Strain performance of tilapia in freshwater prawn polyculture

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Abstract

Production performance of two tilapia (Oreochromis niloticus) strain viz. Chitratalada and GIFT (Genetically Improved Farmed Tilapia) in fish-prawn polyculture system was compared, and possible effect of tilapia inclusion in freshwater prawn (Macrobrachium rosenbergii) culture was evaluated in 120 days of grow-out phase. There were three treatments, i.e. only freshwater prawn as control (T1), prawn + Chitratalada (T2), and prawn + GIFT (T3) with three replications of each. Stocking densities for prawn juvenile was 30,000 ha⁻¹ in all the treatments and for both tilapia strains were 10,000 ha⁻¹. Floating feed containing 28% protein for tilapia and pelleted sinking feed for prawn were provided twice daily at a rate of 10-5% bw adjusted after each month of sampling. Water transparency was significantly lower (P<0.05) in treatment T1 with significantly higher chlorophyll-a content that increased with progression of time. Along with, plankton abundance was significantly higher (P<0.05) in T1 indicating prawn-tilapia mixed culture is better than traditional single species culture of prawn in terms of water quality management. Average individual weight, final weight, survival and production of prawn did not differ significantly (P>0.05) among the treatments. In case of tilapia, average individual weight was significantly higher in Chitratalada (254.22 g) than that of GIFT (201.52 g). However, survival of GIFT was significantly higher (92.50%) than that of Chitratalada (65.83%). Gross and net production of tilapia did not vary significantly. It was concluded that prawn-tilapia mixed culture is advantageous over traditional mono culture regarding production augmentation, and tilapia inclusion improving water quality.

Keyword: Chitratalada, GIFT tilapia, Strain, Freshwater prawn, Polyculture

Introduction

Increase of productivity through a more efficient utilization of the available natural food, is the most important aspect of polyculture (Hepher and Pruginin, 1981). Polyculture is the art of growing two or more compatible aquatic species with different feeding habits of spatial distribution together in a single waterbody (Zimmermann and New, 2000). In polyculture, combination of species that have different feeding niches increase overall production without a corresponding increase in the quantity of supplemental feed (Zimmermann and New, 2000). Thus, the system can improve water quality by creating a better balance among the microbial communities of the pond, resulting in enhanced production. Polyculture of tilapia (Oreochromis niloticus) in prawn pond is now one of the most important techniques and can be a source of extra income for the poor fish farmers. Prawn (Macrobrachium rosenbergii) polyculture has a potentially higher net return than prawn monoculture (Rouse and Stickney, 1982). Culture of prawn with fish also improves the ecological balance of the pond water, preventing the formation of massive algal blooms (Cohen et al., 1983; Uddin et al., 2006).

M rosenbergii is a benthophagic omnivore an excellent species for polyculture along with tilapia (Alam et al., 2001). Nile tilapia is omnivorous but feed predominantly on phytoplankton and can utilize blue-green algae (Beveridge and Baird, 2000). The attributes which makes Nile tilapia (O. niloticus) so suitable for fish farming are their general hardiness, great tolerance to adverse environmental conditions, ease of breeding, rapid growth rate, ability to efficiently convert organic and domestic wastes into high quality protein, and good taste (Pullin and Lowe-McConnell, 1982). Tilapia is considered as the most popular species of tilapia cultured around the globe (Ridha, 2011). For higher production, the GIFT (Genetically Improved Farmed Tilapia) strain was developed by the International Center for Living Aquatic Resources and Management (ICLARM) through several generation of selection from a base population involving eight different strains of Nile tilapia, Oreochromis niloticus (Eknath et al., 1993) and was imported in Bangladesh in the year 2005 (ADB, 2005). The Thai-Chitratalada strain introduced to the Royal Chitratalada Palace in Thailand in 1965 and originates from Egypt via Japan and this strain also performed parallel to other improved strain in grow-out (Yakupitiyage, 1998). Both the strains have higher potential to contribute in production augmentation in polyculture with the freshwater prawn.
Though, both the tilapia strains are stocked by the farmers for higher production in commercial purpose but they may perform differently with the similar culture environment and investment. Nevertheless, the performance of different tilapia strains was not evaluated in Bangladesh context. Similarly, it can be positively presumed that the culture of freshwater prawn for export market and tilapia in the same pond for household consumption may be an innovative option for fish farmers. Contrariwise, tilapia may exhibit negative impact on prawn survival that may hamper total production (Garcia-Perez et al., 2000; Uddin et al., 2006). Therefore, we compared the growth performance of GIFT and Chitralada in freshwater prawn culture system with a view to finding better performed strain, and simultaneously, we evaluated the effect of tilapia addition on prawn production performance.

