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# Effects of iso-nitrogenous fertilizers as nutrient sources on carp polyculture in Bangladesh

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Abstract
A 120-day long experiment was conducted to find out the effects of urea *plus* triple super phosphate (UT), cow manure (CM) and poultry manure (PM) having iso-nitrogen content on pond productivity and fish yield. Three fertilizer treatments, with three replicates each, were randomly assigned into nine earthen ponds of 100 $m^2$ each. The stocking fish were rohu (*Labeo ruhita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) in each treatment pond at the rate of 10000/ha with the ratio of 1:1:1. All ponds were fertilized fortnightly at the rate of 125 kg/ha urea *plus* 100 kg TSP/ha, 7000 kg/ha cow manure and 3500 kg/ha poultry manure for the treatment of UT, CM and PM, respectively, having an iso-nitrogen content of 56 kg in each. Though the physico-chemical water quality parameters were more or less similar in all treatment ponds, the chlorophyll-*a* content and abundance of total plankton were significantly higher ($P < 0.05$) in the ponds receiving the treatment PM. Final growth as well as per unit production of fish was significantly higher ($p<0.05$) with the treatment of PM (2067 kg/ha/4 months) followed by UT (1639 kg/ha/4 months) and CM (1246 kg/ha/4 months). The over all results showed that the poultry manure proved to be superior to urea *plus* TSP and cow manure, even when nitrogen content is similar, in carp polyculture system under prevailing conditions.

Key words : Iso-nitrogenous fertilizer, Water quality, Fish production

## Introduction

Fertilization is the cheapest and simplest means of increasing aquatic productivity. The natural productivity of a pond can be greatly enhanced by the use of fertilizer, which may make up or provide the essentially needed nutrients for the production of aquatic biota serving as, either directly or indirectly, the food of fishes. Several workers have observed direct correlation between plankton and fish yield (Olah 1986). While fertilization is considered for increasing the pond productivity, nitrogen and phosphorus are the major key factors playing the most dominant role to this regards (Hepher 1962 and Saha *et al.* 1968).

In terms of nitrogen, urea is considered more economical than other nitrogenous fertilizers, because it is a bicomponent physiologically neutral fertilizer, containing approximately 46% of pure nitrogen, as aquatic plants assimilate both ammonia and carbon dioxide being released out by urease hydrolysis (Wolny 1967). Pond fertilization practices using animal wastes are also widely used in many countries to sustain pond productivity at low cost (Perker and Olah 1990). Cow and poultry manure are the best among the commonly used organic manures in Bangladesh. However, cow manure contains less amount of nitrogen over that of poultry manure. The differences in nitrogen content in cow and poultry manure could be an important factor in case of manure standardization for maintaining optimum level of pond productivity.

Although a number of studies have been conducted on effects of fertilization on plankton production and growth of fish (Wahab *et. al.* 1994, Ahmed *et. al.* 1997, Wahid *et al.* 1997), studies on the effect of cow and poultry manure having a similar quantity of nitrogen are still very limited or scanty. Thus, the present study was undertaken to determine the effect of three iso-nitrogenous fertilizers *viz.*, urea *plus* triple super phosphate, cow manure and poultry manure on water quality, pond productivity and fish production.

## Material and methods

The experiment was conducted for a period of 4 months from July to October'99 at the Field Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Nine earthen ponds with an area of 100 $m^2$ each and average maximum depth of 1.5 m were used for this study. Ponds were rain fed and well exposed to sunlight.

### *Experimental design*

The experimental ponds were randomly divided into three treatment groups for three levels of iso-nitrogenous fertilizers, *viz.*, urea plus triple super phosphate (UT), cow manure (CM) and poultry-manure (PM) with three replications for each. The rate of urea and triple super phosphate for the treatment UT was fixed to the standard inorganic fertilization rate of 125 kg and 100 kg/ha per application, respectively, in Bangladesh aquaculture conditions. As the UT, i.e., 125 kg urea plus 100 kg triple super phosphate contains 56 kg N, the loading rates of CM and PM were calculated equivalent to 56 kg N as 7000 kg and 3500 kg/ha, respectively. The iso-nitrogenous fertilization rates were calculated on the basis of nitrogen content in respective fertilizers and manures. The total nitrogen content in poultry manure, cow manure and urea, used during the course of experiment, was analyzed (on oven dry basis) as 1.6%, 0.8% and 45%, respectively according to the methods given by APHA (1992).

