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WATER QUALITY UNDER DIFFERENT POND MANAGEMENT

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Abstract

Temperature, visibility, pH, dissolved oxygen, total hardness, total alkalinity, orthophosphate-phosphorus, chlorophyll-a and phytoplankton-zooplanton abundance were measured frequently in polyculture ponds, of which two ponds were fertilized with urea and superphosphate (1st treatment); two ponds were fertilized with urea, superphosphate and supplied with supplemental feed (17% protein) at 3% of fish biomass (2nd treatment), and two ponds were used as control. The experiment extended from September 1992 to February 1993 for two seasons, fall and winter. Data of the two seasons showed that the average concentration of PO4-P and NH4-N decreased, while, NO3-N increased from fall to winter in all treatments. No treatment effect was observed for nitrate (NO3-N), ammonia (NH4-N) in the chemical fertilizer and control treatments. Phytoplankton and zooplankton abundance were significantly different ($P<0.05$) between treatments, the hightes abundance was in 1st treatment. Net fish production were 89.2, 599 and 1079 kg/ feddan in control, 1st and 2nd treatments, respectively.

INTRODUCTION

There are several levels of fish pond management.Production at each level varies with species, specific stocking, fertilization, feeding and water exchange rates. To increase fish production, it is necessary to provide more food by increasing inorganic nutrient concentrations, feed or both. Ball (1949) observed that the closer the fish feed, the more their yield by fertilization. Pather (1969) reported that, fish supplied with feed usually do not obtain a large percentage of their food from natural sources. At other times, the use of fertilizer in fed ponds encourages excessive plankton blooms.

In this study, concentrations of selected water quality variables were evaluated under two pond management regimes (namely, chemical fertilizer and feed) during fall and winter.

MATERIALS AND METHODS

Six earthen ponds-0.25 feddan (f) each-were used. Ponds are located at the Central Laboratory for Aquaculture Research (CLAR) experimental unit. Ponds depth averaged 0.9 m. Water level was maintained by periodic additions of water from canal which branched from Ismaelia canal. In September 1992, all ponds were stocked with 1000 common carp, 150 silver carp and 50 tilapia spp. Average weights were 3.4, 5.0 and 12.0g, respectively. Two treatments and control in duplicate were studied to evaluate the effect of different managements on water quality. First treatment (1st) had inputs of urea (46% N), 16 kg/f and superphosphate (15.5 % P2O5) 25 kg/f weekly. Second treatment (2nd) had inputs of urea (46%N), 16 kg/f, superphosphate (15.5 % P2O5) 25 kg/f weekly, and supplemented feed (17% protein) at 3% of fish biomass adjusted periodically for weight gain. Fish were harvested on 2nd-3rd March 1993. Water quality determinations were made periodically between September and February every ten days for two growing seasons, fall and winter.

Water samples were collected with column sampler (Boyd 1979). Visibility was measured with sechii disk. conductivity with salinity meter, pH with pH meter 234, temperature and dissolved oxygen (DO) with oxygen YSI meter, hardness and alkalinity by titration, turbidity, ammonia-nitrogen, nitrate-nitrogen, orthophosphate-phosphorus were measured according to APHA, 1989.

Water was collected from all water depths for phytoplankton (enumeration-classification) and chlorophyll-a analysis. Each phytoplankton sample consisted of 500 ml of water measured into a flat bottoed, 10 liter Naglen gar containing formalin 5% according to (Boyd 1992). The sample was concentrated by setting. A 1-ml aliquot of the concentrate was placed into a sedgwick-Rafter counting cell, and each phytoplankter was identified to algal division and counted with the aid of a compound microscope (Weber 1973).

Water samples for chlorophyll-a analysis were filtered through 0.45 micrometer pore size Millipore filter, the pads were then acetone extracted in darkness at 4°C for 24 h. Chlorophyll-a concentration was calculated as suggested by Weber (1973). Water samples for zooplankton enumeration and classification were filtered through net 8 micrometer mesh size, the same procedure for counting phytoplankton were used with zooplankton. Statistical analysis of data obtained was carried out according to SAS (1989).

RESULTS AND DISCUSSION

Water quality data collected during the study are summarized in Table 1. Temperature averages were 24°C in fall and 14°C in winter.

In fall, average dissolved oxygen content of watter was similar in 1st and 2nd treatments ($P<0.05$), whereas, during winter DO concentrations were similar ($P>0.05$) for all treatments.

