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# DETERMINATION OF THE SUITABLE DOSAGE OF INORGANIC FERTILIZER TO INCREASE GROWTH AND YIELD OF THREE LOCAL GOGO RICE CULTIVERS

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## ABSTRACT

Fertilization is one of the important factor to increase production. The aim of this study was to determine the appropriate dosage of inorganic fertilizers to increase the growth and yield of three cultivars of upland rice. This research was conducted at the Center for Research and Development of Gogo Rice, Faculty of Agriculture, Tadulako University, Kalama, Tamarenja Village at an altitude of 180 to 250 above sea level with a latitude of 00º 26'51.5" South Latitude and 119º49'50.6" East Latitude, Sindue District, Donggala Regency, Central Sulawesi Province. The time of the research started from March to August 2020. This research was compiled and carried out using the factorial 2 factors Randomized Block Design (RBD) method. The first factor used three local upland rice cultivars, namely: Pae Bohe, Buncaili, and Uva Buya, while the second factor used six doses of inorganic fertilizers, namely: No fertilization, NPK fertilization 100 kg/ha, 200 kg/ha, 300 kg/ha, 400 kg/ha, and 500 kg/ha. There were 18 combinations, where each treatment was repeated three times so that there were 54 research units. Parameters observed included plant height, number of productive tillers, age of panicle appear, harvest age, number of panicle grains, percentage of empty grain, 1000 grain weight and production. The results showed that the Pae bohe cultivar with fertilization dose of 500 kg/ha produced the highest number of productive tillers (6.69 per clump), the lower percentage of grain pests (5.34%), and the highest production (3.82 tons/ha).

Keywords: Upland Rice, Growth and Yield, Inorganic Fertilizer.

## INTRODUCTION

National rice production has been sourced from lowland rice, where lately national rice production has decreased from year to year due to an increase in population and the multiplication of the function of paddy fields to non-rice fields, (Samudin, et al., 2020) . One alternative to increase national rice production is to utilize upland rice, because upland rice can grow and produce on marginal lands (Sarwanto, et al., 2018; Nuralam, et al., 2020).

The development of upland rice plants experiences many obstacles that can reduce the production and quality of rice

produced, including, nutrient deficiencies and excessive poisoning of Al and Fe nutrients, frequent water shortages or drought and many others. Given the many obstacles in the development of upland rice plants, efforts and real actions are needed to overcome these problems. One solution that can be done is through improving cultivation techniques, namely by applying balanced fertilization. This is important because the productivity of rice plants is largely determined by the intake of nutrients obtained by plants from the fertilizers given, (Rosa and Fitri, 2016).

NPK compound fertilizer is a mixed fertilizer that contains more than one type of plant nutrients (macro), especially N, P, and K, (Jufri and Rosjid, 2012; Fitriatin, et al., 2018). Giving compound fertilizer once can cover several elements so that it is more efficient in use when compared to a single fertilizer. NPK compound fertilizer has a different composition. Use NPK Mutiara compound fertilizer, for example, with the same composition, namely 16-16-16. The content of Mutiara NPK fertilizer is that the nutrient content is more complete, the application is more efficient in terms of labor, it is not too hydroscopic so that the soil is stored and does not quickly agglomerate, (Ambarita, et al., 2017; Kaya, 2013)

Based on that description, it is considered importan to carry out research on "Determination of the Right Inorganic Fertilizer Dosage to Increase the Growth and Yield of Three Local Upland Rice Cultivars" to be able to determine and recommend the right dose of inorganic fertilizer to increase the growth and yield of local upland rice.

## RESEARCH METHODS

This research was conducted at the Center for Research and Development of Upland Rice, Faculty of Agriculture, Tadulako University in Kalama area, Tamarenja Village at an altitude of 180 to 250 above sea level with a latitude of 00$^{o}$ 26'51.5" South Latitude and 119$^{o}$49'50.6" East Longitude, Sindue District, Donggala Regency, Central Sulawesi Province. Starting from March to August 2020.

