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Test of Water Hyacinth Bokashi and Plant Growth Regulator on Black Rice Plants

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Abstract

Water hyacinth is a type of plant that grows in freshwater environments. This plant is an ideal raw material to produce bokashi which increases the availability of soil nutrients. To maximize the function of the water hyacinth bokashi, a growth regulator is used to encourage plant upatake of soil nutrients. This study aimed to examine the single effect and interaction between water hyacinth bokashi (BHW) and plant growth regulators (PGR) on black rice. Data were analyzed with a factorial randomized block design. The first factor is WHB (B) 0 t ha^{-1} and 2 t ha^{-1}, while the second factor is PGR (Z) 0 ppm and 1.5 ppm. The results showed that the best effect of grain weight per hectare was treatment with WHB 2 t ha^{-1}, PGR 1.5 ppm, and their interactions were 10.34 t ha^{-1}; 11.09 t ha^{-1}, and 12.16 t ha^{-1} harvested dry rice

Keywords: black rice, plant growth regulator, water hyacinth

A. Introduction

Water hyacinth is a wild plant that is abundant in freshwater, such as rivers, reservoirs, and especially lakes. Sometimes, the existence of water hyacinth interferes with the activities of fishermen who work in freshwater to support their families. According to (Asrijal, A. Muin Pabinru, 2005) water hyacinth can be used as an organic material in the production of fertilizer, for instance as the main material for compost or bokashi which is believed to help reduce the use of inorganic fertilizers. The results of another study on the use of water hyacinth as bokashi in intercropping systems on soybeans, corn, and upland rice (Asrijal, Yunus Musa, Ambo Upe, Bachrul Ibrahim, 2018) revealed that the best production results were soybean, corn, and upland rice intercropping and are a better farm income.

According to (La Karimuna, Nini Mila Rahni, 2016), bokashi increases production of corn and peanut, seed dry weight, and weight per 100 seeds. Bokashi caused differences in plant height, number of leaves, stem diameter, cob weight, number of seed rows, and yield of Sweet corn variety sweet Boy in the Integrated Crop Management system (Rommy Andhika Laksono, Nurcahyo Widyodaru Saputro, 2018). Bokashi is able to significantly increase seed yield per plant on soybeans (Sumadi Sumadi, Denny Sobardini Sobarna, Pujawati Suryatmana, Meddy Rachmadi, 2018), plant height, number of leaves, leaf width, plant fresh weight, plant fresh weight per plot, and fresh weight per hectare, bokashi made from water hyacinth obtained the best results for pakchoy plants (Rahmawati, 2020).

Basically, physiological engineering using cytokinins can be an option to stimulate the growth of lateral branches and shoots and break shoot dormancy (Anjarsari, I. R. D., Hamdani, J. S., Victor Zar, C. S., Nurmala, T., Sahrian, H., & Rahadi, V. P., 2018). PGR from sweet corn contains auxin in the form of IAA (27.9303 ppm); gibberellins (442.8318 ppm); and cytokinins in the form of Kinetin (34.5724 ppm) (Asrijal, Elkawakib Syam'un, Yunus Musa, 2018a). The results demonstrated that PGR derived from sweet corn yielded significant results. The growth and production components of shallots and shallots with high adaptability are shallots of the Bima variety (Asrijal, Elkawakib Syam'un, Yunus Musa, 2018b).

The addition of 200 ml of young coconut into the culture medium gave the best in vitro chrysanthemum growth in terms of shoot and root formation, number of shoots, number of roots, and shoot height in all chrysanthemum varieties; and all observed characters have high heritability and genetic diversity (Bdr, 2018). Giving organic matter as a source of PGR with a frequency of one time was better in increasing the fresh weight of mangosteen seedlings than the frequency of two or three times with a weight difference of 0.47 g (12.71%). The development of Mangosteen seedling root was enhanced by a single application of sprout extract, wheras two or three onion extract were required (Berlintina, D., Karyanto, A., Rugayah, & Hidayat, K. F., 2020). The concentration of POH significantly affected the fresh weight of tubers per plot, while the concentration of growth regulators significantly affected the number of bulbs per plot and the yield of shallots by 8.09 t ha^{-1} (Asrijal, 2021).

