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The Effect of Urea and KCl Fertilization on the Growth and Results of Gogo Rice of Situ Pateggang Variety

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Abstract: Rice requires nitrogen for the growth of plant vegetative organs. Potassium plays a role in regulating the osmotic pressure and turgor pressure of plants, especially in a dry land. The purpose of this study was to determine the effect of varieties and nitrogen and potassium fertilization on the growth and yield of upland rice. The research was conducted in Bleberan Village, Kab. Gunungkidul and continued at the Laboratory of the Department of Agricultural Cultivation, Faculty of Agriculture, Gadjah Mada University. This study used a split-plot *design of three* replications. Planting The main plot is nitrogen fertilization which consists of no nitrogen fertilization (0 kg.ha^{-1} Urea), nitrogen fertilization according to the recommendation (350 kg.ha^{-1} Urea) and twice recommended nitrogen fertilization (700 kg.ha^{-1} Urea). Subplots potassium fertilization which consists of no potassium fertilization (0 kg.ha^{-1}), potassium fertilization according to the recommendation (225 kg.ha^{-1} KCl), and twice recommended potassium fertilization (450 kg.ha^{-1} KCL). This planting uses polybags, per plot there are 10 polybags containing 3 upland rice seeds. There were 9 treatment combinations, each of which was repeated three times. Analysis of the data using variance, then the Tukey test with a level of 5% was carried out. The results showed that Urea fertilization did not increase the total dry weight of the plant, the number of panicles and 1000 grain weight, and grain yield per clump. KCl fertilization with a dose of 60 g/plot (450 kg/ha) increased the total dry weight of the plant but did not increase the number of panicles and 1000 grain weight and plant yield.

Keywords: Fertilization; Nitrogen; Potassium; Rice Gogo

Introduction

The increase in population and people's income level has driven an increase in demand for food, especially rice. The need for rice continues to increase in line with the rate of population growth which is faster than the growth in available food production (Anggraini et al., 2013). Based on survey results using the Area Sampling Framework (KSA) method, in 2020 the rice harvest area is estimated at 10.66 million hectares or a decrease of 20.61 thousand hectares (0.19%) compared to 2019 (Rusdi et al., 2009; BPS, 2015).

The development of upland rice is one of the strategic steps to support and increase rice production nationally. Nationally, the planting area of upland rice from year to year has an average productivity of 2.3 tonnes/ha, compared to 4.3 tonnes/ha of paddy rice (Rusdi et al., 2009). Upland rice is very potential to be developed considering the dry land area which reaches 144.47 million ha, around 99.65 million ha (68.98%) is potential land for agriculture (Heryani and Rejekiningrum, 2019). Generally, farmers plant upland rice in watersheds (DAS), dry land between plantation crops that are not yet productive, and rain-fed areas or upland rancah.

The main obstacles to upland rice cultivation on this land are nutrient deficiencies, drought and pests, and disease attacks. One alternative to meet the needs of nutrients in the soil is through fertilization. Fertilization is one of the efforts made by humans to increase crop production per unit area of land. According to Brady et al. (2008) in fertilization practice when the essential elements (nitrogen, phosphorus, and potassium) are used in the right dosage, not only tend to control, and create a balance, support, and complement each other, but also other elements will be fulfilled. Ideally, the

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added elements complement the elements already available in the soil so that the amount of nitrogen (N), phosphorus (P), and potassium (K) available to plants becomes balanced. Based on the results of soil analysis at the study site, it showed that the nitrogen and potassium content was in low status, while the phosphorus content was in the moderate to a high category so the induction of nitrogen and potassium fertilization is important to do. Senjaya et al. (2018) stated that the use of nitrogen fertilizers can increase the height of rice plants of the Situ Patenggang variety. A similar statement was also made by Putra (2012), that the application of fertilizer, both the type and the dosage of fertilization, greatly affects the response of rice plants so that it has an impact on rice growth, especially on the height of the rice plant of the Situ Patenggang variety. Whereas IRRI (2007) explained that the element K is needed to move the products of photosynthesis in plants. A similar statement was also made by Inam et al. (2011) that the element potassium plays a role in the process of food translocation, cell extension, and protein formation.

