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RESEARCH ARTICLE

SITE-SPECIFIC FERTILIZATION FOR LOWLAND RICE PRODUCTION IN WEST KALIMANTAN

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ABSTRACT

Application of fertilizer recommendations until now is generally treated equally in all locations. The variety of soil fertility in location was not relevant to use one dosage fertilizer recommendation. The purpose of this study was determine rice of recommendation dosage of NPK phonska fertilizer in rice fields. This study compared the fertilization treatments of NPK phonska based on the method of field experiments in rice fields by using a randomized block design, where each treatment was repeated four times. The treatment were P0 : without NPK Phonska and Urea fertilizer (control), P1 : NPK Phonska 300 kg ha^{-1} and Urea 200 kg ha^{-1}, P2 : NPK Phonska 200 kg ha^{-1} and Urea 235 kg ha^{-1}, P3 : NPK Phonska 250 kg ha^{-1} and Urea 220 kg ha^{-1}, P4 : NPK Phonska 350 kg ha^{-1} and Urea 180 kg ha^{-1}. The results showed plant highest in the treatment of P2 at 106 cm, where the fertilization treatment of NPK Phonska at 200 kg ha^{-1} and Urea at 235 kg ha^{-1}. The fertilization with NPK Ponska 350 kg ha^{-1} and Urea 180 kg ha^{-1} (P4) showed the most number of tillers at 12.2 tillers and the highest of grain weight per hill at 29 grams. It can produce dry grain (stand for 14%) at 7.5 t ha^{-1} and the profits is IDR 22,773,581,00.

Keywords: fertilizer recommendation, lowland, NPK Phonska, rice, West Kalimantan.

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INTRODUCTION

One of the challenges in efforts to increase rice production is fertilizer efficiency associated with an increase in the income of farmers and environmental sustainability, especially under current climate change situation (Naher et al., 2011). In the Strategic Plan of the Ministry of Agriculture 2010-2014, the Government sets a target of achieving a surplus of 10 million tonnes of rice in 2014 to ensure national food security (Azdan. 2011), and to support the target specified in West Kalimantan of 340,000 tons.

Achievement surplus 340,000 tons of rice in West Kalimantan are still faced with the problem of low productivity of rice at an average 3.09 t ha^{-1}. The low productivity is due to partly by the different levels of soil fertility in each region so that the fertilizer recommendation is given not to be the same in every region (Rahman and Parkinson. 2007; Haefele et al. 2010). Fertilizer recommendations are supposed to take into account the site-specific soil fertility (Ezui et al. 2010).

Application of fertilizer recommendation for rice until now was same in all locations such as on fertile soils with high nutrient content and in poor soil with low nutrient content

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(Mukhopadhyay et al. 2008). The diversity of soil fertility conditions between regions or locations in an area, then the fertilization of a national recommendation is not relevant anymore (Adnyana. 2011). Fertilization is an effort to increase the availability of nutrients in order to meet the needs of plants. The diversity of soil fertility conditions and specific local environment in some areas, causing the need for balanced fertilization based on specific local conditions and resources (Suryana, 2004).

In some areas of intensification, Excessive fertilization leads to imbalance of soil nutrients, damaging soil properties, environmental pollution and increasing the emissions of methane (CH_4) and nitrous oxide (N_2O) (Simarmata et al. 2012; Das and Adhya. 2014). Excessive fertilization which is not appropriate in dosage, time, and way can cause the plants not to grow optimally, either because of nutrient deficiencies or excessive fertilization (Dobermann and Fairhurst, 2000). The excessive fertilization also leads to inefficiency of production costs that are often resulted in farmers not to get the maximum profits even loss on rice farming (Buckley and Carney. 2013). Therefore it needs rice fertilization technology that can provide the maximum benefit to the farmers based on the nature and characteristics of the paddy fields (Zeng et al. 2012).

The site specific fertilization is a soil nutrient balance-based fertilization technology which uses a rational and efficient fertilization based on the plant needs (Dobermann et al., 2004). Fertilization approach based on the site specific fertilization is to guide the use of fertilizers rationally, efficiently, and extensively by farmers (Pampolino et al. 2007). Therefore, the presentation of the site specific fertilization principles needs to be simplified and adjusted with the local way in order to be easily applied by extension workers and farmers and then to be developed on local land condition and rice crop (Janssen et al., 1990). This site specific fertilization technology needs to be tested in every area in accordance with the nature and diversity of rice fields' characteristics and rice farmers' characteristics in rice farming management in each region in Indonesia, including in Pontianak Regency, West Kalimantan Province.

