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Effect of Carp and Fish Feed on Yield and Soil Nutrient Availability under Integrated Rice-Fish Culture

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Abstract

The field experiment was carried out during the rainy season of 1997 and 1998 in the coastal alluvial soil (initial available N: 171 kg·ha^{-1}, available P_2O_5: 22.4 kg·ha^{-1} and available K_2O: 156.7 kg·ha^{-1}, pH 7.0) of South 24-parganas district of West Bengal, India. Both grain and straw yield of tall indica rice (variety: NC 492) were significantly higher under all types of carp (*Labeo rohita* Ham., *Catla catla* Ham., *Cirrhinus mrigala* Ham.) over no fish. Application of fish feed not only increased the fish yield by 7% but also increased the grain and straw yield of rice by 19 and 13% respectively. Introduction of carps in rice field and application of fish feed improved the nitrogen, phosphorus and potassium availability in soil.

Introduction

Rice-fish integration is the most important farming system in developing countries including India, not only for optimum utilization of available land water resources, but also for minimizing the risk element in single crop enterprise and provision of greater income. Approximately 6% of rice cultivated area in India is under deep water rice which provides greater scope for rice-fish integration (Ghosh and Saha 1980). It is primarily because of the natural compatibility that exists between rice and fish in a controlled ecosystem. The inland fresh water fish culture in the paddy field plays a significant role in the economic utilization of waste wetlands in food production as dual purpose. The introduction of fish in the rice field can turn material and energy into fish production, accelerate the growth of rice and increase solar energy fixation and thereby raise the productivity of the rice field. Fish also helps in improving soil fertility by grazing on aquatic biomass and contributing through their feces, to nitrogen accumulation at soil surface (Brahmanand and Mohanty 1999). Thus a symbiotic relationship between rice and fish makes rice-fish integration one of the successful integrations in India. The present study documents the impact of fish feed and types of different carp on the yield performance of rice and fish as a whole,

thereby making the system more economic, efficient, and popular among the farmers.

Materials and Methods

The field experiment was conducted during the rainy seasons of 1997 and 1998 in the Moori-Ganga micro watershed area of coastal and saline zone of South 24-parganas district of West Bengal, India. The soil of the experimental field was fine in texture and silty-clay in nature having initial available soil N of 171 kg·ha^{-1}, available P_2O_5 of 22.4 kg·ha^{-1} and available K_2O of 156.7 kg·ha^{-1} with pH 7.0. The pH and Ec of water were 7.5 and 2.52 ds m^{-1} respectively. The experiment was laid out in split-plot design with two main plot treatments (without and with fish feed of powdered mustard oilcake + rice husk in 1:1 ratio at the rate of 6 times of body weight of fish at weekly interval) and four sub-plot treatments [types of carp *i.e.* no fish, rohu (*Labeo rohita* Ham.), catla (C*atla catla* Ham.) and mrigal (*Cirrhinus mrigala* Ham.)] in four replications. The rice variety was *Sabita* (NC 492), a tall indica one. Twenty five days old seedlings were transplanted on the 1st week of August and fingerlings of carps were released at the rate of 2 carps m^{-2} in the paddy fields at the end of August.

On the average each fingerling weighed 6 g at the time of release. Rice was supplied with a fertilizer dose of N, P_2O_5, K_2O @ 60: 30: 30 kg·ha^{-1}, where full dose of P_2O_5, K_2O and 1/4th dose of N was applied as basal and the rest ½ and 1/4th dose of N was applied in two splits at 20 and 40 days after transplanting. Fish and rice were harvested on the 3rd week and at the end of November, respectively. The crop was harvested from 5 m x 4 m net area of each plot (gross plot size 6 m x 5 m), discarding 1 m around to avoid the border effect and threshed. The grain and straw were sun dried thoroughly and weighed separately for each plot. The yield from each plot was then converted to q·ha^{-1} basis. Average weight of each fish per treatment was studied at weekly interval (table 1). Available N was estimated by extracting the soil with KCl, available phosphorus following Olsen's method and available potassium was estimated with the help of flame photometer after extracting the soil with 1(N) ammonium acetate (Jackson 1967). The data were subjected to statistical analysis using analysis of variance method (Gomez and Gomez 1984) and the significance of different sources of variations were tested by error mean square using Fisher and Snedecor's 'F" test at probability level of 0.01 and 0.05.

Results

Application of fish feed increased the grain and straw yield of rice by 19 and 13% respectively, which were significant at 5% level only. The addition of fish feed also helped to increase the fish yield by 7%, which was significant both at 1 and 5% level.

Table 1. Average weight /fish (g) at different week after release.