The tools used consisted of machetes, sickles, hoes, spray guns, rulers, tape measure, cameras, stationery, label paper, and plastic bags. The materials used were upland rice cultivars Pae Bohe, Buncaili, Uva buya, Mutiara NPK fertilizer with a ratio of 16:16:16, Seprin Liquid Organic Fertilizer (POC), and insecticides.

This study was compiled and carried out using a factorial Randomized Block Design (RBD) method with 2 factors. The first factor used three local upland rice cultivars, namely: Pae Bohe, Buncaili, and Uva Buya, while the second factor used six doses of inorganic fertilizers, namely: No fertilization, NPK fertilization 100 kg/ha, 200 kg/ha, 300 kg/ha, 400 kg/ha, and 500 kg/ha. There were 18 treatment combinations, each treatment was repeated three times so that there were 54 experimental unit experiment.

The resulting data were analyzed using analysis of variance followed by the Honest Significant Difference Test at the 1% level to determine the differences produced by each treatment.

The research was carried out in several stages, namely: carrying out land clearing. Beds preparation with a size of 120 x 210 cm. Measure the planting distance and planting hole with a distance of 30 x 30 cm so that there are 28 planting holes or plant clumps. Planting with the TABELA system (Direct Seed Planting) as many as 5 seeds each hole.

Plants care namely cleaning weeds, fertilization given according to the treatment applied at the age of 3 WAP, a dose of 100 kg/ha is equivalent to 25.2 grams per bed or 0.9 grams per plant, a dose of 200 kg/ha is equivalent to 50.4 grams per bed or 1.8 grams per plant, the dose 300 kg/ha is equivalent to 75.6 grams of beds or 2.7 grams of planting, a dose of 400 kg/ha is equivalent to 100.8 grams of beds or 3.6 grams of planting, a dose of 500 kg/ha is equivalent to 126 grams of

beds or 4.5 grams of planting, fertilization is given by injecting beside seedling with a distance of 5 cm from the plant.

Measurements and observations include plant height observed measuring 5, 7, 9, 11, and 13 WAP, number of productive tillers aged 13 WAP, age of panicle appear and harvest age calculated when the plant has reached 85% panicle out and panicle harvested, the number of ungrained panicles is calculated after harvest by calculating the entire grain in one panicle, the percentage of empty grains is calculated after harvest by calculating the number of unfilled grains (empty grain) then percentage using the formula: Total Empty Grains/Total Grains x 100, the weight of 1000 grain was measured after harvest by weighing 1000 grain that was full for each treatment at a moisture content of 14%, the production of tons/ha was measured after harvest by weighing all the yields in each treatment at a moisture content about 14%.

## RESULTS AND DISCUSSION

### Plant height

The results of the analysis of variance showed that the application of various doses of fertilizer and three cultivars of upland rice and their interactions had no significant effect on plant height aged 5-14 WAP.

Figure 1. shows that the three cultivars used increase in plant height due to an increase in doses of up to 400 kg/ha. The results showed that at the age of 5 WAP, plants that were not fertilized produced the lowest plant height, namely 28.47 cm, after being fertilized at a dose of 400 kg/ha the plant height increased to 41.69 cm. At the age of 7 WAP, plants that were not fertilized produced the lowest plant height, namely 57.76 cm, after being fertilized at a dose of 400 kg/ha the plant height increased to 71.69 cm

At 9 WAP, plants that were not fertilized produced the lowest plant height, namely 99.49 cm, after being fertilized at a dose of 400 kg/ha the plant height increased to 122.43 cm. At 11 WAP, plants that were not fertilized produced the lowest plant height, namely 110.70 cm, after being fertilized at a dose of 400 kg/ha the plant height increased to 137.08 cm. At 13 WAP, plants that were not fertilized produced the lowest plant height, namely 137.28 cm, after being fertilized at a dose of 400 kg/ha the plant height increased to 169.45 cm.

