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EFFECT OF WATER QUALITY, FOOD AVAILABILITY AND CROWDING ON REARING CONDITIONS AND GROWTH PARAMETERS OF SOME ECONOMICAL FISH SPECIES GROWN UNDER POLYCULTURE SYSTEMS.

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ABSTRACTCT

To evaluate the effect of water quality, availability of natural or supplementary feeds and crowding on rearing cnditions and growth parameters of *Mugil cephalus*, *Oreochromis niloticus*, *Cyprinus carpio* and *Hypothalmichthys molitrix* grown under three polyculture conditions, fish were reared at moderate density (15,365 fish/ha) with and wothout supplementary feeding as well as a higher density (31,745 fish/ ha) with supplementary feeding. Phytoplankton zooplankton were accelerated by using organic and chemical fertilizers in all experimental ponds. The results showed that: 1) Equilibrium between water quality parametrers is needed to achieve maximum survival and growth conditions, 2). The availability of natural food increased the growth of *M. cephalus* by 20.7% in absence of supplementary preferable feeding, 3) For *C. carpio* and *O. niloticus*, the availability of supplementary feeding in addition to natural food is very important to accelerate their growth and production, 4) Due to presence of a special filtrating gill structure *H. molitrix* can consume natural food efficiently in addition to finely ground supplementary feeding and hence grows faster, 5). Under crowding condition the total gain increased accompained by decreasing individual size and poorest survival and production parameters was observed in *M. cephalus*, and 6) The percentage returns of total variable costs were enhanced using moderate density, fertilization and supplementary feeding.

INTRODUCTION N

In the time where the world fisheries are destined to play an important role in human nutrition, in Egypt fish become increasingly a luxury food. As many as 400,000 ha of fresh, brackish and salt water areas can be easily transformed into fish farms. Most of these areas are of such fertility that with addition of fertilizers and supplementary food, good production would be achieved (Eissawy and El-Bolock, 1975).

In Egypt, production of food-fish weighing between 50-500 gm, is traditionally carried out using advanced fry which have been raised in a fattening pond for several months. The most widely spread farming system is polyculture, using complementary species, organic fertilizing and supplementary feeding (semi-intensive fish culture). According to Anonymous (1983) polyculture of complementary fish species rests on three principles: 1) Complete use of the pond, both in depth (from the surface to the benthic zone) and over its entrie surface area; 2) Complete use of all types of natural food present in the pond and 3) Taking advantage of mutual benefits while avoiding competition for food.

Studying the physio-chemical and biological charcteristics in fish culture is of considerable importance as they mainly affect the growth, production, reproduction and survival of fish. Specially in newly developed fish farms, the following up of water quality parameters, facilitates the better management of the farm. Ponds with good water quality will produce more and healthier fish (Boyed, 1982).

The present study was carried out in order to: 1. Declare the effects of water quality, availability of natural and supplementary feeds and crowding on rearing conditions and growth parameters of Mugil cephalus, Oreochromis niloticus, Cyprinus carpio and Hypothalmichthys molitrix grown under different polyculture conditions and 2) Evaluate the economical values of the three experimental polyculture systems.

MATERIALS AND METHODS

The present study was carried out at El-Khashaa Fish Farm, Kafr El-Shiekh Governorate, Egypt on polyculture of 4 fish species: Gery mullet (Mugil cephalus), tilapia (Oreochromis niloticus), common carp (Cyprinus carpio) and silver carp (Hypothalmichthys molitrix). Investigations were conducted on uniform ponds each of 0.945 ha, with an average depth of 1.2 m, fed individually with brackish water from El-Gharbia drain (salinity 1.5-5.5‰). Three polyculture conditions were practiced in rearing the 4 experimental fishes as follows:

Species	Size (g)	No. of advanced fry/ha
Polycultures A and B		
M. cephalus	0.41	6984
O. niloticus	0.41	4444
C. carpio	1.08	2667
H. molitrix	1.30	1270
Polyculture C		
M. cephalus	0.41	10264
O. niloticus	0.41	12275
C. carpio	1.08	5291
H. molitrix.	1.30	3915

Fish in polyculture type A (PTA) received only cow manure (30 kg/ha) and chemical fertilizers (15.0 kg superphosphate + 9.6 kg urea/ha) every two weeks in order to accelerate the development of phytoplankton and zooplankton. While the fish in polyculture types B (PTB) and C (PTC) were given pelleted supplementary feeds, containing 17.5% crude protein at the rate of 3% of fish body weight/day for six days a week when there is an abundance of natural food; cow manure (30-38 kg/ha) and chemical fertilizers (12-13 kg superphosphate + 7.1-7.3 kg urea/ha) every two weeks.

The ponds were stocked in mid-August 1987 and harvested in eight September 1988. The water temperature during the experiment ranged between 15 and 28°C. During the study period, random fish samples from experimental ponds, were caught to adjust feed requirements and regulate growth performance. The input costs and returns from the three experimental polyculture conditions were calculated.

Monthly water samples were collected from the center of each pond using a polyethylene bucket. Dissolved oxygen was immediately fixed in field and determined using Winkler technique. pH was measured using a portable pH meter (Orion Research Model 210). Samples for dissolved phosphorus, nitrate and ammonia were kept in polyethylene containers. Filtration was performed after sampling on 0.45 um Millipore membrane filters 47 mm diameter. The filters were used for chlorophyll a determination using the 90% acetone extraction method while the filtrate was used for the colorimetric determination of phosphorus and nitrogen forms according to the methods described by Golterman et al. (1978).

Estimation of phytoplankton standing crop was carried out using the sedimentation technique. One liter of water sample was collected and concentrated to 100 cc. Subsamples were transferred to counting cells and different plankters were counted using a research microscope. Results are given as number of species/liter. Zooplankton samples were collected by filtering 40 liters of the pond water through a 55 u plankton net 25, then concentrated to about 100 cc. Few milliliters of the concentrated samples were counted and results were expressed as numbers/m^3.

RESULTS AND DISCUSSION

Water Quality and Nutrient Status:

Figure 1 shows that the dissolved oxygen content of the three polyculture types was fair for healthy production. In PTA and PTB values exceeded 5 mg/l. The high stocking density in PTC may lead to the remarkable drop in dissolved oxygen below the satisfactory limit and desirable range for most fish stages and activities.

