# INCREASED STOCKING DENSITY OF GIANT FRESHWATER PRAWN (*Macrobrachium rosenbergii*, de Man 1879) POSTLARVAE IN HAPA NETS WITH DIFFERENT SUBSTRATE POSITIONS

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***Abstract***

*Decapod crustaceans is vulnerable to different environmental fluctuations. Thus, a variety of farming systems have been made by shrimp growers to solve these problems. This study assessed the survival, growth rate and interaction effect of stocking density and substrate positions of giant freshwater prawn (Macrobrachium rosenbergii, de Man 1879) postlarvae when cultured in experimental framed hapa net installed in pond for 90 days. Three stocking densities were used in different substrate positions in 3 replicates stocked in 27 framed hapa nets. Results revealed lowest stocking density apparently showed better growth and bigger prawns compared to higher stocking density. Further, the mean growth of the commodity, size class distribution were significantly influenced by the stocking density. Survival rate, on the other hand, favored lower stocking density. No interaction effect among treatments was observed. Feed Conservation Ratio (FCR) improved with low stocking density. Moreover, densities of 20 pieces/m$^3$ favored the better growth and survival rate of M. rosenbergii even with or without substrates. Shorter culture period affected the production yield.*

***Keywords:*** *framed hapa net culture, giant freshwater prawn, Macrobrachium rosenbergii*

## 1.0 Introduction

Decapod crustaceans farming utilizes a variety of farming systems since they are greatly affected by different environmental fluctuations. Thus, variations of the different farming systems have been made by shrimp growers to solve their problems (Corre, 1993). This study aims to assess the survival, growth rate and interaction effect of giant freshwater prawn (*Macrobrachium rosenbergii*, de Man 1879) postlarvae when cultured in experimental framed hapa net installed in pond for 90 days. This giant freshwater prawn is locally known as "ulang" in Visayan term is found in the Indo -pacific region and it is a popular freshwater food in Africa, Asia, South America, Pacific countries, Central & North America (New, 1995).

For the past two decades, the culture of giant freshwater prawn spread quickly as an alternative to shrimp culture due to the decline of the shrimp industry. From 1993-2002, the world production of giant freshwater prawn increased from 17,000 to 195,000 tons. In 2008, the Philippines made it to the top 15 producers of this species. In recent years, however, new environment-friendly shrimp farming technologies have been achieved, particularly by Southeast Asian Fisheries Development Center–Aquaculture Department (SEAFDEC-AQD) in Binangonan Freshwater Station at



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Binangonan, Rizal Province (Fernandez, 2002). They have embarked again in the research of the freshwater prawn since the government is stanch in alleviating the poverty and hunger of Filipino people by improving and utilizing our fisheries own commodity, by establishing a hatchery produced seedlings and by conducting a research to improve the survival thus, inviting more fish farmers to venture the culture of this giant freshwater prawns.

Freshwater prawn was not considered by the fish farmers of Surigao del Sur for culture due to low survival rate and the scarcity of seedlings coming from the wild and hatchery produced. It is been said that production yield is affected by the intensity of stocking density. Thus, this study explored on another farming system innovations to the survival, growth rate and interaction effect of giant freshwater prawn (*Macrobrachium rosenbergii*, de Man 1879) post-larvae when cultured in experimental framed hapa net installed in pond for 90 days.

With the recent call of the government in stanch of alleviating the poverty and hunger of Filipino people, this study would be beneficial since it explored prawn farming innovations that is a major source of improving productivity and economic growth throughout and emerging economies.

## 2.0 Research Design and Methods

Giant freshwater prawn (*M. rosenbergii*) postlarvae was obtained from the Bureau of Fisheries and Aquatic Resources - Regional Fisheries Research and Development Center for Freshwater (BFAR-RFRDC)- Nabunturan, Compostela Valley Province. These postlarvae were packed in polyethylene plastic bag with oxygen and placed inside the Styrofoam box and transported to the study station. The postlarvae were acclimatized and temporarily stocked in hapa net that was already installed in a freshwater pond at Surigao del Sur State University-Lianga Brackishwater Fish Farm. The prawn remained for seven days intended for conditioning purposes to ensure that animal samples included in the study were healthy. The experiment was conducted from February to May 2013.