Materials and Methods

Experimental design and site

The experiment was conducted in a completely randomized design into 3 treatments with 3 replications of each in 9 earthen ponds (80 m² each) at the Fisheries Field Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh for a period of 120 days from mid April to mid August 2009. Only prawn, prawn with GIFT and Prawn with Chitralada were stocked as treatment T1, T2 and T3, respectively. Stocking density of prawn was 30,000 h⁻¹ and tilapia as 10,000 h⁻¹ in all treatments. The ponds were fenced by fine meshed synthetic net to protect rodents and escaping of prawn. The water depth was maintained around 1 m, and two palm leaves were used as shelter of prawn juveniles in each pond.

Pond Preparation and stocking

All undesirable fishes were completely eradicated by drying of the ponds and aquatic weeds were removed manually. Lime (CaCO₃) was applied at a rate of 250 kg ha⁻¹ and fertilized 3 days after liming with urea and triple super phosphate (TSP) each at a rate of 25 kg ha⁻¹ after three days of liming. The juvenile of M. rosenbergii (0.715 g) were collected from Bangladesh Fisheries Research Institute, Mymensingh. Prawn juveniles were brought to the experimental site using plastic tanks equipped with aerators. The fry of Chitralada (0.90 g) were collected from a local hatchery at Kasinathpur, Pabna district and GIFT fry (0.89 g) were collected from local hatchery Agro-3 at Mymensingh district. In order to ensure the same age, fry of the same hatching date was collected and was transported to the experimental site through well-oxygenated air tight plastic bag.

Post stocking management

Floating feed for tilapia was provided 5 minutes before giving the sinking feed for prawn. Both were fed with pelleted feed containing 28% crude protein, daily at a rate of 10% of body weight for 1st month, 8% for 2nd month, 6% for the 3rd month and 5% of body weight for rest of the cultured period. Half of the required ration for a day was supplied in the morning and rest half in the evening. Feed requirement were calculated and adjusted after each sampling of prawn once in a month.

Water quality monitoring

The transparency of water was measured by a Secchi disc of 20 cm diameter. Water temperature and dissolved oxygen was recorded by digital dissolved oxygen (DO) meter (YSI MODEL 58). pH was measured by a direct reading pH meter (HACH) at the pond site. Plastic bottles with stopper having a volume of 250 ml each and marked with pond number were used for collection of water samples. Water samples were collected by using a sampler designed in a manner that it was representative to all layers of the water column (vertical haul of the tube sampler covering about 1 m depth). Then the samples were transferred to the laboratory and 100 mL of water from each bottle was filtered through a glass microfibre filter paper (Whatman GF/C) with the help of an electric air pump for nutrient and chlorophyll-α analyses. Total alkalinity was determined using the titrimetric method (Stirling, 1985). Chlorophyll-α was determined using a spectrophotometer (Milton Roy Spectronic, Model 1001 plus, Rochester, NY, USA) after acetone extraction (Boyd, 1982). Nutrient analyses were performed using a HACH kit (model DR 2010, HACH, Loveland, CO, USA a direct reading spectrophotometer). Total alkalinity was determined by acid titration following Stirling (1985).
For plankton samples, ten litres of water was sampled monthly from five different locations of each pond and filtered through a 25 mm meshed plankton net. Each filtered sample was transferred to a measuring cylinder and made up to a standard volume of 50 mL with distilled water and buffered formalin (10%), and preserved in a sealed plastic bottle until analysis. Plankton was counted using a Sedgewick Rafter counting cell (S-R cell) under a binocular microscope (Olympus, M-4000D, Tokyo, Japan) following Stirling (1985). The quantitative estimation of plankton was done using the following (Stirling, 1985) equation:

\[ N = \frac{(A \times 1000 \times C)}{(V \times F \times L)} \]

Where, \( N \) = Number of plankton cells or units per liter of water, \( A \) = Total number of plankton counted, \( C \) = Volume of final concentrate of the sample in ml, \( V \) = Area of field (mm\(^2\)), \( F \) = Number of fields counted, \( L \) = Volume of original water in liter.

