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PRODUCTION PERFORMANCE OF VANNAMEI SHRIMP (LITOPENAEUS VANNAMEI) CULTURED IN INTENSIVE SYSTEMS WITH DIFFERENT STOCKING DENSITIES

Kinerja Produksi Udang Vaname (*Litopenaeus vannamei*) Yang Dipelihara Pada Sistem Intensif Dengan Kepatadan Berbeda

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ABSTRACT

Vannamei shrimp (*Litopenaeus vannamei*) is a significant aquaculture commodity experiencing rapid global growth, including in Indonesia, to address the decline in production of tiger shrimp. This study aims to evaluate the impact of stocking density on vannamei shrimp production in an intensive aquaculture system. Conducted over four months at PT. Laut Biru Lombok's intensive pond, the research compared two stocking densities (211 and 189 shrimp/m²) and assessed parameters such as growth, survival rate, feed conversion ratio, and productivity. Results indicated that a lower stocking density (189 shrimp/m²) generally provided better growth, survival, and feed conversion ratio, though productivity differences were not significant. In conclusion, a lower stocking density enhances the performance of vannamei shrimp in intensive aquaculture systems.

Keywords: Water quality, Rearing density, Growth

ABSTRAK

Udang vaname (*Litopenaeus vannamei*) adalah komoditas budidaya penting yang mengalami pertumbuhan pesat secara global, termasuk di Indonesia, sebagai upaya menggantikan produksi udang windu yang menurun. Penelitian ini bertujuan untuk mengevaluasi pengaruh kepadatan tebar terhadap hasil produksi udang vaname dalam sistem budidaya intensif di tambak. Penelitian dilakukan selama empat bulan di Tambak Intensif PT. Laut Biru Lombok dengan dua perlakuan kepadatan tebar (211 dan 189 ekor/m²) dan menganalisis parameter seperti pertumbuhan, kelangsungan hidup, rasio konversi pakan, serta produktivitas. Hasil menunjukkan bahwa kepadatan tebar yang lebih rendah (189 ekor/m²) cenderung memberikan pertumbuhan, kelangsungan hidup, dan rasio konversi pakan yang lebih baik, meskipun perbedaan produktivitas tidak signifikan. Kesimpulannya, kepadatan tebar yang lebih rendah meningkatkan performa budidaya udang vaname dalam sistem intensif.

Kata Kunci: Kualitas air, Padat tebar, Pertumbuhan

INTRODUCTION

Vannamei shrimp (Litopenaeus vannamei) is an important commodity that is currently widely produced globally. The nutritional value and taste that are widely demanded increase production profits so that this commodity continues to be developed (Kharisma & Manan, 2012). In Indonesia, vannamei shrimp was officially introduced as a fishery aquaculture commodity to overcome the decline in tiger shrimp production caused by disease attacks since 1996 (Firmansyah, 2021). Vannamei shrimp cultivation is developing a lot in Indonesia, especially in coastal areas. The development of this cultivation is supported by diverse cultivation technologies, enabling large-scale production with high stocking densities (Ariadi et al., 2019). Some of the advantages of vannamei shrimp as a cultivated commodity are having fast growth, resistance to disease, high survival, being able to be raised at high stocking density, and low feed conversion ratio (Ramdani et al., 2018). In addition to having these advantages, vannamei shrimp is the largest contribution to increasing the country's foreign exchange so that vannamei shrimp production continues to be increased (Rahim et al., 2021; Magampa & Suwono, 2016). Efforts made to increase vannamei shrimp production are to implement vannamei shrimp cultivation using an intensive system (Lama et al., 2020).

Intensive cultivation of vannamei shrimp requires special attention to various factors, both internal and external. Internal factors include the source and quality of the seeds, while external factors include water quality, feeding, technology used, and pest and disease control. This intensive cultivation system generally has a high stocking density, which is between 80-300 fish/m², so optimal water quality management is needed to support the growth and survival of shrimp (Firmansyah, 2021). In addition to water quality management, intensive intensive system cultivation needs to be considered to get optimal production results.