### *Pond preparation, stocking and fertilization*

Before starting the experiment, ponds were drained out, renovated and made free of any unwanted aquatic organisms. Lime (CaO) was applied at the rate of 250 kg/ha and left over for 5 days to sundry. After 5 days of liming, the ponds were filled up with underground water and fertilized with respective fertilizer at selective dosages.

Seven days after fertilization, each pond was stocked with rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) at the rate of 10000 fingerlings/ha with the ratio of 1:1:1. The stocking size of fish is given in Table 3. During the entire period of the experiment, fertilizers were applied twice in a month, while both CM and PM were applied into the ponds as slurry on wet basis and UT was diluted with water and sprayed over the pond water.

*Monitoring of water quality*

Physicochemical parameters, *viz.,* temperature, transparency, dissolved oxygen (DO), pH, ammonia-nitrogen ($NH_4$-N), nitrite-nitrogen ($NO_2$-N), nitrate-nitrogen ($NO_3$-N), phosphate-phosphorus ($PO_4$-P) and chlorophyll-*a* of each pond water were monitored at ten days interval between 09.00-10.00 hours. Temperature was measured by digital thermometer (precision = $\pm 0.1^0$C) and DO by a digital DO meter (YSI model 58). Transparency was measured by a Secchi disc and pH by a digital pH meter (Jenway model 3020). Analyses of $NH_4$-N, $NO_2$-N, $NO_3$-N was done by using a HACH kit (model DREL 2000). Phosphate-phosphorus concentrations were determined by a spectrophotometer (Milton Roy Spectronic, model 1001 plus) according to methods of Stirling (1985). Chlorophyll-a was determined spectrophotometrically at 664 nm and 750 nm of absorbance after acetone extraction (Boyd, 1979).

*Plankton enumeration*

Quantitative and qualitative samples of phytoplankton and zooplankton were taken fortnightly throughout the experimental period. To enumerate plankton population, 10 samples (5 liters of water in each sample) of water were collected from different areas and depths from each pond and were filtered through a fine mesh (25$\mu$) plankton net. Then the filtered samples were taken in a measuring cylinder carefully and made up to a standard volume of 100 ml with distilled water. Samples were then preserved in small sealed plastic bottles containing 5% buffered formalin. Plankton were enumerated using a Sedgewick-Rafter counting cell (S-R cell). A 1ml sample was transferred to the counting chamber of the S-R cell (providing 10000 fields) and left to stand for 15 minutes to allow the plankton to settle. Using a binocular microscope (Swift M-4000), all cells/colony-forming units occurring in randomly selected 10 fields of the S-R cell were counted. Plankton density was estimated using the following formula:

$$N = (P \times C \times 100)/L$$

Where, N is the number of plankton cells or units per litre of original water
P is the number of plankton counted in 10 fields
C is the volume of final concentrate of the sample (ml)
L is the volume (litres) of the pond water sample.

Identification of plankton to genus level was carried out using keys from Ward & Whipple (1959), Prescott (1962), Belcher & Swale (1976), Palmer (1980) and Bellinger (1992).

### *Fish sampling and harvesting*

Fish of each species (n>10) from each pond were caught at each fortnight sampling day using a cast net. To determine growth gain, total length (cm) and weight (g) of each fish were measured using a centimeter scale and an electronic balance (Ohaus model CT1 200). At the end of the experiment, the pond water was pumped out and all fish were harvested, measured and weighed. Weight gain per fish was calculated by deducting the average initial weight from the average final weight. Specific growth rate (SGR; % body weight/day) was estimated using the formula:

$$\frac{\text{Log}_e\text{(final weight)} - \text{Log}_e\text{(initial weight)}}{\text{Culture period (days)}} \times 100$$

### *Data analysis*

For statistical analyses of data, a one-way ANOVA was carried out using *STATGRAPHICS Version-7* statistical package for the PC.

