Rearing of Carp of Fry and Post-Larvae of Freshwater Prawn in Simulated Seasonal Waterlogged Condition of Different Depths

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The study was carried out to explore the possibility of raising carp fry to advanced fingerlings stage along with post-larval rearing of freshwater prawn, in simulated waterlogged conditions of various depths. Growth performance of all species improved with increase in water depth, probably due to less mutual competition for food and space that cause physiological stress and relatively stable water quality. With the increase in water depth from 20 – 110 cm (T1-T4), the productivity increased significantly (524.4 – 1051.3 kg/ha/120 days). However, the percentage increase in productivity reduced from 32% (T1-T2) to 20.5% (T3-T4) probably due to higher survival rate and density-dependent growth.

INTRODUCTION

About 20.5 million ha of rainfed lowlands (CRRI, 1992) in India are prone to waterlogging of various depths, which are yet to be utilized to the fullest. Keeping in view the duration of water availability (4-5 months), if these seasonal shallow (up to 50 cm), semi-deep (50-100 cm) and deep (more than 100 cm) waterlogged areas can be utilized for short-duration aquaculture, particularly fry and post-larval rearing of fish and prawn, it would be a step in favour of expanding aquaculture and enhancing fish production. However, successful rearing of fry to advanced fingerling stage (4-5 month) of fish is one of the most important and crucial step, especially in seasonal waterlogged condition, which depends on several factors such as size of stocked material, stocking density, water quality, rearing duration, water depth etc. As higher density and adverse hydro-biological conditions may often lead to severe consequences resulting in poor growth and survival (Boyd and Pillai, 1985), an understanding of the complex interactions continuously taking place between the ecosystem and stocked organism is essential to enhance the survival and yield. Although much work have been carried out on several aspects of poly/composite culture (Sinha, 1972; Jhingran, 1991; Jena et al., 1998 and 2002), the present study is an attempt to explore the possibility of fry to advanced fingerling stage and post-larval rearing of fish and prawn respectively, in simulated waterlogged conditions of various depths.
MATERIAL AND METHODS

The present study was carried out at research farm of WTCER (ICAR), Bhubaneswar (Lat. 20°30’N and Long. 87°48’10”E), India during 1999-2001 for three successive years. Twelve plots of 10 x 10 m size were selected for this study. Excavation work was carried out to maintain four different range of water depths (T1: 30-50 cm, T2: 50-70 cm, T3: 70-90 cm and T4: 90-110 cm) in triplicate as treatments. Rainwater as well as run-off water from the catchment area were allowed to enter the excavated fields. Excess water from the excavated fields were allowed to spill out into the drainage channel through the outlets fixed at 50 cm, 70 cm, 90 cm and 110 cm height in T1, T2, T3 and T4, respectively. The outlets were fitted with fine-meshed net to prevent escape of fish and prawn. After proper preparation of the excavated fields, liming @ 2000 kg/ha, manuring with raw cattle dung @ 5000 kg/ha and fertilization (Urea + SSP, 1:1) @ 3 ppm was carried out prior to stocking. Fry of Catla catla, Labeo rohita, Cyprinus carpio and post-larvae (PL3) of Macrobrachium rosenbergii were stocked in the excavated fields in the ratio of 30:30:25:15. Stocking density was 25000/ha and rearing was continued for 120 days (4th week of July – 4th week of November). Supplemental feed (rice bran + groundnut oil cake, 1:1) @ 10%, 8%, 6% and 4% of mean body weight (MBW) was given twice a day, during 1st, 2nd, 3rd and 4th month to harvesting, respectively. Periodic manuring @ 500 kg/ha and liming @ 150 kg/ha were carried out at every 15 days interval to maintain plankton population in the ecosystem. Plankton estimation, primary productivity, weekly observation on soil and water quality were recorded using standard methods (APHA, 1989; Biswas, 1993). Field test instruments were also in use to analyze in situ water pH (Checker-1, HANNA, USA), soil pH (DM-13, Japan) and dissolved oxygen (YSI-55, USA). Crop performance, fortnightly fish/prawn growth, survival rate, condition factor and feed conversion ratio were estimated using standard methods (Mohanty, 1999).

