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Production performance of *Macrobrachium rosenbergii* (De Man) in monoculture versus polyculture system

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Abstract

The production performance of *Macrobrachium rosenbergii* was compared in monoculture and polyculture systems with Indian major carps, *Labeo rohita* and *Catla catla*. The stocking density of prawn in monoculture was 13,545/ha; in polyculture the prawn was stocked at 8,645/ha while rohu and catla were each equally stocked at 2,470/ha. In monoculture, the initial weight of prawn was 4.13 ± 0.15 g and in polyculture system the average initial weight of prawn, rohu and catla were 4.10 ± 0.10, 68.0 ± 3.93 and 73.33 ± 3.05 g respectively. The final average weight of *M. rosenbergii* was 103.03 ± 6.80 and 92.83 ±3.55 g in monoculture and polyculture ponds respectively. The final average weight of rohu and catla were obtained at 278.56 ± 10.37 and 262.81 ± 11.62 g respectively. In both the systems, fertilizer and supplementary feed were used. The survival rate of prawn in monoculture and polyculture were found at 65% and 75% respectively; survival for both rohu and catla was obtained at 90%. The total production of prawn in monoculture and polyculture systems were 906.8 and 605.18 kg/ha respectively where the production of rohu and catla in polyculture were 619.1 and 584.2 kg/ha respectively. The average production costs in monoculture and polyculture systems were 149,510.7 Tk/ha and 150,058 Tk/ha respectively. In monoculture and polyculture systems the gross incomes were 255,650 and 295,066 Tk/ha respectively. The net incomes for the systems were 106,139.3 and 145,008 Tk/ha respectively. The study concluded that the polyculture of *M. rosenbergii* is comparatively more preferable in traditional and improved traditional polyculture systems.

Keywords: *Macrobrachium rosenbergii*, Monoculture, Polyculture and Production

Introduction

Greater Khulna region is considered as the most suitable area for prawn cultivation as over 75% of country's prawn production comes from this coastal area. Shrimp and prawn play an important role in the economy of Bangladesh. Frozen fish and fisheries products have achieved the second position in foreign exchange earning and shrimp and prawn has contributed about 90% income of the total frozen products (Biswas, 1996). Bangladesh earned about 1800 crore Taka by exporting frozen shrimp and prawn products in 2001-2002 (DoF, 2003).

Farmers in Bagerhat district developed the gher farming technology in 1980s. Gher farming was then spreaded rapidly to other districts: Khulna, Jessore, Gopalganj and Satkhira and the number of ghers increase by approximately 10-20 percent every year. Gher farming is now the primary livelihood strategy of more than 100,000 rural households in the south-western region of Bangladesh (CARE Bangladesh, 2000). Gher farming has brought about dramatic changes in the society as well as to the institutions that govern the local and the regional economy. It also generates substantial foreign currency for the country every year through exporting prawns.

Gher farming has now been widespread in south-west part of Bangladesh, refers to the cultivation of the giant freshwater prawn (*Macrobrachium rosenbergii*) in freshwater. These range from monoculture to polyculture farms where several species are grown together. In polyculture gher farming, the freshwater prawn (*M. rosenbergii*) culture with fin fishes such as Indian major carps, common carps and other exotic fishes (Hoq *et al.*, 1996; Islam *et al.*, 1999).

A little effort has been given to compare the growth performance of *M. rosenbergii* between monoculture and polyculture systems, which are widely practiced in Bangladesh. Huq and Islam (2003) conducted an experiment at Khulna University campus on suitable species composition in the polyculture technique of Thai pangus with carps and prawn. Islam *et al.* (1999) conducted an experiment on the feasibility study of polyculture of *M. rosenbergii* with carps. The present study was carried out to compare production performance between monoculture and polyculture of *M. rosenbergii.*

Material and methods

Study area and duration

The experiment was carried out in the farmer's ponds at Fakirhat Upazilla under the district of Bagerhat, Bangladesh from 1 June to 1 December 2002.