Stocking density affects the survival rate and growth of vannamei shrimp. Stocking density that is too high will have an impact on the low survival of vannamei shrimp (Rakhfid et al., 2017). According to Effendi, (2004) stocking density can determine the level of maintenance intensity. The dense influence of stocking is competition to get food, shrimp competence to get space to move and oxygen. If this happens, it will cause uneven growth, high mortality rates and implications for survival rates and affect production. According to Briggs et al., (2004) a good stocking density for vannamei shrimp to grow and develop, which is around 60-150 individuals/m2. Meanwhile, according to Haliman and Adijaya, (2005) the concentration of vannamei shrimp cultivation which is widely carried out in various regions in Indonesia, is around 100-125 individuals/m2. Therefore, this study was conducted to compare different stocking densities against the production of intensively cultivated vannamei shrimp.

METHODS

Place and Time

This research was carried out for 4 months in January-April 2024. The research was carried out in the Intensive Pond of PT. Blue Sea of Lombok, West Nusa Tenggara.

Tools and Material

The facilities used in this study include a pond plot area of 1,600 m2 which is equipped with reservoirs, WWTP, irrigation systems, aeration and other equipment. Water quality measuring instruments include thermometers, sechidisks, DO meters, pH meters, refractometers. Shrimp growth performance measuring instruments include scales, containers, and stationery. The ingredients used are shrimp fry, feed, probiotics, lime, molasses, saponins, trichloroisocyanuric ccid, cupri sulfate ($CuSO_4$), bran, yeast and fresh water.

Procedure

Pond Preparation

The preparation of the pond begins with the drying and cleaning of the bottom of the pond and other facilities and infrastructure, especially concrete ponds, maps, and mills to remove post-harvest manure. Drying is carried out for one month in direct sunlight. Construction repairs include the construction of ponds, bridges, mills, and biosecurity devices. An 8-inch diameter drainage central pipe is installed to collect dirt at the bottom of the pond, perforated every 1-2 cm and wrapped in black waring. Liming with lime (CaO) at a dose of 15 ppm is carried out on the walls and bottom of the pond.

Preparation of Water Media

Seawater is pumped and channeled into a 5,000 m² reservoir. Water disinfection is carried out with 90% calcium hypochlorite at a dose of 20 ppm for 24 hours and CuSO4 at a dose of 2 ppm. The waterwheel is operated during disinfection. The formation of plankton is carried out by giving a mixture of bran and molasses. Biosecurity is applied by installing a waring on the inlet pipe.

Fry Stocking

The fry used are SPF (specific pathogen free) derived from PT. Suri Tani Pemuka in stadia PL 7-8. Before spreading the fry, a calculation of the density of the pond and feed arrangements is carried out. Two bags of fry were randomly checked to ensure their health. Each bag contains 2,500 fry. With a pond area of 1,600 m², the total fry stocked reached 338,000 heads, with a density of 211 heads/m². Acclimatization and fry distribution are carried out in the afternoon.

Feed Management

The commonly used types of feed are powder, crumble, and pellets with a content of 35% protein, 4% crude fiber, 6% fat, 12% moisture content, and 15% ash content. DOC phase 1-30 is given powder form feed and crumble blind feeding method. DOC >31 is used pellet-shaped feed based on anco control with index system. Feed began to be given to anco from 50 g in DOC 10, increased to 100 g in DOC 26-35, and reached 150 g in DOC 40 until harvest. Feed is stored in a cool, well-ventilated room at a temperature of 20-30°C.

Water Quality Measurement

Water quality measurements including temperature, pH and brightness are carried out daily in the morning and evening using a thermometer, pH meter and sechi disk. Dissolved oxygen (DO) measurements are carried out twice a week using a DO meter. Salinity measurements are made weekly using a refractometer.

Research Design

The research design was carried out with a complete randomized design of 2 treatments and 6 replicates. The research treatment was the stocking density of vannamei shrimp, namely treatment A with a density of 211 fish/m2 and treatment B with a density of 189 fish/m2. The test of the study is the number of pond plots that are randomly arranged.

Research Parameters

The parameters observed referring to the Yunarty and Renitasari (2021) method include Average Body Weight (ABW), Average Daily Growth (ADG), biomass, population, survival, feed conversion ratio and productivity.

