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Fish Pond Fertilization: Comparison of Ecological Conditions under Different Fertilizer Regimes

Abdul Ghaffar, Muhammad Afzal and Muhammad Iqbal
Department of Zoology and Fisheries, University of Agriculture, Faisalabad, Pakistan

Abstract: The physico-chemistry of two fresh water fish ponds was investigated for a duration of 255 days to see the affect of two different doses of inorganic fertilizers (urea and SSP). Both the ponds were treated with fertilizers at the basis of 0.08 and 0.1 % N of body weight of fish daily. Statistically, ammonia, nitrates and biomass were significant in both the treatments. But, temperature, light penetration, pH, electrical conductivity, dissolved oxygen, total alkalinity and total hardness were non-significant. Environmental changes were observed in the pond ecosystem when fertilized with different doses of inorganic fertilizers.

Key words: Fish pond, fertilization, urea, SSP, ecological conditions

Introduction

Application of organic and inorganic fertilizers, tend to produce changes in ecological conditions through plankton production (Qin and Culver, 1995). Plankton algae are food for fish as well for zooplankton which, in turn, is food for carps also (Hassan and Javed, 1999; Javed *et al.*, 1990).

The availability of suitable food and ecological conditions for fish in the pond are the basic needs for securing high fish production and protein quality. 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 pond (Mahboob *et al.*, 1988; Hassan *et al.*, 2000). The over and uncontrolled production of plankton may blast the fish pond ecosystem resulting in the mass mortality of fish through utilization of dissolved oxygen and accumulation of CO_2. The distribution of phytoplankton were generally related to the variations of light and temperature. The effect of light and temperature were modified by the nutrients, particularly when nitrogen and phosphates were present in surprisingly low concentrations (Hassan *et al.*, 2000). So it is important to observed that the environmental changes in the pond ecosystem when fertilized with organic or inorganic fertilizers. This study describes the variations as influenced by the different doses of inorganic fertilizers at Fisheries Research Farms, University of Agriculture, Faisalabad.

Materials and Methods

Two earthen ponds of uniform dimensions (22 x 7.5 x 1.8 m^3) were selected at Fisheries Research Farms, University of Agriculture, Faisalabad, for the experiment which lasted 255 days. Nitrogen and phosphorus fertilizers were added in both the ponds (NP; 1:1) on the basis of 0.08 and 0.1% nitrogen of live body weight of fish daily in pond 1 and 2, respectively (Table 1). Urea and single supper phosphate (SSP) were used as sources of nitrogen and phosphorus, respectively, in both the ponds. Pond 1 received 82.81 kg of fertilizer (urea 21.36 kg, SSP 61.46 kg) and the fortnightly dose ranged between 3.89 to 6.38 kg (Table 1). Pond 2 received 93.36 kg of fertilizer (urea 24.00 kg, SSP 69.36 kg) and the dose was ranged between 4.00 and 7.73 kg (Table 1). Each pond was stocked with three fish species i.e., *Hypophthalmichthys molitrix*, *Labeo rohita* and *Cirrhinus mrigala* in the ratio of 37:35:15, respectively.

Fertilizer doses were gradually increased in both the fertilizer regimes. Fertilizer dose was applied fortnightly in each of the pond. The water samples were taken prior to the application of fertilizer in plastic bottles. Air and water temperature was recorded with the help of an alcoholic thermometer. Secchi's disc was used for determining light penetration, while pH and conductivity of water samples were determined with pH meter (Jenco-607) and conductivity meter (Mod. MC-1, MARK V) in the laboratory. Dissolved oxygen, ammonia, nitrates, total alkalinity, total hardness and biomass were estimated according to Boyd (1981). The data obtained was subjected to statistical analysis with the help of student's t-test following the Steel and Torrie (1986).