RESULTS AND DISCUSSION

Water quality changes in response to daily, seasonal and climatic rhythms, while fish and prawn adapt to this natural fluctuation to a certain level and fail thereafter due to stress. In this experiment, various hydro-biological parameters did not show any distinct trend between the treatments except in the cases of total suspended solids, temperature, dissolved oxygen and ammonia. Most of the parameters were within/nearly optimum ranges (Table 1) throughout the culture period except the concentration of ammonia and plankton density. The recorded minimum and maximum ranges of total plankton counts were 1.9 x 10²-2.8 x 10² and 6.3 x 10³-14.1 x 10³ nos/l, respectively during the experimental period. Plankton density increased with the advancement of rearing period. Average plankton abundance was minimum in T1 followed by T2, T3 and T4, respectively, probably due to increased total suspended solids
and reduced transparency that had restricted light penetration (Mohanty, 1996). The availability of CO$_2$ for phytoplankton growth is related to total alkalinity, while water having 20-150 ppm total alkalinity produce suitable quantity of CO$_2$ to permit plankton production (Boyd and Pillai, 1985). The recorded minimum and maximum contents of total alkalinity during the experimental period were 55 and 107 ppm, respectively, reflecting conducive condition of the system, probably due to periodic liming. The dissolved oxygen contents showed a decreasing trend with the advancement of rearing period, attributed to gradual increase in biomass, resulting in higher oxygen consumption (Mohanty, 1995). Decreased transparency, increased level of ammonia and concentration of total suspended solid was probably due to entry of run-off water from the catchment along with sediment and other nutrients, periodic manuring, metabolic deposition and organic load (Mohanty, 1999). Average primary production in the first month of rearing ranged between 93 and 117 mgC/m$^3$/h, which improved further with the advancement of rearing period. The recorded maximum primary productivity in all the treatments ranged between 308 and 533 mgC/m$^3$/h. Low primary production in the initial phase of rearing was probably due to adsorption of nutrient ions by suspended soil/clay particles as well as rich organic matter. In general, water reaction process was low during monsoon (July–August) due to dilution of alkaline substances or dissolution of atmospheric CO$_2$.

![Table 1](image)

**Table 1. Minimum and maximum average range of water and soil quality parameters at different water depths in simulated waterlogged condition (1999 - 2001)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T$_1$</th>
<th>T$_2$</th>
<th>T$_3$</th>
<th>T$_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Dissolved oxygen (ppm)</td>
<td>6.9</td>
<td>8.1</td>
<td>7.2</td>
<td>7.7</td>
</tr>
<tr>
<td>Temp. (°C)</td>
<td>26.9</td>
<td>30.8</td>
<td>27.2</td>
<td>30.7</td>
</tr>
<tr>
<td>Total alkalinity (ppm)</td>
<td>55</td>
<td>79</td>
<td>61</td>
<td>86</td>
</tr>
<tr>
<td>Nitrate-N (ppm)</td>
<td>0.006</td>
<td>0.051</td>
<td>0.007</td>
<td>0.049</td>
</tr>
<tr>
<td>Nitrite-N (ppm)</td>
<td>0.06</td>
<td>0.42</td>
<td>0.06</td>
<td>0.51</td>
</tr>
<tr>
<td>Dissolved organic matter (ppm)</td>
<td>0.01</td>
<td>0.17</td>
<td>0.02</td>
<td>0.16</td>
</tr>
<tr>
<td>Total suspended solid (ppm)</td>
<td>126</td>
<td>311</td>
<td>107</td>
<td>281</td>
</tr>
<tr>
<td>Phosphate-P (ppm)</td>
<td>0.07</td>
<td>0.23</td>
<td>0.07</td>
<td>0.3</td>
</tr>
<tr>
<td>Transparency (cm)</td>
<td>17</td>
<td>28</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>Soil pH</td>
<td>6.8</td>
<td>6.9</td>
<td>6.6</td>
<td>6.8</td>
</tr>
<tr>
<td>Available - N in soil (mg/100 g)</td>
<td>7.9</td>
<td>9.7</td>
<td>7.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Available - P in soil (mg/100 g)</td>
<td>0.25</td>
<td>0.43</td>
<td>0.31</td>
<td>0.44</td>
</tr>
<tr>
<td>Organic carbon in soil (%)</td>
<td>0.19</td>
<td>0.33</td>
<td>0.16</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Irrespective of treatments, faster growth rate was recorded for *C. catla* followed by *C.carpio* and *L.rohita* during 120 days of culture, except in T$_1$ where, *C. carpio* performed higher growth rate than *C. catla* (Fig 1). This was probably due to insufficient
natural food availability at the surface layer attributed by high suspended solids (126 – 311 ppm). Moreover, faster growth rate of *C. catla* and *C. carpio* were attributed to effective utilization of supplemental feed, ecological niches and rich detrital food web that was maintained through periodic manuring, liming and initial fertilization, which agrees to the findings of Mohanty (1995). Observations on feed conversion ratio (FCR) also supports the conclusion of effective utilization of ecological niches, as minimum and maximum FCR was 1.08-1.12, 0.97-1.23, 1.14-1.37 and 1.18-1.35 in T₁, T₂, T₃ and T₄, respectively. FCR increased with increase in survival and biomass. This was probably due to higher degree of metabolic deposition/organic load (Mohanty, 1999), low dissolved oxygen and increased level of ammonia that affected feed intake pattern (Boyd and Pillai, 1985) towards latter stage of rearing. Comparative daily growth performance (Table 2) was moderate to good probably due to optimum prevailing temperature (> 25°C), water pH (> 6.5), nitrate (>0.5 ppm), phosphate (>0.2 ppm) and total alkalinity more than 50 ppm (Banergea, 1967; Mount, 1973; Boyd and Pillay, 1985; Mohanty, 1996).