Experimental ponds

The present study was conducted using three ponds in monoculture system (MP1, MP2, MP3) and three ponds in polyculture system (PP1, PP2, PP3). Water surface areas of the three monoculture ponds were 0.40, 0.61 and 0.49 ha and the areas of three polyculture ponds were 0.57, 0.53 and 0.61 ha.

Liming and fertilization

During pond preparation, liming was done 10-15 days after ploughing. CaO was used at the rate of 500 kg/ha. Urea, TSP and cow dung were applied at a rate of 30, 20 and 500 kg/ha respectively in all the experimental ponds. After stocking, Urea, TSP and cow dung were applied once a month at a rate of 15, 10 and 125 kg/ha respectively.

Stocking of prawn and carp fingerlings

Prawn (*Macrobrachium rosenbergii*) and carp fingerlings (*Labeo rohita* and *Catla catla*) were collected from local supplier and stocked in all the experimental ponds. The average initial weight of *M. rosenbergii* in monoculture ponds was 4.13 ± 0.15 g, while in polyculture system the average initial weight was 4.10 ± 0.10g. The average initial weights of *L. rohita* and *C. catla* were 68.0 ± 3.39 and 73.33 ± 3.05 g respectively. All the fishes were stocked on 1 June 2002. In monoculture ponds, post-larvae (PL) of *M. rosenbergii* was stocked 13,500 indivisuals/ha. In polyculture ponds, stocking rate of *M. rosenbergii, C. catla* and *L. rohita* were 8,500, 2,500 and 2,500 individuals/ha respectively.

Grow-out management

Feeding: Feeding of fingerlings and post-larvae were carried out from the next day after stocking in both monoculture and polyculture ponds. After stocking, first two months rice bran and wheat flour were supplied 8-12 kg/ha/day. From the third month snail meat was supplied 50-60 kg/ha/day in monoculture ponds and rice bran and snail meat were supplied 12-15 kg and 40-50 kg/ha/day respectively in polyculture ponds. Sometimes the feed supply was stopped immediately after heavy rainfall or when plankton bloom occurred.

Monitoring of water quality parameters: The five major parameters viz. water temperature, water transparency, depth, dissolved oxygen (DO) and pH of the experimental ponds were recorded fortnightly at 10-12 a.m. All parameters were recorded by using kit box (Model: FF-3, USA).

Growth and production monitoring: The production (weight) of both carps and prawn were recorded monthly through random sampling method. Weight of fish was measured with a triple beam simple balance nearest to the gram. The growth rate of both prawn and carps were calculated using formula of Mahmud *et al.* (1993):

$$\text{Growth rate (g/day)} = \frac{W2 - W1}{T2 - T1}$$

Where,

W2 = Weight (g) at time T2 — T 2 = Date of last sampling.

WI = Weight (g) at time T 1 — T1=Date of previous sampling

The gross and net production (kg/ha) of fishes were calculated by the following formula:

$$\text{Gross production (kg/ha)} = \frac{\text{Survival rate x stocking density x Final weight (g)}}{1000}$$

$$\text{Net production (kg/ha)} = \frac{\text{Survival rate x stocking density x Net weight (g)}}{1000}$$

Survival rate

The survival rate of fish/prawn in a pond was calculated by the following formula:

$$\text{Survival rate} = \frac{\text{Total catch of fishes}}{\text{Initial release of fishes}} \times 100$$

Results and discussion

Physico-chemical parameters

The physico-chemical parameters of the experimental ponds were determined (Table 1). All the physico-chemical parameters of the experimental ponds were found normal and within culturable range.

