Growth, Yield and Analysis of Rice (Oryza Sativa) Farming Due to the Application of PT. PIM Commercial Fertilizer

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ABSTRACT

Rice (*Oryza sativa* L.) is one of the food crops included in the type of cereal plant and plays an important role in the economic life of the Indonesian people. The growth and yield of rice plants are largely determined by the amount and type of fertilizer applied. PT Pupuk Iskandar Muda (PT PIM) is a subsidiary of PT Pupuk Indonesia (Persero) engaged in the chemical industry, especially producing urea, ammonia, NPK, and Polivit fertilizers. Various types of fertilizers produced by PT PIM are applied to various plants, especially rice plants. This research aimed to determine the effect of PIM commercial fertilizer on the growth, yield and economic analysis of rice plants. This research was done in Pinto Makmur Village, Muara Batu District, Aceh Regency from June 2020 to December 2020. The environmental design used was a single factor Randomized Block Design (RBD). The types of treatment were three fertilizers produced by PT PIM (PT PIM'S NPK-UP, PT PIM'S NPK-U, and PT PIM'S NPK) and one type of competitor fertilizer. The results showed that PIM commercial fertilizers could increase the growth and yield of rice plants. This can be seen from the variables of plant height, the maximum number of tillers, panicle length, grain weight per panicle, and dry milled grain yield. The best treatment is PT PIM'S NPK-UP (NPK Fertilizer + Urea + PT PIM Polivit). PT PIM commercial fertilizer can be applied to rice cultivation as it can provide benefits. The treatment that can produce an R/C value > 1 is PT PIM'S NPK-UP fertilizer (NPK + Urea + Polivit PT PIM fertilizer).

***Keywords**: NPK, Polivit, R/C ratio, urea*

1. INTRODUCTION

Rice (Oryza sativa L.) is one of the food crops included in the type of cereal plant and plays an important role in the economic life of the Indonesian people [1]. Rice is part of the grain used as a staple food to meet needs [2]. Processed rice is consumed by most of the population as the main source of carbohydrates in the daily diet which aims to supply energy sources [3].

Rice has carbohydrates, protein, fat, water, iron, magnesium, phosphorus, potassium, zinc, vitamins B1, B2, B3, B6, B9, and fiber [4]. The nutritional content of each type of rice varies. The advantage of rice compared to other food sources is that it has a higher carbohydrate and energy content, while other foods have a lower carbohydrate and calorie content [5]. The carbohydrate content in rice is 77.1 g, 8.4 g protein, 1.7 g fat, and 0.2 g fiber (Ministry of Health Republic of Indonesia, 2018). Indonesia is an agricultural country and has a lot of rice fields [6] but still imports rice [7]. This is due to the increasing population so that the need for rice is also increasing [8].

In 2018 rice production in Indonesia was 59.60 million tons/year, and in 2020 rice production decreased to 54.65 million tons/year (Statistics of Indonesia, 2020). Rice production in Indonesia has not met the consumption needs of the people. Therefore, to increase production, it is necessary to apply appropriate rice cultivation techniques [9], one of which is balanced, effective, and efficient fertilization. The use of fertilizers, especially artificial fertilizers, is one of the key factors in increasing food production and achieving rice self-sufficiency in Indonesia [10]. Fertilizers that are commonly used are single fertilizers and compound fertilizers [11].

PT Pupuk Iskandar Muda or commonly called PT PIM, is a subsidiary of PT Pupuk Indonesia (Persero) which is engaged in the chemical industry, especially producing urea, ammonia, NPK, and Polivit fertilizers. Urea fertilizer from PT PIM contains 46% nitrogen, 1.2% biuret content, and a maximum moisture content of 0.5%. The benefits of urea fertilizer are greener plant leaves, faster plant growth (height, number of tillers, branches, etc.), and increased plant protein content. NPK contains 15% nitrogen (N), 15% phosphate (P2O5), 15% potassium (K). P3 plays a role in the growth and improvement of fruit quality (contains complete macronutrients), increases resistance to pests, stimulates root growth, and makes plants greener and more fertile. Polivit contains 48% of sulfur trioxide (SO3), 12% of potassium oxide (K2O), 9% of magnesium oxide, 25% of calcium oxide. The benefits of PIM's Polivit for plants are increasing plant growth and strength, resistance to disease and weather, increasing crop productivity/yield, and improving product quality. The experiment results conducted on one of the corn plantations in Karo Regency showed significant results. Corn production that is applied with PT PIM's Polivit fertilizer can produce 9 to 10 tons, and this is an increase in yield from normal production, which is 8 tons (Pupuk Indonesia (Persero), 2019).