Tilapia and freshwater prawn was sampled monthly using seine net to assess their growth and health condition. At least 10 prawns from each pond were taken to make assessment of growth trends and to readjust feeding rate. Length and weight of prawn and sampled fish were measured using a measuring scale and digital electronic balance (OHAUS, MODEL No. CT-1200-S). Prawn and tilapia were handled carefully to avoid stress during sampling.

**Final harvesting of prawn and tilapia fish**

At 120\(^{th}\) day of stocking, water was pumped out from the ponds and all prawns and tilapias were harvested, weighed by an electronic balance and measured by a measuring scale. Weight gain per fish was calculated by deducting the average initial weight from the average final weight. The net production of each species was calculated by deducting stocked biomass from gross production (harvested biomass). Specific growth rate (SGR) was estimated as:

\[ \text{SGR} = \left[ \ln (\text{final weight}) - \ln (\text{initial weight}) \right] \times 100 / \text{culture period (days)}. \]

Survival rate of prawn and fish was calculated by the following formula:

Survival (%) = (No. of harvested individual/ No. of stocked individual) \times 100

**Statistical analysis**

For the statistical analysis, significant variation among the means of the treatments were compared and determined through descriptive one-way analysis of variance (ANOVA) using the SPSS (Statistical Package for Social Science, version-16.0) and post-hoc analysis was done by Duncan Test. Independent two tailed t-test was performed to analyze the growth and production performance of tilapia. Significance was assigned at 0.05% level.

**Results and Discussion**

**Water quality parameters**

The mean values of each water quality parameter in different treatments are presented in Table 1. The mean values of water temperature were 30.66±0.15, 30.68±0.17 and 30.69±0.18 °C in treatment T\(_1\), T\(_2\) and T\(_3\), respectively (Table 1). New (2000) stated that the optimum temperature range for M. rosenbergii is between 26 and 32 °C. Temperature of pond water was found to be more or less similar in different treatments and was within suitable range (21.9°C to 33.5°C) for prawn culture described by Fair and Foftner (1981). Water transparency was significantly lower in T\(_1\) and followed decreasing pattern due to the absent of plankton feeding tilapia. Monthly variation in transparency among treatments is shown in the Fig. 1 and the linear regression analysis depicts monthly decreasing pattern of transparency in T\(_1\). The mean values of water transparency of treatments T\(_1\), T\(_2\) and T\(_3\) were 29.67±1.81, 35.67±0.81 and 35.93±0.97 cm, respectively (Table 1). Transparency reading is about 20-30 cm indicating that water body is productive (Boyd, 1990). Wahab et al. (1995) reported that the transparency of productive water bodies should be 40 cm or less.
Means with the different superscripts in same row are significantly different (P< 0.05)

Table 1. Mean (±SE) water quality parameters as obtained under three treatments.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments</th>
<th>F-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>T1 30.66±0.15</td>
<td>0.006</td>
<td>NS</td>
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<tr>
<td></td>
<td>T2 30.68±0.17</td>
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<td></td>
<td>T3 30.69±0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transparency (cm)</td>
<td>T1 29.87±1.81ab</td>
<td>7.202</td>
<td>*</td>
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<tr>
<td></td>
<td>T2 35.67±0.81ab</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>T3 35.93±0.97ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen (mg l⁻¹)</td>
<td>T1 4.76±0.08</td>
<td>0.202</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>T2 4.83±0.09</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>T3 4.82±0.08</td>
<td></td>
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<tr>
<td>pH</td>
<td>T1 7.62±0.14</td>
<td>0.653</td>
<td>NS</td>
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<td></td>
<td>T2 7.42±0.11</td>
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<td></td>
<td>T3 7.55±0.13</td>
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<tr>
<td>Alkalinity (mg l⁻¹)</td>
<td>T1 50.00±3.53</td>
<td>1.118</td>
<td>NS</td>
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<tr>
<td></td>
<td>T2 57.60±3.42</td>
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<tr>
<td></td>
<td>T3 56.53±3.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₃ (mg l⁻¹)</td>
<td>T1 0.027±0.0035ab</td>
<td>2.964</td>
<td>*</td>
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<tr>
<td></td>
<td>T2 0.018±0.0022ab</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>T3 0.020±0.002b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PO₄ (mg l⁻¹)</td>
<td>T1 0.970±0.284</td>
<td>0.115</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>T2 1.179±0.401</td>
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<tr>
<td></td>
<td>T3 1.191±0.398</td>
<td></td>
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<tr>
<td>Chlorophyll-α (µg l⁻¹)</td>
<td>T1 0.0898±0.008a</td>
<td>5.492</td>
<td>*</td>
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<tr>
<td></td>
<td>T2 0.063±0.007b</td>
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<tr>
<td></td>
<td>T3 0.058±0.007b</td>
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</table>