## Results and discussion

The mean values of water quality parameters monitored during the period of experiment are given in Table 1. The values of water temperature, transparency, pH, DO, total alkalinity, $PO_4$-P, $NO_2$-N, $NO_3$-N, $NH_4$-N and chlorophyll-*a* ranges from 28.0 to 33°C, 18 to 46 cm, 6.35 to 8.90, 4.15 to 6.10 mg/l, 74.41 to 96.55 mg/l, 0.23 to 2.45 mg/l, 0.035 to 0.063 mg/l, 1.94 to 2.64 mg/l, 0.35 to 0.63 mg/l and 102.74 to 299.76 µg/l respectively. Variations in water temperature, transparency, DO, pH, $NO_2$-N, $NO_3$-N and $NH_4$-N among treatment ponds were found similar. However, significant differences ($P < 0.05$) in total alkalinity, phosphate-phosphorus and chlorophyll-*a* values were observed among the treatments (Table 1). The water quality parameters measured in different treatments throughout the experimental period were found to be within the acceptable ranges for fish culture (Lakshmanan *et al.* 1971, Dewan *et al.* 1985, Dewan *et al.* 1991, Ahmed 1993, Wahid *et al.* 1997).

Table 1. Mean value (± SD) of water quality parameters in different treatments

| Water quality parameters | Treatments | | |
|---|---|---|---|
| | UT | CM | PM |
| Water Temperature (°C) | 30.56 ± 0.22 | 30.63 ± 0.27 | 30.95 ± 0.24 |
| Transparency (cm) | 27.54 ± 1.13 | 27.93 ± 1.45 | 25.67 ± 1.40 |
| Dissolved oxygen (mg/l) | $5.01 \pm 0.09^{ab}$ | $4.89 \pm 0.08^{b}$ | $5.24 \pm 0.01^{a}$ |
| pH | 6.70 - 8.70 | 6.65 - 8.45 | 6.35 - 8.90 |
| Total alkalinity (mg/l) | $79.38 \pm 2.91^{a}$ | $77.61 \pm 3.19^{a}$ | $92.32 \pm 4.23^{b}$ |
| $PO_4$-P (mg/l) | $1.69 \pm 0.09^{a}$ | $1.22 \pm 0.12^{b}$ | $0.73 \pm 0.09^{c}$ |
| $NO_2$-N (mg/l) | 0.061 ± 0.02 | 0.036 ± 0.00 | 0.035 ± 0.00 |
| $NO_3$-N (mg/l) | 2.50 ± 0.14 | 2.18 ± 0.16 | 2.06 ± 0.12 |
| $NH_3$-N (mg/l) | 0.48 ± 0.01 | 0.43 ± 0.08 | 0.52 ± 0.11 |
| Chlorophyll-*a* (µg/l) | $116.11 \pm 13.37^{b}$ | $122.52 \pm 17.16^{b}$ | $253.16 \pm 46.51^{a}$ |

*Values in the same row having no or the same superscript are not significantly different.

Though the nitrogenous nutrient content in treatment ponds were similar, it is interesting to note that the phosphorus content was significantly higher ($P < 0.05$) in the pond water receiving UT (1.69 ± 0.09 mg/l) compared to 1.22 ± 0.12 mg/l and 0.73 ± 0.09 mg/l in pond receiving CM and PM, respectively (Table 1). The lowest levels of phosphorus in the pond receiving CM and PM might be due to that the primary producers utilized the phosphorus in organic form more efficiently than that in inorganic form for their luxurious growth. This is being supported by the significantly highest ($P < 0.05$) chlorophyll-a content of 253 ± 51 μg/l in the ponds received poultry manure (PM) followed by that of 122.52 ±17.16 μg/l (Table 1) in the ponds received cow manure (CM). It has further been observed that the chlorophyll-*a* content had an inverse relationship with the phosphorus concentration. The absence of direct relationship between phosphorus and chlorophyll-*a* concentration was also evident in the fertilization studies of Metzger and Boyd (1980).

Plankton population indicates the productive status of a water body, because these are the direct and basic source of food for most of the animals in aquatic habitat. The abundance of plankton with their different groups has been shown in Table 2.

Table 2. Mean abundance of plankton (x $10^4$ cells/l) in pond water under different treatments

| Plankton groups | Treatments | | |
|---|---|---|---|
| | UT | CM | PM |
| Bacillariophyceae | $13.07\pm2.11^b$ | $20.50\pm3.14^{ab}$ | $48.29\pm19.51^a$ |
| Chlorophyceae | $32.36\pm6.53^b$ | $45.39\pm5.97^b$ | $100.93\pm29.07^a$ |
| Cyanophyceae | $24.36\pm6.57^b$ | $31.71\pm4.26^b$ | $79.64\pm19.93^a$ |
| Euglenophyceae | $6.07\pm2.21^b$ | $13.14\pm3.05^{ab}$ | $23.50\pm6.68^a$ |
| Total phytoplankton | $76.71\pm11.35^b$ | $105.79\pm12.80^a$ | $244.93\pm54.24^a$ |
| Crustacea | $80.93\pm14.53^a$ | $49.71\pm6.11^a$ | $53.21\pm12.38^a$ |
| Rotifera | $37.00\pm4.97^a$ | $31.14\pm3.21^a$ | $29.14\pm6.39^a$ |
| Total zooplankton | $111.36\pm13.36^a$ | $80.93\pm7.78^a$ | $82.36\pm18.24^a$ |
| Total plankton | $197.57\pm24.62^b$ | $191.93\pm17.92^b$ | $341.29\pm69.73^a$ |