Postlarvae were stocked in 27 experimental framed hapa nets (fig. 1) with the dimension of 1m Length x 1m Width x 1.1m Height consisting of three stocking densities of 20 ($T_1$), 30 ($T_2$) & 40 ($T_3$) pieces/ $m^3$ with three replicates at different substrate positions.

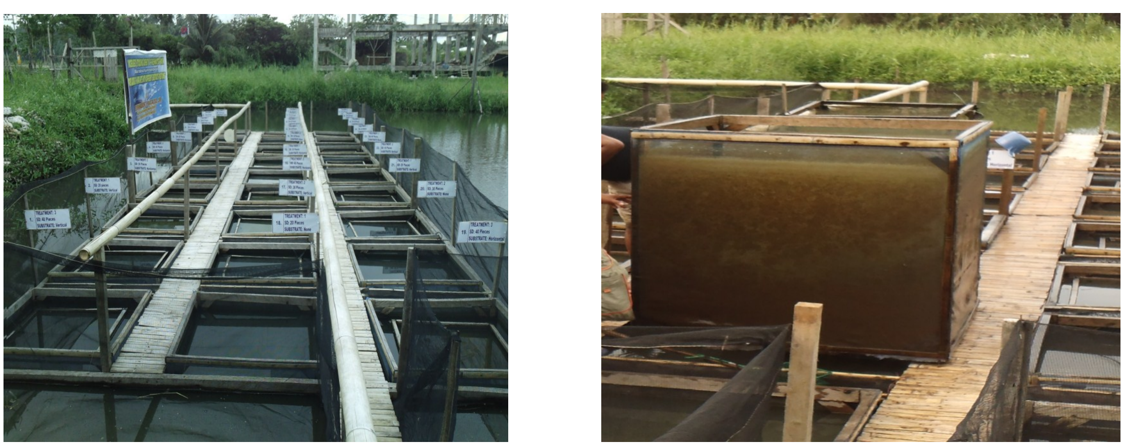

Figure 1. Set-up and the experimental framed hapa net

**(a)** **(b)**

Figure 2. The horizontal (a) and vertical (b) substrate

These stocking densities were categorized as semi-intensive to intensive culture system. The treatments and each replicates utilized the non-substrate, vertical and horizontal substrate positions (fig. 2). Mortalities due to stress and environmental changes were replaced within 10 days from stocking.

The prawns were given commercial feed in two (50-50%) to three feeding (30-30-40%) frequencies daily. Feeding rate tapered down from 10% to 5% until the duration of the study was satisfied. Feeding time was at 8 am and 4 pm for two feedings while 8 and 10 am and 4 pm for the three feedings a day. The daily feed ration was divided into two and three in order to avoid wastage of feed given to the animals. Water quality was monitored twice a day at 8:00 a.m. and 4:00 p.m. for the entire duration of the study. Thermometer was used to determine the water temperature while pH meter for acidity and alkalinity. A Secchi disc was also used to determine the transparency of the water.

Analysis of Variance (ANOVA) of two-way analysis in randomized complete block design was used to compare the effect of the 3 stocking densities ($T_1$-20 pieces/m$^3$, $T_2$-30 pieces/m$^3$ and $T_3$-40 pieces/m$^3$) using the different substrate positions (non-substrate, vertical and horizontal) on the growth, survival and the interaction effect between factor A and B. DMRT was used to determine differences among treatment means. Survival percentage was transformed into arcsine before ANOVA.

## 3.0 Results and Discussions

Tabular data on the effect of the stocking densities using different substrate positions on the average body weight and estimated average yield are presented in tables 1-2 respectively.

The tabular data shows that $T_1$ obtained the highest ABW and the least ABW are obtained by $T_3$. Moreover, extrapolated yield of the prawns in this culture shows that highest production yield is obtained by those having a highest stocking density with 938.96 grams/m$^3$/year which has a difference of 182.96 grams/m$^3$/year of the gained yield of the lowest stocking at 756 grams/m$^3$/year. However, the average body weight of highest stocking density of 4.81 grams is lower compared to the lowest stocking density of 6.75 grams.

