Regression Studies of Dry Weight of Planktonic Biomass on Physico-chemical Parameters of Ponds with Special Reference to Fertilization

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ABSTRACT : The regression equations of dry weight of planktonic biomass upon physico-chemical characteristics of fifteen ponds in three replicates under the influence of artificial feed, broiler manure, buffalo manure, N:P:K (25:25:0) and a control pond was obtained after one year of experimental period by using stepwise regression method. Water samples from each of the ponds were analyzed daily. However, the average values were calculated on the basis of 15 day intervals designated as fortnight. In artificial feed supplemented pond the regression of average nitrates on dry weight of planktonic biomass accounted for 71.7% of the variation in biomass. In broiler manure fertilization pond the regression of total nitrogen on dry weight of planktonic biomass held it responsible for more than 74.6% of variation in biomass. In buffalo's manure fertilized pond more than 82% of the variations in biomass were due to total nitrogen. In case of N:P:K (25:25:0) treated pond 66% of the variation in the dry weight of planktonic biomass was due to average nitrates. The control pond showed the dependence of biomass on light penetration. This equation explained more than 62 percent of variation in biomass. Other variables also showed some contribution towards variation in biomass under all the treatments in these regression studies. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 2 : 172-175)***

Key Words : Dry Weight, Regression, Relationship, Physico-Chemical

INTRODUCTION

Productivity of ponds is measured in terms of the biomass which represents the instantaneous quantity of organisms. Changes in the planktonic biomass depend upon physico-chemical environment of the water body (Boyd, 1984; Mahboob et al., 1988a; 1993a,b). The phytoplankton showed a direct relationship with light penetration, pH, dissolved oxygen, total alkalinity and total hardness of water (Vasisht and Jindal, 1980; Forsyth et al., 1983). Zahid (1997) reported highly significant correlations among dry weight of planktonic biomass, water temperature, total alkalinity, carbonates, bicarbonates and nitrates. The present study was undertaken to apply regression statistics to summarize the variability of complex data set and to present it in a more understandable manner.

MATERIALS AND METHODS

The experiment was started on November 30, 1997 under ambient conditions typical of Faisalabad and completed on November 29, 1998. Ground water of Faisalabad is somewhat salty. Fifteen newly dug earthen fish ponds of dimensions 15 × 8× 2.5 m (length × width × depth) were used in three replicates in a factorial design for this experiment. Approximately four months old fingerlings of *Catla catla* (thaila), *Labeo rohita* (rohu), *Cirrhina mrigala* (mori), *Hypophthalmichthys molitrix* (silver carp), *Ctenopharyngodon idella* (grass carp) and *Cyprinus carpio* (common carp) were stocked in the ratios of 10:30:12.5:25:10:12.5, respectively with the stocking density of 2.87 m^3/fish.

Feed supplementation of T_1 and fertilization of T_2, T_3 and T_4 with broiler manure, buffalo manure and N: P: K (25:25:0) was based on their nitrogen contents at the rate of 0.15 gm nitrogen per 100 gm of wet fish weight daily for one year. However, control pond (T_5) remained without any additives in terms of feed or fertilizers.

Nitrogen and phosphorus percentages of treatment material

Treatment	Treatment material	% Nitrogen	% Phosphorus
T_1	Artificial feed (Vegetable sources)	5.60±0.03	2.05±0.06
T_2	Broiler manure	4.62±0.12	1.66±0.14
T_3	Buffalo manure	1.02±0.05	0.96±0.02
T_4	N:P:K (25:25:0)	25.00±0.04	25.0±0.04
T_5	Control (no additive)		

Water samples from each of the ponds were analyzed daily for the period of one year (November 30, 1997 to November 20, 1998). However, the average values were calculated on the basis of 15 day intervals (designated as fortnight). The samples were collected for 24 fortnights. Water samples were collected from surface, column and

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Received August 27, 2001; Accepted January 15, 2002

bottom of each of the ponds. To make the samples representative, six samples were collected from each of the substations A, B, C, D, E and F and were mixed to have a composite sample. The samples were stored in clean glass bottles of one-liter capacity, fixed with chloroform and immediately taken to the laboratory for analysis. Dissolved gases, temperature and pH (at the pond site) were determined immediately after collection. The light penetration was determined with the help of Sechhi's disc. The temperature of pond water was recorded with the help of electronic thermometer (HI-8564: Hanna) from surface, column and bottom three times a day (6 a.m. 12 p.m. and 18 p.m.) and fortnights averages were obtained, while air temperature and daily light hour records were obtained from the Department of Agriculture Meteorology, University of Agriculture, Faisalabad, Pakistan.

The chemical factors such as dissolved oxygen, carbon dioxide, carbonates, bicarbonates, total alkalinity, calcium, magnesium, total hardness, chlorides, orthophosphates, nitrates, total solids and total dissolved solids were determined through A.P.H.A. (1975) and Boyd (1981). Sodium and potassium were determined by flame photometer (PEFI). Total nitrogen of water was determined by the method of AOAC. (1984).

Dry weight of planktonic biomass was measured indirectly, from the values of total solids and total dissolved solids by the following formula as described by Mahboob (1986).