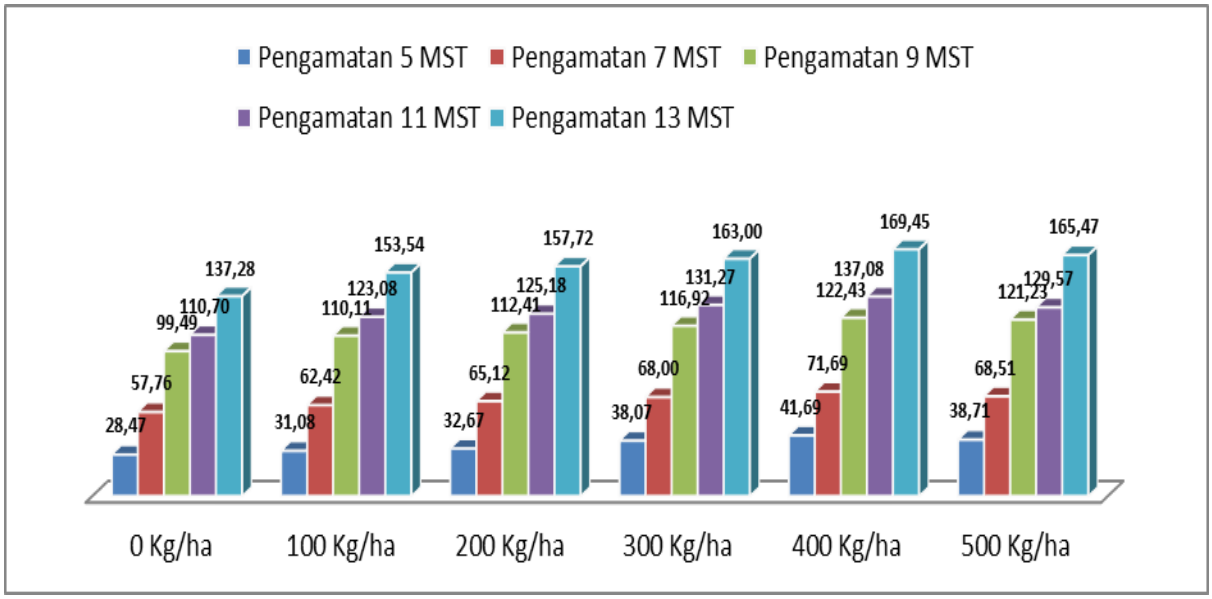


Figure 1. The average value of plant height at various doses of inorganic fertilizers

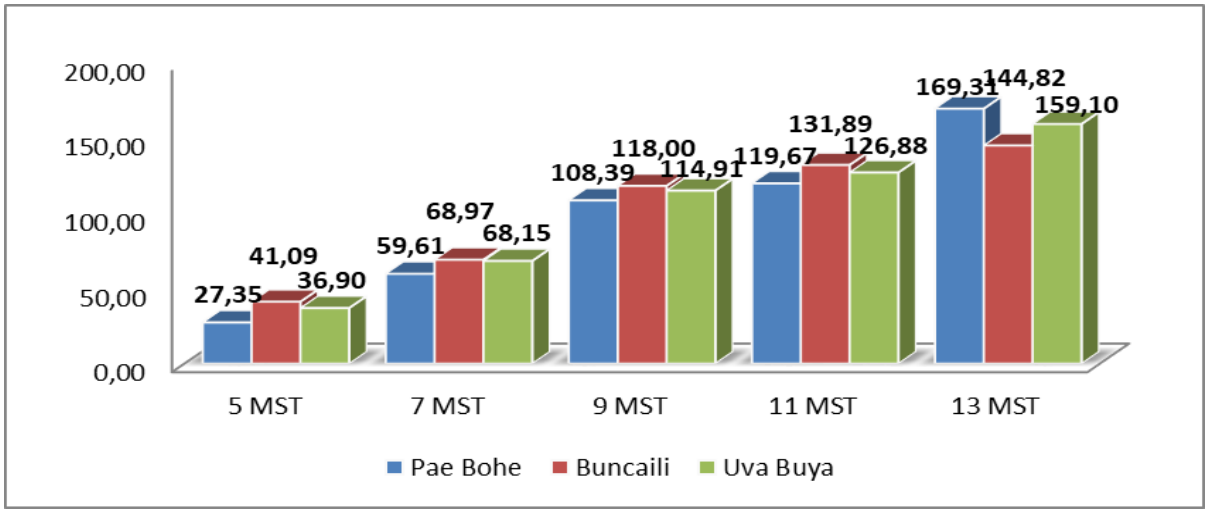


Figure 2. The average value of plant height in various cultivars of upland rice

Table 1. The average value of the number of productive tillers of three upland rice cultivars given various doses of inorganic fertilizers.