Table 1: Fortnightly dose distribution schedule of fertilizer in two treatments

Treatment 1 (Kg)			Treatment 2 (Kg)		
Urea	SSP	Total fertilizer	Urea	SSP	Total fertilizer
01.00	2.89	3.89	1.03	2.97	4.00
01.01	2.92	3.93	1.08	3.11	4.19
01.02	2.96	3.98	1.10	3.16	4.27
01.04	3.01	4.06	1.11	3.20	4.32
01.07	3.09	4.16	1.12	3.24	4.36
01.10	3.19	4.29	1.14	3.29	4.44
01.15	3.32	4.48	1.20	3.45	4.65
01.18	3.40	4.58	1.28	3.67	4.95
01.20	3.46	4.66	1.37	3.95	5.32
01.25	3.61	4.87	1.43	4.14	5.57
01.31	3.79	5.11	1.46	4.22	5.69
01.37	3.95	5.33	1.57	4.53	6.11
01.42	4.10	5.53	1.69	4.87	6.57
01.46	4.20	5.66	1.74	5.03	6.77
01.50	1.33	5.83	1.81	5.22	7.03
01.54	4.45	5.99	1.88	5.43	7.31
01.64	4.73	6.38	1.91	5.81	7.73
21.36	61.46	82.82	24.00	69.36	93.36

Results and Discussion

In the aquatic habitat, the physico-chemical conditions of water and presence of various types of flora and fauna have an effective influence on fish production. Many factors affect the pond fish culture, important ecological parameters are temperature, light penetration, pH, electrical conductivity, dissolved oxygen, total alkalinity, total hardness, ammonia, nitrates and biomass. Proper range of these factors is necessary for fish culture.

Statistically, inter-pond differences in ammonia, nitrates and biomass were significantly different (Table 2). But, temperature, light penetration, pH, electrical conductivity, dissolved oxygen, total alkalinity and total hardness were non-significant, statistically (Table 2).

Temperature affects the fish growth by influencing physico-chemical conditions of water. It also affects the speed of chemical changes in soil, water and the contents of dissolved gases. Khan *et al.* (1978) reported that temperature of water has correlation with pond production. Pond water temperature fluctuated between 14 and 31.80 °C. The inter-pond differences were non-significant. Hasan and Macintosh (1991) stated that feed

Corresponding Author: Mr. Abdul Ghaffar, Department of Zoology and Fisheries, University of Agriculture, Faisalabad, Pakistan

Table 2: Comparison of ecological conditions of two fertilized fish ponds

Parameters	Treatment 1	Treatment 2	T-calculated
Temperature (°C)	21.63±01.51	21.49±01.46	1.28NS
Light penetration (cm)	19.15±01.05	17.56±00.86	1.10NS
pH	8.46±00.12	8.28±00.10	1.29NS
Electrical conductivity (m.mhos/cm)	2.81±00.19	2.72±00.18	0.64NS
Dissolved oxygen (mg l^{-1})	7.74±00.20	7.69±00.15	0.22NS
Ammonia (mg l^{-1})	1.51±00.14	2.16±00.24	4.22*
Nitrates (mg l^{-1})	1.35±00.17	2.12±00.21	2.53*
Total alkalinity (mg l^{-1})	402.77±12.46	385.55±10.70	1.42NS
Total hardness (mg l^{-1})	214.77±10.02	212.11±11.50	0.52NS
Biomass (mg l^{-1})	96.11±8.53	157.00±16.74	3.38*

* = Significant at alpha level 0.5%, NS= Non-significant.

Table 3: Comparison of fortnightly observations of physico-chemical characteristics of two fertilized fish ponds

