



Growth, Survival Rate, and Reproductive Performance of Two Superior Strains of The Giant Freshwater Prawn (*Macrobrachium rosenbergii*)

Ikhsan Khasani*, Asep Sopian, Fajar Anggraini, Wahyu Pamungkas

Research Institute for Fish Breeding, Ministry of Marine Affairs and Fisheries, Subang, West Java, Indonesia

**Corresponding author: ikhsankhasani@gmail.com*

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ABSTRACT

The high productivity and quality of the harvested prawn are the main objectives of the intensive giant freshwater prawn (GFP) culture. Therefore, the breeding program to create a superior strain of the prawn has been conducted in several countries to support prawn farming. The purpose of this study was to evaluate the productivity and female reproductive performance of the GFP superior strains, namely the selected GI Macro (GI) and Siratu (SR) in the three farming conditions. The GI has resulted from an individual selection program based on standard length and maturation level characters. The multi-location test was conducted in the grow-out phase for 90 days at the three locations based on altitude, namely low-lands (in Subang, 10-25 m above the sea level, asl), medium-lands (in Ciamis, 70-100 m asl), high-lands (in Kuningan, 700-800 m asl). The growth characters consisting of total length/TL, standard length/SL, and body weight/BB of GI and SR were not significantly different, both on the Low, medium, and high lands ponds. The survival rate of the GI ($87.3 \pm 7.26\%$) was significantly higher than the SR ($71.0 \pm 0.08\%$) in the medium-land pond. In the high-lands pond, the survival rate of the SR ($72.33 \pm 0.32\%$) was significantly higher than the GI ($55.8 \pm 6.27\%$). Meanwhile, the productivity and percentage of the gravid female in the low-lands pond were not significantly different. The data suggested that the selected GI Macro is a location-specific genotype, more suitable to be cultured in the low and moderate-lands pond with warm temperature characteristics.

Keywords: Freshwater Prawn, Growth, Multi-location, Reproduction

ABSTRAK

Produktivitas tinggi dengan kualitas udang yang baik merupakan tujuan utama pada budidaya udang galah secara intensif. Oleh karena itu, program pemuliaan untuk menghasilkan strain udang galah unggul dilakukan pada sejumlah negara untuk mendukung budidaya udang galah. Tujuan dari penelitian ini adalah untuk mengevaluasi produktivitas dan performa reproduksi dua strain udang galah unggul, yaitu strain udang galah GIMacro hasil seleksi (GI) dan strain Siratu (SR) pada tiga kondisi lingkungan budidaya. GI merupakan populasi hasil seleksi individu berdasarkan karakter panjang standar dan level maturasi terhadap strain GIMacro II. Uji multi-lokasi dilakukan pada fase pembesaran selama 90 hari pada tiga lokasi perkolaman dengan level ketinggian berbeda, yaitu dataran rendah (di Subang, 10-25 m di atas permukaan laut, apl), dataran sedang (di Ciamis, 70-100 m apl), dan dataran tinggi (di Kuningan, 700-800 m apl). Data karakter pertumbuhan (panjang total/PT, panjang standar/PS dan bobot badan/BB) tidak menunjukkan perbedaan nyata antara GI dan SR yang dipelihara di dataran rendah, dataran sedang dan dataran tinggi. Kelangsungan hidup strain GI ($87.3 \pm 7.26\%$) signifikan lebih tinggi dibandingkan strain SR ($71.0 \pm 0.08\%$) pada kolam dataran sedang. Sementara itu, di dataran tinggi kelangsungan hidup strain SR ($72.33 \pm 0.32\%$) lebih tinggi dibandingkan GI ($55.8 \pm 6.27\%$). Namun demikian, produktivitas dan prosentase induk bertelur pada pengujian di dataran rendah tidak menunjukkan perbedaan nyata. Data yang diperoleh menunjukkan bahwa populasi udang galah GIMacro hasil seleksi memiliki karakter unggul pada lingkungan spesifik, dan lebih sesuai dikembangkan di kolam dataran rendah dan dataran sedang yang memiliki karakter suhu hangat.