Average seasonal concentration for orthophosphate in fall was the same in 1st and 2nd treatments ($P>0.05$) and was higher than the control ($P<0.05$).

There was a build-up of orthophosphate in fall pond water in all treatments with time, although PO4-P dosage was 0.5 mg/1/week, the final concentration of PO4-P in fall reached 1.0, 1.07 and 0.73 mg/1 PO4-P in 1st, 2nd and control treatments, respectively. Generally, orthophosphate concentration was higher in fall (0.73-1.07 mg/1) than that of winter (0.55-0.81 mg/1). Orthophosphate concentrations were greatly reduced ($P<0.05$) in 2nd treatment during winter (0.55 mg/1). Total alkalinity was higher during winter (300-425 mg/l caco3) than that of fall (229-237 mg/1 caco3) due to the reduced photosynthetic activity and uptake of HCO3 from the ater. The same trend was observed for total hardness among all treatments. Therefore, alkalinity and hardness mg/1 as caco3 decreased, consequently, the concentration of phosphorus increased.

In fall, ponds fertilized with urea and superphosphate had less concentration of nitrate as compared to ponds fertilized with urea, superphosphate plus supplemented feed ($P<0.05$). The same trend was observed with ammonia-nitrogen. However, no treatment effect was observed for nitrate (NO3-N) and ammonium (NH4-N) in the chemical fertilizer and the control treatment. In winter, the concentration of nitrate (NO3-N) increased, while, that of NH4-N decreased compared to the chemical ferti-

Table 1. Water quality data collected monthly (average) during the fall and winter seasons 1992.

Season	fall			winter		
Parameters	control	superphosphate + urea	superphosphate + urea + feed	control	superphosphate + urea	superphosphate + urea + feed
Temperature ^{o}C	24.00a	24.00a	24.00a	14.00a	14.00a	14.00a
Visibility (cm)	18.30a	16.20b	16.30b	18.00b	15.50c	22.50a
Turbidity (JTU)*	57.50c	70.80b	84.08a	52.00b	80.00a	53.00b
TSS (mg//)**	376.00b	364.00c	382.00a	352.00a	352.00a	352.00a
pH	8.11a	8.69a	8.88a	8.70a	8.80a	8.60a
DO (mg/1)	4.66b	6.84a	7.68a	9.10a	9.20a	8.70a
Total Alkalinity (mg/1)	235.00b	229.00c	237.00a	425.00a	300.00c	337.00b
Total hardness (mg/1)	197.00a	176.50c	183.50b	254.00a	247.00b	244.00c
NH4-N (mg/1)	0.78b	0.74b	1.01a	0.55a	0.45c	0.50b
NO3-N (mg/1)	0.41b	0.40b	0.63a	0.52b	0.70a	0.41c
PO4-P (mg/1)	0.73b	1.00a	1.07a	0.70a	0.81a	0.55b

* JTU = Jackson turbidity unit

** TSS = total soluble solids

(Mean with the same letter are not significantly different) lizer, whereas, chemical fertilizer plus treatment decreased NO3-N and increased NH4-N. The major source of ammonia in pond water was direct excretion of ammonia by fish (Tucker and Boyd 1985) and by urea inputs which were applied in fertilizer. The concentration of NH4-N increased in the 2nd treatment about 20% more than in the 1st treatment which may be due to increased ammonia production in direct proportion to the feeding (Boyd 1989).

Seasonal trends in phytoplankton abundance (Table 2) showed that, in fall, total number of phytoplankton was significantly higher than that of winter in all treatments. The respective decrease in phytoplankton abundance during winter was 71.93, 70.73 and 36.2% of that of fall in 1st, 2nd and control treatments, respectively. These trends are related closely with total alkalinity which increased in winter 31.2, 42.19 and 57.9% than the alkalinity in fall in the 1st, 2nd and control treatments, respectively.

In fall and winter seasons, total number of phytoplankton was significantly different among treatments. The chlorophytes were numerically dominating on sampling dates followed by euglena, cyanophytes and then chrysophytes.

The total amount of phytoplankton was 279-727 x 10^3 and 178-204 x 10^3 organisms/ml during fall and winter, respectively. Estimates of phytoplankton passed on chlorophyll-a analysis are presented in Table 2. In fall, concentration of chlorophyll-a was significantly the highest in 1st treatment than in 2nd treatment followed by control ponds. The concentration of chlorophyll-a decreased from fall to winter in 1st and 2nd treatments, while, there was no significant difference in control ponds among the two seasons. In winter, there was significant difference between concentration of chlorophyll-a in 1st and 2nd treatments. These trends are related to decrease of total phytoplankton numeration. The equation obtained in the present study relating phytoplankton abundance /ml and chlorophyll-a (r2 = 0.992) was

$Y = 0.604X + 4.5$ where:

X - phytoplankton (number/ml)

Y - chlorophyll-a (u/l)

4.5 - constant number

Seasonal trends in zooplankton abundance (Table 3) showed that, in fall and

Table 2. Mean phytoplankton abundance (organism x 10^3 /ml).