Growth of *M. rosenbergii* at high densities may be affected due to many prawns which are in close contact with Blue

Table 1. Average body weight (ABW) of *M. rosenbergii* PL at increased stocking densities using different substrate positions

| **Treatments pieces/m³** | **Replicates** | **Average Body Weight (g) Substrate Positions** | | | $\bar{x}$ (g) |
|---|---|---|---|---|---|
| | | **NS** | **V** | **H** | |
| 20 | 1 | 6.89 | 7.39 | 6.48 | |
| | 2 | 6.60 | 7.13 | 6.45 | |
| | 3 | 6.79 | 6.32 | 6.69 | |
| | **Average** | **6.76** | **6.95** | **6.54** | **6.75** |
| 30 | 1 | 6.43 | 5.87 | 5.44 | |
| | 2 | 5.72 | 5.30 | 6.86 | |
| | 3 | 5.50 | 5.75 | 5.79 | |
| | **Average** | **5.88** | **5.64** | **6.03** | **5.85** |
| 40 | 1 | 3.88 | 4.61 | 4.90 | |
| | 2 | 5.05 | 4.84 | 4.52 | |
| | 3 | 5.25 | 5.23 | 5.01 | |
| | **Average** | **4.73** | **4.89** | **4.81** | **4.81** |

Table 2. Estimated average yield of *M. rosenbergii*

| **Stocking Densities Pieces/m³** | **Production Yield** | |
|---|---|---|
| | (grams/m³/cropping) | (grams/m³/year) |
| 20 | 378.00 | 756.00 |
| 30 | 456.30 | 912.60 |
| 40 | 469.48 | 938.96 |

Claw (BC) males, which inhibit their growth. This result is further supported by the study of New (1988), wherein he stressed out that yield increases with increasing prawn stocking density, to an optimum level, but average size is inversely related. Marketable yield was even more markedly favored by the lowest stocking density tested.

Analysis of variance (ANOVA) which is shown in table 3 reveals that there is no significant difference on the growth of *M. rosenbergii* in the 3 different substrate positions (Factor A) being used. However, the growth of *M. rosenbergii* reveals a significant difference between the three stocking density. Specifically, $T_1$ (20 pieces/m³) differed significantly from the other 2 treatments ($T_2$-30 pieces/m³ and $T_3$-40 pieces/m³).

The results show a non-significant interaction of the prawn being tested when using the different substrate positions in an increased stocking densities, indicating that the data difference representing the different substrate position was not significantly affected by the increased stocking densities being applied and that the effect of increased stocking densities did not differ significantly with the different substrate position tested in relation to the growth of *M. rosenbergii.* The growth curve of both treatment 1, 2 and 3 shows a constant weight increment from the start of the culture and noticeably on day 75, treatment 1 exhibited slightly higher compared to treatments 2 and 3 but decreased a bit during the last phase of the culture (fig. 3).

Table 3. ANOVA on the final mean weight of *M. rosenbergii* at increased stocking densities with different substrate positions

| Source of Variation | Degrees of Freedom | Sum of Squares | Mean Sum of Squares | Computed F | Tabular F |
|---|---|---|---|---|---|
| Replications | 2 | 0.02 | 0.01 | 0.42ns | 3.63 |
| Treatments | 8 | 17.47 | 2.18 | 9.08* | 2.59 |
| DSP (A) | (2) | 0.01 | 0.005 | 0.021ns | 3.63 |
| **St D (B)** | **(2)** | **16.95** | **8.48** | **35.33*** | **3.63** |
| A x B | (4) | 0.51 | 0.13 | 0.54ns | **3.01** |
| Error | 16 | 3.83 | 0.24 | | |
| Total | 26 | 21.32 | | | |