Kata kunci: Udang Air Tawar, Pertumbuhan, Multi-lokasi, Reproduksi

1. Introduction

The giant freshwater prawns (GFP), *Macrobrachium rosenbergii*, was known as the largest species of the freshwater prawn from the palaemonid family (Wowor & Ng 2007). The economically important freshwater prawn has several numbers of advantages aspect to be cultured, including high tolerance to a wide salinity range, 0-15 ‰ (Hadie, 2015), omnivorous feeding habit (low protein requirement in their feed), high market demand (Zafar et al., 2015). Therefore, the GFP can be cultured in inland ponds, brackish water ponds, pen culture, and paddy fields (Nair et al., 2013; Dewi et al., 2020). The world production of giant prawns has increased from 203,028 tons in 2013 (FAO 2016) to 234,400 tons in 2018 (FAO, 2020).

To increase the productivity of giant prawns (*Macrobrachium rosenbergii*), several superior strains have been produced and officially released to the public for cultivation (Pillai et al. 2021). The superior varieties of the GFP in Indonesia include GI Macro I (Hadie et al. 2000), GI Macro II (Krettiawan et al. 2013), and Siratu (KKP 2015). The three strains were obtained through a selection method based on growth character with superiority in growth character. Although it has gone through several tests before the release of these strains, after a certain period, the genetic quality of these strains begins to decline, including the slow growth and early maturation, which results in low productivity (Nair & Salin 2012; Wijaya et al., 2020). Therefore, further selection breeding was carried out to improve the genetic quality of the GI Macro II.

The selection program based on growth character and maturity level for several generations has increased the growth performance of the prawn, by about 35% (Khasani and Sopian, 2021). Several tests are needed as consideration for releasing a

candidate of the new superior strains. One of which is a comparative test (multi-location or multi-system test) of the candidate versus the famous superior strains that have developed in the prawn farming community. The superior strain of aquaculture animals that have wide adaptability will provide many advantages, there are relatively stable levels of productivity at various farming locations and reduces the risk of the farming process when environmental conditions change (Aryanto & Listyowati. 2015). More specifically, the purpose of this study was to evaluate the production performance of the superior strains candidate of the GFP in several aquaculture environments. The result of this research is one of the basic considerations to determine the location for the development of these superior strain candidates, whether they have wide adaptability or are more suitable for a specific location.

2. Materials and Methods

The research was carried out in three locations, there were the ponds in the Research Institute for Fish Breeding (RIFB) Subang (low-lands, 0-25 m above sea level, asl), prawn farmer ponds in Pamarican, Ciamis (moderate-lands, 70-100 m asl), and fish farmer ponds in Kuningan (high-lands, 700-800 m asl). The tested prawns consist of two superior strains of the giant freshwater prawn in Indonesia, namely the selected GI Macro II (Genetically Improvement of *Macrobrachium*) and Siratu.

The comparative test (grow-out phase) was carried out for four months. Seeds prawn (2.97 ± 0.45 cm of total length and 1.75 ± 0.26 g of body weight) were reared in the 200-300 m² earthen ponds with a density of 10 m⁻² (in Subang) and a density of 5 m⁻² (in Ciamis and Kuningan), each population was reared in three ponds at each location. Agriculture-lime (100 g/m²) was spread in the pond to maintain the stability of the pH and

Table 1. The geographic and water quality parameters of three locations during the multi-location trial for the selected GI Macro II and Siratu of the giant freshwater prawn, and the optimum level for the prawn.

Parameters	Test-location			Optimum level (Boyd & Zimmerman 2010)
	Subang	Ciamis	Kuningan	
Altitude (m asl)	10	70	765	
Temperature (°C)	28-34.5	26-32	21-28	25-32
Dissolved oxygen (mg L ⁻¹)	3.2-6.8	3.4-7.0	2.2 – 5.0	3-7
pH	7.9 – 8.4	6.9 – 8.3	6.9 – 8.2	7-8.5
NH ₃ (mg L ⁻¹)	0.0 - 0.015	0.0 - 0.01	0.0 - 0.01	< 0.5
NO ₂ (mg L ⁻¹)	0.0 - 0.10	0.0 - 0.03	0.0 - 0.01	< 1.0

Note: asl: above sea level

to eradicate small fish in the ponds. Three sets of palm leaf shelters were placed in each test-pond to reduce cannibalism of the molting prawns. The commercial feed with 28-30% of crude protein content was given as much as 15% (first month), 10% (second month), 7.5% (third month), and 5% (the fourth month) of prawn biomass weight per day, based on average prawn weight and prediction of survival rate. Prawn feed was given in three times per day. The main parameters consist of total length (TL), standard length (SL), body weight (BW), survival rate (SR), harvested prawn biomass (PB), and percentage of mature (ovigerous and post-ovigerous) females. The TL is a distance between the tip of the rostrum and the tip of the telson, body straightened. The SL is a distance between the base of the eye and the base of the uropods (Wahidah et al. 2017). The maturation level of prawn females was grouped into five types, refer to Ra'anani et al. (1985); Revathi et al. (2012). Parameters of water quality of prawn rearing ponds observed were temperature, dissolved oxygen (DO), pH, ammonia, and nitrite. The water quality was observed once a month using a water quality checker for the temperature, pH, DO, and a spectrophotometer for ammonia and nitrite parameters.