Temperature (°C)		Light penetration (cm)		pH		Electrical conductivity (m.mhss/cm)		Dissolved oxygen (mg l^{-1})		Ammonia (ppm)		Nitrates (mg l^{-1})		Total alkalinity (mg l^{-1})		Total hardness (mg l^{-1})		Planktonic Biomass (mg l^{-1})	
T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
15.80	15.60	11.90	20.00	8.00	8.00	3.90	3.40	7.00	7.00	3.60	2.10	0.85	0.80	500	400	200	230	163	71
15.60	15.15	10.00	11.20	8.50	7.90	2.50	2.90	7.60	7.50	3.40	2.00	1.10	1.50	400	360	224	260	160	130
15.13	14.99	12.00	18.60	8.80	8.90	2.30	2.60	8.20	8.10	3.10	2.20	1.70	1.50	420	420	252	250	50	20
14.50	14.62	20.00	17.00	8.60	8.40	2.10	2.80	8.00	7.90	3.00	2.10	2.20	1.70	400	400	260	260	90	97
14.00	14.12	18.00	16.00	7.30	8.30	2.40	3.00	9.00	8.90	3.20	1.90	1.60	0.80	420	20	268	244	110	276
14.30	14.91	22.00	14.00	8.00	7.90	2.10	2.30	9.20	7.50	2.50	1.80	1.09	2.00	400	380	260	220	120	200
15.40	15.65	26.00	12.00	7.90	8.20	1.70	2.10	7.90	6.30	2.70	2.00	3.20	2.40	400	420	250	270	149	161
17.30	17.51	24.00	18.00	9.10	8.40	1.60	1.70	6.20	7.20	1.70	1.90	2.80	2.00	380	360	194	220	118	170
20.90	20.01	20.00	25.00	9.00	8.17	2.50	2.60	6.90	7.90	1.80	1.70	1.02	1.80	400	380	240	242	90	113
22.64	22.62	15.00	21.00	9.40	7.80	4.40	4.20	7.80	8.60	1.70	1.60	1.60	1.00	380	360	212	226	80	111
23.64	24.00	18.00	16.00	8.20	9.10	4.30	3.60	8.30	8.40	2.50	1.80	1.00	1.70	420	400	240	254	109	219
27.50	28.05	23.00	18.60	8.70	8.30	3.00	2.50	8.70	7.90	3.50	1.50	1.20	2.20	480	360	214	220	39	154
28.25	27.95	17.80	18.90	8.90	8.70	2.90	2.40	7.80	6.40	1.50	1.00	1.01	2.90	400	460	194	194	52	139
27.55	26.95	19.00	23.00	8.50	7.90	2.60	2.90	5.80	7.70	1.20	1.50	1.08	4.10	380	340	200	168	82	279
31.80	30.90	22.00	20.00	8.00	7.60	3.60	4.10	7.80	7.50	0.80	0.50	1.02	2.80	480	480	210	190	81	139
30.25	29.95	21.00	18.00	8.20	7.90	3.40	2.80	7.90	7.80	0.50	0.25	0.90	3.10	400	300	180	138	80	250
26.80	25.95	22.10	16.00	8.40	8.20	2.80	1.40	8.10	8.00	2.00	1.00	0.30	3.20	310	380	130	120	95	207
28.05	27.95	23.00	12.90	8.90	9.00	2.50	1.70	7.20	7.90	0.25	0.50	0.80	2.80	210	320	118	112	62	90

T1 = Treatment 1, T2 = Treatment 2.

conversion ratio is directly related with temperature and it was concluded that 32 °C was the optimum temperature for carp. Javed *et al*. (1990) observed curvilinear relation between the water temperature and increase in fish weight in fertilized ponds. The seasonal variation in temperature was highly significant but fluctuated below the optimal requirements. Inter-ponds differences for water temperature were non-significant.

One of the most obvious and familiar properties of water is its transparency. The light penetration depends upon the roughness of water surface and angle of radiation. Natural waters is never pure and contain many substances which further interfere with light penetration. Secchi's disc visibility play an important role in observing the extent of light penetration in the pond. Visibility of Secchi's disc is affected due to the algal blooms. (Adel and Soub, 1984; Boguslaw, 1984). The values fluctuated were within the optimal ranges showing the sufficient availability of plankton crop for the feeding of fish (Table 3). Difference in fertilizer dose failed to produce significant difference in the Secchi's disc visibility values.

Qin and Culver (1995) stated that the fertilizer application significantly affects the pH of medium. However, no significant difference was found in this investigation. The pH values of both the ponds ranged between 7.30 to 9.40 (T1) and 7.60 to 9.10 (T2) well above the optimal limits (Table 3). Hassan (1989) observed that the production was more in experimental ponds whose pH was ranged from 6.9 to 9.5.

Total alkalinity of a water body is the sum of carbonate and bicarbonates of Ca^{+2} and Mg^{+2}. The results obtained indicated high values of total alkalinity which was mainly due to higher concentration of carbonates and bicarbonates (Table 3). However, inter-ponds differences for total alkalinity were non-significant.

Total concentration of dissolved substances and suspended substances, in natural water is the useful parameters for describing the chemical density and morphology of a given water body. They also act as a fitness factor and a general measure of productivity. Inter-pond differences of total dissolved solids and planktonic biomass were significant ($P < 0.05$). The values of total dissolved solids and biomass remained high for the whole study period showing the richness of water in nutrients and production. Electrical conductivity is the measure of electrolytes. Temperature and ecological conditions are responsible for the fluctuations of salt contents which, in turn, influence the production and growth of fish (Jana *et al*., 1981). Concentration of electrolytes remained quite high for the whole period of research work (Table 3). Seasonal fluctuations in electrical conductivity occurred in both the ponds. However, inter-ponds differences for electrical conductivity were non-significant.