cv = 8.45%
* = significant
ns = not significant

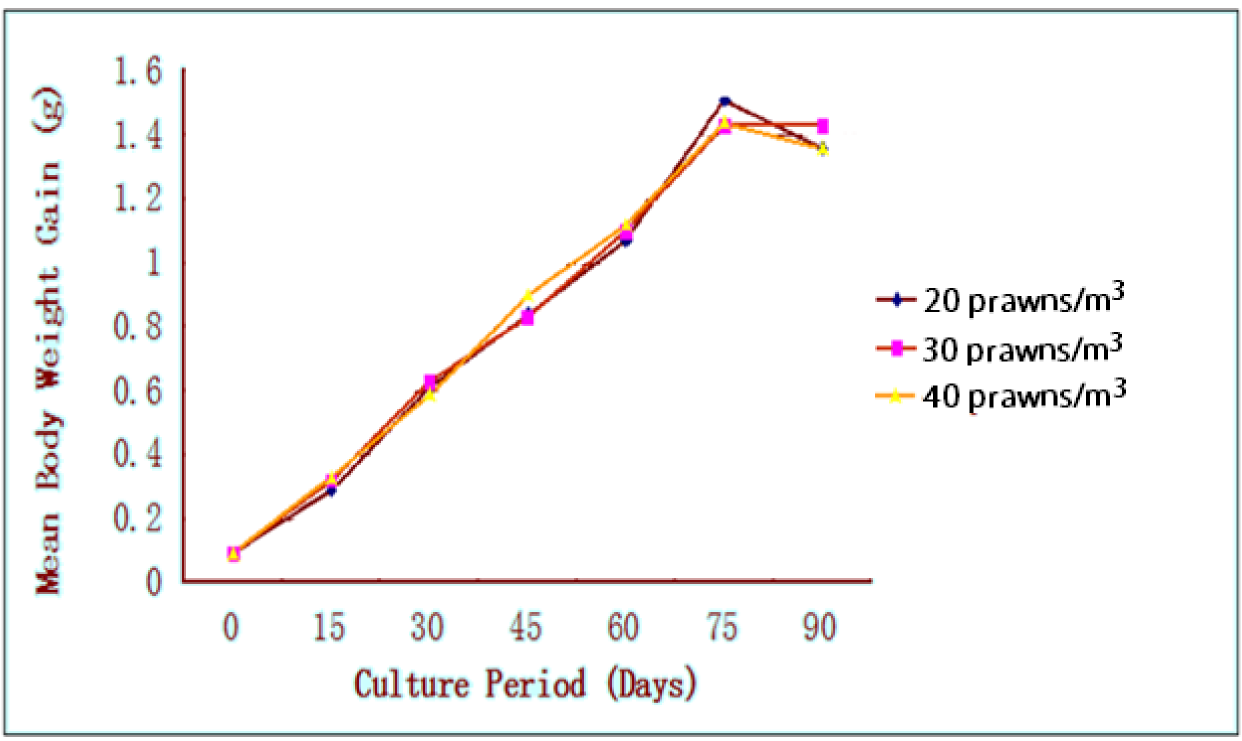


Figure 3. Weight gain curve of *M. rosenbergii* at increased stocking densities with different substrate positions

According to New (2002), the growth of prawns is anchored by sexual dimorphous. As observed, growth rates between the male and female was inhibited in the presence by the latter but not *vice versa*. Further, the mean weights of the prawn after 3 months of culture are slightly lower than those obtained by Cuvin-Aralar, et. al. (2007), although the culture in their study was five (5) months and the stocking density is ranging from 15 up to 90 prawns per $m^2$ and the mean weight at harvest ranged from 26.3 to 14.3 grams from the lowest to the highest stocking density.

Another variable that was measured in this study is the mean survival rate of the *M. rosenbergii* of which results is presented in table 4.

Table 4. Mean survival rate of *M. rosenbergii* PL in hapa net with different substrate positions within 90 days of culture

| **Treatments pieces/m³** | **Replicates** | **Different Substrate Positions** | | | $\overline{x}$ (%) of Prawn Density |
|---|---|---|---|---|---|
| | | **NS (%)** | **V (%)** | **H (%)** | |
| 20 | 1 | 100.00 | 80.00 | 85.00 | |
| | 2 | 100.00 | 95.00 | 95.00 | |
| | 3 | 95.00 | 95.00 | 95.00 | |
| | **Average** | 98.33 | 90.00 | 91.68 | **93.33** |
| 30 | 1 | 86.67 | 83.33 | 96.67 | |
| | 2 | 83.33 | 90.00 | 90.00 | |
| | 3 | 83.33 | 83.33 | 86.68 | |
| | **Average** | 84.44 | 85.55 | 91.12 | **87.04** |
| 40 | 1 | 85.00 | 77.50 | 82.50 | |
| | 2 | 75.00 | 92.50 | 92.50 | |
| | 3 | 75.00 | 70.00 | 80.00 | |
| | **Average** | 78.33 | 80.00 | 85.00 | **81.11** |
| $\overline{x}$ (%) of Prawn Density | | **87.03** | **85.18** | **89.27** | |