Limited nitrogen and potassium elements in the soil will cause the plant's response to decreasing. 1) symptoms of element N deficiency will first appear on old leaves, the leaves turn yellow, causing plants to become stunted, reducing yields and dry weight, and 2) Element K deficiency symptoms will cause small necrotic spots on the veins with burnt shoots and margins on older leaves (Gardner et al., 1991). In sorghum plants, a deficiency of elemental N significantly reduces leaf area, total chlorophyll content, and photosynthetic rate thereby reducing plant dry weight (Zhao et al., 2005). Potassium element deficiency causes plants to be very sensitive to high irradiation levels, causing plants to quickly become chlorosis and necrosis when exposed to high light intensity (Cakmak, 2005). In addition to the existence of fertilization technology, the use of appropriate varieties is also one of the technologies that can increase the yield of upland rice on dry land. Based on these considerations, it is necessary to carry out research with the aim, especially the application of nitrogen and potassium nutrients. The technology package is very prospective for increasing rice yields in a dry land.

Method

Research conducted in RPH Menggoran, Hamlet Srikoyo, Village Bleberan, Districts Playen, Gunung Kidul, D.I. Yogyakarta from March to August 2021. Observations were made at the research location and the Laboratory of the Department of Agricultural Cultivation, Faculty of Agriculture, Gadjah Mada University.

The research materials were Situ Patenggang rice seeds, urea, SP-36, KCl, 80% acetone, and distilled water. The research tools are a photosynthetic analyzer type LI-6400 (Li-Cor), 21D spectronic meter, glass object, microscope, oven, and Leaf Area Meter. The research used a Split Plot Design with three replications. The main plot (main plot) is nitrogen fertilization consisting of no nitrogen fertilization (0 kg.Urea.ha-1), nitrogen fertilization according to the recommendation (350 kg.Urea.ha-1), and nitrogen fertilization twice the recommendation (700 kg.Urea.ha-1). Sub-plots were potassium fertilization consisting of no potassium fertilization (0 kg.KCl.ha-1), recommended potassium fertilization (225 kg.KCl.ha-1), and potassium fertilization twice the recommendation (450 kg. KCl. ha-1). There were 9 treatment combinations, each of which was repeated three times, so there were 27 treatment combinations. This planting uses polybags, per plot 10 polybags are planted with 3 upland rice seeds. The observed variables were plant height, root length, root surface area, relative growth rate, net assimilation rate, total dry weight, number of productive tillers, number of grains per panicle, and number of 1000 grains. Data analysis using variance was then carried out by the Tukey test with a level of 5%.

Result and Discussion

Plant Height

Plant height is a variable that can be measured simply. Plant height was also observed as an indicator of growth as well as a parameter to measure the influence of the environment or the treatment being tested (Table 1).

The ANOVA results on the plant height parameter did not show any interaction between Urea fertilization and KCl fertilization. Urea fertilization at 100-gram planting and Urea fertilization at 50-gram planting showed significant differences with no Urea fertilization. Urea fertilization can increase the height of rice plants.

During the vegetative growth period, plants need nitrogen in large quantities. Plants that get an adequate supply of N elements will form a wide enough leaf blade which has an impact on photosynthesis and produces assimilate thereby facilitating plant growth, including plant height.

KCl fertilization did not show any significant difference. This shows that KCl fertilization with various doses did not show a different effect on the height of the Situ Patenggang rice variety. Because the element K plays a more important role in regulating the osmotic pressure and cell turgor, it also plays a more important role in the growth and development of plant roots for the absorption of water and nutrients from the soil (Sutoro et al., 2015). Ispandi, (2003) also suggested that nutrient K is needed in the formation, enlargement, and elongation of tubers (roots). Dan Wijaya, (2008), suggested that the element Potassium plays a role in improving rice grains. This may be the reason that KCl fertilization with various doses did not significantly affect the plant height of the Situ Patenggang rice variety.