Biomass = Total solids - Total dissolved solids

The data thus obtained for total 24 fortnights were subjected to forward step-wise regression analysis. For the step-wise regression the correlation coefficients of the candidate variables with dependent variable were calculated. The variable with highest correlation coefficient was included in the model. The model was fitted and its significance was tested. If the result was significant the variable was retained in the model; otherwise it was dropped and the next variable with the highest correlation was taken and the procedure was repeated. Next, partial correlation coefficients of the remaining variables with the dependent variable (dry weight of planktonic biomass) were calculated and the variable with the highest partial correlation coefficients was included in the model. The model was fitted and its significance was tested. The same procedure was continued till the optimum model was achieved.

For step-wise regression analysis, statistical software MSTATC was used.

RESULTS AND DISCUSSIONS

Artificial feed supplemented Pond (T_1)

The first equation in Table 1 is the regression of average nitrates on an average dry weight of planktonic biomass; 71.7% of the variations in biomass. It showed that the nitrogen present in the artificial feed might assimilate into organic nitrogen usually in the form of nitrogenous material and NPN protein. The present results are in accord with the findings of Mahboob et al. (1993a). They reported significant contributions of nitrates and total nitrogen towards the increase in planktonic biomass. At second step water temperature was included in the equation, which gave about 10.8 percent increase in R^2. Further increase in R^2 (6.2 percent) was noticed with the introduction of total nitrogen at the third step. At step 4 the inclusion of pH the equation increased the R^2 to 0.907 (Table 1). The regression coefficients remained significant. Brezonik et al. (1984) mentioned that high pH values promote the growth of phytoplankton and results in blooms. On the other hand Khan and Siddique (1974) and Mahboob et al. (1988) argued that high values of pH during blooming periods were the result and not the cause of phytoplankton. The latter explanation seems to be more convincing.

Broiler manure fertilized pond (T_2)

Fifth equation gave the regression of total nitrogen on an average dry weight of planktonic biomass and held it responsible for more than 74.6% of variation in the concentration of biomass in the pond with T_2 (Table 1). This exhibited a reasonable contribution of total nitrogen in increasing the biomass production in the pond. At second step (Eq-6) water temperature was included; both the regression coefficients were significant and this relation indicated that 6.2 percent variations in biomass is due to water temperature. Zahid (1997) Mahboob and Sheri (2001) reported that temperature significantly affects the intensity of light and has a corresponding effect on the primary productivity. At step-3 (Eq-7) ammonia was introduced, it further increased R^2 up-to 0.855. At step-4 (Eq-8) total nitrogen was removed. It resulted in a minute change in R^2 to 0.843. The inclusion of magnesium in the next step (Eq-9) seems to have further increase in R^2 value by 3.2% while at the 6th step the inclusion of dissolved oxygen in the equation increased the R^2 to 0.900. Step-7 (Eq-11) on the introduction of pH into the line gave only a small R^2 change i.e. 1.7%. All the regression coefficients were significant with R^2=0.917 for all the selected variables, which appears to be of high reliability.

Buffalo's manure fertilized pond (T_3)

The equation-12 (step 1) showed a dependence of

Table 1. Step-wise regression equations of average dry weight of planktonic biomass on selected physico-chemistry parameters of pond water

