ROLE OF MICRO AND MACRONUTRIENTS ENRICH FERTILIZERS ON THE GROWTH PERFORMANCE OF PRAWN (*Macrobrachium rosenbergii*), ROHU (*Labeo rohita*) AND MOLA (*Amblypharyngodon mola*) IN A POLYCULTURE SYSTEM

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Abstract

A six month's experiment was carried out in earthen ponds to evaluate the effect of micro and macro nutrients on the growth performance of Prawn (*Macrobrachium rosenbergii*), Rohu (*Labeo rohita*) and Mola (*Amblypharyngodon mola*) in a polyculture system during July to December 2017. The trial was conducted into two different treatments and one control each with three replications. In treatment-1, macronutrients enrich fertilizers like urea, TSP and molasses-yeast mixture were applied at the rate of 2.45, 2.45, and 3.09 (g m^{-2} week^{-1}), whereas in treatment-2 micronutrients composition mixer applied at the rate of 4.50 g m^{-2} week^{-1} while no micro and macronutrients were applied in control. The mean value of all water quality parameters showed no significant differences among control and two treatments when One-way ANOVA was performed except hardness. The average final mean individual weights of prawn, rohu and mola in control, treatment-1 and treatment-2 were 22.10, 24.35, and 24.70 g; 141.10, 190.60 and 182.20 g; 3.36, 3.67 and 3.73 g, respectively. The survival rates of various species namely prawn, rohu and mola in control, treatment-1 and treatment-2 were 73.33, 89.58 and 86.25%; 78.00, 74.00 and 74.00%; 10.67, 15.33 and 15.33%, respectively. There was no significant difference in the survival rates of prawn, rohu and mola among control and treatments. Production after six months of culture was 351.8, 461.5 and 445.3 kg ha^{-1} in control, treatment-1 and treatment-2, respectively which were significantly different at 5% level of significance.

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Introduction

Bangladesh is blessed with huge water resources with a wide range of aquatic diversity. This country is one of the world's leading fish producing countries with a total production of 41.34 lakh MT, where aquaculture contributes 56.44 percent to total production and ranked 5th in world aquaculture product (FAO, 2016). Moreover, this country has achieved self-sufficiency in fish production. Still Government is trying to sustain this growth performance. As we know that, the polyculture is particularly ideal in developing countries due to certain options such as management and investments. It is now the most common practice of carp culture and several species combinations (Hoq *et al.,* 1996). Mola (*Amblypharyngodon mola*) is a micronutrient-rich small fish that is very popular, and grows well along with carps in ponds. The concept of prawn (*M. rosenbergii*), rohu (*L. rohita*) and mola (*A. mola*) polyculture rests on the idea that when compatible species of different feeding habits are cultured in the same ponds, the maximum utilization of all the fish food of different column of the ponds is established. On the other hand, it is widely recommended that biological productivity in aquaculture ponds is limited by nutrients. Actually optimizing production in pond fish culture by the use of fertilizers is an important task as plankton is the basic food of all the organisms living in the water and fishes and other aquatic organisms depend on this basic food directly and indirectly (Moses,

1983; Westly, 1984). The quantity of nutrients in a pond plays a major role in determining the amount and quality of plankton (Debeljak *et al.,* 1990; Harris, 1986; Pearson *et al.,* 1984). Actually, pond fertilization enhances the growth of primary producers, which are consumed by fish, ultimately augmenting the fish crop. Inorganic fertilizers are more readily soluble and have immediate effect on plankton growth. Although a number of studies have been conducted on the effects of inorganic macro fertilizers like nitrogen and phosphorus in carp polyculture (Wahab *et al.,* 1994) and benefits of using macro nutrient enrich fertilizer in aquaculture is well established (Chakrabarty *et al.,* 1976; Green *et al.,* 1989, Boyd, 1982; Boyd 1976), no studies on the evaluation of micronutrient enrich fertilizer effectiveness on plankton was found to be conducted in our country. In accordance with Green *et al.* (1992), application of macro and micronutrients enrich fertilizers in fish ponds results higher fish production than from natural unfertilized systems. Phytoplankton need numerous other trace metals (micronutrients) required for the activity of key enzymes and other intracellular functions to grow (Hassler *et al.,* 2012). The main purpose of pond fertilization is to augment the production of plankton, which serves as natural food of the fishes; because fertilization stimulates both the autotrophic and heterotrophic levels which increase fish production (Garg and Bhatnagar, 1999). The macro and micronutrient enrich fertilizer can be an effective tool to enhance the production of prawn (*M. rosenbergii*), rohu (*L. rohita*) and mola (*A. mola*) in polyculture system. Therefore, the aim of the proposed research was to find out the role of micro and macronutrients enrich fertilizer in the production of prawn, rohu and mola polyculture system.