Dissolved oxygen is the most significant ecological factor of the fish pond ecosystem. Mahboob (1992) recorded the maximum average dissolved oxygen when there was abundance of phytoplankton. Similar trend was observed in this investigations. The water remained close to the saturation values with regard to oxygen showing the presence of healthy environment for fish in most of the study period.

Total hardness mainly on the cations of Ca^{+2} and Mg^{+2} interms of $CaCO_3$ as reported by Ali and Khan (1976). Inter-pond differences in total hardness was non-significant. High values of hardness might had affect the fish growth.

The concentration of NO_3 and ammonia (NH_3) remained very high for the whole period both in the ponds which might had affected the fish growth as the concentration of total ammonia was significantly higher than the maximum recommended concentrations in carp ponds (Boyd, 1981).

Therefore it is concluded that the application of organic and inorganic fertilizers, tend to produce changes in ecological conditions through plankton production .

References

Adel, M. and F. Soub, 1984. Physical and microbiological studies on King Talal Dam Reservoir Water (Jordan). Dira Sat. Nat. Sci., (AMAN), 10: 67-91.

Ali, S.R. and A. Khan, 1976. Diurnal variations in the three ponds of Aligarh. Indian J. Zool., 4: 22-30.

Boguslaw, A., 1984. Ecological characteristics of lakes in northeastern Poland vs. Their trophic gradient: 3 - Chemistry of water in 41 lakes. EKO. POL., 31: 287-308.

Boyd, C.E., 1981. Water Quality in Warm Water Fish Ponds. Craftmaster Printers, Inc., Opelika, Alabama, pp: 359.

Hassan, M., 1989. Effect of cowdung (urea-fed) manure fertilization of fish pond on the growth performance of three major carps. viz., *Catla catla, Labeo rohita* and *Cirrhina mrigala*. M.Phil. Thesis. Univ. Agric. Faisalabad. Pakistan, pp: 91.

Hassan, M., M. Javed and S. Hayat, 1996. Impact of physico-chemistry of water on the planktonic productivity and fish yields of pond fertilized with broiler droppings. Pak. Vet. J., 16: 31-35.

Hassan, M. and M. Javed, 1999. Planktonic biomass conversion efficiency of major carps integrated farming systems. Pak. J. Biol. Sci., 2: 1564-1568.

Hassan, M., M. Javed and G. Mahmood, 2000. Relationships between biotic and abiotic components of broiler droppings fertilized pond ecosystems. Pak. J. Biol. Sci., 3: 2171-2175.

Hasan, M.R. and D.J. Macintosh, 1991. Effect of environmental temperature and feeding rate on the growth, food utilization and body composition of common carp (*Cyprinus carpio*) fry. Fish nutrition in practice: 4th International Symposium on Fish Nutrition and Feeding Biarritz., France, June: 24-27.

Jana, B.B., U.K. De and R.N. Das, 1981. Environmental factors affecting the seasonal changes of net plankton in 2 tropical fish ponds in India. Schweiz Zhydrel, 42: 225-246.

Javed, M., M.B. Sial and S.A. Zafar, 1990. Fish pond fertilization. 2: Influence of broiler manure fertilization on the growth performance of major carps. Pak. J. Agric. Sci., 27:212-215.

Khan, A.A., A.Q. Siddiqui, M. Ali and T. Hamid, 1978. Physico-chemical and biological characteristics of a pond. Chantal J. Zool. Res. Aligarh, 2: 1-13.

Mahboob, S., 1992. Influence of fertilizer and artificial feed on the growth performance in composite culture of major, common and some Chinese carps. Ph.D. Thesis, Deptt. Zool. Fisheries, Univ. Agric., Faisalabad, Pakistan, pp: 261.

Mahboob, S., A. N. Sheri, M. B. Sial and M. Javed, 1988. Influence of physico-chemical factors on the dry weight of planktonic biomass in a commercial fish farm. Pak. J. Agric. Sci., 25: 217-224.

Qin, J. and D.A. Culver, 1995. Separate and combined effect of larval walleye and fertilization on plankton community structure in enclosures. J. Fresh Water Ecology, 10: 385-391.

Steel, R.G.D. and J.H. Torrie, 1986. Principles and Procedures of Statistics. International Student Edition. McGraw Hill International Book Company Inc. New York, USA, pp: 633.