| Cultivar / Fertilier Dose | Pae Bohe | Buncaili | Uva Buya | HSD 1% |
|---|---|---|---|---|
| NPK 0 Kg/ha | $_{p}4.44^{b}$ | $_{p}2.63^{a}$ | $_{p}2.40^{a}$ | **0.94** |
| NPK 100 Kg/ha | $_{p}5.00^{b}$ | $_{pq}3.25^{a}$ | $_{pq}3.27^{a}$ | |
| NPK 200 Kg/ha | $_{pq}5.31^{b}$ | $_{pq}3.44^{a}$ | $_{q}3.44^{a}$ | |
| NPK 300 Kg/ha | $_{q}6.13^{b}$ | $_{pq}3.50^{a}$ | $_{q}3.47^{a}$ | |
| NPK 400 Kg/ha | $_{q}6.13^{b}$ | $_{q}3.63^{a}$ | $_{q}3.81^{a}$ | |
| NPK 500 Kg/ha | $_{q}6.69^{b}$ | $_{q}4.00^{a}$ | $_{q}3.79^{a}$ | |
| **HSD 1%** | | **0.94** | | |

Note: Numbers Followed By The Same Letters Do Not Show Differences And Numbers Followed By Different Letters Show Differences.

The results of the analysis of variance showed that the application of various doses of inorganic fertilizers had an effect on plant height. The results showed that the Buncaili cultivar produced the highest plant height at 5-11 WAP, but at 13 WAP the Pae Bohe cultivar produced the highest plant height.

**Number of Productive Tillers**

The results of the analysis of variance showed that cultivars, fertilizer doses, and their interactions had a very significant effect on the number of productive tillers.

The results of the HSD test at the 1% level showed that the Pae Bohe cultivar produced a higher number of productive tillers at a dose of 500 kg/ha (6.69 per clump) and was significantly different from the other cultivars, but not significantly different from the doses of 200 kg/ha (5.31 per clump), 300 and 400 kg/ha (6.13 clump). (Table 1).

**Age of Panicle Exit And Time to Harvest**

The results of analysis of variance showed that cultivars and fertilizer doses, as well as their interactions, had no significant effect on panicle exit and harvest age.

The results of the research shown in Figure 3 show that the Uva Buya cultivar

has a faster panicle exit and harvesting age (105 and 135 DAP) compared to the Pae Bohe and Buncaili cultivars.

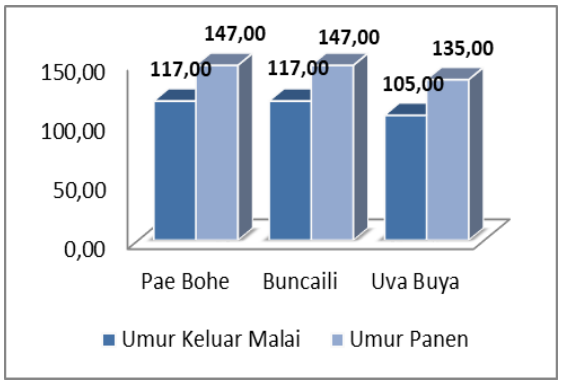


Figure 3. Average values of age of panicle appear and harvesting age of various upland rice cultivars.

**Number of Grain per panicle.** The results of the analysis of variance showed that cultivars, fertilizer dosages, and their interactions had a very significant effect on the number of grains per panicle.