Data Analysis

The data obtained in the form of vannamei shrimp growth, feed conversion ratio, survival and productivity were analyzed by ANOVA Test using IBM SPSS Version 26 program. Water quality data were analyzed descriptively and compared with supporting literature.

RESULT

Average Body Weight (ABW) and *Average Daily Growth* (ADG)

The observation results showed positive shrimp growth based on an increase in Average Body Weight (ABW) and Average Daily Growth (ADG) (Figure 1). Based on the results of statistical tests, there was no significant difference between ABW and ADG in each treatment. The ABW of treatment A was observed to be higher in DOC 43 to 64, and lower in DOC 69-76. The same thing was also found in the observation of ADG which was observed to have a high tendency in treatment A in DOC 43-57, but decreased in DOC 64-76.

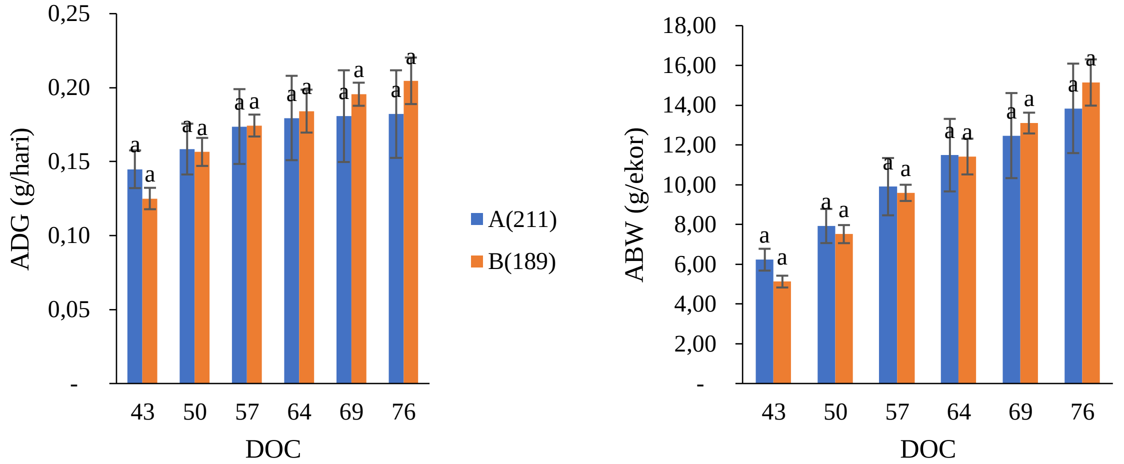

Fig 1. Observation results of Average Body Weight (ABW) and Average Daily Growth (ADG) of vannamei shrimp (A: density 211/m^2, B: density 189/m^2)

Biomass and Population

The results of biomass observation showed an increase at each observation time of both treatment A and B. Based on the results of the biomass and population statistical test, there was no significant difference in each treatment during the observation period. The biomass of treatment B tended to show higher results than A at the end of the observation. Shrimp populations also tend to decline starting from DOC 57 to 76 in both treatments.

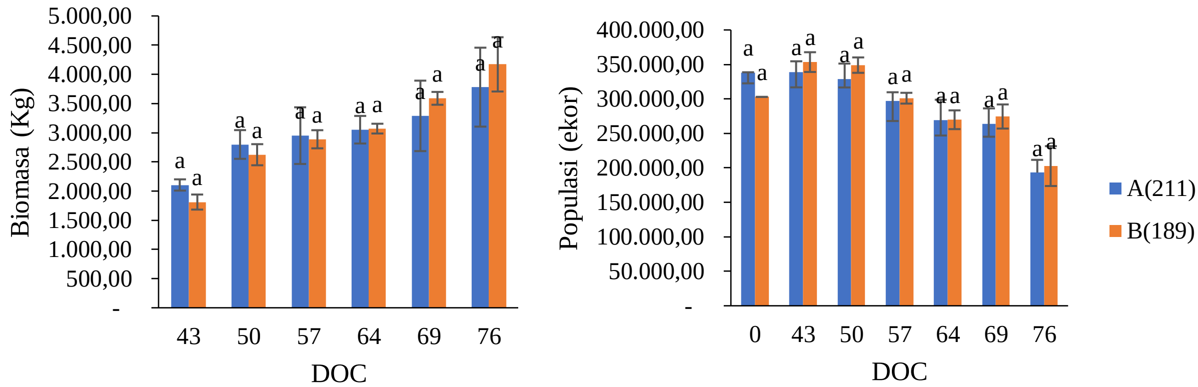

Fig 2. Results of observation of biomass and population of vannamei shrimp (A: density 211/m^2, B: density 189/m^2)