Table 1. Physico-chemical parameters of the experimental ponds

Parameters	Measured value		Recommended range
	Monoculture ponds	Polyculture ponds	
Water temperature (°C)	21.5 – 35.00	22 - 34	22 –32 (Ling, 1969)
Water transparency (cm)	35.00 - 41.00	30.0 - 38.00	34 – 60 (Humayun *et al.*, 1986)
Water depth (m)	0.60 – 1.40	0.62 – 1.39	1.0 –1.5 (Huq and Islam, 2003)
Dissolved Oxygen (mg/l)	6.33 – 8.00	6.5 - 9	4.5 – 9.9 (George, 1961)
pH	7.50 – 8.50	7.1 – 8.5	7 – 9 (Boyd and Fast, 1992)

Growth performance

The growth of *Macrobrachium rosenbergii* (weight) of monoculture ponds is presented in Fig.1. The initial average body weight of *M. rosenbergii* in MP1, MP2 and MP3 were 4.3, 4.1 and 4.0 g respectively. After six months, the final weight of *M. rosenbergii* in MP1, MP2 and MP3 were 110.5, 99.6 and 99 g respectively. The initial average body weight was measured at 4.13 $\pm$ 0.15 g and the final average body weight was measured at 103.03 $\pm$ 6.80 g. Therefore, the growth increment [Final weight - Initial weight] of the prawn in monoculture pond was found to be 98.57 g.

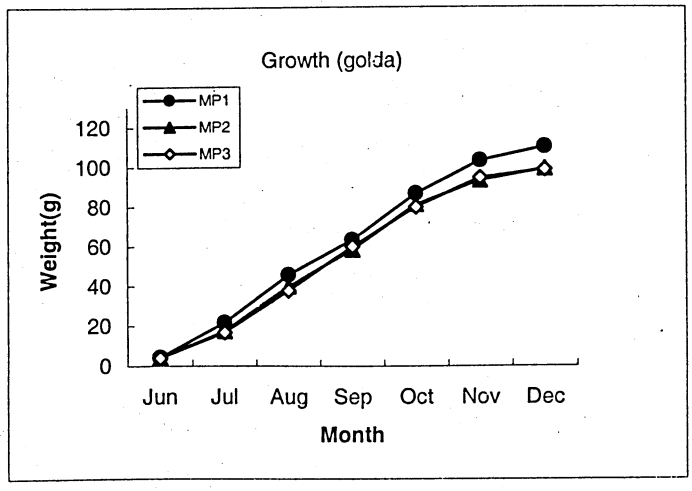

Fig.1. Monthly weight (g) of *Macrobrachium rosenbergii* in monoculture ponds during the study period

The growth of *M. rosenbergii* by weight in all the polyculture ponds is presented in Fig. 2 showed a similar pattern of growth with monoculture system However, the growth increment of the prawn in polyculture pond was found to be 88.73 g. It also indicated that *M. rosenbergii* gained higher growth in monoculture system than in polyculture system (Fig. 3).

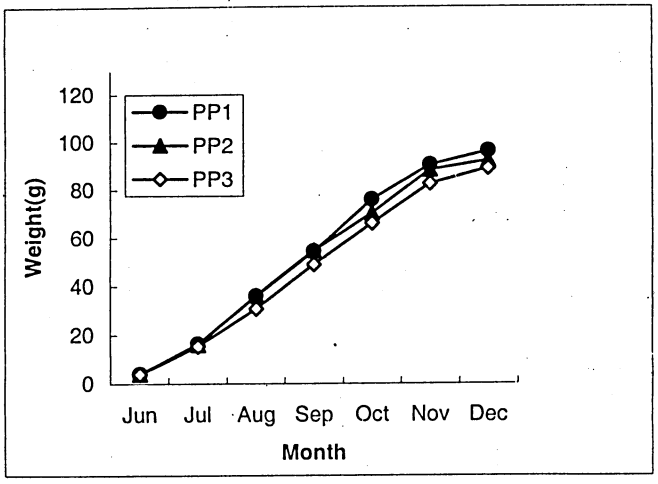

Fig. 2. Monthly weight (g) of *Macrobrachium rosenbergii* in polyculture ponds during the study period