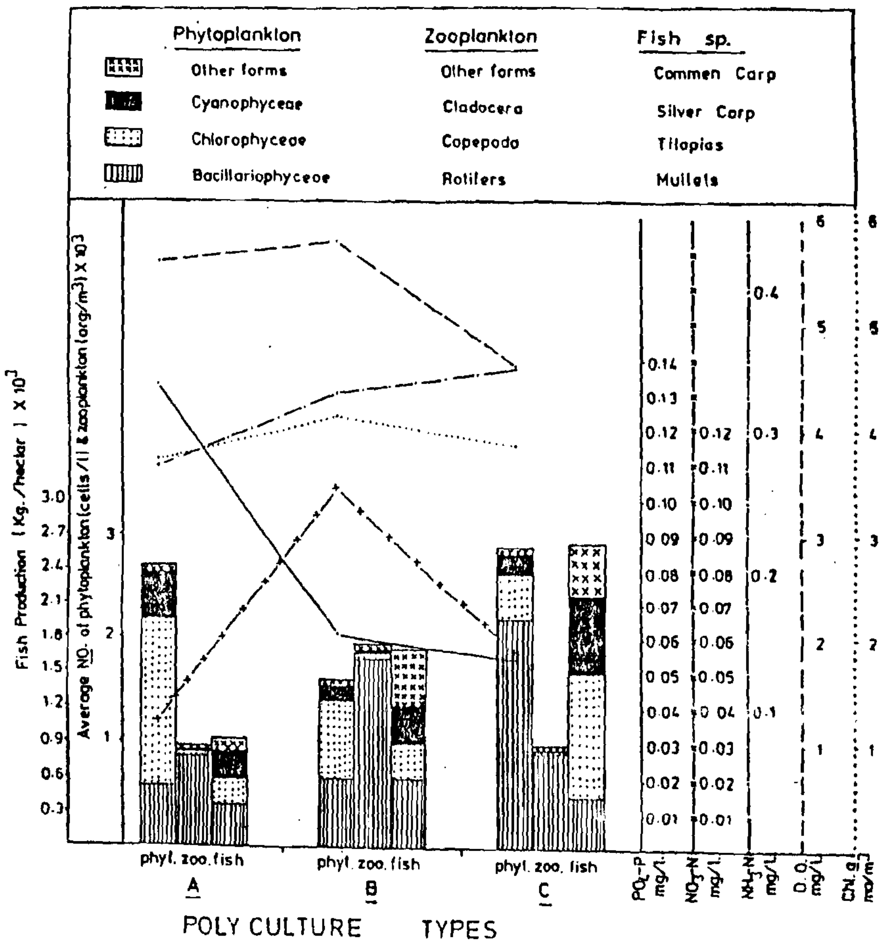

Fig. (1)
Average water quality parameters, phyto-and zooplankton populations as well as fish production (Kg/ha) in the different polyculture types studied.

The pH in the different polyculture types ranged between 7.77 and 7.99. Such values fall in the desirable range for good fish production. However, fluctuations in reactive phosphorus content between the three polyculture types were recognized. The average value in PTA (0.132 mg/l) reached nearly double those of PTB and PTC (Fig. 1). On the other hand, nitrate values were maximum in PTB (average 0.103 mg/l) in a reversed pattern with the total phytoplankton counts in this polyculture type. This indicates that nitrate in all polyculture types studied is more critical for the growth of the primary producers than phosphorus. Ammonia, the main product of metabolic and decomposition processes, increased regularly with fish density and presence of supplementary feeding. The unionized ammonia, did not exceed 0.014 mg/l indicating no prediction of lethal or even sublethal effects.

The N/P ratio in the three polyculture types (A, B and C) was 2.34, 7.01 and 7.39, respectively. Despite the similarity in ratios between PTB and PTC the equilibrium attained between nitrogen forms and phosphorus in PTB situated this type as attaining the most suitable water quality conditions for fish growth.

The statistical correlation between N/P ratio and phytoplankton biomass expressed as chlorophyll a as well as that between the individual ingradients indicate that nitrogen in the three polyculture types is the main controller of phytoplankton growth than phosphorus. Such stability in N/P ratio leads to a subsequent elevation in growth and production parameters in PTB and PTC.

Food Availability, Crowding and Fish Production:

The effect of natural or supplementary feeds availability on growth parameters of the three polyculture conditions is presented in Table 1 and Figure 1. It is evident that, the availability of supplementary feed in PTB resulted in a significant ($p < 0.01$) increase of the overall growth rate by 62.5%, in comparison with results obtained in PTA; however, the increasing rates of the overall survival and condition factor were insignificant. On the other hand, the overall daily and total gain in PTB were nearly double those of PTA. Miller (1975) summarized the advantages of supplementary feeding for fish in the following points: 1) faster growth occurs; and 2) greater production is possible while Hepher and Pruginin (1981) suggested that, the highest fish growth and yields are achieved by using fertilization and supplementary feeds.