Table. 1. The Effect of Urea and KCl Fertilization on the Average Plant Height

Fertilization	Plant height (cm)
Dose Urea	
0 grams	52.44 b
50 grams	58.72 a
100 grams	61.05 a
Dose KCl	
0 grams	53.11 p
30 grams	57.55 p
60 grams	61.05 p
Interaction	(-)
CV	4.59

Description: Numbers followed by the same letter in the same column are not significantly different According to DMRT 5%. The sign (-) indicates no interaction between factors.

Root Length and Root Area

Roots are the main vegetative organs that supply water, minerals, and essential materials from the soil to plants as a source of food for plants. The role of roots in plants is as important as the canopy, the canopy functions to provide carbohydrates through photosynthesis, so the function of the roots is to provide nutrients and water needed in metabolism (Wijaya et al, 2008). Root length and root area (Table 2) are variables that affect the uptake of nutrients through the roots, the longer the roots and the wider the roots, the more likely it is that water and nutrients can be absorbed by the roots from the soil.

ANOVA results on the parameters of root length and root area did not show any interaction between Urea and KCl fertilization. Urea fertilization did not show any significant differences in the parameters of root length and root area. This is because the N element in Urea is an element that plays a greater role in the formation of chlorophyll in plant leaves. Urea fertilization with various doses did not show a significant difference between the parameters of root length and root area of the Situ Patenggang rice variety. As stated by Kurniawan (2017), that the element Nitrogen is one of the nutrients that is mobile toward the ends of plants, especially young leaves. KCl fertilization with 60 grams of planting showed a significant difference with 30 grams of KCl fertilization and without KCl fertilization. This is possible because the availability of potassium in the soil is very low, so only high doses of KCl can provide enough potassium in the soil for plant needs. Element K is needed by plants in the growth and development of roots in carrying out the absorption of water and nutrients for plants in supporting the process of plant growth and development. As stated by Iin et al. (2016) that K fertilization at a dose of 211 kg K2O ha-1 showed good results on the parameters of root length, the number of tubers, tuber diameter, and the number of economical tubers.

Table 2. Effect of Urea and KCl Fertilization on Average Root Length and Root Area

Fertilization	Root length (mm)	Root area (mm^2)
Dose Urea		
0 grams	2.667.6 a	3.249.2 a
50 grams	3.472.0 a	3.900.1 a
100 grams	4.016.5 a	4.513.3 a
Dose KCl		
0 grams	2.507.7 q	2.209.7 q
30 grams	2.456.2 q	2.709.8 q
60 grams	5.192.2 p	6.662.2 p
Interaction	(-)	(-)
CV	30.98	29.67

Description: Numbers followed by the same letter in the same column are not significantly different according to DMRT 5%. The sign (-) indicates no interaction between factors.

Net Assimilation Rate

The net assimilation rate is the rate of accumulation of dry weight per unit leaf area per unit of time and is a measure of the average photosynthetic efficiency of leaves in a population of rice plants as shown in Table 3.

Table 3. Effect of Urea and KCl Fertilization on Net Assimilation Rate

Fertilization	Net assimilation rate (g/cm2/a week)
Dose Urea	
0 grams	0.12 a
50 grams	0.11 a
100 grams	0.20 a
Dose KCl	
0 gram	0.13 a
30 grams	0.16 a
60 grams	0.14 a
Interaksi	(-)
CV	16.10

Description: Numbers followed by the same letter in the same column are not significantly different according to DMRT 5%. The sign (-) indicates no interaction between factors.

The results of ANOVA on the parameter of net assimilation rate did not show any interaction between Urea and KCl fertilization. Urea fertilization and KCL fertilization with various doses did not show significant differences in the net assimilation rate parameter. This shows that the Situ Patenggang rice plant can efficiently supply nutrients, water, sunlight, and CO2 which are absorbed by plants in the process of photosynthesis, resulting in no different amounts of assimilation.