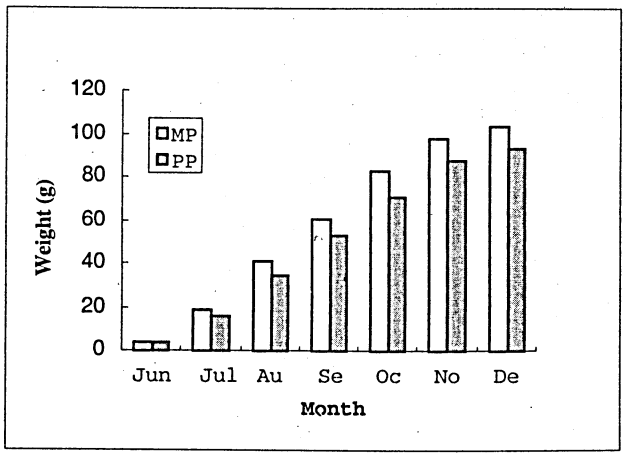

Fig. 3. Monthly weight (g) of *Macrobrachium rosenbergii* in monoculture and polyculture systems

The growth of *L. rohita* of the polyculture ponds is presented in Fig. 5. The initial average body weight of *L. rohita* in PP1, PP2 and PP3 were 72.5, 66.3 and 65.2 g respectively. After six months of culture period, the final weight in PP1, PP2 and PP3 were 275.3, 270.1 and 290.1g respectively. The initial average body weight was 68 $\pm$ 3.93 g and the final average body weight was 278.56 $\pm$ 10.37 g. The growth increment of *L. rohita* in polyculture pond was found to be 210.5 g.

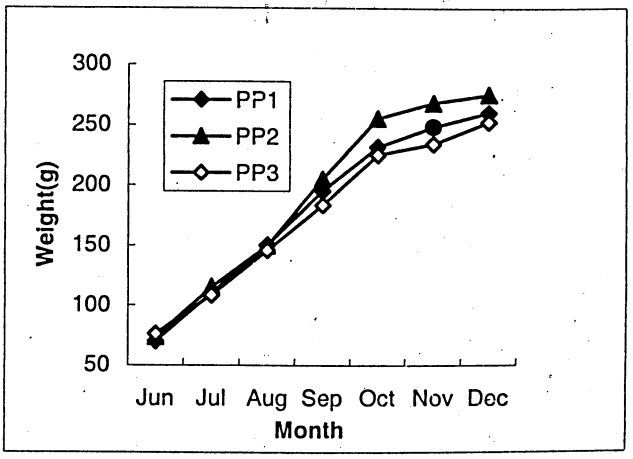

Fig. 4. Monthly weight (g) of *Catla. catla* in polyculture ponds during the study period

The growth of *C. catla* of the ponds is presented in Fig. 4. The initial average body weight of *C. catla* in PP1, PP2 and PP3 were 70.2, 73.5 and 76.3 g respectively. After six months, the final weight in PP1, PP2 and PP3 were 260.5, 275.4 and 252.5 g respectively. The initial average body weight was measured at 73.33±3.05 g and the final average body weight was measured at 262.81±11.62 g respectively. Therefore, the growth increment of *C. catla* in polyculture pond was found to be 189.47 g.

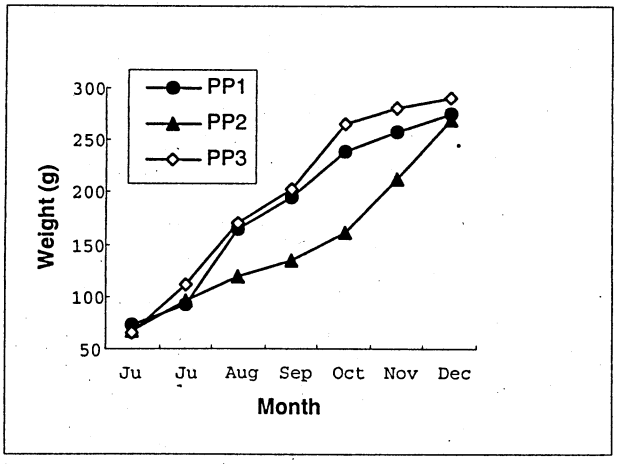

Fig. 5. Monthly weight (g) of *L. rohita* in polyculture ponds during the study period