Treatment	Regression Equations		R^2
T$_1$	Biomass=-22.21+19.43^{a} (Nit.) (2.60)	Eq. 1	0.717
	Biomass=-113.32−18.12^{a} (Nit.)+ 4.41^{a} (W.T.) (2.13) (1.23)	Eq. 2	0.825
	Biomass=-185.14+9.04^{b} (Nit.)=4.97^{a} (W.T.)−10.41^{a} (T.N.) (3.23) (1.02) (3.11)	Eq. 3	0.887
	Biomass=-498.72+8.12^{b} (Nit.)−3.95^{a} (W.T.)−11.77^{b} (T.N.)+39.00^{a} (pH) (3.05) (1.08) (3.05) (19.53)	Eq. 4	0.907
T$_2$	Biomass=-76.95+17.41^{a} (T.N.)--- (2.16)	Eq. 5	0.746
	Biomass=-165.76+16.54^{a} (T.N.)---−4.37^{a} (W.T.)--- (1.69)	Eq. 6	0.808
	Biomass=-192.25+5.78^{a} (T.N.) ---−7.75^{a} (W.T.) ---−214.79^{a} (Amm)--- (4.57) (2.00) (1654.75)	Eq. 7	0.855
	Biomass=-196.47+9.43^{a} (W.T.)---−6148.03^{a} (Amm.)---T.N. (Removed) (1.52) (640.08)	Eq. 8	0.843
	Biomass=-271.70+10.22^{a} (W.T.) ----+5215.29^{a} (Amm.) ---−1.84^{b} (Mg.)--- (1.44) (607.60) (0.81)	Eq. 9	0.875
	Biomass=-353.63+8.61^{a} (W.T.)---+5215.29^{a}(Amm.)---+3.20^{b} (Mg)--- -8.91^{a} (D.O.)- (1.51) (614.96) (0.97) (4.10)	Eq. 10	0.900
	Biomass=-94.49+8.33^{a} (W.T.)--−5281.79^{a} (Amm.)--+3.01^{b} (Mg.)--−9.81^{b} (DO)-40.02 (pH) (1.44) (575.70) (0.92) (3.86) (20.65)	Eq. 11	0.917
T$_3$	Biomass=-100.58+15.0^{a} (T.N.) (1.55)	Eq. 12	0.824
	Biomass=-177.34+14.81^{a} (T.N.)+3.85^{a} (W.T.) (0.99) (0.59)	Eq. 13	0.934
	Biomass=-478.29+14.22^{a} (T.N)+3.90^{a} (W.T.)---−36.19^{a} (T.N.)--- (0.92) (0.59) (14.99)	Eq. 14	0.949
	Biomass=-470.87+13.92^{a} (T.N.)+4.54^{a} (W.T.)+36.09^{b} (T.N.)−0.230^{a} (Carb)--- (0.88) (0.64) (14.05) (0.12)	Eq. 15	0.957
	Biomass=-438.60+15.72^{b} (T.N.)+3.67^{a} (W.T.)--−34.59^{b}(pH)---0.32^{a}(Carb)--214.50^{b} (Amm.) (0.95) (0.61) (11.97) (0.10) (403.68)	Eq. 16	0.971
T$_4$	Biomass=-24.00+16.64^{a} (Nit.) --- (2.50)	Eq. 17	0.668
	Biomass=-70.99 + 14.10^{a} (Nit.) ---+5.75^{a} (L.P.) --- (1.77) (1.77)	Eq. 18	0.853
	Biomass=-73.91+11.08^{a} (Nit.) ---+5.64^{a} (L.P.)---−5.64^{a} (L.P.)---+ 451.25^{b} (P.) (2.00) (1.00) (1.00) (181.17)	Eq. 19	0.888
T$_5$	Biomass=-131.68 +484^{a} (L.P.) (0.79)	Eq. 20	0.717
	Biomass=-152.19 + 4.73^{a} (L.P)-3.30^{a} (DO.) (0.53) (0.62)	Eq. 21	0.825
	Biomass=-130.83+9.04^{a} (L.P.)-2.62^{a} (D.O.)−0.47^{a} (W.T.) (0.47) (0.59) (0.17)	Eq. 22	0.887
	Biomass=-116.77−4.08^{a} (L.P.)−2.1^{a} (D.O.)+0.73^{a} (W.T.)+-10^{b} (Carb) (0.44) (0.56) (0.18) (0.04)	Eq. 23	0.907

Biomass=average dry weight of planktonic biomass.

T.N.=average total nitrogen, P.=average orthophosphates. L.P.=average light penetration. D.O.=average dissolved oxygen. W.T.=average water temperature. Carb.=average carbonates, Mg.=average magnesium. Ammo.=average ammonia superscript, b=significant at $p<0.5$ superscript a= significant at $p<0.01$.

Standard errors (Fig in parenthesis) and significance (superscript) are mentioned for the every equation of each treatment.

increase in dry weight of planktonic biomass upon total nitrogen. This equation explains more than 82 percent of the variations in biomass under T$_3$. Boyd (1984) demonstrated that fertilizers usually contain nitrogen in ammonium or nitrate, which dissolves readily, and resulting ions may be absorbed by the plants and assimilated into organic nitrogen, which increase the primary productivity. The present findings are in line with the findings of the above-mentioned worker. Further increase in R^2 (11 percent) in the equation was obtained with the introduction of water temperature. In the next steps inclusion of more variables e.g. pH, carbonates and ammonia (step 3-5) resulted in only small R^2 change i.e. 3.7%. Overall R^2 value remained 0.971, which indicates considerably high reliability.

N: P: K (25:25:0) fertilized pond (T4)

Equation 17 at step-1 explains almost 66 percent of the variation in biomass was due to average nitrates. At second step (Eq-18) the light penetration was introduced in the linear equation. This equation explained more than 85% of the variations in the biomass which showed further 19 percent variations because of light penetration. The lower Secchi's disc visibilities indicate sufficient plankton productivity to support enough production as a result of response to the treatments (Mahboob et al., 1988) and Zahid (1997). Orthophosphates introduced on third step explained almost 3.8% of the variation in biomass. According to McQueen and Lean (1987), the phytoplankton densities varied with the concentration of orthophosphates. The partial regression coefficients of nitrates, light penetration and orthophosphates were highly significant.

Control pond (T_6)

The equation-20 (step-1) shows the dependence of biomass on light penetration (Table 1). This equation explained about 72% of variation in biomass. At second step dissolved oxygen was introduced in the equation that gave about 10% increase in R^2. The results of the present study corroborate the findings of Vasisht and Jindal (1980) and Forsyth et al. (1983). The amount of dissolved oxygen produced in photosynthesis was a function of both phytoplankton abundance and light penetration. At step-3 water temperature was introduced which further increased R^2 up-to 0.887 while at the 4th step the inclusion of carbonates in the equation increased the R^2 to 0.907 (Table1).

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