HSD test results at 1% level showed that the Buncaili cultivar produced an average value of thenumber of grain per panicle that was higher at a dose of 500 kg/ha (227.75 grains) but was not significantly different from the cultivars Pae bohe (185.50 grains) and Uva buya (207.45 grains), and not significantly different from doses of 200 kg/ha (195.38 grains), 300 kg/ha (201.06 grains), and doses of 400 kg/ha (201.69 grains). (Table 2.)

**Percentage of Empty Grain**

The results of analysis of variance showed that cultivars, fertilizer doses, and their interactions had a very significant effect on the percentage of empty grain.

Table 2. The Average Value of The Number of Per Panicle Grain of Three Cultivars of Upland Rice to The Application of Various Doses of Inorganic Fertilizers.

| Cultivar / Fertilier Dose | Pae Bohe | Buncaili | Uva Buya | HSD 1% |
|---|---|---|---|---|
| 0 Kg/ha | $_{p}97.75^{a}$ | $_{p}141.75^{b}$ | $_{p}92.04^{a}$ | **46.72** |
| 100 Kg/ha | $_{pq}110.50^{a}$ | $_{pq}161.50^{b}$ | $_{q}153.25^{ab}$ | |
| 200 Kg/ha | $_{pq}125.75^{a}$ | $_{qr}195.38^{b}$ | $_{qr}179.92^{b}$ | |
| 300 Kg/ha | $_{q}138.50^{a}$ | $_{r}201.06^{b}$ | $_{qr}180.78^{ab}$ | |
| 400 Kg/ha | $_{r}183.00^{a}$ | $_{r}201.69^{a}$ | $_{r}205.54^{a}$ | |
| 500 Kg/ha | $_{r}185.50^{a}$ | $_{r}227.75^{a}$ | $_{r}207.45^{a}$ | |
| **HSD 1%** | | **46.72** | | |

Note: Numbers followed by the same letters do not show differences and numbers followed by different letters show differences.

Table 3. Average Empty Grain Percentage of Three Cultivars of Upland Rice Against Various Doses of Inorganic Fertilizers.

| Cultivar / Fertilizer Dose | Pae Bohe | Buncaili | Uva Buya | HSD 1% |
|---|---|---|---|---|
| 0 Kg/ha | $_{q}21.56^{a}$ | $_{r}44.18^{b}$ | $_{q}34.71^{ab}$ | **14.51** |
| 100 Kg/ha | $_{pq}15.78^{a}$ | $_{q}27.58^{ab}$ | $_{q}33.53^{b}$ | |
| 200 Kg/ha | $_{pq}11.34^{a}$ | $_{pq}18.53^{a}$ | $_{pq}25.67^{a}$ | |
| 300 Kg/ha | $_{pq}8.24^{a}$ | $_{pq}15.04^{a}$ | $_{pq}21.08^{a}$ | |
| 400 Kg/ha | $_{p}5.57^{a}$ | $_{pq}14.77^{ab}$ | $_{pq}20.58^{b}$ | |
| 500 Kg/ha | $_{p}5.34^{a}$ | $_{p}10.48^{a}$ | $_{p}15.29^{a}$ | |
| **HSD 1%** | | **14.51** | | |

Note: Numbers followed by the same letters do not show differences and numbers followed by different letters show differences.

Table 4. Average Weight Value of 1000 Grain of Three Cultivars of Upland Rice Against Various Doses of Inorganic Fertilizers.

| Cultivar / Fertilier Dose | Pae Bohe | Buncaili | Uva Buya | HSD 1% |
|---|---|---|---|---|
| 0 Kg/ha | $_{p}27.25^{a}$ | $_{p}26.16^{a}$ | $_{p}29.79^{b}$ | **2.00** |
| 100 Kg/ha | $_{q}30.00^{b}$ | $_{p}26.40^{a}$ | $_{pq}30.44^{b}$ | |
| 200 Kg/ha | $_{q}30.44^{b}$ | $_{p}27.15^{a}$ | $_{pq}31.06^{b}$ | |
| 300 Kg/ha | $_{q}30.46^{b}$ | $_{p}27.51^{a}$ | $_{pq}31.62^{b}$ | |
| 400 Kg/ha | $_{q}31.38^{b}$ | $_{p}27.56^{a}$ | $_{pq}31.79^{b}$ | |
| 500 Kg/ha | $_{q}31.44^{a}$ | $_{q}31.99^{a}$ | $_{q}31.80^{a}$ | |
| **HSD 1%** | | **2.00** | | |

Note: Numbers followed by the same letters do not show differences and numbers followed by different letters show differences.