The main data, consisting of total length, standard length, body weight, survival rate, productivity, and percentage of a mature female, were shown in the average value with a standard deviation of replications. Statistical analysis was

performed use the t-test. The data of water quality parameters were narrated descriptively.

3. Results and Discussions

3.1. The Environment of The Test-ponds

The water quality parameters are very influential on the life of aquaculture organisms, including the giant prawns. The pond water parameters in low-lands (Subang) and moderate-lands (Ciamis) during the study are relatively similar. In general, most of the water parameters in the three locations are still acceptable for the giant freshwater culture, except the water temperature in Kuningan (high-land pond). The water temperature in the high-land pond water tends to be cold, especially in the early morning which has an impact on decreasing prawn feeding activity and triggering mortality of the molting prawn. The pond water parameters in three test locations during this research and the optimum water parameters for the giant freshwater prawn culture were shown in Table 1.

Molting, or ecdysis, is one of the most important physiological aspects of crustacean life (Silva et al. 2019). This physiological process directly or indirectly impacts the lives of these prawns, mainly feeding, reproduction, metabolism, behavior, and sensitive acuity (Barbieri et al., 2017). The dissolved oxygen in the high-land pond was often low, due to low light intensity. Generally, highland areas have high

Table 2. Phenotypic and production performances of the selected GI Macro II (GI) and Siratu (SR) reared in three different pond locations for four months

Parameters	Locations					
	Subang		Ciamis		Kuningan	
	GI	SR	GI	SR	GI	SR
Total length (mm)	113.3 ^a	108.99 ^a	121.6 ^a	117.4 ^a	91.37 ^a	95.13 ^a
S.D	25.89	17.01	4.40	1.72	3.64	3.18
Standard length (mm)	70.56 ^a	65.96 ^a	75.52 ^a	72.88 ^a	56.58 ^a	58.24 ^a
S.D	8.28	11.57	2.12	1.48	2.57	2.08
Bodyweight (g)	19.22 ^a	15.37 ^a	22.73 ^a	19.71 ^a	8.40 ^a	9.27 ^a
S.D	5.87	12.51	2.03	2.04	1.05	0.51
Productivity (Kg H ⁻¹)	1140 ^a	1000 ^a	991.7 ^a	699.7 ^b	234.36 ^a	335.2 ^b
S.D	340	195	178.33	71.89	14.69	10.72
Post-mature female (%)	17.4 ^a	25.8 ^a	23.33 ^a	26.56 ^a	2.5 ^a	10 ^b
S.D	15.80	1.20	3.52	4.56	2.5	0

Note: The same superscript letter in the same row and column indicated insignificant differences ($P > 0.05$). S.D = standard of deviation

rainfall levels with low light intensity and low temperatures in the rainy season.

3.2. Growth and Productivity

The growth of the giant freshwater prawns, both of the selected GI Macro II and Siratu, in Ciamis test ponds, was better than in Subang and Kuningan ponds, which was indicated by the achievement of body length and body weight (Table 2).

The growth, production, and reproductive female in Table 2 show that only productivity parameters in the Ciamis location that significant differences between the selected GI Macro and Siratu. The higher productivity of the GI Macro II is affected by the higher survival rate of the selected GI Macro II (Figure 1.) than the Siratu. On the other hand, the growth of giant prawns in the Ciamis test pond which was better than in the Subang pond was due to differences in prawn stocking densities. The stocking density of the prawn seeds in the Ciamis pond was lower, 5 m⁻² than in the Subang pond, 10 m⁻². At higher stocking densities, the prawns tend to compete for food and territory, so some of the energy is used for these activities (Tuli et al. 2014). Meanwhile, the difference in the growth of giant prawns in the low and moderate-land (Subang and Ciamis) and in the high-land pond (Kuningan) was significantly influenced by the environmental conditions of the waters, especially the temperature and dissolved oxygen of the pond water.