Treatment		At release	At 1st WAR	At 2nd WAR	At 3rd WAR	At 4th WAR	At 5th WAR	At 6th WAR	At 7th WAR	At 8th WAR	At 9th WAR	At 10th WAR	At 11th WAR	At harvest
Without fish-feed	Rohu	6	9.2	13.2	17.4	22.8	27.8	33.4	40.8	47.7	53.9	61.5	69.3	77.1
	Catla	6	10.3	15.2	20.5	25.4	31.2	37.9	44.6	52.3	60.8	70.6	81.5	93.2
	Mrigal	6	9.0	13.1	17.8	22.3	27.1	32.2	38.3	44.4	50.8	57.3	65.2	71.4
With fish-feed	Rohu	6	11.3	16.6	22.3	30.4	40.7	51.6	63.9	76.6	91.3	106.6	121.3	136.0
	Catla	6	11.7	17.7	24.8	33.9	43.7	55.6	67.3	82.9	99.8	117.1	135.3	151.2
	Mrigal	6	10.2	15.7	21.2	29.5	38.7	48.7	59.3	71.6	85.8	98.5	112.3	125.4

WAR = week after release
Average mortality of fish (%) = 45

Different types of carp influenced the grain and straw yield of rice and fish yield significantly (Table 2). Higher grain (24.33 q·ha^{-1}) and straw yield (43.01 q·ha^{-1}) of rice was achieved by the plots where catla was allowed. Among the carps, catla produced the highest amount of fish yield (13.44 q·ha^{-1}) while the performance of rohu and mrigal was statistically at par.

Table 2. Effect of fish feed and carp on grain, straw yield of rice and fish yield.

Treatments	Pooled Yield (q ha^{-1}) of two years		
	Rice grain	Rice Straw	Fish
Fish-feed			
Without fish-feed	18.69	33.03	8.86
With fish-feed	22.25	37.34	15.13
S. Em ±	0.46	0.98	0.48
C. D. (0.01)	N.S	N.S	3.96
C. D. (0.05)	2.08	4.40	2.15
Type of carps			
No fish	15.41	28.02	-
Rohu	22.99	37.38	11.72
Catla	24.33	43.01	13.44
Mrigal	19.15	32.33	10.82
S. Em ±	0.78	1.03	0.36
C. D. (0.01)	3.17	4.19	1.55
C. D. (0.05)	2.31	3.07	1.11

N.S.= Not Significant
Coefficient of variation for grain yield of rice = 10.76%
Straw yield of rice = 7.26 %
fish yield = 8.10%

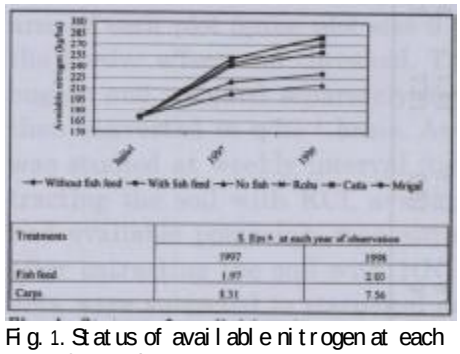

Fig. 1. Status of available nitrogen at each year of experiment.

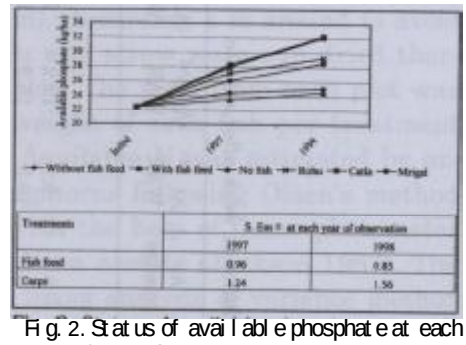

Fig. 2. Status of available phosphate at each year of experiment.

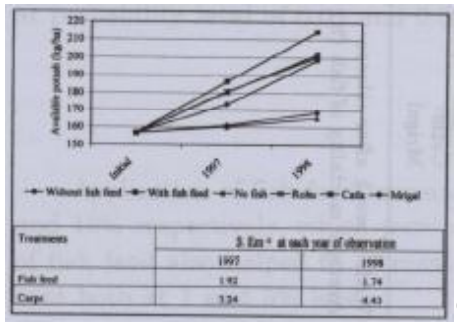

Fig. 3. Status of available potash at each year of experiment.

In general, available nitrogen (Fig. 1), phosphate (Fig. 2) and potash (Fig. 3) status of soil were improved after two years of experiment. Application of fish feed increased the soil nitrogen, phosphate and potash status by 111, 9.7, 57.7 $kg \cdot ha^{-1}$ respectively, which was far better than the control. All the carps performed better to improve the N, P and K status of soil in comparison with the application of no fish. Among the carps catla was superior compared to the others.

Discussion

Introduction of catla, rohu and mrigal in rice fields may increase the CO_2 concentration by respiration in crop canopy level and accumulate higher percentage of nitrogen and other elements in soil through their feces (Brahmanand and Mohanty 1999) and thereby increase the grain and straw yield to 24 to 58% and 15 to 53%, respectively. This finding was corroborated by the views of Grist (1975).

On the other hand, an additional higher yield of fish was also observed (10.82 to 13.44 $q \cdot ha^{-1}$) under paddy cum fish culture ecosystem, which provided several natural planktons useful for rapid growth of fish (Jhingran, 1991). Application of fish feed not only increased the fish yield by providing better feeding material but also helped to increase the productivity of rice due to its manurial value. A similar finding was reported by Dutta et al. (1984). Fish feed by its manurial potentiality and carps with the help of their feces helped to improve the nitrogen, phosphate and potassium status of soil which was reflected on the outcome from each component of the integrated rice-fish culture.

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