Table 1 indicates that, the highest decline in tilapia and common carp production occurred in PTA with no supplementary feeds available. However, this polyculture type showed high development of phytoplankton (mainly chlorophyceae 58.6% and diatoms 21.8%) and zooplankton (mainly Rotatoria 90%) (Fig. 1). This may be attributed to one or more of the following: 1) in modern carp culture, more artificial feed is employed (Tal and Hepher, 1967 and Bardach et al., 1972) while supplementary feeding is essential for success in large scale cultures of tilapia (Barach et al., 1972 and Essa et al., 1988); 2) the high level of food competition between the silver carp and O. niloticus. The filtration capacity of silver carp is more efficient than O.niloticus. Silver carp possesses a definite selectivity to diatoms, protozoa and green algae due to presence of a special filtrating gill structure (Vinogradow, 1979). In PTA, such groups constituted about 79% of the total phytoplankton; and 3) common carp feeds mainly on planktonic organisms as well as animalcuels living near the banks and on the bottom (Huet, 1972 and Ahlfors et al., 1982) which are rare under the present polyculture conditions.

In contrast, M. cephalus exhibited a higher growth rate in PTA, probably due to the dominance of preferable natural foods, chlorophyceae (Thompson, 1963) which constituted about 54% of the total phytoplankton crop (Fig. 1). In PTA, silver carp maintained maximum growth rate compared with common carp or tilapia reared in the same conditions. However, the growth parameter of silver carp in PTB were not only higher than those of tilapia, mullet and common carp, but also exceeding those of silver carp in PTA (Table 1). This could be explained that silver carp feeds mainly on phytoplankton and smaller zooplankton species, principally Rotatoria (Wilamovski, 1972) which are not sufficiently exploited by the usual species in polyculture, and thereby increase their growth; in addition, silver carp can eat finely ground supplementary feed and thus grows faster (Sivalingam, 1975 and Hepher and Pruginin, 1981).

The effect of crowding on the growth parameters and survival rates of fish are shown in Table 1. Results revealed that, the overall growth and survival rates under crowding condition (PTC) were density dependent. With increasing density, the total gain increased by 53% accompined by decreasing individual size. The high stocking density PTC may lead to the considerable drop in dissolved oxygen values below the satisfactory limit for desirable growth (5 mg/l). However, sharing of natural and supplementary feeds between individuals could be a cause for the reduction in individuals' growth rates. Despite the availability of natural food (primary producers, Fig. 1) in PTC, they were unbeneficial for cultured fish. Fish appetite could be affected strongly by low oxygen concentration i.e. 4.3 gm/l (Hickling, 1962). In an intensive culture of grass carp, Shireman et al. (1977) observed that the slow growth of grass carp at high stocking densities was due to individuals disturbing each other during feeding and during normal activity, while at low densities such disturbances might be absent resulting in increased growth. The results of Verani et al. (1983) also agreed with our present findings, where they observed that high fish production is obtained with high rate of stocking and use of feeds. *M. cephalus* is more sensitive to low oxygen concentration (less than 5 mg/l) and muddy water (Sivalingam, 1975). This is reflected on the poorest survival, condition factor and total gain of *M. cephalus* in crowding conditions, PTC (Table 1).

Economic Analysis:

Details of the input costs and returns for the three polyculture conditions are presented in Table 2. Results showed that the input costs varied with several factors, such as stocking density and quality of supplementary feeds. The costs of establishing the three polyculture conditions were found to be lower than the gain in revenue from fish sales. This recommends the suitability of the three polyculture conditions to be quite efficient in terms of operation and production. Table 2 shows also that, the percentage returns of the total variable costs recorded a higher value in PTB receiving supplementary feeding at moderate density (183.1%) compared with PTC receiving also supplementary feeding but under crowding conditions (103.3%). However, PTA which is receiving only organic and chemical fertilizers (without supplementary feeding) at moderate density, exhibited the lowest value (79.6%), indicating the profitability of using fertilizers only to accelerate natural food production and thereby increasing fish production as well as the gain in revenue from fish sales.

From the results of the present study it can be concluded that, PTB receiving organic and chemical fertilizers as well as supplementary feeding at moderate density seemed to be the more efficient polyculture type in terms of operation and production giving high and encouraging returns.