Relative Growth Rate

The ability of upland rice plants to produce dry matter as a result of assimilation per unit initial plant dry weight per unit time is shown in Table 4.

Table 4. Effect of urea and KCl fertilization on the relative growth rate

Fertilization	Relative Growth Rate (g/g/a week)
Dose Urea	
0 grams	0.03 a
50 grams	0.04 ab
100 grams	0.05 b
Dose KCl	
0 grams	0.04 a
30 grams	0.04 a
60 grams	0.04 a
Interaction	(-)
CV	12.46

Description: Numbers followed by the same letter in the same column are not significantly different according to DMRT 5%. The sign (-) indicates no interaction between factors.

The ANOVA results on the relative growth rate parameter showed that there was no interaction between Urea fertilizer and KCl fertilization. Urea fertilization at a dose of 100 grams per plant showed significantly different results with no Urea fertilization, Urea fertilization at 50 grams per plant showed no significant difference with 100 grams of Urea fertilization per plant or without Urea fertilization. This shows that Urea fertilization can increase the relative rate of upland rice patenggang upland rice. These results are relevant to the average plant height with Urea fertilization which is shown in Table 1, which shows that Urea fertilization can increase the plant height of upland rice patenggang so that it affects the results of the relative growth rate which is shown in Table 4. KCl fertilization on the relative growth rate parameter showed no significant difference at all KCl fertilization doses. This shows that KCl fertilization with various doses did not have a different effect on the relative growth rate. These results are relevant to the average yield of plant height with KCl fertilization which is shown in Table 1, which shows that there is no significant difference between all doses of KCl fertilization and has an effect on the results of the relative growth rate.

Total Plant Dry Weight

The total plant dry weight is the total weight of the plants after being dried in an oven for 3 days at 80 ^{0}C until the weight is constant. So that only the results of the photosynthesis process and the components stored in plants remain, shown in Table 5.

ANOVA results on the total plant dry weight parameter did not show any interaction between Urea fertilization and KCl fertilization. Urea fertilization at 100-gram planting and Urea fertilization at 50-gram planting showed significant differences with no Urea fertilization. This happens because, with Urea fertilization, the Situ Patenggang rice variety will produce higher plant growth compared to those without Urea fertilization. As seen in the parameters of plant height (Table. 1), parameters of root length and root tapers (Table. 2), and parameters of the number of per panicle grain and 1000 grain weight (Table. 4), urea fertilization showed a higher value than without fertilization Urea. This happens because there is a correlation between the value of plant root weight, crown weight which is influenced by plant height, and grain weight of rice to the total dry weight of rice plants. So that if it is accumulated then Urea fertilization will produce a higher total value compared to without Urea fertilization. An increase in N uptake will be followed by an increase in plant growth which includes plant height, number of leaves, fresh weight, dry weight, and plant N content.

Table. 5. The effect of urea and KCl fertilization on the total dry weight of rice plants of the Situ Patenggang variety

Fertilization	Total dry Weight (grams)
Dose Urea	
0 grams	26.07 b
50 grams	31.75 a
100 grams	35.92 a
Dose KCl	
0 grams	19.60 q
30 grams	26.90 q
60 grams	47.24 p
Interaction	(-)
CV	21.00

Description: Numbers followed by the same letter in the same column are not significantly different according to DMRT 5%. The sign (-) indicates no interaction between factors.

KCl fertilization with 60 grams of planting showed a significant difference with 30 grams of KCl fertilization and without KCl fertilization. The total dry weight of Situ Patenggang rice plants is the accumulation of plant parts from the roots to the grains of rice. This can be seen in the parameters of plant height (table 1), root length (table 2), number of grains per panicle, and weight of 1000 grains (table 4). KCl fertilization showed the highest value so if it was accumulated it would affect the total dry weight of Situ Patenggang rice plants and give the highest value. The better the plant growth, the total dry weight of the plant will increase. The higher the total dry weight produced and followed by the ability of plants to distribute high assimilate will produce a high economic dry weight as well.