![Fig. 1 Growth performance of *C. catla*, *L. rohita*, *C. carpio* and *M. rosenbergii* at different water depths in simulated waterlogged condition](image)

Table 2. Average survival and productivity of fish and prawn at different water depths in simulated waterlogged condition

<table>
<thead>
<tr>
<th>Treatment (water depth)</th>
<th>Species reared</th>
<th>Initial MBW (g)</th>
<th>Final MBW (g)</th>
<th>ADG (g)</th>
<th>Min.-max. Ponderal index (Kn)</th>
<th>SR (%)</th>
<th>Productivity (Kg ha⁻¹ 120 days⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-50 cm</td>
<td><em>C. catla</em></td>
<td>0.64 ±0.07</td>
<td>59.3 ±4.3</td>
<td>0.48</td>
<td>0.91-1.07</td>
<td>30.6</td>
<td>524.44</td>
</tr>
<tr>
<td></td>
<td><em>L. rohita</em></td>
<td>0.52 ±0.05</td>
<td>45.3 ±7.3</td>
<td>0.37</td>
<td>0.89-1.01</td>
<td>41.3</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td><em>C. carpio</em></td>
<td>0.68 ±0.13</td>
<td>68.6 ±4.3</td>
<td>0.56</td>
<td>0.98-1.08</td>
<td>48.3</td>
<td>47.3</td>
</tr>
<tr>
<td></td>
<td><em>M. rosenbergii</em></td>
<td>0.04 ±0.01</td>
<td>26.2 ±1.1</td>
<td>0.22</td>
<td>1.01-1.14</td>
<td>42.1</td>
<td>42.1</td>
</tr>
</tbody>
</table>
Periodic organic manuring, liming and additional run-off nutrient that improved primary productivity (308 and 533 mgC/m²/h) also enhanced the growth rate (Noriega-Curtis, 1979). Growth performance (Fig. 1) of all species improved with increase in water depth, probably due to less mutual competition for food and space that cause physiological stress (Wedemeyer, 1976) and relatively stable water quality (Mohanty, et al., 2001). Sinha and Ramachandran (1985) also reported that, under crowded condition, fish suffers stress due to aggressive feeding interaction, eat less and grow slowly. Further, in static ecosystem, prolonged exposure to dissolved oxygen below optimal level (>5.0 ppm) as in case of T1, suppress growth rate (Pillay, 1992). Growth performance of M. rosenbergii under different water depth conditions did not show any distinct variation as average daily growth rate ranged between 0.21 and 0.24 g. During 120 days of culture, post-larvae stocked at 0.04 g attained maximum growth of 28.9 g in T2 and survival rate of 60.5% in T4 under polyculture system. New (1988) reported that, post-larvae stocked at 0.06 g reached 28.2 g in 170 days and juvenile stocked at 0.5 g reached 54 g in 120 days under polyculture system, while survival rates are usually reckoned to be about 50% in most cases. However, in this experiment, survival rate increased with increase in water depth and average survival rate ranged between 42.1-60.5%. To minimize post-larval mortality and improve survival rate, stocking juveniles rather than post-larvae is preferable (Willis and Berrigan, 1977). Overall survival rate of fish was high at higher water depth, while in all treatments survival rate was low in case of C. catla and high in case of C. carpio. Low survival rate was, however, attributed by insufficient availability of natural food in the initial stage of rearing, increased ammonia level (0.16 - 0.29 ppm) due to increased nitrogen input from agricultural fields through run-off water, increased metabolic rate and organic load contributed by increased density and biomass. Condition factor (Ponderal index) of fish and prawn was less than 1.0 at the initial three weeks of rearing and improved thereafter with gradual improvement in water quality. Yield in terms of productivity (kg/ha/4 months) of fish and prawn was, however, lowest at T1 and significantly higher (p < 0.05)
at T₄ (Table 2), probably due to improved survival rate and water quality. With an increase in water depth by 20 cm (T₁-T₄) the productivity increased significantly (524.4 – 1051.3 kg/ha/120 days). However, the percentage increase in productivity reduced from 32% (T₁-T₂) to 20.5% (T₃-T₄) probably due to relatively higher survival rate and density-dependent growth.

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REFERENCES