Means with the different superscripts in same row are significantly different (P< 0.05)

The dissolved oxygen (DO) concentrations under different treatments were found to fluctuate from 4.45 to 5.44, 4.88 to 5.65 and 4.50 to 5.45 mg l⁻¹ in treatment T₁, T₂ and T₃, respectively. The mean values of dissolved oxygen concentration in treatments T₁, T₂ and T₃ were 4.76± 0.08, 4.83±0.09 and 4.82±0.08 mg l⁻¹ respectively. There was no significant difference (P> 0.05) among the treatments in terms of DO.

Kunda et al. (2008) found dissolved oxygen level ranged from 5.98 to 6.53 mg l⁻¹ in freshwater prawn polyculture.

The circum-neutral pH or slightly alkaline pH is most suitable for fish culture that range from 6.8 to 8.4 (Hossain et al., 2000). Tilapia seems to grow best in neutral or slightly alkaline water. pH values fluctuated from 7.0 to 7.9, 6.7 to 7.6 and 7.0 to 7.8 in treatment T₁, T₂ and T₃, respectively (Table 1). Mean values of pH were 7.6 ± 0.14, 7.4 ± 0.11 and 7.5 ± 0.13 in treatment T₁, T₂ and T₃, respectively. There was no significant difference (P> 0.05) among the treatments in terms of pH.

According to Boyd (1982) total alkalinity should be more than 20 ppm in fertilized ponds. Mean values of total alkalinity were 50.00±4.40, 57.60±3.42 and 56.53±3.78 mg l⁻¹ in treatment T₁, T₂ and T₃, respectively. The highest value of total alkalinity was 64.93 mg l⁻¹ in T₂ and the lowest value was 32 mg l⁻¹ in T₁. Waterbodies having total alkalinity 40 ppm or more are considered more productive than waterbodies of lower alkalinity (Mairs, 1966). The ranges of NO₃-N were found to vary from 0.010 to 0.035, 0.00 to 0.023 and 0.010 to 0.025 mg l⁻¹ in treatments T₁, T₂ and T₃, respectively. The mean values of NO₃-N in ponds under treatments 1, 2 and 3 were 0.027±0.004, 0.018±0.002 and 0.020±0.002 mg l⁻¹ respectively. Concentration of NH₃ was significantly higher in T₁ than the other two treatments presumably due to lack of utilization by only a single species. Nitrate can accumulate in production systems without affecting fish growth (Heinsbroek and Kamstra et al., 1990) and tilapias can tolerant nitrate concentration of up to 0.45 mg l⁻¹ (Chervinski, 1982). The PO₄-P concentration ranged from 0.22 to
2.045 mg l\(^{-1}\) with the mean values of 0.971±0.284, 1.179±0.402 and 1.191±0.398 mg l\(^{-1}\) in T\(_1\), T\(_2\) and T\(_3\), respectively. There was no significant difference \((P>0.05)\) among treatments when ANOVA was performed.