Materials and Methods

Study area and period

The study was conducted from the experimental pond complex II at Fisheries and Marine Resource Technology Discipline of Khulna University, Khulna in Bangladesh during July to December, 2017. All ponds were rectangular in shape with a maximum depth of 1.5 m. All the ponds were fully exposed to prevailing sunlight.

Experimental Design

The trial was conducted into two different treatments and one control with three replications each. Stocking density of prawn (*M. rosenbergii*), rohu (*L. rohita*) and mola (*A. mola*) were same in all treatments shown in the Table 1. In treatment T_1, macro nutrients like urea, TSP and Molasses-yeast mixture were applied at the rate of 2.45, 2.45, and 3.09 (g m^{-2} week^{-1}), and micro nutrients composed mixer applied at the rate of 4.5 g m^{-2} week^{-1} in treatment T_2 while no micro and macro nutrients were applied in control.

Table 1. Research design.

Parameter/Stocking Density	Control	Treatment-1	Treatment-2
Area of each pond	120 - 150 m^2	120 - 150 m^2	120 - 150 m^2
Water depth	1-1.5 m	1-1.5 m	1-1.5 m
Prawn	2/m^2	2/m^2	2/m^2
Rohu	0.1/m^2	0.1/ m^2	0.1/ m^2
Mola	2/m^2	2/m^2	2/m^2
Fertilization application	Without fertilizer	Traditional inorganic fertilizer	Commercial inorganic fertilizer
Dose	No	Urea 2.45, TSP 2.45, Molasses-yeast mixture 3.09 (g/m^2/week)	Before stocking: 2 kg/1000 m^3 of water During culture period: 1 kg/1000m^3/week
Replication	3	3	3

Table 2. Composition of micro nutrient enrich fertilizer.

Type	Composition
Micro nutrient enrich fertilizer	Dicalcium Phosphate: 500000 mg, Cobalt: 120 mg, Copper: 10000 mg, Choline: 6000 mg, Folic Acid: 120 mg, Biotin: 5 mg, Manganese: 2000 mg, Selenium: 100 gm, Zinc: 11000 mg, Iron: 20000 mg, Pantothenic acid: 1300 mg, Vit-A: 300000 UI, Vit-D$_3$: 160000 UI, Vit-E: 2000 mg, Vit-K$_3$: 200 mg, Vit-B$_1$: 600 mg, Vit- B$_2$: 300 mg and Vit B$_6$: 300 mg

Pre-stocking management

At the beginning of June, ponds were renovated and cleaned of aquatic vegetation. All unwanted fishes and other aquatic organisms were eradicated by dewatering. Pond dikes were repaired using the excavated bottom soils. The weeds of embankment were also cleaned manually. Surroundings of all ponds were fenced by 1 m high nylon net to prevent the entry of fishes, snakes and other predators, and escape of prawn. Lime was applied to the pond bottom at the rate of 250 kg ha^{-1}. The ponds were filled with water after seven days of liming from adjacent deep tube well by using pump. As presented in Table 1, all ponds of treatment 1 were fertilized with inorganic fertilizer like, Urea 2.45, TSP 2.45, Molasses-yeast mixture 3.09 (g m^{-2} week^{-1}) and micro nutrients composed mixer (Table 2) applied at a rate of 4.5 g m^{-2} week^{-1} respectively in treatment 2, while no fertilizers were applied in control. After the first fertilization and before fish stocking, the ponds were left 10 days to allow plankton development.