The application of urea at a dose of 200 kg/ha on rice plants can increase the number of tillers, panicles, and grains per clump [12]. The results of Gumelar's research (2017) showed that giving 250 kg/ha of urea to rice plants increased the plant height, number of tillers per clump, number of panicles per clump, and weight of 1000 grains of dry grain content. The results of [13] showed that the application of NPK at a dose of 188.75-274 kg/ha on dry field rice could increase plant height, productive tillers, panicle length, and grain dry weight. [14] stated that giving NPK 125 kg/ha to rice plants could increase leaf area.

Indonesian agriculture is currently still dominated by conventional agriculture [15], which uses a very large application input [16]. The use of inputs is highly dependent on the use of artificial inputs which include chemical fertilizers and pesticides [17]. Artificial inputs are often used excessively and do not pay attention to the balanced use of fertilizers [18]. Therefore, the long-term use of artificial inputs can have major ecological and economic impacts [19]. Therefore, it is necessary to conduct research that examines the use of artificial fertilizers and their effects on plant growth and yields, also considering the results of their economic analysis.

This research aims to determine the effect of PT PIM commercial fertilizer application on growth and yield, as well as economic analysis of rice plants. In addition to that, the success of this research can be a promotional effort to introduce and show the advantages of PT PIM's products to the public.

2. MATERIALS AND METHODS

This research was done in Pinto Makmur Village, Muara Batu District, Aceh Regency, Indonesia from Juli to November 2021. The equipment used in this research is agricultural tools in general and equipment for collecting observational data. The materials used are MR219 variety rice seeds, 15-15-15 PIM's NPK fertilizer, PT PIM' Urea fertilizer, PT PIM's Polivit fertilizer, pesticides, and promotional media that will be placed around the agricultural demonstration plots.

This research was done using a demonstration plot system with several single factor treatments. The environmental design used was a single factor Randomized Block Design (RBD). The treatments consisted of four types of fertilizers (three types of fertilizer produced by PT PIM and one type of competitor fertilizer), which are:

1. PT PIM'S NPK-UP: Multi nutrient NPK with a dose of NPK (300 kg/Ha) + urea (220 kg/Ha) + polivit (30 kg/Ha)
2. PT PIM'S NPK-U: NPK+ urea with a dose of NPK (300 kg/Ha) + urea (250 kg/Ha))
3. PT PIM'S NPK: PT PIM'S NPK + urea with a dose of NPK (300 kg/Ha) + urea (220 kg/Ha)
4. Competitor's NPK: Competitor's NPK (300 kg/Ha) + urea (220 kg/Ha).

Treatment and nutrient requirements for each plot were made based on the soil analysis results prior to the implementation of the activity. The combination of treatments is made based on the assumption of general fertilizer recommendations and will be adjusted after obtaining the soil testing results at the demonstration plot site. With this assumption, the fertilizer needed is 75.36 kg of NPK, 57.91 kg of urea and 1.74 kg of polivit.

The application of fertilizer was made in several growth phases. In the early growth phase (age 0-10 DAP), the fertilizer applied is 50% urea, 50% NPK, and 50% Polivit. In the active tiller phase (age 21-28 DAP), the fertilizer applied was 25% urea, 25% NPK, and 25% polyvit. In the primordia phase (age 35-50 DAP), the amount of fertilizer applied was 25% of urea, 25% of NPK, and 25% of polyvit.

The data obtained in this research is based on tiles. Tile productivity data is used to estimate the potential yield of a particular area. This research was done using legowo rice planting system type 3:1. The size of the tiles is made with a distance of 2.5 m x 2.5 m = 6.25 m2 with a total of 81 clumps. Data were analyzed statistically by using analysis of variance (variance test). The results that show significant differences will be further tested with the Duncan's Multiple Range Test (DMRT) at a level of 5%.

3. RESULTS AND DISCUSSION

Results

Based on the variance results, the application of PT PIM's fertilizers affected some of the observed variables such as the plant height at 30 and 60 DAP, leaf color chart at 60 DAP, number of tillers at 30 DAP, grain weight per panicle, and yield of milled dry grain. The results of the further test of plant height due to the application of PIM's fertilizers are presented in Table 1.

Table 1. Effect of PT PIM's fertilizer on rice plant height

Treatment	**Plant Height (cm)**		
	30 DAP	**45 DAP**	**60 DAP**
PT PIM's NPK-UP	64.20 a	79.32 a	102.55 a
PT PIM's NPK-U	58.50 b	74.00 ab	98.75 a
PT PIM's NPK	53.60 c	71.85 b	96.65 ab
Competitor's NPK	51.25 c	71.43 b	91.80 b

Note: The numbers followed by the same letter in the same column are not significantly different based on the 5% DMRT test. DAP=Day After Planting.