The water temperature has a very strong influence on the growth of aquatic animals, especially the giant freshwater prawns. The growth of giant prawns is always accompanied by a molting process, which is strongly influenced by environmental temperature (Shailender et al. 2012). At optimal temperature, the ecdysis process (the one phase of the molting process) takes less time, and the prawn

can return to feeding activity. In the present study, these components of growth of the prawns were strongly influenced by temperature, yielding the different growth rates observed at the different temperatures of the test locations. In addition, Tidwell (2012) stated that the greatest effect of temperature for aquaculture animals is its relationship with growth rate. In any aquaculture system, the temperature is correlated with growth performance, as all cultured animal species are poikilothermic.

The lower proportion of mature females is one of the breeding goals of the GI Macro II (Khasani et al. 2021). The percentage of mature (avigorous and post-ovigorous) females (PMF) of the selected GI Macro II is not significantly different from the Siratu, both on Subang and Ciamis locations. On another side, the PMF in Kuningan-ponds is significantly lower than the other's location and shows a difference between GI Macro and Siratu. The data show that pond environment condition, especially the water temperature has more effect on the harvested prawn size and female reproductive performance than the strain. Referring to Ra'anani et al. (1991), the maturation of GFP females was relatively size specific. Further, Taranger et al (2010) stated that age and size at puberty of aquaculture animals were affected by genetic and environmental factors.

3.3. Survival Rate

Aquaculture productivity is not only influenced by growth aspects, it is also strongly influenced by survival rate during the process. The survival of the selected GI Macro II in the highland environment (Kuningan) is relatively low ($55.8 \pm 6.27\%$), while in the Ciamis pond it is relatively high ($87.3 \pm 7.1\%$). Meanwhile, the survival of the Siratu strain in all locations was relatively similar at a moderate level (64-71%). Correia et al. (2003) stated that in semi-intensive

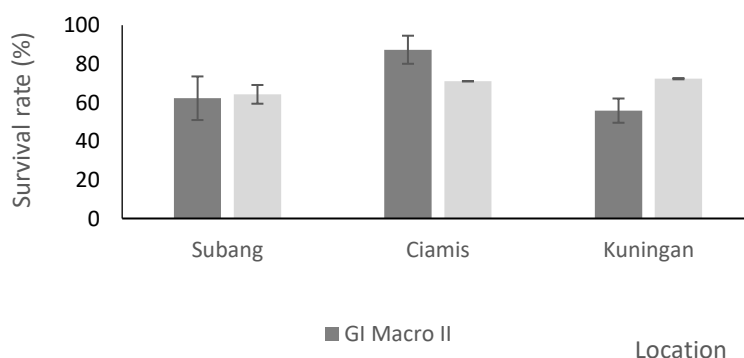


Figure 1. The survival rate of the selected GI Macro II and Siratu in three pond locations

giant prawn farming with a stocking density of 6 m⁻², the prawn survival was 84-86%. The survival rate of the selected GI Macro II and Siratu in the three test-location was shown in Figure 1. Commonly, higher stocking density in prawn farming stimulate cannibalism among the prawn and reduces the survival of the animal (Romano & Zeng 2017).

The survival rate of the giant freshwater prawns at the three test locations indicated that the selected GI Macro II was more appropriate to be reared in environmental conditions with warm temperatures and lower stocking density. Meanwhile, the Siratu strain has better adaptability to lower temperature and is more recommended to be cultivated in the highland area. The difference in the adaptability of the two strains is very possible due to the environmental conditions in which the strains were produced. The selected GI Macro II is a strain that has resulted from a breeding program conducted in Subang, with a warm temperature character (28-34 °C) (Khasani et al. 2018). Another hand, the Siratu strain has resulted from the breeding activities carried out in Sukabumi, which is a highland area with a low-temperature range (21-30 °C), especially in the rainy season. The two superior giant freshwater prawn strains were produced through individual selection based on growth characters (phenotypic character). In general, the appearance of an organism's phenotype is determined by internal (genetic) factors and influenced by external factors (environment). Organisms with good genetic quality will produce an optimal phenotypic appearance if it is supported by an optimal environment that suits the needs of the organism (Manuck & McCaffery 2014).

4. Conclusions

Based on the result from the study, it can be stated that the selected GI Macro II is a location-specific genotype, and more suitable to be developed in the lowland and moderate-land pond. Meanwhile, the Siratu is a superior strain that has a higher tolerance to low-temperature conditions than GI Macro.

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