13.0	14.5	13.6	12.0	15.8	63.5	15.4	61.9	62.5	45.0	52.8	5.40	5.26	6.75	6.70	6.40	6.40
2-7-97	12.2	21.0	31.0	9.62	15.6	13.2	78.8	51.8	45.6	57.4	6.02	69.7	7.48	7.50	7.52	6.51	7.50	6.30

Table V. Seasonal variation in physico-chemical factors under different treatments

Date	Phosphate (mg/L)						Total solids (mg/L)						Total dissolved solids (mg/L)						Planktonic Biomass (mg/L)					
	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
2-10-96	0.01	0.09	0.45	0.02	0.07	0.26	1100	1110	960	960	959	962	1010	1025	865	850	840	820	90	85	95	110	119	142
2-11-96	0.05	0.15	0.44	0.35	0.05	0.35	1275	1160	980	955	1085	945	1100	990	870	845	935	840	175	170	110	110	150	105
2-12-96	0.05	0.02	0.43	0.02	0.02	0.25	1200	1280	1282	1206	1110	1210	1120	1220	1220	1106	975	1070	80	60	62	100	135	140
2-1-97	0.03	0.25	0.32	0.15	0.09	0.39	1252	1185	1198	1100	1108	1185	1180	1110	1010	1005	971	1040	72	75	188	95	137	145
2-2-97	0.02	0.05	0.01	0.30	0.01	0.02	1200	1137	1125	1073	1403	1291	1130	1010	1020	918	1280	1116	70	127	105	155	123	175
2-3-97	0.15	0.35	0.25	0.25	0.25	0.01	1130	1185	1305	1163	1398	1192	1050	1098	1195	1100	1205	1020	80	87	110	63	194	172
2-4-97	0.25	0.12	0.35	0.01	0.20	0.15	960	1092	1193	1068	1270	1226	915	1043	1101	1010	1185	1058	45	49	92	56	85	168
2-5-97	0.27	0.39	0.26	0.20	0.26	0.25	1020	1015	1235	1110	1188	1290	940	940	1145	1060	1103	1068	80	75	90	50	85	220
2-6-97	0.07	0.35	0.35	0.26	0.05	0.16	1220	1070	1078	990	1295	1410	1120	955	950	900	1150	1230	100	115	128	90	145	180
2-7-97	0.03	0.16	0.50	0.07	0.09	0.22	1260	1190	1200	1110	1125	1284	1150	1068	1040	940	940	1090	110	122	160	170	185	194

80 mg/L, bicarbonates 310-370 mg/L) in all treatments. Tahir (1988) mentioned similar trend in carbonates and bicarbonates concentration. In the present study the pattern of seasonal variation in total alkalinity corresponded with the total hardness as also reported by Chaughtai (1979) (Table III).

The magnesium ions were greater (15.44-81.62 mg/L) than calcium (9.62-48.7 mg/L). The same results were obtained by Javed (1988). Role of phosphorus in productivity of aquatic medium is well recognized. It is clear from the results that significant amount of phosphate were present throughout the study period. The level varied from time to time; the lowest concentration of phosphate was noted in October and highest during May (0.01-0.39 mg/L) which seems to be due to decomposition of biotic life (Harvey, 1960).

The water sample under study had variable levels of nitrates which could be attributed to fluctuations in the biological activity and the degree of contamination. It is evident from the results that there was a seasonal fluctuation of nitrates 3.0-4.50 mg/L was higher in warmer months than colder months. This was due to heavy planktonic biomass in all the six ponds. The results are also in line with the findings of Nazneen (1980) and Toyama (1982) found that green algae were the most abundant phytoplankton in the summer and diatoms developed profusely in the winter (Table IV).

The patterns of seasonal variations in the concentration of total solids (TS) and total dissolved solids (TDS) were similar. A steady increase in the concentration of total solids and total dissolved solids from December to February was possible due to less deposition of suspended matter. Total solids present in water have a favourable effect on the availability of natural food to fish. It is generally believed that total solids are likely to support fish production. Productivity of the ponds was measured by the dry weight of biomass. The biomass varied from 90-194 mg/L. Biomass peak recorded in June and July was due to entire living community (Producers, Consumers, Decomposer etc.) It is expressed as standing crop. The maximum value 90 mg/L of biomass was observed in winter months (Table V).

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