Survival and Feed Conversion Rate

The results of the observation of shrimp survival (Figure 3) showed that treatment A was significantly lower from DOC 57 to 76 compared to treatment B. The final survival of treatment A was 77.15±5.54% and treatment B was 90.39±6.32%. The feed conversion rate value shows an increase during the maintenance period of each treatment. Feed conversion values show significant differences in DOC 64. The final result of the feed conversion ratio was 1.37±0.22 for treatment A and 1.19±0.14 for treatment B.

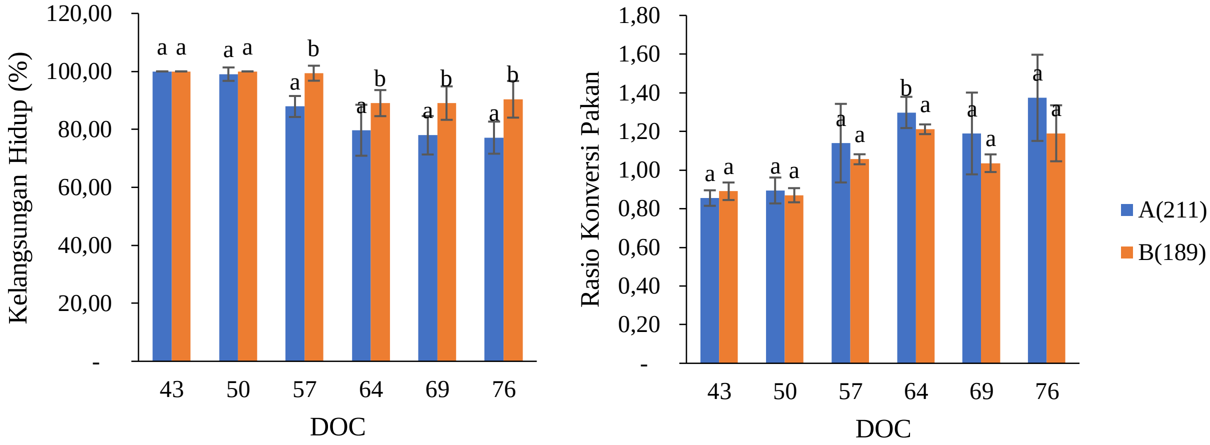

Fig 3. Results of observation of survival and feed conversion ratio of vannamei shrimp (A: density 211/m^2, B: density 189/m^2). Different superscript letters show noticeable different results (P<0.05)

Productivity

The results of the observation of productivity showed an increase during the maintenance period. Although there was no statistically significant difference in productivity in each treatment, the highest productivity tendency in treatment B was 26.07±2.91 Kg/Ton compared to treatment A which was 23±624.23 Kg/Ton (Figure 4). Significant differences were only observed in DOC 43.

