OBSERVATIONS ON INTENSIVE COMPOSITE FISH CULTURE

by

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Abstract

In intensive composite fish culture work carried out in experimental ponds of the Killa fish farm, Cuttack, India, high fish productions, on an average of about 8 200 kg/ha/yr, were obtained from two freshwater ponds. The species cultured were indigenous major carps *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* and the exotic carps *Hypophthalmichtys molitrix*, *Ctenopharyngodon idella* and the Indonesian strain of the common carp, *Cyprinus carpio* var. *communis*. The fingerlings were stocked at a combined stocking density of 10 000/ha, the ponds fertilized and supplementary feed in the form of a mixture of ground nut oil cake and rice polish provided each day. Desired aquatic weeds were put in for feeding the grass carp.

The notable features were the attainments of average weights of over 1 kg within a year of culture by the exotic carps which constituted 60% of the fingerlings stocked, the attainment of sexual maturity by *Notopterus chitala* (a small mouthed predator) and the excellent growth of *Macrobrachium rosenbergii* stocked in few numbers.

Higher production was obtained in the pond that received higher inputs and this addition of organic load was possible without adversely affecting the pond condition because of better depth conditions (water volume) and recent desilting of the same. High fish productions may be obtained through intensive polyculture in India, but as the ponds used are still-water ones the optimum quantity of input required must be known by further experimentation. By spending more than required for the inputs, over-fertilization may pollute the water, adversely affecting production.

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1. INTRODUCTION

High productions have been obtained by composite fish culture or poly-culture of the Indian major carps and exotic carps in experimental studies (Chaudhuri et al., 1974; Chaudhuri et al., 1975) thereby establishing the soundness of this technology which was developed gradually. Tried under different agro-climatic conditions in different parts of India, sizeable fish crops have been obtained by such fish culture (Sinha, 1975). In all these studies an intimate relationship was noted between the input and the output (the fish), prominent among which are the feed and fertilizers which account for the greatest part of the expenditure.

As fish culture is carried out in dug-out still water ponds in India, with no facilities for purification of the water or removal or washing away of the accumulated metabolites, use of inputs in excess could cause fish kills, by making the system polluted and through production of algal blooms causing violent fluctuations in the dissolved oxygen. As such, judicious use of feed and fertilizers is necessary for profitable composite fish culture.

2. EXPERIMENTS UNDERTAKEN

Composite fish culture was undertaken in two stocking ponds of the Killa experimental fish farm at Cuttack, in Orissa, in 1974-75. The ponds, one 0.5 hectare in area (Pond A) and the other of 0.4 hectare (Pond B) are rain-fed, weed-free and free from flooding. The species of fish stocked were the major Indian carps *Catla catla*, *Labeo rohita* and *Cirrihinus mrigala* and the exotic carps *Hypophthalmichthys - molitrix* (silver carp), *Ctenopharyngodon idella* (grass carp) and the Indonesian strain of common carp, *Cyprinus carpio* var. *communis*.

Stocking density and species ratio

The ponds which had an average water depth varying from 1.5 to 1.75 metres were stocked at the rate of 10 000 fingerlings per hectare in the ratio of catla 1: silver carp 2.5: rohu 2: grass carp 1.5: common carp 2: mrigal 1. To this were added a few numbers of the featherback *Notopterus chitala* and juveniles of the giant freshwater prawn *Macrobrachium rosenbergii*. Table 1 denotes the size of fingerlings stocked.

The ponds used had been previously cleared of fish by use of the fish toxicant, oil cake of mahua (*Bassia latifolia*) at 200 ppm and the stocking was done a month after poisoning the ponds.

Management techniques

The management techniques involved fertilization, supplementary feeding with artificial feed, providing desirable aquatic weeds for grass carp and removal periodically of harvestible fish that had registered weights of around 1 kg (considered marketable). The quantity of the inputs are given in Table 2.

The larger quantity of inputs provided in pond B was possible because of better depth conditions (water volume) and recent desilting, unlike the other pond in which occurrence of rich bloom of *Microcystis* sp. etc. restricted the use of inputs.

