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THE EFFECT OF STOCKING RATE ON WATER QUALITY, SOIL CHEMISTRY AND FISH PRODUCTION

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Abstract

Monoculture system was carried out in common carp ponds treated with chemical fertilizers (urea-superphosphate) plus supplemental feed (17% protein). Effect of three stocking rates 2100, 4200 and 6300 fish/feddan were tested on water quality, soil chemistry and fish production from 12 April to 4th November 1992, in 9 earthen ponds located in the experimental unit at Cental Laboratory for Aquaculture.

At the highest stocking rate (6300 fish/ feddan), organic matter accumulated reduced concentration of dissolved oxygen, increased chemical oxygen demand (COD) and concentration of ammonia-nitrogen. Slight differences in pH and orthophosphate-phosphorus in pond soil were realized in all treatments. Fish production increased and average individual fish weight decreased with increasing stocking density.

INTRODUCTION

There is significant relation between fish stocking density, water quality, fish growth and fish production in intensive fish culture system (Feldman and Cyghoe 1961, Scatt and Wross 1973, Kharetonova *et al.* 1976, Lesile 1979, Maclina *et al.* 1979-1980 and Moyan 1984). This experiment aimed to study the effect of fish stocking rates on water quality, soil chemistry and fish production.

MATERIALS AND METHODS

Common carp (*Cyprinus carpio*) with average weight 3 g was stocked in 12 April 1992, in nine earthen ponds, 0.25 feddan each, with average depth 0.8-0.9 m located in the experimental unit at the Central Laboratory for Aquaculature Research, Abbassa-Sharkia Governorate.

Three stocking rates were involved: 1st 2100, 2nd 4200 and 3rd 6300 fish / feddan. Each treatment was replicated 3 times. Ponds were fertilized with the same rate of mineral fertilizers, 30 kg superphosphate (15.5% P_2O_5) and 16 kg urea (46% N) per feddan weekly. Supplementary feed (17% protein) 3% of fish biomass was used six days a week.

Water samples were collected weekly using water sampler. Samples were analyzed for pH using pH meter model 345, dissolved oxygen DO mg/1 using YSI meter, ammonia-nitrogen (NH_4-N) mg/1, orthophosphate-phosphorus (PO_4-P) mg/1, hardness and alkalinity mg/1 as $CaCO_3$ (APHA 1989). Chemical oxygen demand (COD) mg O/1 was determined monthly (Boyd and Tucker 1992). Soil samples were collected at the end of each season (Spring, summer and fall) for measuring pH, NH_4-N and PO_4-P. (Jackson 1958).

Fish samples were collected monthly, and the experiment ended in 2-4 November 1992.

RESULTS AND DISCUSSION

Results presented in Table 1 show that dissolved oxygen concentration ranged between 5.3 to 7.3 mg/1 (mean: 6.37 mg/1) in 1st treatment (2100 fish/f), while, DO ranged between 5.2 to 6.2 mg/1 (mean: 5.75 mg/1) and between 3.9 to 5.1 (mean : 4.52 mg/1) in 2nd treatment (4200 fish/f) and 3rd treatment (6300 fish/f), respectively. There was no significant difference between 1st and 2nd treatment in the mean value of DO. The 3rd treatment had significantly low DO concentration, as compared to other treatments.

Chemical parameters in pond water, Table 2 showed that the mean of pH was 7.97, 8.07 and 7.83 in 1st, 2nd and 3rd treatments, respectively, and there were no significant differenes between treatments ($P>0.05$).

Through the experimental period, irrespective to stocking density, average ammonia-nitrogen concentration increased in summer, then, decreased in fall which was related to the increase in fish feeding activity in summer and decline in the activity gradually with decreasing temperature in fall.

Table 1. Average dissolved oxygen concentration (DO) mg/1 in pond water with the three stocking rates.

Treatment	Spring		Summer			fall		Mean
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	
1 st	7.3	7	6.9	5.7	5.3	5.9	6.2	6.37 a
2 nd	6.2	5.8	5.5	5.2	5.2	5.8	6.1	5.75 a
3 rd	5.1	4.6	4.2	4.2	3.9	4.5	4.7	4.52 b

Means with the same following letter is not significantly different (P>0.05)

Table 2. Average chemical parameters in pond water.

Treatment	Season	pH	NH4-N mg/1	PO4-P mg/1	hardness	Alkalinity
					mg/1 as caco3	
1 st	Spring	7.9	0.51	0.46	159.7	173.0
	summer	8.3	1.80	0.36	161.0	186.7
	fall	7.7	0.49	0.37	156.0	166.7
mean		7.97a	0.93b	0.39b	158a	175a
2 nd	Spring	8.1	0.70	0.71	157.8	166.7
	summer	8.3	1.80	0.91	172.5	187.0
	fall	7.8	0.53	0.39	161.6	174.7
mean		8.07a	1.01b	0.67a	163a	175a
3 rd	Spring	7.8	1.54	0.37	140.0	145.0
	summer	8.1	1.70	0.48	154.0	159.0
	fall	7.6	0.63	0.43	146.3	144.5
mean		7.83a	1.29a	0.426 b	143a	149 b

Means with the same following letter is not significantly different (P>0.05)

NH4-N mean concentration was significantly higher in the 3rd treatment ($P<0.05$). However, it was not significant between 1st and 2nd treatments. The mean concentration of orthophosphate (PO4-P) mg/1 was significantly higher in 2nd treatment than in the other treatments. In the 3rd treatment (6300 fish/feddan), the alkalinity (as CaCO3) was significantly lower than in the 1st and 2nd treatments. Low alkalinity water, under this study was harmless to fish, but was low enough to reduce the amount of carbon dioxide available for plankton. Chemical oxygen demand in water, Table 3, showed that the mean chemical oxygen demand (COD) mg/1 was the highest ($P<0.05$) in the 3rd treatment as a result of increasing stocking rate and artificial feeding as well. High COD of water samples is an indication of increasing organic matter concentration (Cole and Boyd 1986).