Results show that survival rate was highest in lower stocking density. This only implies that test organism in lower stocking density have enough space compared to higher densities which in turn may lessen cannibalism. This finding is supported by Smith and Sandifer (1975) as cited by Nair, et al., (1996) which mentioned that *M. rosenbergii* is aggressive and cannibalistic when reared at high densities. They added that low stocking rate could be suggested as a possible means to reduce cannibalism.

On the other hand, treatment with different substrate positions, survival rate is the highest at horizontal substrate compared to vertical and non-substrate. One of the plausible reasons for this is that horizontal position increases the space and the test organism is on at rest position and it's not really prone to cannibalism compared to vertical position wherein they just only cling to the substrate. Meanwhile, survival rate respective to the number of days of culture reveals in fig. 4 shows that high survival rate takes place among the three treatments and its replicates during the entire culture period. This may be attributed to the shorter span of culture period which limits the test organisms to be exposed to stress and environmental fluctuations that might be a factor to mortalities of prawns. Additionally, the periodic cleaning of hapa nets also contributed in maintaining a healthy environment of the prawns.

The present survival rate result of this study is higher compared to the result of the 5 months culture of *M. rosenbergii* in cage of Curvin- Aralar et al., (2007). The survival of their cultured organisms ranging from 55.3% to 36.9% for 15 to 90 prawns $m^2$. Their findings are explained that the culprit beyond the lower survival rate was brought by mortalities from stress due to frequent sampling in monitoring its growth and survival rate from month to month and through improved methodology by reducing its sampling once a month.

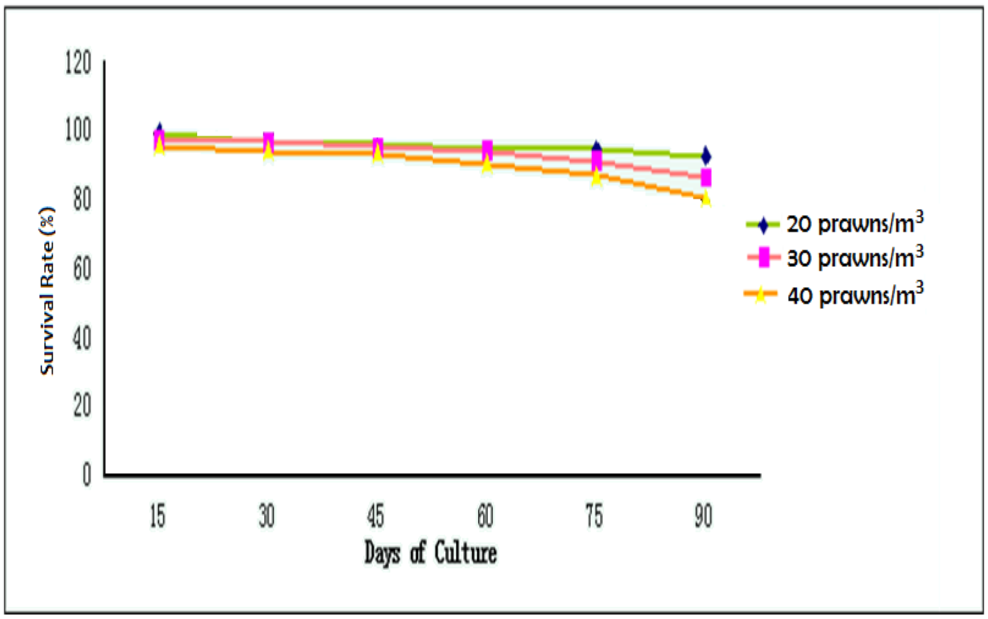


Figure 4. Survival rate of *M. rosenbergii* at increased stocking densities with within 90 days of culture

ANOVA shown in table 5 reveals that the provision of different substrate positions (Factor A) for the survival of *M. rosenbergii* postlarvae is not significantly different from each other. However, stocking densities (Factor B), on the survival of the cultured prawn shows a significant difference between the 3 treatments. Furthermore, the lower the stocking density per cubic meter favored the better survival rate. The result show a non-significant interaction between substrate positions and stocking densities. It implies that the survival rate of the giant freshwater prawn was not directly affected by both stocking densities and different substrate positions.