The entire quantity of cowdung, inorganic fertilizers as well as lime were added in split-up doses. Raking the pond bottom with a spike-like rake was done after each application of lime applied on the water surface. This was with the idea of hastening mineralization of deposits at the pond bottom.

Aquatic weeds provided consisted of *Spirodela*, *Lemna*, *Ceratophylum*, *Najas* and *Azolla*. Also provided as chopped bits was the pond margin-weed *Enhydra fluctuans* (Chaudhuri et al., 1974). Because of the dearth of the desired macrovegetation in areas around Cuttack, the quantity of weeds that could be procured to feed grass carp was much less than desired.

The supplementary feed mixture of ground nut oil cake and rice polish, found useful in earlier experimental studies for the growth of the cultivable carps, was given in quantities which were increased as the fish grew. To begin with, a very low quantity of 4 + 4 kg/ha was broadcasted each day which rose to 40 + 30 kg/ha (oil cake + rice polish) towards the end of the culture period. The rice polish used was deoiled, which was cheaper than bran with oil. The feed mixture of oil cake and bran was broadcasted over the water surface. During periods of low water level when algal blooms appeared, intensified and persisted, feeding was totally stopped as was fertilization. Such a state of affair was more prevalent in pond A than in the smaller pond B, as explained earlier. This was observed from the plankton collections made which revealed the greater dominance of *Microcystis* sp. (3 700 to 7 600 units/litre) causing the blooms in pond A.

Physico-chemical conditions

Water and soil analyses were carried out each month and the observations made are presented in Table 3.

Available nitrogen and phosphorus values were initially very high in both the pond soils and after two months these dropped. At the end of the experiment, the levels of both the nutrients were low which indicated the utilization of these major nutrients in both the ponds.

Organic carbon, the reserve nutrient in the bottom soil, was of moderate magnitude indicating that basically the ponds were productive. Nevertheless, for achieving high fish production, fertilization and feeding were resorted to. As the soil reaction was near neutral, which is favourable for the release of nutrients in the water phase, levels of dissolved inorganic N and P fluctuated between moderate and high. Water quality of the ponds was alkaline and the values of alkalinity pointed towards productive conditions (Banerjea, 1967).

Plankton

The plankton density in pond A varied from 0.1 ml/45 l recorded in March to 2.3 ml/45 l found in May. Except for the summer months, plankton population revealed in the collections was poor varying from 0.1 ml to 0.35 ml. In the other pond, there was little variation in the plankton density from 0.15 ml to 0.45 ml. The greater density of plankton in pond A, during the summer was because of the *Microcystis* sp., which was perhaps ill-utilized (Sukumaran et al., 1968).

The predominant forms among phytoplankters were *Microcystis*, *Pediastrum*, *Navicula*, *Scenedesmus* and *Cosmarium* and among zooplankters nauplii of copepods, *Cyclops* and *Diaptomus* were more common. The plankton pattern was not much different from that recorded in ponds under composite culture by other workers (Lakshmanan et al., 1971, Sinha et al., 1973 and Chaudhuri et al., 1975), the minor differences being due to the difference in the inputs.

Fish production

The gross and net productions recorded in the two ponds were 7 503 kg/ha/yr and 7 090 kg/ha/yr (Pond A) and 8 867 kg/ha/yr and 8 496 kg/ha/yr (Pond B) when these were harvested at the end of a year of culture. The survival, average sizes attained and contribution of species weight-wise in the total production, indicated the excellent culture quality of the fast growing silver carp. The possible mortality of some of the stocked fingerlings of silver carp in the larger tank minimized to some extent its production. The outstanding performance of grass carp and common carp is also noteworthy particularly the attainment by these of average weights over 1 kg. Such high production of these three exotic carps together is a striking feature of these experiments. Chaudhuri et al. (1974) in their experiments on intensive fish culture of Indian and exotic carps got higher average weights of these exotic species but the survival percentages were lower. Productions by these species in experiments reported by Chaudhuri et al. (1975) are comparable. Sinha and Gupta (1975) mentioned larger average sizes attained by silver carp and grass carp, but in these cases the stocking densities were lower (at 5 000/ha) than in the experiments reported herein.