Stocking

Stocking in nursery pond

Prawn PL was purchased from a commercial hatchery in Coxes bazar during middle of May 2017 and stocked in nursery pond. While rohu fry and brood mola were purchased from a local seller in Khulna at July 2017.

Stocking in grow-out ponds

Prawn, rohu and mola were stocked in grow out ponds during July 2017. The mean initial weight of prawn, rohu, and mola were 2.32, 94.13 and 2.00 g, respectively in both two treatments and control as well. Before stocking, fish fry and prawn juveniles were conditioned kept in a hapa.

Post stocking management

All ponds were subject to the same regime of feed and fertilizer application. Feed was provided as farmer regular use in traditional culture system as it is. Fish are fed daily at the rate of 5% body weight throughout the study period. Half of the required food was applied evenly over the surface of the ponds, in the morning and the rest half in the evening. Fertilization with urea, TSP and molasses-yeast mixture was done at the rate of 2.45, 2.45, 3.09 (g m^{-2} week^{-1}), respectively at every 7 day interval in T_1 to keep natural food available in the water and micronutrients composition mixer applied at the rate of 4.5 g m^{-2} week^{-1} in treatment-2 While no fertilization is applied in control.

Water sampling and analysis

Water quality parameters like temperature, transparency, DO, pH, alkalinity, hardness, nitrate-nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), and ammonia-nitrogen (NH_3-N) were measured fortnightly. Some of the important analytical methods in some cases with some modification were set up in the Water Chemistry Research Laboratory of Fisheries and Marin Resources Technology (FMRT) Discipline. The water quality parameters like temperature, pH, dissolved oxygen (DO), alkalinity, hardness, ammonia (NH_3), nitrite, nitrate were analyzed during the whole experiment periods fortnightly.

Growth check

Five individuals of each species from each treatment are sampled monthly to check the growth and health condition as well as feed adjustment.

The following parameters were used to evaluate the growth of fishes:

a) Weight gain (gm) = Average final weight (g) — average initial weight (g)
b) Survival rate (%) = (No of fish harvested/ No of fish stocked) x 100

Harvesting of fish

Ponds were completely harvested by seine net after six months of rearing. All fishes were counted and weighed separately to assess survival rate and production.

Statistical analysis

The data collected during experiment were recorded. Data were analyzed using MS excel and the statistical package SPSS (16). One-way ANOVA test was performed to identify any significant differences among treatment means. Significance was assigned at the 5% level.

Results and Discussion

Water quality

Water quality parameters were analyzed to observe any considerable changes that might have occurred in response to different in treatments. Various physical, chemical and biological parameters of pond water were determined under control and two treatments. All parameters were present within the acceptable range for fish culture. Water quality parameters in control and treatments have been presented in Table 3.

Table 3. Mean (±SD) values and ranges of water quality parameters

Parameters	Experimental groups		
	Treatment-1	Treatment-2	Control
Temperature (°C)	25-31	25-31	25-31
	28.50±2.06[a]	28.73±2.23[a]	28.86±2.30[a]
DO (mg/l)	6-8	6-8	6-8
	7.09±0.94[a]	7.36±0.92[a]	6.64±0.92[a]
pH	7.35-8.70	7.5-8.70	7.5-8.70
	8.32±0.42[a]	8.33±0.37[a]	8.23±0.44[a]
Alkalinity (mg/l)	200-300	200-300	200-275
	247.73±32.51[a]	245.45±31.26[a]	220.45±24.54[a]
Hardness (mg/l)	165-200	165-200	155-170
	184.55±11.93[b]	183.18±14.19[b]	164.09±5.39[a]
Nitrite (mg/l)	0.0285-0.9715	0.0235-0.1095	0.0235-0.1095
	0.08±0.04[a]	0.09±0.03[a]	0.07±0.03[a]
Nitrate (mg/l)	0.130-0.285	0.130-0.285	0.125-0.235
	0.21±0.05[a]	0.20±0.05[a]	0.17±0.03[a]
Ammonia (mg/l)	0.0415-0.1380	0.0415-0.1380	0.0380-0.1070
	0.09±0.03[a]	0.09±0.03[a]	0.07±0.02[a]

* Figures in the same row having the same superscript are not significantly different.