Pigmented rice such as black rice contains bioactive compounds that have the potential as a functional food source - having the following characteristics: total phenolic compound content 261.7 - 353.0 mg GAE/100 g bk, anthocyanins 52.4 - 126.1 mg/100 g bk, starch 69.8 - 72.8% bk, amylose 22.4 - 26.1% bk (Arifa, A. H., Syamsir, E., & Budijanto, S., 2021). Black rice in relation to its nutraceutical properties and role in reducing non-communicable diseases. Another study described the diversity of locally pigmented rice and its potential to reduce the risk of hyperlipidemia, hyperglycemia, and for cancer prevention (Rarastoeti Pratiwi and Yekti Asih Purwestri, 2017). The use of the chemical mutagen colchicine as a material to induce polyploidy in plants provides an opportunity to increase the production of black rice, which has historically had low yield. Due to the numerous health benefits of black rice, consumer demand has increased (Prabawa & Purba, 2019). In addition, the characteristics of black rice included a range of 15.8 to 24.9 productive tillers per clump, an early harvest age between 115.2 and 121.9 days after sowing, and a yield greater than 5.4 tons ha^{-1} (Kuncoro, D., Sani, M., Bambang Sapta Purwoko, Dewi, I. S., Suwarno, W. B., Maharijaya, A., & Widajati, E., 2021). Therefore, the application of water hyacinth bokashi and growth regulators derived from sweet corn extract is anticipated to increase the growth and yield of black rice. This study aimed to determine the effect of using water hyacinth bokashi and plant growth regulators in increasing black rice production.

B. Methology

The research was carried out from June to December 2021 in Asorajang Village, Tanasitolo District, Wajo Regency. The materials utilized were growth regulators (PGR) derived from sweet corn extract, black rice seeds, NPK fertilizer, molasses (sugar water from Camming Sugar Factory), EM4, bran, cow dung, water hyacinth, and water. The tools used are a 5-liter bucket of water, soil used for the 2020 season of rice cultivation, an electric scale, a 50-liter water basin (a container for making bokashi), a safety net, a semi-automatic knapsack sprayer, a measuring cup, a syringe, a camera, and notebook.

Data analysis with factorial randomized design with 2 factors, factors 1 are water hyacinth bokashi (WHB) 0 tons ha^{-1} (B0); water hyacinth bokashi (WHB) 2 tons ha^{-1} (B1), Factor 2 are growth regulators (PGR) 0 ppm (Z0); growth regulator (PGR) 1.5 ppm (Z1), then repeated 5 times, so the number of experimental units is 20 units.

Each research unit uses a 5-liter bucket of water. Seedlings were planted 35 days after sowing (DAS) in buckets filled with corn and water hyacinth bokashi (WHB) according to treatment doses (0 tons ha^{-1} and 2 tons ha^{-1}) with a bucket spacing of 20 cm x 20 cm. NPK fertilizer was applied to each bucket with a fertilization dose of 200 kg ha^{-1} one week after planting (WAP). Application of growth regulators (PGR) 5 times, starting at 2, 3, 4, 5, and 6 weeks after planting (WAP), according to treatment doses (PGR 0 ppm and PGR 1.5 ppm). Pests and diseases are controlled according to rice cultivation standards.

