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 x 8 x 2.5 m (length x width x 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 m3/fish.

Feed supplementation of T1 and fertilization of T2, T3 and T4 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 (T5) remained without any additives in terms of feed or fertilizers.

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

| Treatment | Treatment material | % Nitrogen | % Phosphorus |
|-----------|--------------------|------------|--------------|
| T1        | Artificial feed (Vegetable sources) | 5.60±0.03 | 2.05±0.06 |
| T2        | Broiler manure     | 4.62±0.12 | 1.66±0.14 |
| T3        | Buffalo manure     | 1.02±0.05 | 0.96±0.02 |
| T4        | N:P:K (25:25:0)    | 25.00±0.04 | 25.0±0.04 |
| T5        | Control (no additive) |           |              |

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RESULTS AND DISCUSSIONS

Artificial feed supplemented Pond (T₁)

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 nitrogenuous 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 R². Further increase in R² (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 R² 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 (T₂)

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 T₂ (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 R² up-to 0.855. At step-4 (Eq-8) total nitrogen was removed. It resulted in a minute change in R² to 0.843. The inclusion of magnesium in the next step (Eq-9) seems to have further increase in R² value by 3.2% while at the 6th step the inclusion of dissolved oxygen in the equation increased the R² to 0.900. Step-7 (Eq-11) on the introduction of pH into the line gave only a small R² change i.e. 1.7%. All the regression coefficients were significant with R²=0.917 for all the selected variables, which appears to be of high reliability.

Buffalo's manure fertilized pond (T₃)

The equation-12 (step 1) showed a dependence of
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 R² change i.e. 3.7%. Overall R² value remained 0.971, which indicates considerably high reliability.

| Treatment | Regression Equations | R²   |
|-----------|----------------------|------|
| T1        | Equation 1            | 0.717|
| Biomass=22.21+19.43\(^{\text{a}}\) (Nit.) (2.60) | Eq. 1 |
| Biomass=113.32+18.12\(^{\text{a}}\) (Nit.)+4.41\(^{\text{a}}\) (W.T.) (2.13) |   |
| Biomass=185.14+9.04\(^{\text{a}}\) (Nit.)+4.97\(^{\text{a}}\) (W.T.)+10.41\(^{\text{a}}\) (T.N.) (3.23) |   |
| Biomass=498.72+8.12\(^{\text{a}}\) (Nit.)+3.95\(^{\text{a}}\) (W.T.)+11.77\(^{\text{a}}\) (T.N.)+39.00\(^{\text{a}}\) (pH) (3.05) |   |
| Biomass=76.95+17.41\(^{\text{a}}\) (T.N.) (2.16) | Eq. 5 |
| T2        | Equation 6            | 0.746|
| Biomass=165.76+16.54\(^{\text{a}}\) (T.N.)+4.37\(^{\text{a}}\) (W.T.) (1.69) | Eq. 6 |
| Biomass=192.25+5.78\(^{\text{a}}\) (T.N.)+7.75\(^{\text{a}}\) (W.T.)+214.79\(^{\text{a}}\) (Amm) (4.57) |   |
| Biomass=196.47+9.43\(^{\text{a}}\) (W.T.)+6148.03\(^{\text{a}}\) (Amm)−T.N. (Removed) (1.52) |   |
| Biomass=271.70+10.22\(^{\text{a}}\) (W.T.)+5215.29\(^{\text{a}}\) (Amm)−1.84\(^{\text{a}}\) (Mg) (1.44) |   |
| Biomass=353.63+8.61\(^{\text{a}}\) (W.T.)+5215.29\(^{\text{a}}\) (Amm)−3.20\(^{\text{a}}\) (Mg)−8.91\(^{\text{a}}\) (D.O.)−1.91\(^{\text{a}}\) (pH) (1.44) |   |
| Biomass=449.48+3.36\(^{\text{a}}\) (W.T.)−5281.79\(^{\text{a}}\) (Amm)−4.00\(^{\text{a}}\) (D.O.) (1.44) |   |
| Biomass=100.58+15.0\(^{\text{a}}\) (T.N.) (1.55) | Eq. 12 |
| Biomass=177.34+14.81\(^{\text{a}}\) (T.N.)+3.85\(^{\text{a}}\) (W.T.) (0.99) |   |
| Biomass=478.29+14.22\(^{\text{a}}\) (T.N.)+3.90\(^{\text{a}}\) (W.T.) (0.92) | Eq. 13 |
| Biomass=470.87+13.92\(^{\text{a}}\) (T.N.)+4.54\(^{\text{a}}\) (W.T.)+36.09\(^{\text{a}}\) (T.N.) (0.88) |   |
| Biomass=438.60+15.72\(^{\text{a}}\) (T.N.) (0.95) | Eq. 14 |
| Biomass=24.00+16.64\(^{\text{a}}\) (Nit.) (2.50) |   |
| Biomass=70.99+14.10\(^{\text{a}}\) (Nit.) (1.77) | Eq. 15 |
| Biomass=73.91+11.08\(^{\text{a}}\) (Nit.) (1.77) |   |
| Biomass=152.19+4.73\(^{\text{a}}\) (L.P.)−3.30\(^{\text{a}}\) (D.O.) (2.00) |   |
| Biomass=131.68+484\(^{\text{a}}\) (L.P.) (0.79) | Eq. 16 |
| Biomass=152.19+4.73\(^{\text{a}}\) (L.P.)−3.30\(^{\text{a}}\) (D.O.) (0.53) |   |
| Biomass=130.83+9.04\(^{\text{a}}\) (L.P.)−2.62\(^{\text{a}}\) (D.O.)+0.47\(^{\text{a}}\) (W.T.) (0.47) |   |
| Biomass=116.77+4.08\(^{\text{a}}\) (L.P.)+2.1\(^{\text{a}}\) (D.O.)+0.73\(^{\text{a}}\) (W.T.)+10\(^{\text{a}}\) (Carb) (0.44) |   |
| 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.
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 (T3)

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 (Table 1).

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