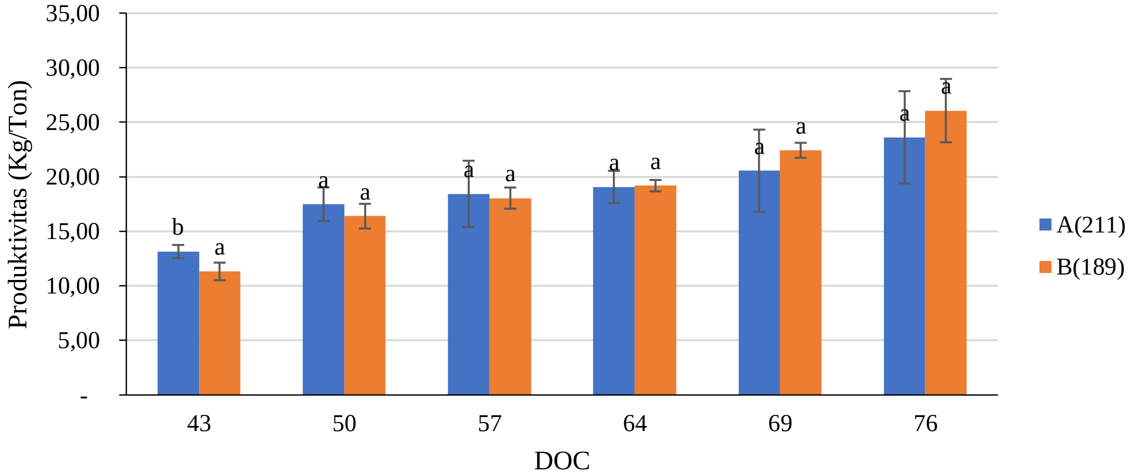

Fig 4. Results of observation of vannamei shrimp productivity (A: density 211/m2, B: density 189/m2). Different superscript letters show noticeable different results (P<0.05).

Water Quality

The water quality during the study showed an optimal range for vannamei shrimp growth. The results of water quality measurements can be seen in Table 1.

Table 1. Results of water quality measurements during the study

Parameters	Treatment A	Treatment B	SNI Standards
Temperature (°C)	28-31	28-31	28-33
pH	7,6-8,3	7,6-8,7	7,5-8,5
DO (ppm)	3-5	3-5	>4,0
Salinity (ppt)	31-34	31-34	30-33
Brightness (cm)	35-70	35-70	25-45

DISCUSSION

Vannamei Shrimp Growth

The results of the study showed that there was a tendency for density to affect shrimp growth. Some previous research results showed that the difference in density in intensive shrimp farming had an effect on growth. According to the results of the research of Purnamasari et al., (2017), shrimp raised at a density of 170 heads/m2 had a higher shrimp weight growth at the end of the study compared to a stocking density of 195 heads/m2. It is suspected that a smaller shrimp population makes growth more optimal, while on the contrary, a larger shrimp population will cause the growth of the average shrimp weight to be less than optimal. The results of the same study (Lama et al., 2020) show that stocking density has a real effect on growth, the lower the density, the less food will be eaten so that the energy obtained from feed can be used optimally. The results of a similar study show that a stocking density of 96 heads/m2 gets a higher ABW value compared to a dense teab of 114 heads/m^2.

In addition to food factors, it is also affected by the stocking density of the shrimp that are raised. The higher the stocking density, the slower the growth will be due to competition in terms of movement space, oxygen and food. Purba, (2012) also explained that the growth of vannamei shrimp is influenced by many factors, one of which is the stocking density of the shrimp that is raised, namely the stocking density of shrimp in a rearing container related to the use of space and oxygen and food for the needs of shrimp metabolism and growth. Hidayah et al., (2020) said that the increasing stocking density in vannamei shrimp will slow down the growth rate of shrimp, although it does not affect the value of the shrimp feed conversion ratio. Effendie, (1979), stated that shrimp growth is influenced by offspring, sex, age, parasites, diseases, and the ability to utilize food. Feed consumption determines the input of nutrients into the body which is then used for growth and other purposes.

Biomass is the total weight of a population. Total biomass is influenced by the average weight of individuals and the number of populations. Vannamei shrimp in treatment A was lower compared to treatment. This is because the growth of biomass depends on the growth of its weight and population growth (Sulanjari & Sutimin, 2008). Vannamei shrimp populations are related to the survival of vannamei shrimp. The higher the stocking density is directly proportional to the total population of vannamei shrimp. According to the results of research by Wahyudi et al., (2022) that low stocking density can produce a greater number of individuals compared to high stocking density.

Survival and Feed Conversion Rate (FCR)

Survival is an organism that is able to survive from the beginning of stocking to the end of maintenance. The results showed that shrimp raised at low density had better survival. According to the results of research by Lama et al., (2020) that survival is best at low density due to competition for movement space in obtaining food so that the nutrients absorbed are good for growth and maintaining biomass. According to the results of the research by Hariyadi et al., (2023) that at a density of 96 heads/m2 has a survival rate of 93.3% compared to a stocking density of 114 heads/m^2 of 86.8%. The more limited space for shrimp to move, so that the competition for feed is higher, as well as the occurrence of cannibalism, especially during the moulting period or the change of shrimp skin (Fauzi et al., 2023). Increasing stocking density decreases the survival of vannamei shrimp also reported by Krishna et al., (2015) and Venero et al., (2009).

