EFFECT OF DIFFERENT TYPES OF SHELTERS ON SURVIVAL AND GROWTH OF GIANT FRESHWATER PRAWN, *MACROBRACHIUM ROSENBERGII*

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Key words: shelters, survival, growth, freshwater prawn, *Macrobrachium rosenbergii*.

ABSTRACT

Shelters play an important role in growth and survival of freshwater prawn *Macrobrachium rosenbergii*, since it is aggressive and has territorial and agonistic behavior. The effect of three types of shelters, namely, *Eichhornea* plant, used tires and PVC pipes on survival and growth of *M. rosenbergii* was investigated in soil based and fertilized cement tanks in triplicate. Tanks without shelters were used as control. Growth of prawns in shelter based tanks was significantly ($p < 0.05$) higher than that of the control. Relatively best growth and survival were achieved in tanks supplied with PVC pipes, which was followed by used tires and *Eichhornea* plants. Increased growth for the treatments of PVC pipes, tires, *Eichhornea* and control was 34.2, 29.8, 24.5 and 13.3 g, respectively. Survival, net production and specific growth rate of prawn were superior in the PVC pipe treatment.

I. INTRODUCTION

Giant freshwater prawn *Macrobrachium rosenbergii* is commercially cultured in India and other south Asian countries. Although its culture is profitable, some constraints within the grow-out phase still remain. *M. rosenbergii* is territorial to some degree and exhibits aggressive and social behavior [13, 27]. Social suppression of growth in this species has demonstrated by laboratory studies [14]. A differential individual growth phenomenon, territorial behaviour, and the cannibalistic nature (particularly when food becomes insufficient) of freshwater prawn are controlled most often by social interactions [5, 23, 29]. These factors can be partially addressed by culture at low density, providing shelters and sufficient food, and employing polyculture practices [21, 22]. Growth variation within the male population is higher in high density culture environments [1]. In high density monoculture of *M. rosenbergii* differential growth rate (heterogeneous individual growth) has been reported [17, 22, 31]. Use of shelters in culture ponds has been reported to reduce the growth variation within a population of freshwater prawn [33]. Provision of shelters also helps to increase the survival and overall production by decreasing cannibalism [5].

Mercy and Shankaran [18] compared the usefulness of pebbles to garden soil and river sand for juvenile *M. rosenbergii*. The survival and growth in weight and length of *M. rosenbergii* reared under total hardness were significantly higher [36]. The effect of added shelters on the production and population characteristics of freshwater prawns in ponds were evaluated using two types of mesh shelters, namely, PVC frames with horizontal plastic mesh and vertical suspended plastic mesh in another study [38]. At harvest, mean growth rate of prawns in ponds with shelter was higher than that of prawns in ponds without shelter. The role of different kinds of locally available shelters, such as PVC pipes, used tires, twigs, living plants, broken tiles, cement pipes etc., on production of *M. rosenbergii* has not been thoroughly investigated. Hence, the present study was conducted to evaluate three types of shelters, live *Eichhornea* plants, used used tires, and PVC pipes in grow-out of *M. rosenbergii*.

II. MATERIALS AND METHODS

The experiment was conducted for 112 days in twelve cement tanks ($5 \times 5 \times 1$ m) containing 15 cm soil base and filled with 80 ± 2 cm water. No aeration was supplied. All tanks were limed with calcium oxide at 0.25 kg (250 kg/ha) filled, and then fertilized with dry poultry manure at the rate of 2 kg

Paper submitted 02/28/09; revised 10/31/09, 06/08/10; accepted 09/17/10.
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Table 1. Mean (± SE) growth, survival and food conversion of freshwater prawn, *Macrobrachium rosenbergii*.

