POLYCULTURE AND FISH YIELD IN RICE-CUM-FISH CULTURE SYSTEM IN DADIN KOWA, GOMBE, NIGERIA

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ABSTRACT

Rice-cum-fish culture was carried out in Dadin Kowa rice fields, Gombe State, Nigeria with a view to determining the effect of different combination of Clarias gariepinus, Oreochromis niloticus and Cyprinus carpio on fish yield. Six rice paddy fields labeled A – C were used for the study. Raised rice seedlings (FARO 27) were transplanted in the paddies before flooding of water. The fish species were stocked at 200 fish / pond in three replicates in different combinations as treatments I, II and III. The fish were fed with wheat bran and rice bran at 5 % body weight. The lowest rice yield (2560 kg/ha) was obtained in the paddy where rice was grown without fish. The fish production recorded in treatment I (534 kg) is significantly higher (P < 0.05) than in other two treatments. It is therefore recommended that rice farmers using irrigation facilities of the river Basin Development Authorities should adopt the rice-cum-fish system for increased rice and fish production in Nigeria

Keywords: Fish species combination, Rice-cum-fish culture, Fish yield

INTRODUCTION

Rice-cum-fish culture involves the simultaneous production of rice and fish in irrigated paddy fields so as to obtain an added production of fish with rice. Emphasis has of recent been shifted to fish production from different aquaculture systems as a means of boosting fish production in the country. This is as a result of dwindling fish supply from capture fisheries and the increasing gap between fish demand and supply in Nigeria. It is against this background that this study was carried out in Dadin-Kowa rice fields in Gombe State, Nigeria. Ita (1980) reported that lack of experimental approach to integrated aquaculture projects and the choice of suitable species combinations are the major problems of Rice-cum-fish culture in rice fields in Nigeria.

In polyculture, fast growing compatible fish species are grown together in rice fields to increase total production of both commodities form the same body of water and land. This has long been practiced in China, India and Israel especially with crop, Tilapia and Millets (Bardach *et al.,* 1972) poverty can be alleviated through food security by adopting sustainable systems (land and water use) for increased rice and fish production. This situation poses the challenge of finding adoptable technologies for improved utilization of land and water resources for fish and rice production simultaneously (Edward *et al.,* 1988).

Studies have been documented on growth performance of *Heterotis niloticus, Clarias gariepinus* and *Tilapia* species under semi-intensive polyculture systems in Nigeria and elsewhere (Omorinkoba *et al.,* 1988; Okoye and Wonah, 1994; Singh, 1994). These studies showed that the three fish species exhibited positive interactions within the ponds.

Okoye and Wonah (1994) have also reported increased total fish production through poly culture trial with *C. gariepinus* and *Oreochromis niloticus* in Wuya fish farms, Bida, Nigeria. The objective of this study therefore, is to determine the effect of different fish combinations on fish yield in Rice-cum-fish culture system, with a view to recommending the outcome to prospective rice/ fish farmers.

MATERIALS AND METHODS

Study Area: Dadin-Kowa is about 40 km from Gombe Nigeria and has an advantage of being strategically located at the bank of river Gongola where water is pumped by UBRBDA with hydro flow pump to rice farmers fields for irrigation purposes. It is endowed with tropical agricultural low land where rice is grown all year round in rainy season and dry season. The area is suitable for rice-cum-fish farming and was therefore selected for this study.

The geology of the Dadin-kowa basin belongs to the pre-cambrian basement complex which covers more than half of Nigeria vine 1956. The area comprises mainly igneous and metamorphic rocks such as granite. On the eastern side are undulating hills rising up to 350 m high.

The soils of the area are composed mainly of weather materials of ferruginous tropical or crystalline acid rocks. Upland areas with thinner soils are characterized by a predominance of short grasses dominated by Hyperhenia and Andropogn species (Keay, 1959), while in low land areas, grasses are interspersed with more trees dominated mainly by Isoberhinia species.

There are two climatological seasons - a rainy season from July to October with a mean annual rainfall of 600 mm, and a hot dry season from March to July.

The dry period is characterized by low temperatures and cold dry northeastern winds between November and February.

Rice Nursery Bed: Rice nursery beds were established in June. After sowing the rice seeds (FARO 27) the nursery beds were covered with grass mulch in order to retain moisture, encourage quick germination and prevent birds from eating the sown seeds. The seeds germinated and the seedlings were ready for transplanting after 35days.

Rice Paddy: The six rice paddy fields used in this study were 50m^2 and each was labeled A-C. all the dikes were compared and raised to 50cm high and 50 cm wide. Refuge trenches were dug round each field to a depth of 0.8m and 1.0m wide. This is to shelter the fish from predators and to offer them cooler, deeper water during the hot times of the day. The trenches also allow for easy fish harvest. Transplanting of rice was done at a spacing of 20 – 30 cm. Three stands were transplanted into each hole.