Table 1 shows that the application of PT PIM's fertilizer affected plant height at the age of 30 and 60 DAP, while at 45 DAP, it had no effect. PT PIM's NPK-UP treatment can produce the highest score. Plant height in the PT PIM's NPK-UP treatment from 30, 45 to 60 DAP experienced a significant increase compared to other treatments.

The effect of PIM's fertilizer application can be seen in other variables. The effect of PIM's fertilizer application on rice plants' leaf color chart is presented in Table 2. The effect of PT PIM's fertilizer application on the maximum number of rice plants tillers is presented in Table 3.

Table 2. Effect of PIM's fertilizer application on leaf color chart of rice plants

Treatment	Leaf Color Chart (levels)		
	30 DAP	45 DAP	60 DAP
PT PIM'S NPK-UP	3.60 a	2.90 a	3.40 a
PT PIM'S NPK-U	3.80 a	2.80 a	3.10 b
PT PIM'S NPK	3.90 a	2.90 a	3.00 b
Competitor's NPK	3.70 a	3.00 a	3.00 b

Note: The numbers followed by the same letter in the same column are not significantly different based on the 5% DMRT test. DAP=Day After Planting.

Based on Table 2, it can be seen that the application of PIM's fertilizers had an effect on the leaf color chart at the age of 60 DAP, while at the age of 30 and 40 DAP, it did not show any difference. PIM'S NPK-UP treatment can produce the highest level of leaf color chart; however, statistically, it does not show any difference with other treatments.

Table 3. The effect of PIM's fertilizer on the maximum number of rice plants tillers

Treatment	Maximum Tiller Number (stem)		
	30 DAP	45 DAP	60 DAP
PT PIM'S NPK-UP	31.50 ab	33.60 a	28.50 a
PT PIM'S NPK-U	32.90 a	38.00 a	31.50 a
PT PIM'S NPK	25.20 c	34.00 a	30.40 a
Competitor's NPK	27.30 cb	35.30 a	31.50 a

Note: The numbers followed by the same letter in the same column are not significantly different based on the 5% DMRT test. DAP=Day After Planting.

Table 3 shows that the application of PT PIM's fertilizer has an effect on the maximum number of tillers at the age of 30 DAP, while at the age of 45 and 60 DAP, it does not show any effect. PT PIM'S NPK-UP and NPK-U treatments produced the highest number of tillers at the age of 30, while at the age of 45 and 60 DAP did not show any difference from other treatments.

The effect of PT PIM's fertilizer application can also be seen in the yield variable. The effect of PT PIM's fertilizer application on the number of productive tillers, panicle length, number of grains per panicle, and grain weight per panicle of rice planting can be seen in Table 4. The effect of PT PIM's fertilizer application on total grain weight per clump, the weight of filled grain per clump, empty grain per clump, and dry milled grain yield of rice plants can be seen in Table 5.

Table 4 shows that the application of PT PIM's fertilizer affects the variables of panicle length and grain weight per panicle. Treatment using the competitor's fertilizer showed that the panicle length and grain weight per panicle values were lower than those using the three PT PIM's fertilizers (PT PIM'S NPK-UP, NPU-U PT PIM, and PT PIM'S NPK).

Table 4. Effect of PT PIM's fertilizer on the number of productive tillers, panicle length, number of grains per panicle, and grain weight per panicle of rice planting

Treatment	Observation			
	Number of productive tillers (stems)	Panicle Length (cm)	Number of grains per panicle (grain)	Grain Weight per Panicle (grain)
PT PIM'S NPK-UP	22.40 a	26.58 a	135.70 a	4.46 a
PT PIM'S NPK-U	26.60 a	25.55 ab	138.60 a	4.40 a
PT PIM'S NPK	22.00 a	24.85 ab	124.10 a	4.27 a
Competitor's NPK	23.90 a	23.90 b	125.90 a	3.39 b

Note: The numbers followed by the same letter in the same column are not significantly different based on the 5% DMRT test. DAP=Day After Planting,

Table 5. Effect of PIM's fertilizer application on total grain weight per clump, the weight of filled grain per clump, empty grain per clump, and dry milled grain yield of Rice Planting

Treatment	**Observation**			
	Total Grain Weight Per Clump (g)	Weight of Filled Grain Per Clump (g)	Empty Grain Per Clump (g)	Milled Dry Grain Yield (kg)
PT PIM'S NPK-UP	50.60 a	48.07 a	5.88 ab	60.10a
PT PIM'S NPK-U	57.96 a	49.97 a	7.99 a	50.18b
PT PIM'S NPK	47.66 a	41.48 a	6.18 ab	50.29b
Competitor's NPK	47.45 a	46.70 a	4.41 a	49.18b

Note: The numbers followed by the same letter in the same column are not significantly different based on the 5% DMRT test. DAP=Day After Planting

Table 5 shows that the application of PIM's fertilizer affects the yield of dry milled grain. PIM'S NPK-UP treatment produces the highest amount of grain. PIM's fertilizer application did not affect total grain weight per clump, the weight of filled grain per clump, and empty grain per clump.