The water temperature, dissolved oxygen (DO) concentration, pH, total alkalinity, hardness, concentration of total ammonia nitrogen (NH_3-N), nitrate-nitrogen (NO_3-N) and nitrite-nitrogen (NO_3-N) of experimental ponds was found to vary from 25 to 31°C, 6 to 8 mg L^{-1}, 7.5 to 8.7, 200-300 mg L^{-1}, 155-200 mg L^{-1}, 0.038 to 0.138 mg L^{-1},0.125 to 0.285 mg L^{-1}, 0.0235 to 0.9715 mg L^{-1} during the experiment in control and two treatments, respectively. No significant difference ($P > 0.05$) was found between control and treatments except hardness. Ahmed (2004), Asaduzzaman (2005), Asaduzzaman *et al.* (2006), Azim *et al.* (1995), Dewan *et al.* (1991), Hoque *et al.* (2014), Hossain *et al.* (1997), Kohinoor (2000), Kohinoor *et al.* (2001), Kohinoor *et al.* (1998), Kunda *et al.* (2008), Mazid (2009), Mollah and Haque (1978), Rahman (2005), Roy (2004), and Wahab *et al.* (1995) also reported similar findings.

Growth and production of fish
Details of growth and production of Prawn (*M. rosenbergii*), Rohu (*L. rohita*) and Mola (*A. mola*) were presented in Figures 1, 2, 3 and Table 3. Among all species, rohu (*L. rohita*) attained the maximum weight at harvest while the production of mola had been affected by prawn (*M. rosenbergii*).

Survival rate
The survival rates of various species namely prawn (*M. rosenbergii*) and rohu (*L. rohita*) in control, treatment-1 and treatment-2 were 73.33, 89.58 and 86.25%, 78.00, 74.00 and 74.00% while mola (*A. mola*) were 10.67, 15.33 and 15.33%, respectively. Perhaps mola (*A. mola*) fishes were consumed by prawn (*M. rosenbergii*). There was no significant difference in the survival rates of prawn (*M. rosenbergii*), rohu (*L. rohita*) and mola (*A. mola*) among control and two treatments.
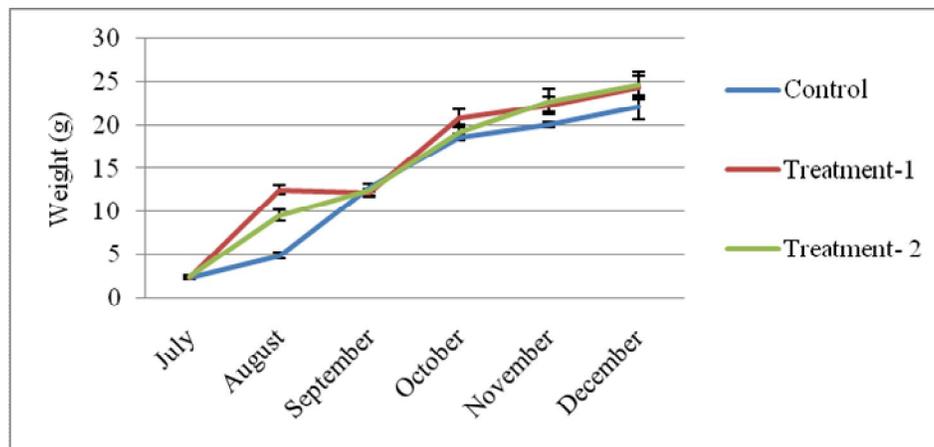