The feed conversion ratio is the overall value of the feed given in the cultivation pond by the calculation of the overall shrimp harvest divided by the amount of feed given during the cultivation process. This study shows that the feed conversion ratio tends to be higher in shrimp with high density. Research by Syah et al., (2017) that the higher the stocking density, the higher the RKP. It is suspected that high stocking density is inseparable from high feeding so that it will have an impact on FCR.

Productivity

The productivity of vannamei shrimp in treatment A tends to be higher because the higher the survival of the shrimp, the higher the productivity of vannamei shrimp, the higher. Kurniaji et al., (2023) stated that in intensive shrimp farming, it is necessary to optimize stocking density because it is closely related to the productivity produced. Stocking density that is too high will increase shrimp mortality and decrease production. Shrimp productivity that has decreased is generally due to death due to disease attacks. Shrimp that are affected by the disease generally have a poor appetite, stunted growth, and the weight of the shrimp becomes small at the age of 80 days, so the harvest tonnage will also decrease (Suryadi et al., 2021). In addition, high stocking density causes a high mortality rate due to competition for movement space, food and oxygen in the pond so that it affects the productivity of cultivated vannamei shrimp. Lailiyah et al., (2018) Other factors that affect the productivity of vannamei shrimp are stocking amount, harvest tonnage, and final average weight of shrimp.

Water Quality

The results of the research of Kilawati and Maimunah (2015) showed that the water quality in the intensive shrimp pond was 29.89 °C, salinity 20.71 ppt, pH 8.33, and DO 4.33 mg/L. The results of the research of Sahrijanna et al., (2014), regarding the study of water quality in vannamei shrimp cultivation with a feed rotation system in intensive ponds, namely temperature 26.79 °C, salinity 34.15 ppt, pH 7.5-8.5 and DO 3.55 mg/L, while the results of research by Budiardi et al., (2008) on the level of feed utilization and water quality feasibility as well as the estimated growth and production of vannamei shrimp are Temperature 29.48 °C, Salinity 36 ppt, pH 8.03 and DO 3.59 mg/L. The optimum temperature for vannamei shrimp to grow ranges from 28 to 31 °C (Arsad et al., 2017). Kharisma & Manan, (2012) stated that the optimal temperature for shrimp rearing is 28–32 °C. The results showed that the temperature was included in the optimal category for its growth.

The results of dissolved oxygen measurements are included in the optimal category for growth. This value range is in optimal condition based on the SNI 01-7246-2006 standard that the minimum DO limit for vannamei shrimp ponds is 3.5 ppm. The optimal pH value for shrimp ranges from 7.5 to 8.5. Makmur et al., (2018), the optimal water pH conditions for vannamei cultivation range from 7.3 –8.5 (optimum at a value of 8) with a tolerance of 6.5–9, lime application is also carried out if the pH is <7, pH levels below the tolerance range can also interfere with the appetite of shrimp. According to SNI 01 -7246 -2006 (2006), that a good salinity range states that, shrimp tend to like salinity that is not too high, which is optimal at salinity of 10 -35 ppt, but shrimp can grow well at salinity of 5 -45 ppt.

The brightness of the water in this pond can be affected by the density of plankton, especially of phytoplankton types. This brightness value is in accordance with the standard that has been set by the company which is at a value of 20 – 40 cm. According to (Boyd, 1989), the optimal brightness value for shrimp farming is at 35 – 45 cm This brightness value also affects the ability of phytoplankton to carry out photosynthesis processes that can help increase the value of dissolved oxygen.

CONCLUSION

The results of this study show that intensive cultivation of vannamei shrimp with a lower density (189 fish/m2) provides a better growth and productivity tendency than high density (211 fish/m2). Significant differences are shown in the survival and feed conversion rate.

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