In terms on the effect on the test organisms' size, results are presented in fig. 5. The size distribution differs significantly among the stocking densities. It can be observed that most of the prawn in lower stocking density ($T_1$-20 prawn/$m^3$) has lower size distributions compared to higher density ($T_2$-30 prawn/$m^3$ and $T_3$-40 prawn/$m^3$). Further, most of the prawn sizes is within the range of 7.0-9.9 cm.

Table 5. ANOVA on the survival rate of *M. rosenbergii* PL in hapa nets with different substrate positions

| Source of Variation | Degrees of Freedom | Sum of Squares | Mean Sum of Squares | Computed F | Tabular F |
|---|---|---|---|---|---|
| Replications | 2 | 138.79 | 69.40 | $2.18^{ns}$ | 3.63 |
| Treatments | 8 | 1,153.63 | 144.20 | 4.54* | 2.59 |
| DSP (A) | (2) | 75.25 | 37.63 | $1.18^{ns}$ | 3.63 |
| **St D (B)** | **(2)** | **738.48** | **368.24** | **11.59*** | **3.63** |
| A x B | (4) | 341.90 | 85.48 | $2.69^{ns}$ | 3.01 |
| Error | 16 | 508.37 | 31.77 | | |
| Total | 26 | 1,800.79 | | | |

cv = 7.99%
* = significant
ns = not significant

Moreover, the mean length of the prawn *M. rosenbergii* respective to the different substrate positions (table 6) are observed to be inversely related, that is, lower stocking density obtain higher mean length while the higher stocking density the lower its mean length. This may be due to less prawns stocked per cubic meter of water (fig. 3).

To determine the significant relationship and interaction effect of the different substrate positions (Factor A) for the mean length of *M. rosenbergii* postlarvae, ANOVA result is not significantly different from each other (table 7). It signifies that the length of freshwater prawn is not mainly affected by the presence of different substrate positions.