Table 5. The Average Production Values of tons/ha of Three Cultivars of Upland Rice with Various Doses of Inorganic Fertilizers.

| Cultivar / Fertilier Dose | Pae Bohe | Buncaili | Uva Buya | HSD 1% |
|---|---|---|---|---|
| 0 Kg/ha | $_{p}0.98^{a}$ | $_{p}1.90^{b}$ | $_{p}2.55^{b}$ | **0.77** |
| 100 Kg/ha | $_{pq}1.55^{a}$ | $_{pq}2.26^{a}$ | $_{pq}3.32^{b}$ | |
| 200 Kg/ha | $_{q}1.99^{a}$ | $_{pq}2.43^{a}$ | $_{pq}3.32^{b}$ | |
| 300 Kg/ha | $_{q}2.62^{a}$ | $_{q}2.76^{ab}$ | $_{q}3.45^{b}$ | |
| 400 Kg/ha | $_{r}3.60^{a}$ | $_{q}2.91^{a}$ | $_{q}3.60^{a}$ | |
| 500 Kg/ha | $_{r}3.82^{a}$ | $^{q}3.28^{a}$ | $_{q}3.70^{a}$ | |
| **HSD 1%** | | **0.77** | | |

Note: Numbers Followed By The Same Letters Do Not Show Differences And Numbers Followed By Differen Letters Show Differences.

HSD test results at 1% level showed that Pae bohe cultivar produced a lower average percentage of empty grain at a dose of 500 kg/ha (5.34%) but was not significantly different from Buncaili (10.48%) and Uva buya (15.29%) cultivars, and not significantly different from doses of 100 kg/ha (15.78%), 200 kg/ha (11.34%), 300 kg/ha (8.24%), and doses of 400 kg/ha (5.57%).

**Weight 1000 Grain**

The results of the analysis of variance showed that the cultivars and fertilizer doses, as well as their interactions, had a significant effect on the weight of 1000 grain.

HSD test results at 1% level showed that the Buncaili cultivar produced an average weight value of 1000 grain which was heavier at a dose of 500 kg/ha (31.99 g) but was not significantly different from the Pae bohe cultivars (31.44 g) and Uva buya (31.80 g), but significantly different from other doses. (Table 4.)

**Production**

The results of the analysis of variance showed that cultivars, fertilizer doses, and their interactions had a very significant effect on the production of tonnes/ha. HSD test results at 1% level showed that the Pae bohe cultivar produced higher average production values at a dose of 500 kg/ha (3.82 tons/ha) but was not significantly different from the Buncaili cultivar (3.28 tons/ha), and Uva buya ( 3.70 tons/ha), and not significantly

different from the dose of 400 kg/ha (3.60 tons/ha). (Table 5.)

**Discussion**

The results showed that the higher the dose of inorganic fertilizer given (dose of 500 kg/ha), the growth and yield also increased and the percentage of empty grain decreased. This indicates that the application of inorganic fertilizer at a dose of 500 kg/ha is the best dose and can meet the needs of upland rice plants for growth and production.

Compound NPK inorganic fertilizer has balanced macronutrients, especially Nitrogen (N) which functions to assist plant vegetative growth, Phosphorus (P) and Potassium (K) elements which function to assist plant development mainly to produce production, (Siska and Ismon, 2019; Pradita, et al., 2017). Giving high doses of inorganic fertilizers causes a lot of nutrients available to plants, and vice versa if the application of fertilizers is low, the nutrient content available to plants is also low (Wahyuni, et al., 2015). This can be seen from the results of the study that applying inorganic fertilizer at a dose of 500 kg/ha produced the highest plant height, the highest number of productive tillers (6.69 tillers), the highest number of panicle grains (277.75 grains), the less percentage of empty grain (5.34 %), the heaviest 1000 grain weight (31.99 grams) and higher production (3.82 tons/ha).