Season	fall			winter		
Parameters	control	superphosphate + urea	superphosphate + urea + feed	control	superphosphate + urea	superphosphate + urea + feed
Diatoms	10b	8c	16a	9a	6b	9a
Blue green algae	23c	47a	41b	5b	4b	7a
Green algae	159c	534a	363b	11c	149a	144b
Euglena	87c	138b	195a	53a	45b	20c
Total number	279c	727a	615b	178c	204a	180b
Chlorophyll-a (μ/1)	173.01c	443.61	374.9b	112.1b	127.3a	113.2b

Means with the same letter are not significantly different (P>0.05).

Table 3. Mean zooplankton abundance (organism /1).

Season	fall			winter		
Parameters	control	superphosphate + urea	superphosphate + urea + feed	control	superphosphate + urea	superphosphate + urea + feed
Rotifer	6c	39a	36a	11c	23a	13b
Cladocera	33b	49a	49a	10b	22a	4c
Copepoda	48c	234a	138b	14b	45a	14b
Ostracoda	00b	3a	1b	00b	00b	2a
Total number	87c	325a	224b	35b	90a	33c

(Means with the same letter are not significantly different (P>0.05).

Table 4. Fish production data for ponds received chemical fertilizer, chemical fertilizer plus feed and control ponds.

Species parameters	control	Superphosphate + urea	Superphosphate + urea + feed
Common carp			
Average weight (g)	21.9c	210.84b	391a
Survival rate	42.5c	60.3a	49.5b
production (kg/f)	37.2c	508.56b	782a
Silver carp			
Average weight (g)	100.73b	133.2b	669a
Survival rate	100a	100a	68.7b
production (kg/f)	40.28c	79.92b	276a
Tilapia spp.			
Average weight (g)	81.39c	87.1 b	106.93a
Survival rate	72b	62c	100a
production (kg/f)	11.72b	10.8b	21a

Mean with the same letter are not significantly different (P>0.05).

winter, total number of zooplankton was significantly higher in 1st treatment than in 2nd and control treatments. Zooplankton abundance declined from fall to winter in all treatments. Copepoda, the main species in all ponds, reached 72, 61 and 55% of total number of zooplankton in 1st, 2nd and control treatments, respectively.

Net fish production, percentage of survival and mean body weight of fish at harvest is shown in Table 4. Fish yield in ponds receiving nitrogen and phosphorus by chemical fertilizer was roughly nine times more than those of control ponds. Fertilization plus feeding increased fish yield to even higher levels than those achieved with fertilization alone. These findings agree with those reported by Hepher (1962 and 1963). In polyculture of Indian major carp and Chinese carps, the production was 420 kg/f in the control ponds and 718.5 kg/f in ponds receiving urea and supplemented feed (Chakrabarty *et al.* 1975). A net production obtained 1773.5 kg/f in carp polyculture ponds using urea, triple superphosphate and potassium. Olah *et al.* (1986) reported on yield in carp polyculture with different treatments as following 1.47, 4.37 and 7.56 kg/f day for control ponds, mineral fertilization. The production in carp polyculture with three treatments was 183.61, 434.45 and 719.75 kg/f in control, triple superphosphate and triple superphosphate and urea, respectively (Yusoff 1988). The resultes in this study showed that the higher net production and average individual fish weight were in 2nd treatment then, in 1st and the control ponds. The production in the 2nd treatment was 2.15% times more than 1st, and 14.46% more than control, and in 1st was 6.72% more than control ponds.

The average weight of silver carp in 2nd treatment was higher than in 1st treatment ($P<0.05$), whereas, mineral fertilizer only was used, fish depended on natural feeding (Phyto-zooplankton and benthos), the competition between them decreased the individual weight of fish, espicially silver carp.

REFERENCES

1. American Public Health Association (APHA). American Water Works Association, and Water pollution Control Federation. 1989. Standard methods for the examination of Water and Wastewater, 17th ed. APHA, Washington, D.C.pp. 1.467.