Table 3. Average chemical oxyen demand (COD) mg/l in pond water.

Treatment	May	Jun.	Jul.	Aug.	Sep.	Mean
1 st	9.4	15.2	12.5	12.5	10.7	11.17 b
2 nd	7.8	15.7	12.3	12.3	12.2	10.56 b
3 rd	8.2	18.9	15.8	21.6	18.6	15.19 a

Means with the same following letter is not significantly different ($P>0.05$)

Average chemical parameters in pond soil, Table 4, showed that there is no effect of fish stocking rates on the mean value of pH, absorbable and souluble NH4-N and PO4-P concentrations. Results showed that absorbable ammonia-nitrogen and PO4-P concentrations accumulated in soil from spring to fall in all treatments and there was slight increase in their concentrations in 3rd treatment. However, such effect was not statistically significant ($P>0.05$).

Net fish production (kg/f), average individual fish weight (g) and survival rate (%) are presented in Table 5. Results showed that increasing fish density in ponds decreased significantly survival rate from 80.2 in the 1st treatment to 78.1% in the 2nd treatment, and to 70.6% in the 3rd treatment.

The average individual fish weight was significantly higher in 1st treatment and decreased significantly in 2nd and 3rd treatments.

Although there was a significant difference between the average individual fish weight in 1st and 2nd treatments, they could be considered from the first class

Table 4. Average chemical parameters in pond water with three stocking rates.

Treatment	Season	PH	absorpobale NH4-N (mg/100 soil)	soluble NH4-N (mg/100 soil)	PO4-P
1 st	Spring	8.4	10.3	3.7	0.07
	Summer	8.1	10.4	7.9	0.14
	fall	8.0	14.5	5.1	0.16
	average	8.16 a	11.73a	5.56a	0.123a
2 nd	Spring	8.2	9.9	3.5	0.08
	Summer	8.1	10.7	7.4	0.15
	fall	8.0	13.5	5.3	0.15
	average	8.1 a	11.36a	5.4a	0.12a
3 rd	Spring	8.2	10.6	4.1	0.07
	Summer	8.1	14.8	10.5	0.16
	fall	8.0	19.6	7.8	0.2
	average	8.1 a	15.0a	7.46a	0.143a

Means with the same following letter is not significantly different (P>0.05)

Table 5. Average fish production (kg/feddan) in ponds with three stocking rates.

Treatment	Stocking rate	Survival rate%	average fish weight (g)	Net production kg/feddan
1 st	2100	80.2a	256a	431 c
2 nd	4200	78.1b	221b	728 c
3 rd	6300	70.6c	178c	793 a

Means with the same following letter is not significantly different (P>0.05)

(1 to 5 fish per kg).

Fish culture caused accumulation of minerals in the form of phosphorus and nitrogen in pond soil. High fish stocking density resulted in accumulation of organic matter which caused a decline in dissolved oxygen concentration and increased ammonia-nitrogen and orthophosphate-phosphorus concentrations. Reduced alkalinity and orthophosphate content in 3rd treatment had a negative effect on the photosynthetic activity which resulted in reducing individual fish weight and fish production (Boyd *et al.* 1981).

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تأثير معدل الكثافة على جوده المياه والتربة والإنتاجية السمكية

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

تم استزراع اسماك المبروك العادى بمتوسط وزن ٣,٢جم فى عدد ٩ أحواض ترابية مساحة كل حوض ٠,٢٥ فدان بمتوسط عمق ٠,٨٥ متر. تقع الاحواض التجريبية بالمعمل المركزى لبحوث الأسماك. وقد بدأت التجربة فى إبريل حتى أكتوبر ١٩٩٢ باستخدام ثلاث كثافات مختلفة (٢١٠٠ ، ٤٢٠٠ ، ٦٣٠٠ سمكه / فدان، ثلاث تكرارات لكل معامله. تم تسميد الأحواض بنفس معدلات التسميد ٣٠ كجم سوبرفوسفات (١٥,٥ ٪ فو ٢أ٥) - ١٦ كجم يوريا (٤٦٪ نيتروجين) / أسبوع/فدان. كانت التغذية الصناعية بمعدل ٣٪ من وزن الأسماك (١٧٪ بروتين) لمده ٦ أيام / أسبوع.

تم دراسة اثر الكثافات المختلفة لنفس المساحة على الأكسجين الذائب ، رقم الحموضة، الامونيا - نيتروجين ، فوسفور، العسر الكلى، القلوية الكلية، محتوي الأكسجين الكيميائى في الماء. فى التربة تم دراسة الامونيا الذائبة والممتصة، الفوسفور الذائب فى المواسم (الربيع - الصيف - الخريف).

أظهرت النتائج إنخفاض تركيز الاكسجين الذائب وزيادة فى الأمونيا نيتروجين فى مياه أحواض المعامله الثالثة بالمقارنة بالمعاملات الأخرى وأنه يوجد إختلافات بسيطة فى درجة الحموضة وتركيز فوسفور - الأرثوفوسفات فى تربه الأحواض بين جميع المعاملات. وتبين أن الانتاج السمكى يزيد مع نقص فى أوزن الأسماك مع زيادة معدل الكثافة فى الاحواض.