The results of ANOVA on the parameters of the number of productive tillers, the number of shoots per panicle, and the weight of 1000 grains did not show any interaction between Urea fertilization and KCl fertilization. Urea fertilization did not show any significant differences in the parameters of the number of productive tillers, the number of panicles per panicle, and the weight of 1000 grains. This happens because the application of urea fertilizer with a high N content does not affect the generative growth of plants and has more effect on plant vegetative growth. Morphologically, the element N plays a role in the formation of the vegetative part of the plant (Jamilah et al., 2012). So that there is no significant difference in the parameters of the number of panicles and the weight of 1000 grains on Urea fertilization.

KCl fertilization showed no significant difference in the number of productive tillers. KCl fertilization of 60 grams per planting and KCl fertilization of 30 grams per planting showed a significant difference with no KCl fertilization on the number of grains per panicle. This is also indicated by the parameter weight of 1000 grains, it can be seen that there is a significant difference between the 60-gram KCl fertilization treatment and 30-gram KCl fertilization without KCl fertilization. This happens because element K is an element that plays a very important role in activating enzymes that play a role in metabolism and biosynthesis. So that rice plants that get a sufficient supply of K elements will be able to produce a high number of panicles. This statement is also reinforced by research results by Maulana (2018), which states that the element Potassium can increase the number of permalai rice grains. As the data shown in Table 4, it can be seen that 60 g of KCl fertilization gives the highest value compared to 30 g of KCl fertilization. This is in line with the statement of Putra (2012), who suggested that the application of fertilizer, both the type and the dose of fertilization, greatly influenced the response of rice plants. Kurniawan (2017) stated that the yield of crop production is strongly influenced by the number of nutrients available in the soil that can be absorbed and utilized by plants. In addition, the type of elements contained in the fertilizer also greatly determines crop yields.

Table 6. The Effect of Urea and KCl Fertilization on the Amount of Permalai Grain and the Weight of 1000 Grains of Grain

Fertilization	Number of Productive Tiller	Number of Grain/Panivles	1000 Grams Weight
Dose Urea			
0 grams	5.66 a	81.67 a	18.88 a
50 grams	6.44 a	90.56 a	19.66 a
100 grams	9.00 a	83.22 a	20.22 a
Dose KCl			
0 grams	6.22 p	67.00 q	17.94 q
30 grams	6.66 p	89.00 p	20.38 p
60 grams	7.22 p	99.00 p	20.44 p
Interaction	(-)	(-)	(-)
CV			

Description: Numbers followed by the same letter in the same column are not significantly different according to DMRT 5%. The sign (-) indicates no interaction between factors.

Apart from being influenced by fertilization, other factors that also influence the production of Situ Patenggang rice are internal factors, namely genetic traits. As in the weight of 1000 grains, the average weight of 1000 grains of Situ Patenggang rice which is given fertilization according to the recommendation, namely with a dose of Urea 50 grams per plant shows a value of 19.66 grams of and KCl fertilization of 30 grams per plant shows a value of 20.38 grams. These results are not much different from the results of the study by Sitohang et al., (2014), which shows the average weight of 1000 grains of Situ Patenggang rice with a value of 19.48 grams. The results showed that Urea fertilization and KCl fertilization with twice the recommended dose showed higher values but did not show a significant difference between Urea fertilization and KCl fertilization according to the recommendations. When viewed from an economic perspective, Urea fertilization and KCl fertilization according to the recommendations are more appropriate to apply.

Conclusion

The results of the study showed that there was no interaction between the strainer and the application of Urea and KCl fertilization. Urea fertilization at 100 grams per plant and 50 grams per plant did not show any significant differences in all growth and yield parameters. The highest value is always shown by Urea fertilization with a dose of 100 grams. KCl fertilization with a dose of 60 grams was able to increase growth, namely root length (5192.2 mm), root area (66622 mm^2), total dry weight (47.24 grams), and increase yield, namely the number of grains per panicle (99 grains), and 1000 grain weight (20.44 grams).

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