Chlorophyll-\(\alpha\) (\(\mu g\ l\(^{-1}\)) value is an indicator of pond productivity shows an inverse relationship with water transparency (Ahmed, 1993). The level of chlorophyll \(\alpha\) varied considerably throughout the experimental period, ranging from 0.011 to 0.107, 0.022 to 0.078 and 0.010 to 0.073 \(\mu g\ l\(^{-1}\) in treatments T\(_1\), T\(_2\) and T\(_3\), respectively. Concentration of chlorophyll-\(\alpha\) were significantly higher in treatment T\(_1\), than in T\(_2\) and T\(_3\). In the treatment T\(_1\), chlorophyll-\(\alpha\) concentration increased with progression of time indicate prawn could not utilize all the phytoplankton and unutilized nutrient supported phytoplankton growth. Moreover, tilapia filters algae from the water column (Dempster \textit{et al.}, 1995). This was supported by significantly higher abundance of phytoplankton cells in treatments T\(_1\), T\(_2\) and T\(_3\), respectively. Concentration of chlorophyll-\(\alpha\) were significantly higher in treatment T\(_1\), than in T\(_2\) and T\(_3\). In the treatment T\(_1\), chlorophyll-\(\alpha\) concentration increased with progression of time indicate prawn could not utilize all the phytoplankton and unutilized nutrient supported phytoplankton growth. Moreover, tilapia filters algae from the water column (Dempster \textit{et al.}, 1995). This was supported by significantly higher abundance of phytoplankton cells in treatments T\(_1\), T\(_2\) and T\(_3\), respectively. The monthly variations of chlorophyll-\(\alpha\) concentration under three treatments are shown in Fig. 2; the trend line is the linear regression line between respective sampling date and chlorophyll-\(\alpha\) concentration \((R^2=0.7832)\) in T\(_1\) that clearly depicts decreasing pattern. But this pattern was not observed in other two treatments.

![Graph showing monthly variation of Chlorophyll-\(\alpha\) among different treatments.](image)

\[y = 0.0097x + 0.0606\]
\[R^2 = 0.7832\]

**Fig. 2.** Monthly variation of Chlorophyll-\(\alpha\) among different treatments. The increasing trend of the relationship between progressive sampling time and transparency is shown as linear regression line for T\(_1\) \((R^2=0.7832)\)

\textbf{Plankton and benthos study}

Mean abundance of plankton and benthos in different treatments are shown in Table 2. The mean abundance of total phytoplankton was 34633 ± 2409 indiv. l\(^{-1}\) in T\(_1\), 27833 ±1767 indiv. l\(^{-1}\) in T\(_2\) and 26367±2137 indiv. l\(^{-1}\) in T\(_3\). Statistical analyses showed phytoplankton was significantly more abundant in prawn monoculture pond. Therefore, tilapia inclusion reduced plankton population in prawn–tilapia culture system. Nile tilapia ingests phytoplankton and can assimilate 70-80% of blue green algae which are hydrolyzed by acid digestion in the stomach (Moriarty, 1997; Bowen, 1982). The mean zooplankton concentration was 4633 ± 418, 4167 ± 438 and 4067 ± 642 indiv. l\(^{-1}\) in T\(_1\), T\(_2\) and T\(_3\), respectively. There was no significant difference \((P>0.05)\) among the treatments in terms of zooplankton abundance. Benthos population of the fish ponds was composed of four major groups: Chironomidae, Oligochaeta, Molluska and Miscellaneous.
Means with the different superscripts in same row are significantly different (P<0.05)

Performance of prawn

The growth rate and yield of prawn in different treatments are shown in Table 3. Survival of prawn in different treatments varied from 60%, 65% and 67.64% in treatments T1, T2 and T3 and did not vary significantly. Among the three treatments, the net production of prawn was higher in T3 (263.13±28.64 kg ha⁻¹/120 days) than T1 (251.06±23.74 kg ha⁻¹/120 days) and T2 (250.04±8.83 kg ha⁻¹/120 days) respectively. Mean individual weight of prawn was 14.36±0.09, 13.23±0.04 and 13.26±0.03 in treatments T1, T2 and T3, respectively (Table 3). Therefore, tilapia inclusion in prawn pond had no negative effect on prawn culture it might be due to in a polyculture setting, tilapia and prawn can utilize different niches in the culture setting. Tilapia can filter feed on phytoplankton and zooplankton in the upper water column but prawn spend most of the time in the bottom substrate and on the detritus settling from above.

Table 3. Comparison of Production performance (Mean±SE) among three treatments. Means with the different superscripts in same row are significantly different (P<0.05). The independent samples two tailed t-test was performed for comparing production performance of two tilapia strains