The Site Specific nutrient management (SSNM) practices are designed to take into account soil nutrient supplying capacity, reasonable grain yield targets, past management history, and corresponding crop nutrient requirements for specific rice crop ping seasons as well as socioeconomic factors (Liang. 2013). Therefore fertilization dosage needs to be adjusted in a variety of locations with different nutrient status. Recommended dosage of fertilizer for rice is influenced by various factors such as the competence of the test method, the carrying capacity of the land, and the crop needs on various nutrients (Setyorini et al., 2006).

The purpose of this study was to test the fertilizer of NPK Phonska from PT. Petro Kimia Gresik in orde to obtain NPK Phonska fertilizer recommendations site spesific based on the needs of rice crops in the province of West Kalimantan.

MATERIALS AND METHODS

The assessment of site-specific fertilization was conducted on rice field owned by farmers in Landak Regency, West Kalimantan Province. This study was carried on from October 2012 to April 2013 rainy season in paddy fields with a semi-technical irrigation. The soil was a clay loam [Inceptisols (U.S. taxonomy)] with pH 4,71, 108 mg kg^{-1} alkali available N, 9,17 mg kg^{-1} Bray-P, and 0,26 cmol (+) kg^{-1} exchangeable K. The cation exchange capacity (CEC) was 12,72 cmol (+) kg^{-1} and base saturation (BS) was 9,9% .

Type of climate in the Village Andeng by that rainfall station from Siatan subdistrict was classified type B (Schmidt and Ferguson classification) with wet 7-9 months (September - March) and 1-3 dry months (July - September), and the average rainfall was 187 days $year^{-1}$. The relative humidity this area was 75% and air temperature was 27-29 ^{o}C. According to Moore (2006) in this region can be classified by type of wetland floodplain. Soil parent material derived from river sedimentary materials, according to Buurman (1988), based on the classification of the parent material is classified as clay stone.

Materials used in this study were inputs such as rice seed, fertilizers, i.e. Urea, KCl, and NPK compound fertilizers "Phonska" and pesticides, stationery and etc. Rice varieties used are Mekongga, which was grown in "legowo" row 4 : 1 (4 rows with interspaces 1 row), with a spacing of 20 cm x 10 cm. This activity followed national recommendation (NPK Phonska 300 kg ha^{-1} and Urea 200 kg ha^{-1}) and several levels of treatment of NPK Phonska and Urea to the extent that the compound fertilizer can improve the productivity of rice in the fields. To determine the extent to which the fertilizer dose can be profitable, then the financial analysis.

This study was conducted in rice fields owned by farmers using Randomized Block Design (RBD) with four replicates. Plot size 6 m x 6 m received treatments:

- P0 : without NPK Phonska and Urea fertilizer (control)
- P1 : NPK Phonska 300 kg ha^{-1} and Urea 200 kg ha^{-1}
- P2 : NPK Phonska 200 kg ha^{-1} and Urea 235 kg ha^{-1}
- P3 : NPK Phonska 250 kg ha^{-1} and Urea 220 kg ha^{-1}
- P4 : NPK Phonska 350 kg ha^{-1} and Urea 180 kg ha^{-1}

Fertilizer application conducted in several stages:

- All treatments using organic fertilizer "Petroganik" with a dose of 500 kg ha^{-1} was given 2 weeks before planting.
- Fertilizer NPK Phonska was given half a dose at 7 days after planting, and at 21 days after planting.
- Urea was given a third dose at 7, 21, and 35 days after planting.

Measurement of rice growth parameters performed on vegetative and generative phase include: plant height, number of tillers, number of productive tiller, grain weight, 1000 grains weight and dry grain yields (MC 14%). The experimental data were analyzed with Analysis of Variance (ANOVA), followed by a further test of significant difference and financial analysis. Observations were randomly assigned to 5 sample plants in each plot (Gomez and Gomez. 1995).

RESULTS AND DISCUSSION

Effect Fertilization on Rice Growth

In this study, the test of the main effect of fertilizer dosage were statistically signifcant ($P<0.05$) for rice growth parameter e.i: plant height, number of tillers and number of productive tiller (Table 1). The average growth of rice on each treatment showed in Table 1, which the lowest growth were given by the no fertilizer and Ponska 300 + Urea 200 fertilizer (P0 and P1). The results of Anova showed significantly different between the treatments. Appearance of the rice crops highest in the treatment of P2 at 106 cm,

Table 1. Results of Growth of Rice in Andeng Village, Sengah Temila District, Landak Regency.