Values with similar or no superscript in the same row are not significantly different ($p < 0.05\%$)

Phytoplankton population was mainly composed of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. Chlorophyceae showed the quantitative dominance over other groups and Euglenophyceae was the least abundant phytoplankton group in all treatments. Zooplankton population consisted of only two plankton groups *viz.*, Crustaceans and Rotifers. The mean abundance of total phytoplankton of 244.93x$10^4$ cells/l was significantly higher ($p<0.05$) with the treatment PM followed by that of 105.79x$10^4$ cells/l with CM and 76.71×$10^4$ cells/l with UT. However, though the concentration of total zooplankton in all treatment ponds was similar ($p<0.05$), the total plankton was significantly abundant with the mean concentration of 341.29x$10^4$/l in the ponds fertilized with poultry manure (Table 2). Dhawan (1986), Dhawan and Toor (1989) reported a higher total phytoplankton and zooplankton concentration in ponds treated with poultry droppings alone and in combination with cow dung, mainly due to the content of phosphates and nitrates. As the fertilizers used in the present experiment had a similar content of nitrogen, the highest concentration of chlorophyll-*a* (Table1) and total plankton (Table 2) with poultry manure suggests that the phosphate along with the organic carbon in manure has a significant regulatory role over the nitrate in primary production. Besides 40% of total nitrogen, the poultry manure releases 50% of its total carbon and 20% of total phosphorus through leaching and decomposition (Knud-Hansen *et al.* 1993).

The growth performance of fish in terms of initial weight, final weight, weight gain, specific growth rate (SGR), survival rates and total production are shown in Table 3. The growth of different fish in three treatments was significantly different when increase in biomass was taken into consideration. Growth and production data were extrapolated in order to express net yields on a per hectare basis over the 120-day culture period. A significantly higher ($p<0.05$) net fish yield of 2067 kg/ha was obtained with the treatment PM followed by 1630 kg/ha with UT and 1246 kg/ha with CM. The survival rates of different species in three treatments at harvest time were fairly high and ranged from 92% to 98%. There were regular increase in weight of fish in all treatments; however, the weight gain was much higher in the poultry manure received ponds followed by urea plus TSP and cow manure received ponds (Fig. 1).

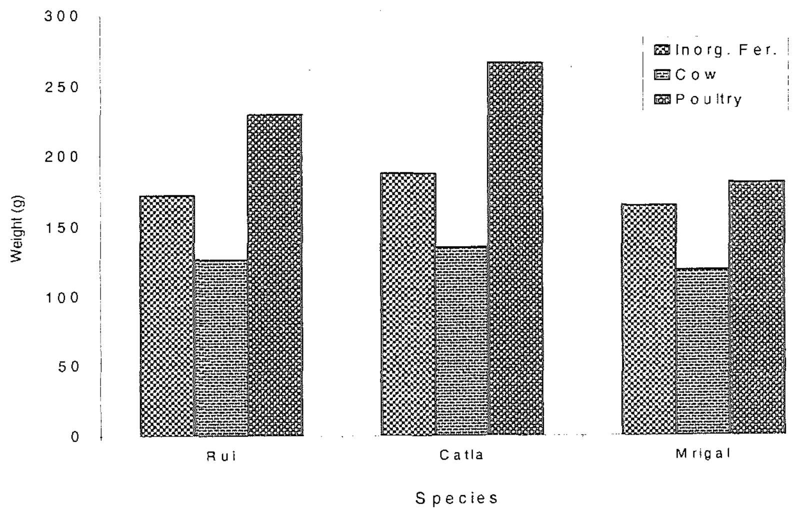


Fig. 1. Treatment wise production of rohu, catla and mrigal under different treatments.