<table>
<thead>
<tr>
<th>Species &amp; Parameter</th>
<th>Prawn (T1)</th>
<th>Prawn and Chitralada (T2)</th>
<th>Prawn and GIFT (T3)</th>
<th>t-test</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tilapia performance</strong></td>
<td></td>
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<tr>
<td>Mean initial stocking weight (g)</td>
<td>0.727</td>
<td>0.725</td>
<td>0.725</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Survival (%)</td>
<td>60</td>
<td>65</td>
<td>67.64</td>
<td>0.276</td>
<td></td>
</tr>
<tr>
<td>Mean final body weight (g)</td>
<td>14.36±0.03</td>
<td>13.23±0.68</td>
<td>13.26±0.56</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td>SGR (% body weight day⁻¹)</td>
<td>2.48</td>
<td>2.41</td>
<td>2.38</td>
<td>0.409</td>
<td></td>
</tr>
<tr>
<td>Gross production (kg ha⁻¹)</td>
<td>258.33±23.83</td>
<td>257.29±8.87</td>
<td>270.29±28.65</td>
<td>0.657</td>
<td></td>
</tr>
<tr>
<td>Net production (kg ha⁻¹)</td>
<td>251.06±23.74</td>
<td>250.04±8.83</td>
<td>263.13±28.64</td>
<td>0.676</td>
<td></td>
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<tr>
<td><strong>Combine production performance</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross production (kg ha⁻¹)</td>
<td>258.33±23.83</td>
<td>1935.5±153.52</td>
<td>2134.45±54.05</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>Net production (kg ha⁻¹)</td>
<td>251.06±23.74</td>
<td>1919.33±153.48</td>
<td>2118.38±54.12</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

Performance of Chitralada and GIFT

Survival rate of GIFT tilapia was significantly higher (P<0.05) (92.50%) than that of Chitralada (65.83%) might be due to less transportation stress which also helped to gain the highest gross and net production of tilapia. Cebreros et al. (2013) observed, for tilapia, the highest survival was 94% and the lowest was 75%, while prawns had final survival rates from 43% to 86% (Table 3). The specific growth rate (SGR) of GIFT tilapia was significantly lower (P<0.05) in T3 (4.52% of bw day⁻¹) than that of Chitralada in T2 (4.70% of bw day⁻¹). Average individual weight of Chitralada (254.22 g) was significantly higher than GIFT (201.52 g) presumably due to more genetically improved species and more environmental friendly. The highest gross and net production of tilapia was found in GIFT (1864.17 kg ha⁻¹/120 days and 1855.24 kg ha⁻¹/120 days) than Chitralada (1678.25 and 1669.25 kg ha⁻¹, respectively). The yields were not significantly
different between the treatments. The mean weight of Chitratalada was found 557.20 g and performed better than Red-stirling tilapia (Moreira et al., 2005). Similarly, no significant differences were found in grown and reproductive traits between Chitratalada and GIFT tilapia (Bhujel, 2000; Yakupitiyage, 1998). Therefore, it may be concluded that the production performance between Chitratalada and GIFT tilapia did not indicate significance difference but higher individual weight can be achieved from Chitratalada and if transport stress can be minimized that would reduce mortality and increase production significantly.

The gross and net combine production of prawn and tilapia among the treatments (Table 3) were 258.33 kg ha$^{-1}$ and 251.06 (T$_{1}$), 1935.5 kg ha$^{-1}$ and 1919.33 kg ha$^{-1}$ (T$_{2}$), and 2134.45 kg ha$^{-1}$ and 2118.38 kg ha$^{-1}$ (T$_{3}$). Prawn-tilapia polyculture increases total yield of fish and prawns (Garcia-Perez et al., 2000). Anggawa (1999) reported that yields of shrimp increased when tilapia were stocked into existing shrimp ponds. Polyculture of freshwater prawn with Nile tilapia was found successful (Mires, 1987) in terms of yield and income in a six months culture period. Cannibalism was only among prawns, which was not influenced by the presence of tilapia, and interactions were intra-specific in the polyculture systems. It was concluded that, prawn-tilapia mixed culture is better than traditional mono-culture of prawn and the performance of GIFT and Chitratalada with prawn were not significantly different, but better individual weight can be gained from Chitratalada by reducing transport stress.

**Conclusion**

The addition of tilapia in prawn pond benefited the freshwater prawn culture practices through (1) reducing exaggerating phytoplankton in waterbody (2) enhancing the utilization of natural foods in the form of plankton, periphyton, microbial organisms (3) enhancing water quality (4) improving survival, production and economic benefit. In a polyculture setting, tilapia and prawn can utilize different niches in the culture setting. Polyculture of prawn improved the ecological balance of the pond water, preventing the formation of massive algal bloom. Further research on the optimization of stocking densities of prawn and tilapia species is required to be emphasized based on improved strain for sustainable tilapia prawn aquaculture.

**References**


Strain performance of tilapia