Hossain *et al.* (2000) conducted an experiment on monoculture of *M. rosenbergii* for 105 days in 12 earthen mini ponds with supplementary diet containing 32% protein. Prawns were stocked at the rate of 2.5 fry/m^2 and fed twice daily. They found the mean final weight 30.45 g that is less then the average growth of the present study (103.03 g). Tidwell *et al.* (1993) worked on the monoculture of *M. rosenbergii* using formulated diet containing 32% protein. They found individual weight of *M. rosenbergii* 42 g, which is also less than the present study. Alam *et al.* (2001) worked on polyculture of *M. rosenbergii* with carps for 8 months. They recorded the highest growth 460, 388, 717, 185 and 67g of *HypopHthalmicthys molitrix, C. catla, CtenopHaryngodon idella, Barbodes gonionotus* and *M. rosenbergii* with the stocking density of 10, 6, 1, 2 and 35/decimal respectively. Though the study was conducted for 8 months; the growth of *M. rosenbergii* (67.91 g) is less than the present study (92.83 g). But *C. catla* showed higher growth (388 g) than the present study (262.8 g). Huq and Islam (2003) conducted a research on polyculture of *Pangasius hypophthalmus* with *C. catla, L. rohita* amd *M. rosenbergii* where stocking density were 50,10,10 and 15 individuals/decimal respectively. After 7 months they found the average weight of pangus, catla, rohu and prawn 502.77, 242.37, 290 and 102.82 g respectively. Siddique *et al.* (1999) conducted another experiment on polyculture of prawn for 105 days in 6 earthen ponds with the ratio of prawn: catla: rohu: mrigal were 1:1:1:1 where the stocking density was 1.5 individual/m^2. They found the growth of prawn, catla, rohu and mrigal 38, 281, 302, and 159 g. Huq and Nandi (2003) conducted a study at Khulna University campus on polyculture of carp with prawn without supplementary feed using fertilizer from October 2002 to March 2003 and the stocking densities of catla, rohu and prawn were 20, 15 and 10 individuals/decimal respectively. They found the average weight of catla, rohu and prawn 60, 120 and 58 g respectively in polyculture system where the weight of prawn and carp were lower than that of the present study. It can be concluded that the growth of *M. rosenbergii, C. catla* and *L. rohita* in the present study is said to be satisfactory.

Production

The total production of MP1, MP2 and MP3 were found to be 395.03, 534.1 and 424.7 kg with the production rate of 975.74, 879.49 and 874 kg/ha respectively (Table 2). Pond MP1 showed better production than MP2 and MP3. The total production and production rate in monoculture system were found to be 1,353.83 kg and 909.8 kg/ha respectively (Table 3).

In the polyculture system, the total production of PP1, PP2 and PP3 were found to be 354.6, 315.99 and 352.01 kg with the production rate of 625.6, 600.3 and 605.18 kg/ha respectively (Table 2). Pond PP1 showed better production than PP2 and PP3 (Table 2).

The average production and production rate in polyculture system were found to be 1022.6 and 605.18 kg/ha respectively (Table 3).

The total production of *M. rosenbergii* were 1353.83 and 1022.6 kg/ha from monoculture and polyculture ponds respectively. The production rate of prawn were 909.8 and 605.18 kg/ha from monoculture and polyculture ponds respectively (Table 3).

The total production and production rate of *L. rohita* from polyculture ponds were found to be 1052.73 kg and 619.1 kg/ha respectively (Table 3). The total production and production rate of *C. catla* from polyculture ponds were found to be 993.38 kg and 524.2 kg/ha respectively (Table 3).

Table 2. Pond wise production (kg) and production rate (kg/ha) of *M. rosenbergii* in different cultured ponds

No of pond	Production (kg)	Production rate (kg/ha)
MP1	395.03	975.74
MP2	534.1	879.49
MP3	424.7	874.17
PP1	354.6	625.6
PP2	315.99	600.3
PP3	352.01	589.64

Table 3. Species wise production (kg) and production rate (kg/ha) of monoculture and polyculture systems

Culture type	Species	Total production (kg)	Total production rate (kg/ha)
MP	*M. rosenbergii*	1,353.83	909.8
PP	*M. rosenbergii*	1,022.6	605.18
	C. catla	993.384	584.2
	L. rohita	1,052.73	619.1