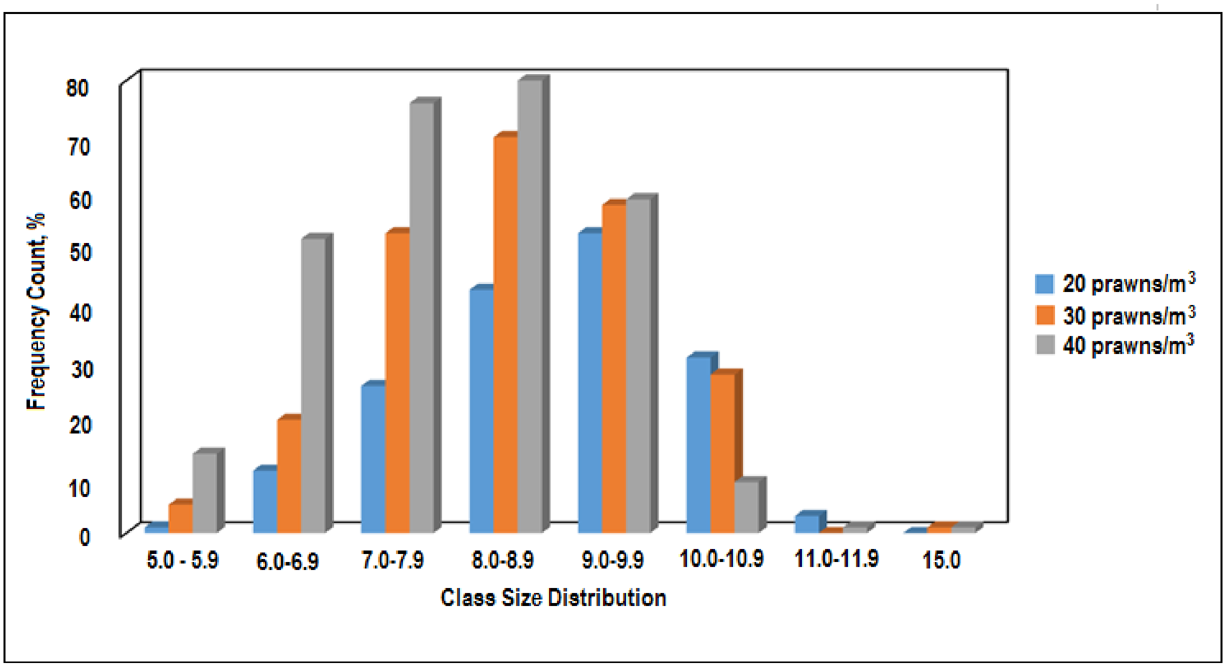


Figure 5. Frequency count per class size distribution of *M. rosenbergii* at increased stocking densities with within 90 days of culture

Table 6. Final mean length of *M. rosenbergii* PL in hapa net with different substrate positions within 90 days of culture

| Treatments pieces/m³ | Replicates | Different Substrate Positions (cm) | | | $\bar{x}$ cm |
|---|---|---|---|---|---|
| | | NS | V | H | |
| 20 | 1 | 9.09 | 9.14 | 8.78 | |
| | 2 | 8.86 | 9.06 | 8.91 | |
| | 3 | 8.84 | 8.91 | 8.49 | |
| | **Average** | **8.93** | **9.04** | **8.73** | **8.90** |
| 30 | 1 | 8.91 | 8.32 | 8.36 | |
| | 2 | 8.81 | 8.41 | 8.86 | |
| | 3 | 8.36 | 8.36 | 8.25 | |
| | **Average** | **8.69** | **8.36** | **8.49** | **8.52** |
| 40 | 1 | 7.51 | 7.79 | 8.08 | |
| | 2 | 8.22 | 8.01 | 8.14 | |
| | 3 | 8.13 | 7.92 | 8.13 | |
| | **Average** | **7.95** | **7.91** | **8.12** | **7.99** |

A significant difference exists between the three populations (Factor B) being tested. DMRT indicates that $T_1$ differed significantly from $T_2$ and $T_3$. No interaction occurred between the stocking density and the different substrate positions.

In terms of the possible parameters that may contribute as threats to the health of the prawn within the culture period, monthly monitoring on water temperature and pH was done. Results are graphically presented in fig. 6. Results reveal that water temperature and pH do not pose any threat to the mortality of the freshwater prawn during the entire culture period. These parameters are within the accepted level that

Table 7. ANOVA for the final mean length of *M. rosenbergii* PL.

| Source of Variation | Degrees of Freedom | Sum of Squares | Mean Sum of Squares | Computed F | Tabular F |
|---|---|---|---|---|---|
| Replications | 2 | 0.20 | 0.10 | $2.27^{ns}$ | 6.23 |
| Treatments | 8 | 4.10 | 0.51 | 11.59** | 2.59 |
| DSP (A) | (2) | 0.04 | 0.02 | $0.45^{ns}$ | 6.23 |
| **St D (B)** | **(2)** | **3.72** | **1.86** | **42.27**** | **6.23** |
| A x B | (4) | 0.34 | 0.085 | $1.93^{ns}$ | 3.01 |
| Error | 16 | 0.70 | 0.044 | | |
| Total | 26 | 5.00 | | | |