Parameters	Treatments			
	No substrate	*Eichhornea*	Used tires	PVC pipes
SGR (%/day)	$2.40^a \pm 0.02$	$2.95^b \pm 0.02$	$3.12^c \pm 0.03$	$3.24^d \pm 0.01$
Survival (%)	$42.0^a \pm 1.63$	$55.0^b \pm 1.63$	$60.0^{cb} \pm 3.26$	$80^c \pm 1.63$
FCR	$3.12^a \pm 0.06$	$3.09^a \pm 0.01$	$3.07^a \pm 0.02$	$3.02^a \pm 0.02$
Yield (g/25 m^2)	$139.47^a \pm 2.43$	$330.30^b \pm 4.79$	$448.00^{cb} \pm 3.65$	$597.90^d \pm 16.30$

Different superscript (a, b, c, d) in the row indicate significant difference ($p < 0.05$) among the control and treatment groups, values are expressed as mean ± SE (n = 6).

per tank before starting the experiment. Subsequent fertilization at 0.5 kg manure/tank was provided each month during the experiment. Different shelters represented different experimental treatments in triplicate and consisted of live *Eichhornea* plants, used used tires and PVC pipes. PVC pipes with a length of 1-2 feet and having 3 inch diameter were used and spread on the bottom of the tanks. Tires (used for two wheeler vehicles) measuring 2 inches diameter (inside) and 2 feet width were placed horizontally above the bottom of tanks. Required number of *Eichhornia* plants to cover exactly 1 m^2 area were measured before introducing in to tanks. The leaves of the plants were floating near the surface, while submerged roots were suspended in the water column. Three dimensional surface area each type of shelter was measured carefully and approximately to 1 m^2 area, which works out to 4 % of the tank bottom area (Table 2). Care was exercised so that different treatments had 1 m^2 sheltered area. Three tanks without shelters served as the control treatment. Each tank was stocked with 25 numbers of juvenile *M. rosenbergii* per tank (10,000/ha) (average weight-0.90 ± 0.06 g). Stocking density adopted in the study was lower than that employed in the commercial farming of *M. rosenbergii*. There was no aeration and water recirculation in the tanks. Therefore, a lower density was employed in the study. A pellet diet containing 35% crude protein and 6% lipid was formulated [12] and fed daily at 10% of body weight, twice daily in two equivalent meals.

Weight of prawn was recorded at 15 day sampling intervals. At least 50% of the stocked prawns were collected during sampled days and their individual length and total weight recorded. At the termination of the experiment, all surviving prawns were collected and their individual length and weight were recorded. Additionally, percent survival, specific growth rate

$$\text{SGR} = 100 \times \frac{(\ln \text{final weight} - \ln \text{initial weight})}{\text{Number of culture days}}$$

food conversion ratio (FCR) and net production were calculated. The data obtained on growth, survival, specific growth rate, yield and FCR were analyzed statistically employing ANOVA and Duncan's multiple range test ($p < 0.05$) [8, 32].

Water was analyzed for different physico-chemical parameters every 15 days (Table 2). Temperature and pH were recorded using a Horiba (Japan) water quality analyzer (Model U-10). When random samples of water on different days were collected little variation was observed. Dissolved oxygen was stabilized around 6 mg/l before prawns were stocked at 7 days post fertilization. Dissolved oxygen was measured by Winkler's method. Carbon dioxide by phenolphthalein method, total alkalinity [4] and total ammonia by modified Strickland & Parsons Method were measured [2].

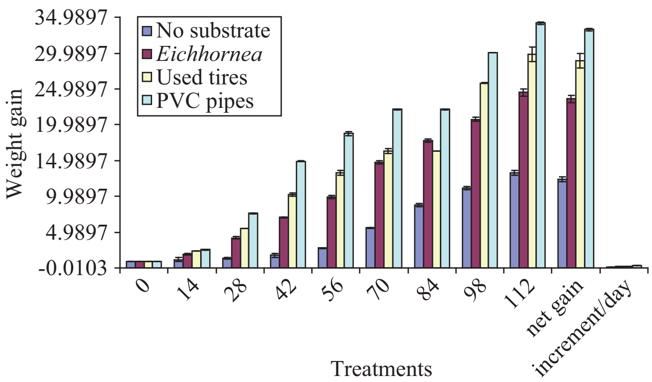

Fig. 1. Weight gain of *M. rosenbergii* recorded during the experimental.