Treatment (kg ha^{-1})	Plant height (cm)	Number of tillers	Number of productive tiller
P0 = control	83 a	7.0 a	5,9 a
P1 = Ponska 300 + Urea 200	103 b	11.3 b	9,2 b
P2 = Ponska 200 + Urea 235	106 b	11.2 b	10,0 b
P3 = Ponska 250 + Urea 220	101 b	11.7 b	10,1 b
P4 = Ponska 350 + Urea 180	104 b	12.2 b	11,2 b

*Remarks : *) The numbers in the same column followed by the same letter indicates not significant difference at 5% level of DMRT.*

where the fertilization treatment of NPK Phonska at 200 kg ha^{-1} and Urea at 235 kg ha^{-1}. Continued test results showed that the treatment of P2 was significantly different from P0 on DMRT 5% level, but not significantly different from other treatments. The treatments of P1, P3, and P4 showed not significantly different, however P1, P3, and P4 significantly different from P0 (Table 1). Acordding to Zaitun et al. (2011) application of NPK fertilizer can improve soil fertility by repairing soil chemical properties in the N, P, and K nutrient availability. Improvement of N, P, and K nutrient availability would affect the nutrient availability, so that this would improve the growth of plant height.

The results of Anova showed in the treatments of fertilization and not fertilization were significantly different on number of tillers. The fertilization with NPK Ponska 350 kg ha^{-1} and Urea 180 kg ha^{-1} (P4) showed the most number of tillers at 12.2 tillers, whereas the treatment is not fertilized showed the least number of tillers at 7.0 tillers. The result aligned with Purnomo (2008) reported that without NPK rice plants produce 12 tillers rising to 20 tillers with the provision of NPK fertilizer at 600 kg ha^{-1}. Continued test results showed that the treatment of P4 significantly different from P0 on DMRT 5% level, but not significantly different by P1, P2, and P3 (Table 1).

The results of Anova showed in the treatments of fertilization and not fertilization significantly different on number of productive tillers. The fertilization treatment of NPK Ponska 350 kg ha^{-1} and Urea 180 kg ha^{-1} (P4) showed the most number of productive tillers at 11.2 tillers, whereas the treatment is not fertilized showed the least number of productive tillers at 6.0 tillers. Continued test results showed that the treatment of P4 significantly different from P0 on DMRT 5% level, but not significantly different by P1, P2, and P3 (Table 1). The study of Kaderi (2004) showed that addition of NPK improved the nutrients for plant, thus number of tiller per clump was higher after the addition of NPK compared to control plant. Growth of tiller number is relative to N sufficiency and efficacy to primordial forming.

Effect Fertilization on Yield of Rice

On paddy field, Landak Regency (Table 2), the response of yield parameter of rice varied from one treatment to another. All fertilization recommended options, gave a better performance than control. Hartatik and Setyorini research results (2008) showed that NPK fertilizer can increase the weight of dry grain by 73% compared to control (without fertilizer).

The fertilization treatment of NPK Ponska 350 kg ha^{-1} and Urea 180 kg ha^{-1} (P4) of grain

Table 2. Results of Yield of Rice in Andeng Village, Sengah Temila District, Landak Regency.

Treatment ($kg\ ha^{-1}$)	Grain weight (gram)	1000 grains Weight (gram)	Dry grain yields (MC 14%) ($t\ ha^{-1}$)
P0 = control	14.3 a	25.0 a	3.9 a
P1 = Ponska 300 + Urea 200	23.4 b	25.3 a	5.7 a
P2 = Ponska 200 + Urea 235	24.0 bc	25.6 a	5.6 a
P3 = Ponska 250 + Urea 220	27.6 bcd	26.2 a	6.2 a
P4 = Ponska 350 + Urea 180	28.5 de	26.4 a	7.5 b

*Remarks : *) The numbers in the same column followed by the same letter indicates no significant difference at 5% level of DMRT.*

weight per hill showed the highest at 29 grams. Continued test results showed that the treatment of P1, P2, P3 and P4 significantly different from P0 on DMRT 1% level. The treatment of P4 significantly different from P1 and P2, but not significantly different by P3, whereas the treatment of P1, P2, and P3, respectively, not significantly different (Table 2).

The results of Anova showed in the treatments of not fertilization and fertilization not significantly different on Weight of 1000 grains. The fertilization treatment of P0 of 1000 grain weight at 25 grams, whereas the treatment of P1, P2, P3, and P4, respectively, were 25,3 grams, 25,6 grams, 26,2 grams, and 26,4 grams. The results of Anova showed in the treatments of not fertilization and fertilization significantly different on grain yields. The average of dry grain yields (moisture content of 14%) on the treatment is not fertilized (P0) is 3.9 t ha^{-1}, respectively, whereas on the NPK Ponska and Urea fetilization treatment (P1, P2, P3, dan P4) were 5.7 t ha^{-1}, 5.6 t ha^{-1}, 6.2 t ha^{-1}, and 7.5 t ha^{-1}. The average of dry grain yields on the fertilization treatment of NPK Ponska at 350 kg ha^{-1} and Urea at 180 kg ha^{-1} showed highest yield at 7.5 t ha^{-1}, whereas the lowest yield at 3.9 t ha^{-1} showed on the treatment is not fertilized.