cv = 2.47%
* = significant
ns = not significant

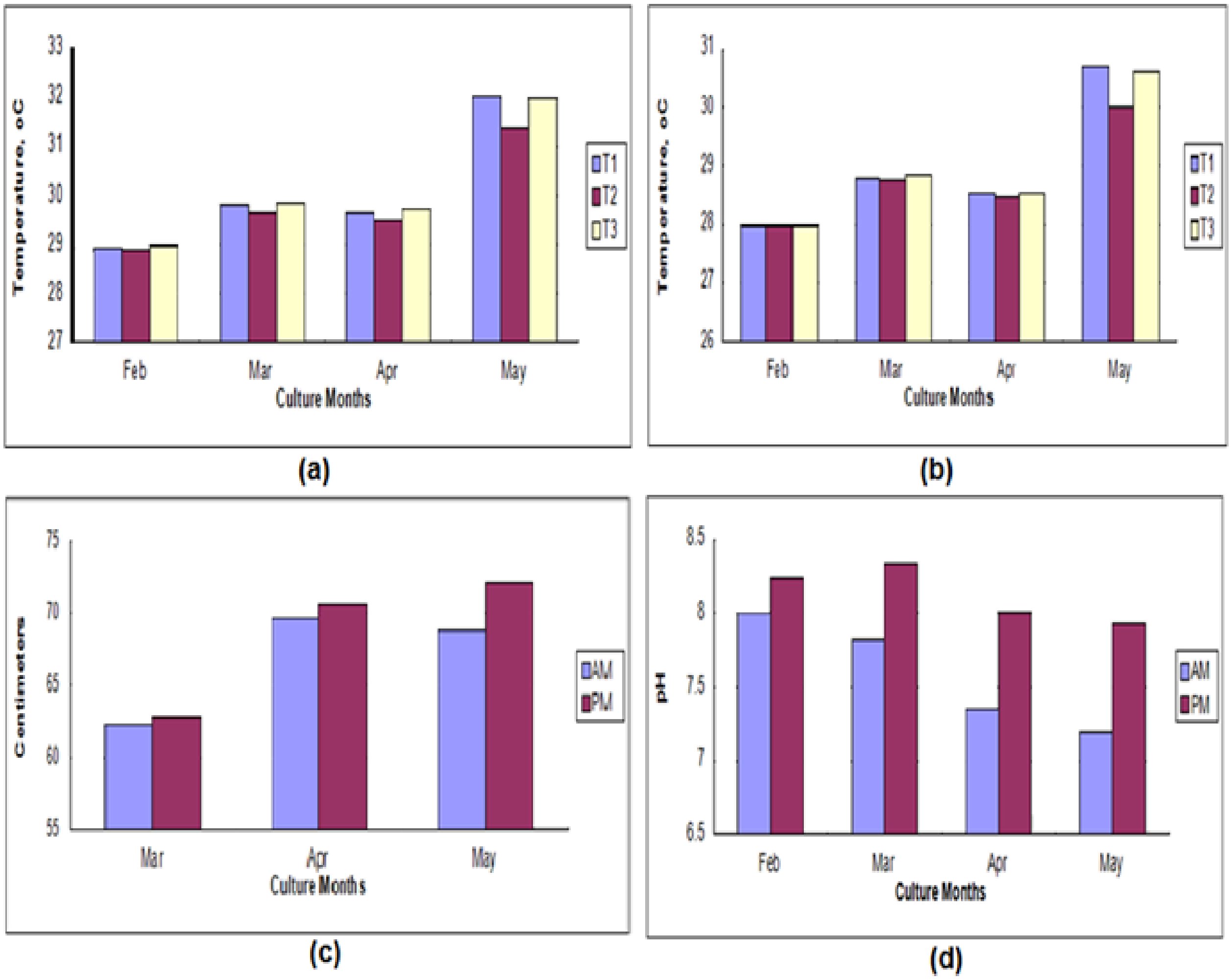


Figure 6. Average monthly parameters namely temperature (a & b), pH and transparency values measured every morning and afternoon

will not adversely affect physiological activities of the freshwater prawn. The fluctuation rate is at minimum level in which the animals can still survive and grow well.

**4.0 Conclusion**

The study concluded that increased stocking density with different substrate positions had no interaction effect. Whereas lower stocking density attained the highest growth and survival rate with respect to ABW. Cost and return analysis of each treatment was evaluated and found out negative due to low production yield caused by the shorter span of culture period and the limited size of framed hapa net as well. Stocking density of 20 pieces/$m^3$ is recommended for the culture of *M. rosenbergii* for it would attain better growth and higher survival rate. Using horizontal positions is a good option to add space and increase survival rate. Further studies shall be conducted but lengthening of culture period shall be considered and a bigger cage to determine the feasibility of the project. Pond culture experiment shall also be conducted to evaluate and compare the growth and survival of *M. rosenbergii* postlarvae.

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