Siddique *et al.* (1999) conducted an experiment to find out a suitable supplemental feed kg/ha for polyculture of *M. rosenbergii* with Indian major carps where the total production ranged between 1,976 to 2,445 kg/ha/105 days. The result of the study showed that feed containing 30% fish meal, 12.5% mustard oil cake, 12.5% sesame meal, 25% rice bran and 20% wheat bran was best for polyculture of *M. rosenbergii* with Indian major carps. Jose *et al.* (1992) found the production of prawn in polyculture experiment ranged between 62.5 – 123 kg/ha/105 days. Hossain *et al.* (2000) conducted another experiment for 105 days in 12 earthen mini ponds with five different formulated diets where the diet containing 30% fish meal, 5% shrimp meal, 5% soybean meal, 10% mustard oil cake, 10% sesame meal, 20% wheat bran, 18% rice bran, 1% oyster shell and 1% vitamin premix showed the highest production ranging from 304.5 to 563.3 kg/ha/105 days in monoculture of *M. rosenbergii.*

Survival rate

The average survival rate of *Macrobrachium rosenbergii* from three monoculture ponds was found to be 65% (Tab 4). After experimental period, survival rates in all the ponds MP1, MP2 and MP3 were found to be 70%, 61% and 64% respectively. In polyculture system, the survival rate of *M. rosenbergii* was found to be 75% (Table 4) and the survival for both rohu and catla was obtained at 90%..

Table 4. Survival rate of different species in monoculture and polyculture system

Culture System	Species	Survival rate (%)
Monoculture	*M. rosenbergii*	65
Polyculture	*M. rosenbergii*	75
	C. catla	90
	L. rohita	90

Huq and Islam (2003) found the range of survival rate for *P. hypophthalmus*, *C. catla* and *L. rohita* was 95-97% and 78% survival rate for *M. rosenbergii*. Siddique *et al.* (1999) conducted an experiment for polyculture of *M. rosenbergii* with Indian major carps where the survival rate of prawn ranged between 73.3 to 86.6%. Hoq *et al.* (1996) observed a survival rate of 32.2 to 75.5% of *M. rosenbergii* in polyculture with supplemental feed mixture of rice bran and oil cake (1:1). Hossain *et al.* (2000) found the survival rate ranging from 46.6 to 66.6% in monoculture of *M. rosenbergii*. Alam *et al.* (2001) found the survival rate of prawn between 66-70% in the polyculture with carps.

Cost benefit analysis

The cost was estimated as 149,510.7 Tk/ha and 150058 Tk/ha for monoculture and polyculture ponds. The gross incomes were estimated as 255,650 Tk/ha and 295,066 Tk/ha in mono and polyculture ponds respectively. Therefore, the net profit in the experimental monoculture and polyculture ponds were 106,139.3 Tk/ha and 145,008.5 Tk/ha (Table 5).

Table 5. Cost benefit comparison between monoculture and polyculture systems in one hectare pond

Characters (Tk/ha)	Monoculture	Polyculture
Seed	67725	72865
Feed	67500	68421.05
Fertilizer + Lime	5714.286	2923.977
Miscellaneous	8571.429	5847.953
Total cost	149510.7	150058
Gross income	255650	295066.4
Net income	106139.3	145008.5
Rate of return (%)	170.99	196.63
Benefit Cost Ratio	1.70	1.96

Huq and Islam (2003) obtained the highest income (Tk. 122,220.83/ha) from the polyculture of *P. hypophthalmus* with *C. catla, L. rohita* and *M. rosenbergii*. The monoculture of *Pangasius hypophthalmus* earned Tk. 9,6225.03/ha. Siddique *et al.* (1999) obtained from polyculture of *M. rosenbergii,* with Indian major carps where the highest net profit (Tk. 72,885/h/105 days) was recorded. It might be concluded from this study that polyculture of prawn (*Macrobrachium rosenbergii*) with Indian major carps is more profitable than the monoculture of prawn.

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