III. RESULTS

The highest growth of *M. rosenbergii* was recorded in the tanks provided with PVC pipes and the lowest growth was in tanks without substrate (control) (Fig. 1 and Table 1). The length recorded also indicated the same trend (Fig. 2). With shelters, the growth of *M. rosenbergii* was significantly higher ($p < 0.05$) in treatment PVC followed by tires. Prawns in tanks provided with shelters had a specific growth rate (SGR) that was higher than that of the control. There was significance difference in SGR in different treatments (Table 1). The survival of prawn was highest for tanks supplied with PVC pipes. The overall survival was lower than expected for all treatments except in tanks supplied with PVC pipes (Table 1).

The food conversion rate (FCR) was better in tanks supplied with PVC pipes, which was followed by tanks supplied with used tires (Table 1). Lower FCR in tanks supplied with PVC pipes was associated with better growth compared to that in other treatments and control. However, statistically there

Table 2. Mean (± SE) values and ranges of water quality parameters and surface area of shelters.

Parameters	Treatments			
	No substrate	*Eichhornea*	Used tires	PVC pipes
Water temperature (°C)	27.2 ± 1.6 (24.0-31.0)	27.3 ± 1.5 (23.5-30.0)	27.4 ±1.4 (24.4-30.5)	28.0 ± 1.8 (24.0-31.5)
pH	7.80 ± 0.18 (7.00-8.20)	7.66 ± 0.20 (7.00-8.10)	7.80 ± 0.21 (7.00-8.50)	7.66 ± 0.23 (7.0-8.40)
Dissolved oxygen (mg/l)	$6.5^a \pm 0.9$ (3.6-10.5)	$7.2^b \pm 0.8$ (4.5-11.4)	$5.7^a \pm 0.5$ (4.1-7.3)	$6.1^a \pm 0.7$ (4.1-8.0)
Carbon dioxide (mg/l)	$0.44^a \pm 0.43$ (0.00-2.80)	$0.81^b \pm 0.57$ (0.00-2.20)	$0.32^a \pm 0.37$ (0.00-2.40)	$0.33^a \pm 0.38$ (0.0-1.60)
Total alkalinity (mg/l)	52.39 ± 4.05 (44.25-70.00)	55.54 ± 10.35 (30.00-80.00)	52.74 ± 9.55 (30.0-82.0)	52.00 ± 7.37 (39.0-80.0)
Total ammonia – N (µg/l)	$5.04^a \pm 1.89$ (0.11-11.24)	$4.91^a \pm 1.33$ (0.09-9.80)	$5.24^a \pm 2.02$ (0.08-9.93)	$3.13^b \pm 1.66$ (0.09-9.48)
Surface area of shelters used	-	0.98 m^2	1.12 m^2	1.08 m^2

Different superscript (a, b, c, d) in the row indicate significant difference ($p < 0.05$) among the control and treatment groups, values are expressed as mean ± SE (n = 6).

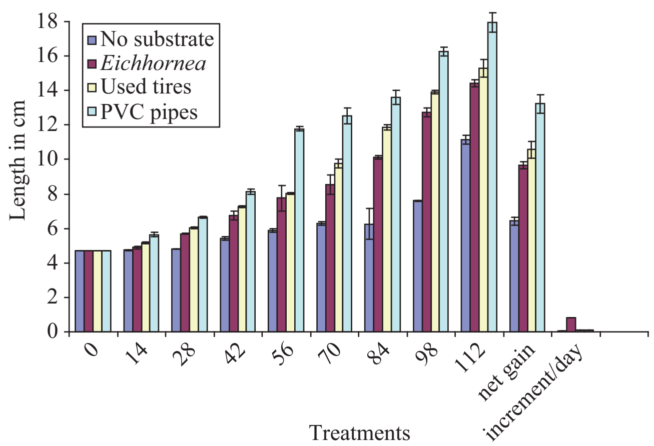

Fig. 2. Length attained by *M. rosenbergii* recorded during the experimental.

was no significant difference in FCR among the treatments. Net yield obtained was higher in tanks supplied with PVC pipes, which was followed by tanks supplied with used tires. There was a significant difference in the yield of prawn harvested in different treatments.