As can be seen from Table 4, the Indian major carps fared less better than the exotic carps but the survivals recorded for these in both the ponds, were excellent.

N. chitala stocked were those that had been harvested from a previous experiment and were of weights 719 g and 706 g at the time of stocking in ponds A and B. It is interesting to record that these minor predators attained maturity in the ponds and the sexes could be distinguished by the examination of genital papillae (Mr. R.M. Bhowmick, personal communication). Weights of the *Macrobrachium rosenbergii* juveniles were 44 g at the time of stocking. Males were stocked in pond A and females in pond B. No special efforts were made to feed the prawns. The entire lot of prawns died in the pond A, before the end of the experiment. The dying adults were taken out from the ponds. The mortality was perhaps due to depletion of oxygen in the pond water which was 1.84 ppm at the time. Prawns from the other pond were harvested along with fish at the end. The average weight of males was 295.15 g and that of females 250.09 g. A few females were in berried condition.

3. DISCUSSION

Considering the quantity of feed provided and fish flesh produced, the feed to fish output ratio worked out to just under 2:1, the pond with more input resulting in the higher output. Similarly, the ratio of aquatic weed provided to grass carp produced was 3.5:1 in pond A and 4.5:1 in pond B. The production of grass carp in both the ponds is nearly about the same and this is also more or less similar, to the high production of the species obtained by composite fish culture by Chaudhuri et al. (1975). The higher average weights of rohu, common carp and grass carp in pond B reflect the higher quantity of feed received by them, as these species are also known to utilize artificial feed efficiently.

The high density of rohu would appear to have affected its own growth, and lesser numbers if used, may make possible attainments of weights around 1 kg by the species. This has also been expressed by Chaudhuri et al. (1975).

The inter-relationship between silver carp and catla, both surface feeders, can be seen from Table 4. Catla performed distinctly better when fewer silver carps were there (because of lower survival) to compete with, as in pond A.

4. CONCLUSIONS

High fish productions varying from 7.5 to 8.5 tons/kg/year could be produced by intensive fish farming in small ponds. But as similar high productions may be achieved by employing even a smaller stocking density (Chaudhuri et al., 1975), it perhaps indicates that in our still-water ponds where only limited inputs can be used without adversely affecting the water conditions, i.e., the living medium of the fish, stocking densities of over 7 500/ha may be relatively more difficult to manage. The economic limit of feeding and fertilization needs to be arrived at by further experimentation so that the optimum required input for achieving high productions is used. Inputs to the pond, which are not utilized by the fish, raise the expenditure of the experiment and also add to the high metabolite load of the pond, creating near polluted conditions. Webber (1973) mentions that excessive fertilization, in aquaculture, cause algal blooms which on death cause high biological oxygen demand and that oxygen is further depleted through its consumption by the micro-organisms growing on the dead algae, all of which could lead to mortality of fish.

Using fewer numbers of rohu and providing more weeds for grass carp to achieve better performance of the stocked carps, because of the benefit derived by all the species directly or indirectly from the semi-digested excreta of grass carp (Hickling, 1966), appear also to be suggested by the experimental observations reported herein.

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Table 1. Details of stocking

Species	Average weights of stocked fishes	
	Pond A	Pond B
Catla	43.24 g	44.73 g
Silver carp	8.25 g	17.59 g
Rohu	36.37 g	28.86 g
Grass carp	90.02 g	71.08 g
Common carp	24.90 g	25.62 g
Mrigal	34.60 g	33.62 g

Table 2. Inputs provided in the ponds

Inputs	kg/ha/yr	
	Pond A	Pond B
a) Organic manure cowdung	7 000	8 750
b) Mineral fertilizers		
i) Urea	110	137
ii) Triple superphosphate	94	117
iii) Commercial lime	190	263
c) Feed		
i) Ground nut oil cake	7 110	9 213
ii) Rice polish	7 650	7 938
iii) Aquatic weeds	6 250	7 812