Further test results DMRT at 5% level showed that the fertilization treatment of NPK Ponska at 350 kg ha^{-1} and Urea at 180 kg ha^{-1} (P4) significantly different from the treatment P0, P1, P2, and P3, whereas the treatment of P0, P1, P2, and P3, respectively, showed no significant difference (Table 2). Increase of NPK fertilizer dosage improve the yield component of paddy rice plant caused by this fertilizer can directly gave the nutrients required by rice plant (Zaitun et al. 2011). Khalid et al. (2003) studied the effect of different levels of NPK (0-0-0, 120-0-0,120-60-0, 12-0-60, 120-60-60, 120-90-0, 120-0-90 and 120-90-90) on the yield and quality of rice cv. IR-6. Data show that paddy yield were affected significantly by different levels of NPK as compared to control.

Value of profits.

The assessment of site-specific fertilization recommendations for lowland rice production provided the best performance in Landak Regency, West Kalimantan Province. The P4 treatment giving the most profitable option (Table 3): a total cost of IDR 8,115,000.00 for all cost cultivation of rice can result income of IDR 24,133,581.00, followed by P3, a cheaper option. Fertilization with Phonska 200 + Urea 235 kg ha^{-1} (P2) can not be recommendated because additional fertilization

Table 3. Profits Value at Each Treatment

Treatment (kg ha^{-1})	Total Cost (IDR)	Grain prices (IDR kg^{-1})	Grain Yield (kg)	Income (IDR ha^{-1})	Profits (IDR ha^{-1})
P0 = control	6,755,000	3,200	3,936	12,594,233	5,839,233
P1 = Ponska 300 + Urea 200	8,035,000	3,200	5,749	18,397,767	10,362,767
P2 = Ponska 200 + Urea 235	7,862,500	3,200	5,594	17,901,767	10,039,267
P3 = Ponska 250 + Urea 220	7,955,000	3,200	6,237	19,959,442	12,004,442
P4 = Ponska 350 + Urea 180	8,115,000	3,200	7,542	24,133,581	16,018,581

only increased small income of rice production in this area, cost of farming is IDR 7,862,500.00 only make a profit of IDR 10,039,267.00. Compared with the control treatment, P4 treatment was only an increase in profit of IDR 4,200,034.00 (the smallest among other treatments), whereas P4 treatment increase in profit of IDR 10,179,348.00 (more than double that of the increase in profits P2 treatment).

Profit analysis in each fertilizer treatment at the expense of other factors of production costs showed P4 treatment where rice plants in the experimental plots fertilized with NPK Phonska at 350 kg ha^{-1} and Urea at 180 kg ha^{-1} providing the highest profit of IDR 16,018,581.00 (Table 3). The best fertilizer dosage in this study need to be adapted to the condition of fertilizer available on this location. This is because some areas in the Province of West Kalimantan less available, even if there is relatively high (Department of Agriculture and Horticulture in West Kalimantan. 2016). In addition, rice yields in this area with a dosage of fertilizer used by farmers nor too low (3,936 kg ha^{-1} of dry grain). Increasing of rice yield in West Kalimantan, especially in the lowland can be done by adding fertilizer P because P available in the soil was very low. It was alleged fixation Al and Fe oxides are quite high in paddy soil (Abolfazli et al. 2012).

CONCLUSIONS AND RECOMMENDATIONS

1. Fertilization of NPK Phonska at 350 kg ha^{-1} and Urea at 180 kg ha^{-1} providing better results than the national recommendation fertilizer of NPK Ponska at 300 kg ha^{-1} and Urea 200 kg ha^{-1}, which can result in dry grain yield at 7.5 t ha^{-1} and make a profit of IDR 16,018,581.00.
2. Fertilization of NPK Phonska at 350 kg ha^{-1} and Urea at 180 kg ha^{-1} can be as a reference for fertilizer recommendation for rice field in the District Sengah Temila, Landak Regency, West Kalimantan Province.
3. The results of of this study can be used as a reference by PT. Petro Kimia Gresik to formulating fertilizer of NPK Ponska and as a fertilizer recommendations.

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