The water quality parameters are presented in Table 2. Water temperature was ranged between 23.5°C to 31.5°C. The pH was slightly alkaline in all the tanks (7.66 to 7.80) indicating favorable conditions for biological production. Dissolved oxygen levels were in the range suitable for prawn culture. A decrease in dissolved oxygen (to a level of 4 mg/l) was noticed in all the tanks immediately after application of manure (before stocking of prawn). Carbon dioxide content (0.32-0.81 mg/l) and ammonia levels (3.13-5.24 µg-N/l) were low throughout the study.

IV. DISCUSSION

The recorded variation in growth and survival of freshwater prawn, *Macrobrachium rosenbergiii* in different treatments in the present study is attributed to nature of the species, its agonistic and territorial behavior and the nature of shelters supplied. *M. rosenbergii* is territorial to some degree and exhibits aggressive and social behavior [13, 25, 27]. Social suppression of growth in this species has demonstrated by laboratory studies [14]. Prawn populations display a disproportionate increase in size variation with time because individual prawns grow at different rates and exhibit heterogeneous individual growth [17, 21, 31]. Laboratory studies revealed that juvenile prawns raised in social isolation grow more uniformly than those raised in groups [28]. Early researchers suggested that natural materials such as branches, aquatic plants, gravel and shells be introduced in to juvenile rearing tanks to reduce the aggressive interactions and possible refuges for moulting prawns [10, 15].

In another study, *M. rosenbergii*, showed a preference for a substrate of 0.5 to 1.5 cm diameter pebbles, compared to garden soil (85% sand and 70% clay), river sand (41% sand and clay 23%) and mud (10% sand and 81% clay), presumably this response was observed because, pebbles provided more space to hide [18]. Freshwater prawns are known to be nocturnal feeders and are believed to prefer reduced or dim light conditions over direct sunlight [25, 27]. During daylight, it remains half buried in sediment or hidden in shelter [20, 36]. Tidwell, *et al*. [34] studying on use of different shelters in *M. rosenbergii* culture reported that PVC frames with horizontal plastic mesh as substrates increased growth. However, the degree of increased growth is not comparable to that recorded in the present study. The food conversion ratio (FCR) was satisfactory and comparable to that previously reported for with other earlier reports on *M. rosenebergii* [7, 22]. Best FCR in tanks with PVC pipes was associated with better growth compared to that in other treatments. However, statistically there was no significant difference in FCR among the treatments.

Water quality and were found suitable for culture of freshwater prawn [6]. Water temperature recorded was found suitable for the growth of freshwater prawn [9]. Prawns undergo stress when water temperature falls below 22°C and exceeds 35°C [16]. In the present study, pH was slightly alkaline in all the tanks (7.66 to 7.80) indicating favorable conditions for biological production [11]. An observation characteristic of waters with predominant heterotrophic food production that accounts for the bulk of oxygen consumption [19]. Carbon dioxide and ammonia levels were low in the present study. [3, 35] Reported growth reduction of *M. rosenbergii* up to 30% when ammonia was more than 100 µg atom-N/l. However, adverse effect of water quality on prawn survival in some treatments could not be ruled out. Growth of prawn was also affected by the increased level of ammonia in the present study.

The selection of shelters by prawn depends on its type, surface area, and water quality. In the present study, PVC pipes, compared to other shelters was associated with significantly higher growth in *M. rosenbergii*. The beneficial effect of shelters on growth and survival may be related to the nocturnal feeding habit and agonistic, and cannibalistic behavior of the animal. This study demonstrates that *M. rosenbergii* production can be significantly increased through the introduction of suitable, locally available and less expensive shelters in culture tanks.

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