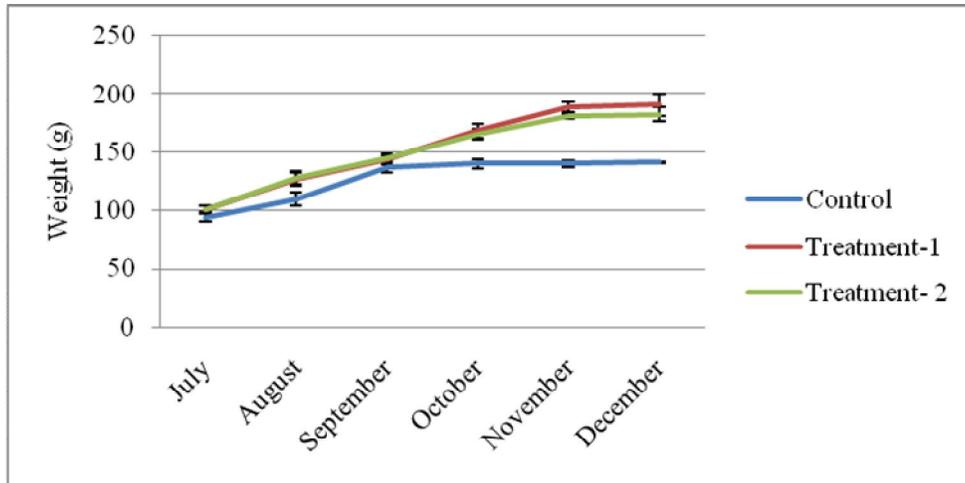Fig. 1. Growth pattern of Prawn (*M. rosenbergii*).
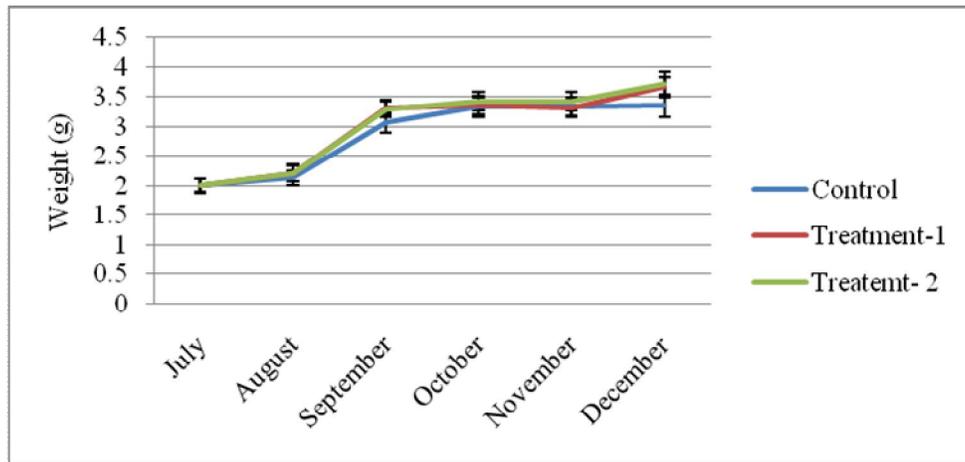
Fig. 2. Growth pattern of Rohu (*L. rohita*).

Fig. 3. Growth pattern of Mola (*A. mola*).

Final Production

The average final mean individual weights of Prawn (*M. rosenbergii*), Rohu (*L. rohita*) and Mola (*A. mola*) in treatment-1 were 24.35, 190.6, 3.67 g and treatment-2 were 24.70, 182.20, 3.73 g while 22.10, 141.10, 3.36 g, respectively in control. The final harvest weights of mola (*A. mola*) in