Flooding and Weeding of Paddy: The rice paddy fields were flooded after transplanting. Care was taken to keep the water level at a minimum of 5cm to allow proper filtering therefore, the water level was kept at 30 -50 cm deep, until the rice matures. Within the paddy, some aquatic weeds resistant to flooding which are associated with rice were hand pulled. Each paddy has a controlled screed water inlet and outlet.

Fertilization of Paddy Rice Fields: Fertilization of the paddy rice filed was done with cow dung at the rate of 10 kg /50 m^2 biweekly. This was done by broadcasting the fertilizer evenly on the fields from various points of the dykes.

Stocking of Fish Fingerlings: *C. gariepinus, C. capio* and *O. niloticus* of initial mean weights of 20.0g, 28.0 g and 25.4 g respectively were stocked at 200 fish / 50m^2 paddy respectively after flooding in three replicates in different combinations as Treatment I (150 *C. carpio* + 50 *O. niloticus*), II (50 *O. niloticus* + 150 *C. gariepinus*) and III (50 *C. carpio* + 150 *C. gariepinus*) with a view of determining the species combination with the highest growth performance and fish production. The control for the experiment was in 3 paddies with each of the following 3 fish species in each paddy: *C. gariepinus, O. niloticus* and *C. Carpio* respectively.

Water Quality Monitoring: Water quality parameter was measured monthly. Turbidity was measured with a seechi disc at the refuge trench. pH was determined with a pH meter equipped with temperature probe. Conductivity of the water was measured with a multi-range conductivity meter (model H -19033, HACH kit). The dissolved oxygen (DO) was determined with dissolved oxygen meter (model 9071, HACH kit, New Delhi, India). Plankton population densities in water were determined in accordance with the standard methods described by APHA (1980).

Feeding: Feeding of the stocked fish in the paddies started immediately after stocking at established feeding spots. The fish were fed once daily. Proximate composition of the feed ingredients were determined and presented in Table 1.

Growth Rate: Monitoring of growth rate of fish in the pond was carried out by randomly arching the fish using a hand net. The weights and lengths of the sample were taken and the fish returned to the trenches. Feeding rates were adjusted accordingly. Feed was used to attract the fish before each sub-sampling. The mean growth rates (MGR) were calculated for the fish species according to the method of Wayne and Davis (1977).

Harvesting of Rice: Rice was harvested from the paddies using sickles after 110 days. The rice grains were threshed, winnowed, weighed and tagged to enable determination of rice yield from the paddies.

Fish Harvesting: The fish were harvested after a culture period of 210 days. The net fish species production was determined. Differences between means were tested by Duncan's multiple range tests (Sokal and Rohlf, 1981).

RESULTS AND DISCUSSION

The summary of the mean initial weight, mean weight gain, mean final weight, stocking density and mean daily weight gain is presented in Table 2. *Cyprinus carpio* has a mean initial weight of 28g in treatment I and III. It has a final weight of 700.0 g and 750.0 g with a mean weight gain of 672.0 g and 722.0 g and daily mean weight gain of 2.5 g for the two treatments respectively. This compares favourably with a mean daily weight gain of 0.73g/day obtained by Okoye and Wonah (1994) in Wuya irrigated rice field in Niger State of Nigeria.

O. nitoticus has a mean initial weight of 25.4 g in treatment I and II and final mean weight of 300.0g and 303.0g with a mean weight of 274.6 g and 274.6 g respectively. The mean daily weight gain of 0.8g in the two treatments is lower than the 1.02 g/day reported by Ita *et al.* (1986) in an integrated system. This might be due to differences in the ecology of the zones in which the experiments were conducted.

C. gariepinus has a mean initial weight of 20.0 g and final mean weight of 800.0 and 820.0 g in treatment II and III with weight gain of 780.0 g and 800.0 g and daily mean weight gain of 2.0 g respectively. This compares favourably with the results of Wayne and Davis (1977) for fish-cum-rice culture studies.

The total fish production in Treatment I, II and III are 534.0 kg for *C. carpio* and *O. nitoticus*, 125.0 kg for *O. nitoticus* and *C. gariepinus* and 145.0 kg *for C. carpio* and *C. gariepinus*.