2. Ball, R.C. 1949. Experimental use of fertilizer in the production of fish. Mich. State College Agric. Exp. Sta., Tech. Bull. 21 : 28 .

3. Boyd, C.E. 1979. Water quality in warm water fish ponds. Al. Agric., Exp. Sta., Auburn Univ., Al. 359 .

4. Boyd, C.E. 1989. Water quality management and irruption in shirmp farming. Al. Agr. Exp. Sta., Aburn univ., Al. 183 .

5. Boyd, C.E. 1992. Water quality and pond soil analysis for aquaculture. Al. Agric. Exp. Sta., Auburn., Al. 349 .

6. Chakrabarty, P.R., D.K. Sen, D./K. Chatterjec, and S.Jena. 1975. On the use of fertilizer and supplementary feed enhancing fish production in fresh water ponds. Proc. Nat. Acad. Sci. India, 45: 192-196 .

7. Hepher, B. 1962. Ten years of research in fish pond fertilization in Israel. II. The effect of fertilization on fish yields. Bamidgeh, 14:29-39.

8. Hepher, B. 1963. Ten years of research in fish pond fertilization in Israel. II.- The effect of fertilization on fish yields. Bamidgeh, 15 : 78-89.

9. Olah, J., V.R. Sinha, S. Ayappan, C.S. Purushotoman, and S. Radheeysham. 1986. Primary production and fish yield in fish ponds under different management practices. Aquaculture, 58 : 111-122.

10. Pather, E.E. 1969. Fishing success in ponds with daily feeding. Proc. Ann. Conf. S.E. Assoc. Game and fish comm., 23: 480-490.

11. Statistical Analysis system (SAS). 1989. SAS user's Guide : Statistics ver. 6.04 Edition. SAS Institute. Inc., Carg, NC.

12. Tucker, C.S. and C.E. Boyd. 1985. Water quality, P. 135-227. In : C.S. Tucker (ed.), Channel catfish culture. Elsevier Sci. Pub. Co., Amsterdam, The Netherlands.

13.Weber, C.I. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. US Environmental protection Agency, Washington D.C.

14. Yusoff, F. 1988. Fish production, primary productivity and nutrient availability in fertilized pond in Malaysia. DISS. ABST. INT. B-Sci. and ENG. vol. 49, no.3.

جودة المياه تحت نظم مختلفة لادارة الأحواض السمكية

زينب عطيه نجدى

المعمل المركزى لبحوث الأسماك - العباسة - مركز البحوث الزراعية - الجيزة - مصر .

تم دراسة درجة الحرارة، الشفافية، رقم الحموضة، الأكسجين الذائب، العسر الكلى ، القلوية الكلية، الأمونيا - نيتروجين الكلية ، الأرثوفوسفات - الفوسفور، كلوروفيل ١، عدد الفيتوبلانكتون و الزوبلانكتون على أحواض ترابية مستزوعة بأسماك المبروك العادى، المبروك الفضى، البلطى بمتوسط وزن ٩,٢١ ، ٧,١٠ ، ٣,٨١ جم على التوالى .. وذلك لعدد ٢ معاملة : المعاملة الاولى - باستخدام السماد المعدنى فقط (اليوريا والسوبرفوسفات)، المعاملة الثانية - باستخدام السماد المعدنى (اليوريا والسوبرفوسفات) مع التغذية الصناعية ٣٪ من وزن الاسماك (١٧٪ بروتين). كل معاملة ذات ٣ تكرار وعدد ٢ حوض بدون اضافات للمقارنة. وقد تمت الدراسة على موسمين - الخريف والشتاء (بداية من سبتمبر ١٩٩٢ وحتى فبراير ١٩٩٣). كان متوسط تركيز الارثوفوسفات الذائبة والأمونيا - نيتروجين يقل من الخريف الى الشتاء ويزداد فى المعاملة الأولى عن الثانية، وفى المعاملتين عن المقارنة. تزداد النترات من الخريف الى الشتاء. وقد أظهرت النتائج أن كثافة الفيتوبلانكتون ، الكلوروفيل ١ ، الزوبلانكتون تختلف بين المعاملات ودائما أعلى فى المعاملة الاولى. اختلفت نوعية المياه بين المعاملات، فاختلفت الانتاجية السمكية اعتمادا على اختلاف ادارة الأحواض حيث كانت الأنتاجية كالتالى : ١.٧٩ ، ٥٩٩ ، ٨٩,٢ كجم / فدان للمعاملتين الثانية ، الأولى والمقارنة، على التوالى.