The results of the study (Hasmi, et al., 2020) found that applying high doses of NPK fertilizer (300 kg/ha) produced the highest plant height (128.44 cm), the highest number of tillers 12.07, the highest number of panicles per clump (12.07 panicles), and the highest production (5.78 tons/ha).

The results also show that each cultivar has a different response to the given dose of inorganic fertilizer. This indicates that each cultivar has a number of genetics that are different from other cultivars so that different growth and yields can be seen between one cultivar and another at the same dose (Mustakim, et al., 2019; Samudin, et al. , 2021; Chong, et al., 2021; Maemunah, et al., 2021)

The results of the study (Nazirah and Damanik, 2015) found that there were differences in the characteristics of the three upland rice varieties, namely Impago 4, 5, and 8 when using the same dose of fertilizer, including the characteristics of plant height, number of panicles, and panicle length.

The properties of plants are influenced by 2 factors, namely genetics and the environment, where if genetics is more dominant in influencing a trait, then that trait will not experience significant changes if the growing environment changes. Conversely, if environmental factors are more dominant in influencing a trait, that trait will also change if the growing environment also changes (Slamet and Rajab, 2021; Aesomnuk, et al., 2021).

This can be seen from the results of research where the Pae Bohe cultivar produced relatively the same percentage of empty grain at a dose of 100 kg/ha at a dose of 500 kg/ha, and 1000 grain weight at a dose of 100 kg/ha at a dose of 500 kg/ha. The Buncaili cultivar produced relatively the same number of productive tillers at a dose of 100 kg/ha at a dose of 500 kg/ha, number of panicle grains at a dose of 200 kg/ha at a dose of 500 kg/ha, percentage of empty grain at a dose of 200 kg/ha at a dose 500 kg/ha, production at a dose of 100 kg/ha to 500 kg/ha. Uva Buya cultivars produced relatively the same number of tillers at a dose of 100 kg/ha at a dose of 500 kg/ha, the number of panicle grains at a dose of 200 kg/ha at a dose of 500 kg/ha, the percentage of empty grain at a dose of 100 kg/ha at a dose of 500 kg/ha, 1000 grain weight at a dose of 100 kg/ha at a dose of 500 kg/ha, and relatively the same production at a dose of 100 kg/ha at a dose of 500 kg/ha.

The results of the study (Nazirah and Damanik, 2015) found that the three impago varieties in the treatment without the application of inorganic fertilizers, and the doses of 150 kg/ha and 250 kg/ha gave results that were not significantly different

in the characteristics of plant height, number of panicles, panicle length, 1000 grain weight and dry grain yield.

The Pae Bohe cultivar also has changing properties which are caused by the application of different fertilizer doses, including the number of productive tillers at a dose of 0-100 kg/ha, relatively the same characteristics, then at a dose of 100-200 kg/ha and at a dose of 300- 500 kg/ha, number of grains per panacle 0-200 kg/ha then 100-300 kg/ha and 400-500 kg/ha, production tons/ha at doses of 0-100 kg/ha then 100-300 kg/ha, and 400-500 kg/ha.

The application of various doses of inorganic fertilizers did not have a significant effect on the aging of panicle shoots and harvesting age, but the results showed that Uva Buya cultivars aged relatively faster than Pae bohe and Buncaili cultivars. This is because the Uva Buya cultivar has the characteristics of a panicle outage and a faster harvest age compared to the Pae bohe and Buncaili cultivars, (Hariyati and Sabarudin, 2021; Chaniago, et al., 2022; Tiwari, et al., 20

## CONCLUSION

Pae bohe cultivar with fertilization dose of 500 kg/ha produced the highest number of productive tillers (6.69 per clump), less percentage of grain weeds (5.34%), and highest production (3.82 tons/ha).

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