Table 1: Nutrient composition of local feed stuff fed to experimental fish

Feed Stuff	Protein %	Gross Energy (Kcal/kg)	Fat (%)	Crude Fibre (%)	Ca (%)	P (%)	Methionine (%)	Lysine (%)	Cystine (%)
Wheat brain	15.33	11.45	3.50	11.00	1.10	1.20	0.18	0.80	0.30
Rice brain	S13.50	16.30	13.10	13.00	0.10	0.70	0.27	0.50	-

Table 2: Growth performance and production of *Clarias gariepinus*, *Cyprinus carpio* and *Oreochromis niloticus* in rice paddies

Treatments	*Fish Species*	*Stocking density*	*Mean Initial Weight (g)*	*Mean Final Weight*	*Mean Weight gain (g)*	*No. of Fish Harvested*	*Weight of Fish harvested (g)*	*Survival rate (%)*	*Mean daily weight gain (g)*
I	*C. carpio*	*150*	*28.0*	*700.0*	*627.0*	*120*	*84000*	*80.0*	*2.5*
	O. niloticus	*50*	*25.4*	*300.0*	*274.6*	*1500*	*450,000*	*78.0*	*0.8*
II	*O. niloticus*	*50*	*25.4*	*303.0*	*277.6*	*43*	*13029*	*86.0*	*0.8*
	C. gariepinus	*150*	*20.0*	*800.0*	*780.0*	*140*	*112000*	*93.3*	*2.0*
III	*C. carpio*	*50*	*28.0*	*750.0*	*722.0*	*35*	*26250*	*70.0*	*2.5*
	C. gariepinus	*150*	*20.0*	*820.0*	*800.0*	*145*	*118900*	*96.6*	*2.0*

The highest fish production (534 kg) recorded in treatment I which is significantly different ($P<0.05$) from those of treatments II and III may be due to the prolific nature of *O. nitoticus*. The produced O. *nitoticus* fingerlings contributed to the high total fish production. About 90 % of the produced *O. nitoticus* fingerlings produced in treatment II were cannibalized by *C. gariepinus*. In treatment III, fingerlings of *C. carpio* were not recorded and this clearly shows that it did not spawn during the period of the experiment. This was in line with the results of rice-cum-fish culture reported by Ibrahim (2006).

Table 3 shows the summary of physical and chemical parameters of the irrigation water used in paddy fields which fall within the range reported by Huet (1975) and Boyd and Lichtkopler (1979) as good for fish culture.

Table 3: Mean values of physical and chemical characteristics of water in rice paddies

Pond No	Mean Temp (^{0}C)	Mean Transparency	Mean pH	Mean D0 mg/l
A_1	27.0	0.32	6.6	3.8
A_2	25.0	0.35	6.5	3.7
A_3	25.5	0.40	6.7	3.9
B_1	26.0	0.30	6.8	4.0
B_2	26.0	0.35	6.4	3.9
B_3	26.0	0.38	6.6	3.4
C_1	24.0	0.40	6.3	3.5
C_2	27.0	0.32	6.8	3.8
C_3	28.0	0.37	6.5	3.6

The phytoplanktons found in the pond included various algae and diatoms. The zooplankotons in the paddy were dominated mainly by *Copepods* of genus *Diaptomus* and *Cylops* and *Cladocerans* of the genus *Daphnia* and *Bosimina.*

Fish Harvesting: The fish were harvested after a culture period of 210 days. The net fish species production was determined. Differences between means were tested by Duncan's multiple range test (Sokal and Rohlf, 1981).

Rice Yield: Table 4 shows that the lowest rice yield (2560kg/ha) was obtained in the paddy where rice alone was grown without fish which served as control.

Table 4: Rice and fish yield in integrated rice-fish culture system

Treatments	Fish Yield	Rice Yield Kg/ha	Increase kg/ha	Increase (%)
Control	-	2560	-	-
I	534	2586	6	0.2
II	125	2583	3	0.1
III	145	2587	7	0.3

This could be attributed to lack of fish faeces which provided extra organic manure in the three treatments. The yield of rice in treatments I, II and III were which were not significantly different ($P < 0.05$). 2586, 2583 and 2587 kg/ha with corresponding percentage increase of 0.2, 0.1 and 0.3 % respectively. This is in line with Randriamiarana *et al.* (1995) and Kumar (1992) who were of the opinion that fish faeces in the paddy serves as organic manure that is important in the improvement of soil texture apart from the addition of nutrients to the soil. Pullin (1995) further suggested that indirect organic fertilizer from fish faeces in rice-cum-fish culture systems guarantees good yield of rice.

Conclusion: The fish yield in Treatment I (534 kg) is significantly higher ($P < 0.05$) than in other two treatments.

This is due to non-predation of *O. niloticus* fingerlings by *C. Carpio*. The lowest rice yield (2560 kg/ha) was recorded in the rice paddy without fish (control). It is therefore recommended that rice farmers using irrigation facilities of the Upper Benue River Basin Development Authority, Dadin Kowa Gombe, should adopt the rice-cum-fish system for maximum utilization of land and water resources. The adoption of the system could lead to simultaneous increase in rice and fish production in this vast lowland agricultural zone of Nigeria.

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