**Table 3.** Details of growth and production of fish under different test treatments of iso-nitrogenous fertilizers in a 120-day culture period

| Treatments | Fish species | At stocking | | At harvest | | Survival rate (%) | SGR (%) | Total weight (kg) | Total production (kg/ha/4 months) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Initial wt. (g) | No. | Final wt. (g) | | | | Species wise | Total |
| UT (urea+TSP) | Rohu | 33 | 7.73 | 31 | 172.49±31.3 | 93.94 | 2.64 | 5.35 | 535 | 1630[b] |
| | Catla | 33 | 7.21 | 31 | 188.15±27.7 | 93.94 | 2.66 | 5.83 | 583 | |
| | Mrigal | 34 | 5.63 | 31 | 165.19±31.0 | 93.94 | 2.82 | 5.12 | 512 | |
| CM (cow-manure) | Rohu | 33 | 7.70 | 33 | 126.86±24.6 | 100 | 2.33 | 4.19 | 419 | 1246[c] |
| | Catla | 33 | 8.59 | 32 | 135.75±35.2 | 96.97 | 2.30 | 4.34 | 434 | |
| | Mrigal | 34 | 5.59 | 33 | 119.15±20.6 | 97.06 | 2.55 | 3.93 | 393 | |
| PM (poultry manure) | Rohu | 33 | 7.52 | 31 | 229.83±44.6 | 93.94 | 2.91 | 7.12 | 712 | 2067[a] |
| | Catla | 33 | 7.45 | 31 | 267.05±27.3 | 96.87 | 2.74 | 8.28 | 828 | |
| | Mrigal | 34 | 5.71 | 29 | 181.83±39.5 | 85.29 | 2.97 | 5.27 | 527 | |

*Values with similar superscript in the same row are not significantly different at 5% level.

This shows the superiority of poultry manure over cow manure due to the fact that poultry manure create more favourable limits of physico-chemical factors and nutrients which in turn increase the plankton production (Sandhu 1982, Dhawan 1986). Functionally, manure might also have acted as a direct food source, but Schroeder (1978) reported that fish fed directly on manure showed poor growth and that the major contribution of the manure is to increase the population of microorganisms. Laha and Mitra (1987) evaluated the effect of poultry manure and cow dung slurry at the rate of 5,000 kg/ha and 8,000 kg/ha, respectively, on the growth of three Indian major carps, *viz.*, rohu, catla and mrigal and observed the significant growth of fish in ponds fertilized with chicken manure than the cow dung slurry. While Mitra *et al.* (1987) evaluated the effect of poultry manure alone and in combination with pig or cow dung on the growth of production of catla, rohu and mrigal in four ponds, they found that the poultry manure alone or in combination with pig manure showed potentially in boosting up the productivity at comparatively cheaper rate.

Enhancement of fish yields by applying manure and fertilizers in composite fish culture ponds is an established phenomenon in many countries. However, studies on how water qualities and fish yield is related to the various iso-nitrogenous fertilizers and manures are very limited and there is none in Bangladesh. The present study on effects of different iso-nitrgenous fertilization on water quality and growth of fishes in composite carp culture is a part of series of experiments on the development of fertilization techniques for the composite carp culture in Bangladesh. Based on the results discussed above it could be concluded that even the nitrogen content in inorganic fertilizer and organic manure is similar, poultry manure seems to be superior than the commonly used urea plus TSP and cow manure for better yield under the prevailing carp polyculture system.

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References

Ahmed, Z.F., 1993. Electivity index and dietary overlap of Catla catla (Ham.) in fertilized and fed and fertilized ponds of Bangladesh. M. Sc. Thesis, Faculty of Fisheries BAU, Mymensingh.

Ahmed, G.U., M.A.R. Hossain, M.A. Wahab and K.M.A. Rahman, 1997. Efects of fertilizer on soil and water quality parameters and growth of a carp (*Labeo rohita*, Hamilton) fry. *Progress. Agric.* 8(1&2) : 111-114.

APHA, 1992. Standard methods for the examination of water and waste water. American Public Health Association. Washington, DC.

Belcher, H. and S, Swale, 1976. A Beginners Guide to Freshwater Algae. Institute of Terrestrial Ecology, Natural Environmental Research Council, London.

Bellinger E.G., 1992. A key to Common Algae. The Institute of Water and Environmental Management, London.

Boyd, C.E., 1979. Water Quality in Warmwater Fish Ponds. Auburn University, Craftmaster Ptinters, Opelika, Alabama.