Observation of plant growth and yield is important in agricultural cultivation. However, aside from observing plants, it is also necessary to analyze farming. The farming business analysis aims to evaluate the profit level earned on the capital issued. The feasibility of business activities can be evaluated by calculating farm business analysis. The results of farming analysis on rice plants that were given various types of fertilizers (3 types of PT PIM fertilizer and 1 type of competitor fertilizer) are presented in Table 6.

Table 6. The results of the farming analysis on rice plants that were given various types of fertilizers (three types of commercial PIM fertilizers and one type of competitor fertilizer)

Treatment	**Total production cost (Rp)**	**Weight of the harvested dry grain (kg)**	**Total income (Rp)**	**Total revenue (Rp)**	**R/C ratio**
PT PIM'S NPK-UP	1,330,350	567	2,664,900	1,334,550	1.003
PT PIM'S NPK-U	1,783,950	734	3,449,800	1,665,850	0.934
PT PIM'S NPK	1,273,125	445	2,091,500	818,375	0.643
Competitor's NPK	1,306,725	412	1,936,400	629,675	0.482

Table 6 shows that fertilizer application greatly determines the amount of profit obtained by farmers. PT PIM'S NPK-UP treatment can produce the highest R/C value which is 1.003 which is better than other fertilization treatments.

Discussion

The results showed that PIM's fertilizer affected plant height, leaf color chart, maximum tiller number, panicle grain weight, and milled dry grain yield (Table 1-5). Overall, PT PIM'S NPK-UP fertilizer showed the best growth and yield compared to other treatments.

PT PIM'S NPK-UP Fertilizer is a multi-nutrient NPK fertilizer with a dose of NPK (300 kg/Ha) + urea (220 kg/Ha) + polyvit (30 kg/Ha). This fertilizer treatment can increase the growth and yield of rice plants. Balanced and efficient fertilization can accelerate cell division so that plant growth will also be faster. [12] state that the rate of division, cell elongation, and tissue formation will be faster if plant nutrient needs can be met. Fertilization on plants is done according to the required dose. If fertilizer is given in small quantities, it has no effect on plant growth [20], but if it is given in excess it can cause plant poisoning so that its growth can be disrupted [21].

Fertilizer application affects the leaf color chart of rice plants [22]. Leaf color is a useful indicator of plant N requirements [23]. Pale leaf color or yellowish-green indicates the plant is deficient in [24]. The application of urea and NPK fertilizers can make plants greener because these fertilizers contain N that plants need [25]. Sufficient nitrogen in the generative phase plays an important role in slowing the leaf aging and maintaining photosynthesis during the grain filling phase [24].

Optimal application of urea, NPK, and polivit fertilizers can increase crop yields because NPK and polyvit both play a role in improving the quality of crop yields. The optimal photosynthesis process produces more photosynthate to increase the percentage of pithy grain and dry milled grain weight. The optimally given nutrient content could meet the nutrient needs of the photosynthesis process so that photosynthesis runs well [27].

PT PIM'S NPK-UP Fertilizer is the only type of fertilizer that can provide benefits. This can be seen from the known R/C value from the farming analysis. R/C (Revenue Cost Ratio) is the ratio between revenue and production costs. R/C is known by dividing the revenue by the total cost [28]. If the R/C Ratio > 1, then the business is profitable or feasible to be developed [29]. If the R/C Ratio < 1, then the business suffers a loss or it is not feasible to develop [30], whereas if the R/C Ratio = 1, then the business is at break event point [31].

Based on the results of the farming analysis that has been done on several of the treatments above, only the PT PIM'S NPK-UP treatment shows an R/C Ratio greater than 1.00, which means for every Rp1,000 of expenses, you will receive an income of Rp1,003. In other fertilization treatments, only the R/C Ratio value is below 1.00, so the business is considered not feasible.

4. CONCLUSION

1. PT PIM's fertilizers can increase the growth and yield of rice plants. This can be seen from the plant height, the maximum number of tillers, panicle length, grain weight per panicle, and dry milled grain yield. The best treatment is PT PIM's NPK-UP (NPK fertilizer + urea + polyvit PT PIM).
2. PT PIM's fertilizer is feasible to be applied to rice cultivation because it can provide benefits. The treatment that can produce an R/C value > 1 is PT PIM's NPK-UP fertilizer (NPK + urea + polyvit PT PIM fertilizer)

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