Table 3. Soil condition and water quality of the experimental ponds

	Soil Condition				Water quality			
	pH	Organic Carbon (%)	Available nitrogen mg/100g	Available P_2O_5 mg/100g	pH	Total alkalinity ($CaCo_3$ ppm)	Dissolved inorganic N (ppm)	Dissolved inorganic P_2O_5 (ppm)
1	2	3	4	5	6	7	8	9
POND - A								
1974 April	6.9	1.77	79.00	20.00	7.5	182.40	0.60	0.40
May					7.6	130.00	1.40	0.30
June	6.9	1.68	44.61	6.40	8.4	147.60	2.00	0,25
July					8.2	150.40	1.50	0.20
August	7.0	1.50	30.78	6.80	8.0	154.20	1.00	0.20
September					7.8	154.40	1.00	0.25
October	7.1	1.23	25.00	7.00	7.7	155.50	0.90	0.30
November					7.7	160.20	0.80	0.40
December	7.0	0.67	10.77	7.20	7.6	160.20	0.90	0.45
1975 January					7.5	160.00	1.00	0.45
February	7.1	0.24	33.76	12.00	7.6	164.50	1.50	0.50
March					8.8	170.00	1.70	0.50
April	6.9	0.60	29.58	4.80	7.3	190.20	2.50	0.60

cont'd...

Table 3. (Cont'd.)

1	2	3	4	5	6	7	8	9
Pond B								
1974 April	7.1	1.02	75.17	10.00	7.6	201.60	1.20	0.35
May					8.0	150.00	0.90	0.30
June	7.1	0.74	39.50	5.60	8.4	123.00	2.00	0.15
July					8.5	130.00	1.50	0.10
August	7.0	1.00	30.20	9.40	8.4	135.50	1.00	0.20
September					8.4	138.20	1.00	0.25
October	7.2	1.50	36.80	12.00	8.4	140.45	0.90	0.35
November					8.5	145.32	0.80	0.40
December	7.3	1.62	40.28	16.00	8.5	160.00	0.70	0.50
1975 January					8.6	190.50	0.80	0.60
February	6.9	1.24	14.60	18.80	8.6	200.00	0.90	0.80
March					8.8	209.00	1.25	1.00
April	7.0	0.70	27.37	5.60	7.5	245.90	2.00	1.60

Table 4. Details of fish production

Pond A

	Stocking Density (ha) fingerlings	Final average weight (g)	Survival (%)	Production (kg/ha/yr)	Contribution by weight (%)
Silver carp	2 500	1 105.38	52.72	1 456.90	19.42
Catla	1 000	828.76	100.00	835.40	11.13
Rohu	2 000	582.44	82.60	962.20	12.83
Mrigal	1 000	843.77	96.60	810.02	10.80
Common carp	2 000	1 019.14	79.90	1 628.60	21.70
Grass carp	1 500	1 259.28	93.33	1 763.00	23.50
N. chitala	26	1 096.15	100.00	28.50	0.37
Prawn	70	295.15	88.56	18.30	0.24
				7 502.92	

Pond B

	Stocking Density (ha) fingerlings	Final average weight (g)	Survival (%)	Production (kg/ha/yr)	Contribution by weight (%)
Silver carp	2 500	1 047.31	96.8	2 534.50	28.50
Catla	1 000	694.23	97.5	676.875	7.63
Rohu	2 000	641.83	80.75	1 110.375	12.52
Mrigal	1 000	816.07	98.75	805.875	9.09
Common carp	2 000	1 096.23	88.0	1 929.375	21.76
Grass carp	1 500	1 358.18	86.17	1 749.00	19.72
N. Chitala	40	1 625.00	83.3	40.625	0.46
Prawn	87+1	230.00	100.0	20.125	0.26
				8 866.750	