Dewan, S., M.J.U. Miah and M.N.Uddin.1985. Studies on the food and feeding habits of *Cyprinus carpio* II. Diel and seasonal patterns of feeding of the fish. *Bangladesh J. Aquaculture*, 6-7(1): 11-18.

Dewan, S, M.A. Wahab, M.C.M. Beveridge, M.H. Rahman and B.K. Sarkar, 1991. Food selection, electivity and dietary overlap among planktivorous Chinese and Indian major carp fry and fingerlings grown in extensively managed rain-fed ponds in Bangladesh. *Aquacult. Fish. Managt*, 22 : 277-294.

Dhawan, A., 1986. Changes in the tissuue composition and reproductive cycle in relation to feeding in major carp, *Cirrhina mrigala* (Hamilton.), PhD Thesis, PAU, Ludhiana.

Dhawan, A. and H.S. Toor, 1989. Impact of organic manures or supplementary diet on plankton production and growth and fecundity of an Indian major carp, *Cirrhina mrigala* (Ham.), in fishponds. *Biological wastes*, 29 : 289-297.

Hepher, B., 1962. Primary production in fishponds and its application to fertilization experiments. *Limnol. Oceanogr.*, 7 : 131-135.

Knud-Hansen, C.F., T. R. Batterson and C.D. Mcnabb, 1993. The role of chiken manure in the production of Nile tilapia, *Oreochromis niloticus* (L.). *Aquaculture and Fisheries Management*, 24 : 483- 493.

Lakshmanan, M..V., K.K. Sukumarran, D.S. Murty, D.P. Chakrabartyand. T. Philipose, 1971. Preliminary observations on intensive fish farming in fresh water ponds by composite culture of Indian and exotic species. *J. Inland Fish. Soc.* India, 3 : 1-21.

Laha, U.K. and B. Mitra. 1987. Effectiveness of some organic manures on the growth of three Indian major carps. *Sci. Cult.* 53 : 84- 86.

Metzger, R.J. and C.E. Boyd, 1980. Liquid ammonium polyphosphate as a pond fish fertilizer. *Tran. Am. Fish. Soc.*, 109 : 563 – 570.

Mitra, B., A. Gupta and U.K Laha, 1987. Effects of some manures on the growth and production of major carps in village ponds of districts Birbhum, West Bengal, *Environ. Ecol.*, 5 : 381-385.

Olah, J., 1986. Carp production in manured pond. In: Aquaculture of cyprinids. (ed. Billard, Rand J. Marcel.) INRA, Paris: 502pp.

Palmer C.M., 1980. Algae and Water Pollution. Castle House Publications Ltd. UK.

Prescott G.W., 1962. Algae of Western Great Lakes Area. Wm. C. B rown Co. Inc. Dubuque.Iowa.

Peker, F. and J. Olah, 1990. Organic fertilization. In: (eds. R. Berka and V. Hilge), Proceeding of FAO-EI FAC symposium on production enhancement in still water pond cultue, Prague, Czechoslovakia : pp 116-122.

Sandhu, J.S., 1982. Role of organic waste in composite fish culture. PhD thesis, PAU, Ludhina.

Saha, K.C, J.C. Sengupta and A.N. Bhattacharya, 1968. Limiting factors controlling the production of Indian major carp fry in nursery ponds. Seminar on production of quality fish feed for fish culture. ICAR, 1-2 November, 1968.

Schroeder, G.L., 1978. Autotrophic and heterotrophic production of micro-organisms in intensively-manured fish ponds, and related fish yields. *Aquaculture*, 14 : 303-325.

Stirling, H.P., 1985. Chemical and Biological Methods of Water Analysis for Aquaculturists. Institute of Aquaculture. University of Stirling. Stirling.

Wahab. M.A. and Z.F.Ahmed, 1992. Effect of planktivorous carp species combination on food organisms and electivity indices in the fishponds. *Progress. Agric.*, 2(2) : 21-30.

Ward, H.B. and G.C. Whipple, 1959. *Freshwater Biology*. John Wiley and Sons Inc., New York.

Wahid, M.I., M.S.Haq, M.A, Wahab, Z.F. Ahmed, and M.S. Islam. 1997. Effects of fertilizer treatments on the water quality and fish production in semi-intensively managed fishponds. *Progress. Agric.*, 8 (1&2): 61-65.

Wolny, P., 1967. Fertilization of warm water fish ponds in Europe. FAO.Fish. Rep. 44 : 64 -81.

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