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TABLE 1

Effect of availability of natural or supplementary feeds and crowding on growth and production parameters of the 4 experimental fish species, reared in different polyculture condition

Polyculture Conditions	Stocking data: Density (fish/ha)	Stocking data: Average weight (g)	Stocking data: Condition factor	Harvesting data: Density (fish/ha)	Harvesting data: Average weight (g) *	Harvesting data: Survival (%)	Harvesting data: Condition factor	Gain: weight gain (g/f/d) **	Gain: Daily gain (kg/ha)	Gain: Total gain (kg/ha)
PTA										
M. cephalus	6984	0.41	1.14	2795	151.06	40.02	1.85	0.41	1.15	419.35
O. niloticus	4444	0.41	1.38	3909	62.26	87.96	3.95	0.17	0.66	241.55
C. carpio	2667	1.08	2.75	2341	52.00	87.78	2.95	0.14	0.32	118.85
H. molitrix	1270	1.30	0.67	697	316.28	62.68	2.02	0.86	0.68	250.11
Total (Average)	15365	0.80	1.48	9841	145.40	69.61	2.69	1.58	2.81	1029.86
PTB										
M. cephalus	6984	0.41	1.14	5367	125.19	76.85	1.92	0.34	1.83	669.03
O. niloticus	4444	0.41	1.38	2841	118.05	63.93	3.88	0.32	0.91	333.56
C. carpio	2667	1.08	2.75	1886	299.66	70.72	3.45	0.82	1.54	562.28
H. molitrix	1270	1.30	0.67	881	402.27	69.37	1.77	1.10	0.97	352.75
Total (Average)	15365	0.80	1.48	10975	236.29	70.22	2.75	2.58	5.25	1917.62
PTC										
M. cephalus	10264	0.41	1.14	4094	120.96	39.89	1.73	0.33	1.34	491.00
O. niloticus	12275	0.41	1.38	10903	106.77	88.82	3.87	0.29	3.17	1159.08
C. carpio	5291	1.08	2.75	3527	151.81	66.66	3.96	0.41	1.45	529.72
H. molitrix	3915	1.30	0.67	2675	284.00	68.33	1.64	0.77	2.07	754.61
Total (Average)	31745	0.80	1.48	21199	165.88	65.92	2.80	1.80	8.03	2934.41

** g/f/d : gm/fish/day.

* Different superscripts indicate statistically significat differences (p.0.001).

TABLE 2

Economic analysis of the three polyculture conditions (values in Egyptian pounds, L.E.)*.

Items	Moderate density + No feeding (PTA)	Moderate density + Suppl.feed (PTB)	High density + Suppl.feed (PTC)
1. Input costs			
- Fish fingerlings:			
M. cephalus (L.E.4/1000 fry)	26.40	26.40	38.80
O. niloticus (L.E.10/1000 fry)	42.00	42.00	116.00
H. molitrix (L.E.10/1000 fry)	12.00	12.00	37.00
C. carpio (L.E.10/1000 fry)	25.20	25.20	50.00
- Supplementary feeds(L.E.0.16/ kg feeds)	-	644.80	923.20
- Fertilizers:			
Cow manure (L.E.1.0/10 kg)	80.00	80.00	100.00
Superphosphate (.E.0.32/10 kg)	12.48	10.08	11.04
Urea (L.E.1.33/10 kg	33.25	24.60	25.27
- Labor (one labor for all experimental ponds at a salary L.E.45/month) and adminstration cost	188.57	188.57	188.57
- Depreciation cost of pond construction; life expectancy twenty years	401.78	401.78	401.78
Total values	821.68	1455.43	1891.66
2. Returns			
- Fish sales	1475.70	4120.30	3846.40
- Net profit	654.02	2664.87	1954.74
- Net profit as a % of total variable costs (%).	79.59	183.10	103.33

* 1 U.S.$ = 2.60 L.E.

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