treatment-1 and treatment-2 was more or less similar as control. The survival rate of prawn (*M. rosenbergii*) in treatment-2 was lower than treatment-1. So the final production of treatment-1 was more than treatment-2 but the individual growth of fish species in treatment-2 is more than any other treatments except rohu (*L. rohita*).
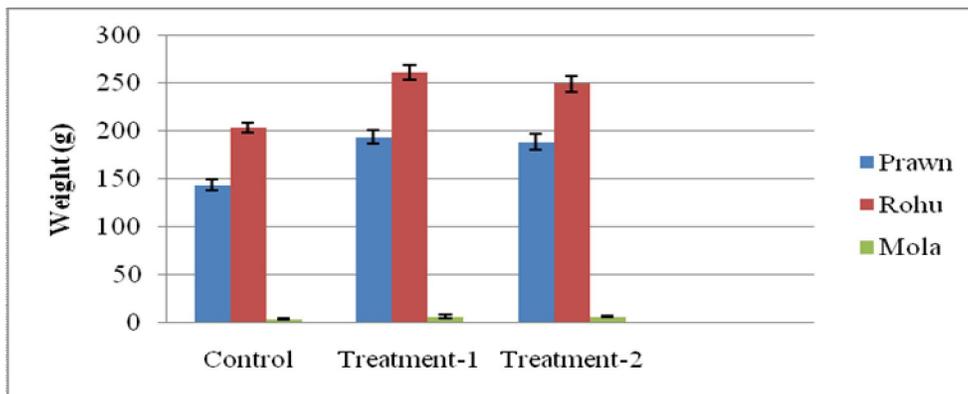

Fig. 4. Total production of prawn, rohu and mola in control and two treatments.

Production after six months of culture was 351.8, 461.5 and 445.3 kg ha^{-1} in control, treatment-1and treatment-2, respectively (Table 4). Significant difference was found in the production of Prawn (*M. rosenbergii*), Rohu (*L. rohita*) and Mola (*A. mola*) among control and two treatments. Thilsted (2003) stated that, total fish production

was 2560, 2412 and 2176 kg ha^{-1} in three treatments, respectively. Though Wahab *et al.* (2008) mentioned an integrated aquaculture of fresh water prawn (*M. rosenbergii*) and mola (*A. mola*) in different plot showed better average production, 222 to 388 kg ha^{-1}, 51 to 68 kg ha $^{-1}$, respectively.

Table 4. Survival and production of prawn, rohu and mola under two treatments.

Treatment		At stocking			At harvest			Survival Rate (%)	Production (kg ha^{-1})	
	Species	Av. Initial wt (g)	No. of fish stocked	Total wt (g)	Av. Final wt (g)	No of fish recovered	Total wt (g)		Species wise	Total
Control	Prawn	2.32	240	556.8	22.10	176	3889.60	73.33	144.0	
	Rohu	94.13	50	4706.5	141.10	39	5502.90	78.00	203.8	351.8
	Mola	2.00	300	600.0	3.36	32	107.52	10.67	4.0	
Treatment-1	Prawn	2.32	240	556.8	24.35	215	5235.25	89.58	194.0	
	Rohu	100.30	50	5015.0	190.60	37	7052.20	74.00	261.2	461.5
	Mola	2.00	300	600.0	3.67	46	168.82	15.33	6.3	
Treatment-2	Prawn	2.44	240	585.6	24.70	207	5112.90	86.25	189.3	
	Rohu	100.85	50	5042.5	182.20	37	6741.40	74.00	249.6	445.3
	Mola	2.00	300	600.0	3.73	46	171.58	15.33	6.4	

In conclusion, fertilizer indirectly took part major role in the production of mola and rohu through increasing plankton production. Additionally, mola probably ensured better production of prawn through consumption as prawn is a carnivorous species in nature. While Rohu–mola culture technology could be a good proposition as a rural aquaculture technology in terms of nutrition and socio-economic aspects. However, it could be concluded that including mola could to maximize the production of prawn as well as rohu in fertilizer included polyculture system though we have to sacrifice mola production. In view of the above, it may be recommended that though the production of mola was not encouraging in fertilizer based prawn, rohu, mola monoculture system but it might be very encouraging with carp included polyculture system to meet the demand of nutritional benefit for rural people specially women and children.

Acknowledgements

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