Growth observations were plant height measured before harvest, number of tillers counted before harvest, panicle length, number of pithy grains per panicle, number of not pithy grains per panicle, number of total grains per panicle, weight of 1,000 pithy grains. Productivity was obtained from the conversion of grain weight per bucket into weight of grain per hectare and dry milled grain (GKG). GKG is calculated based on the formula from (BPS, 2018) namely GKG = GKP x 0.8381. Harvesting was done when 80% of the panicles had turned yellow in each experimental unit and then observations were made. Analysis of the data using Analysis of Variance, if there is a significant effect then proceed with the Analysis of Honestly Significant Difference (HSD) with a confidence level of 5%. Calculation of Analysis of Variance and HSD Test was carried out with Microsoft Excel 2013 software.

C. Result

Plant Height

The results of the variance of plant height per bucket before harvest (128 days after planting) showed that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract had a significant effect, while the interaction treatment had no significant effect. The results of the HSD test at the 5% level in Table 1 demonstrate that the single treatment of WHB at a dose of 2 t ha^{-1} (b1) and PGR extracted from sweet corn at a dose of 1.5 ppm (z1) produced the highest plant heights, respectively (119.00 and 119.60 cm). While the best treatment interaction was the interaction of WHB at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1), the average yield was 125.40 cm (Figure 1).

Table 1. The average plant height in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (cm)

WHB	Average value	different value	HSD (α = 0,05)
B0	110,10	***a***	4,39
B1	119,00	***b***	
PGR	Average value	different value	HSD (α = 0,05)
Z0	109,50	***a***	4,39
Z1	119,60	***b***	

Note: Numbers followed by the same letter are not significantly different in HSD α = 0,05

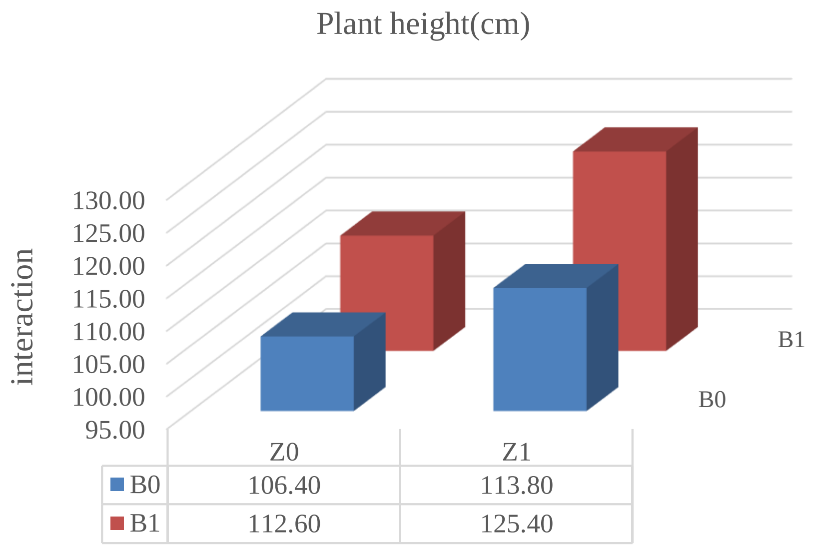

Figure 1. **The average plant height in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (cm)**

Number of tillers

The results of the variance in the number of tillers per bucket before harvest (128 days after planting) depict that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract had a significant effect, while the interaction treatment had no significant effect. The results of the 5% HSD test in Table 2 show that the single treatment of WHB at a dose of 2 t ha^{-1} (b1) and PGR extracted from sweet corn at a dose of 1.5 ppm (z1) produced the highest number of tillers, respectively (29.64 and 28,32 tillers). While the best treatment interaction was the interaction of WHB at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1), resulting in a total of 31.92 tillers (Figure 2).

Table 2. **The average number of tillers in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on the production of black rice (tillers)**

WHB	Average value	different value	HSD (α = 0,05)
B0	23,52	***a***	0,14
B1	28,32	***b***	
PGR	**Average value**	**different value**	**HSD (α = 0,05)**
Z0	22,20	***a***	0,14
Z1	29,64	***b***	

Note: Numbers followed by the same letter are not significantly different in HSD α = 0,05

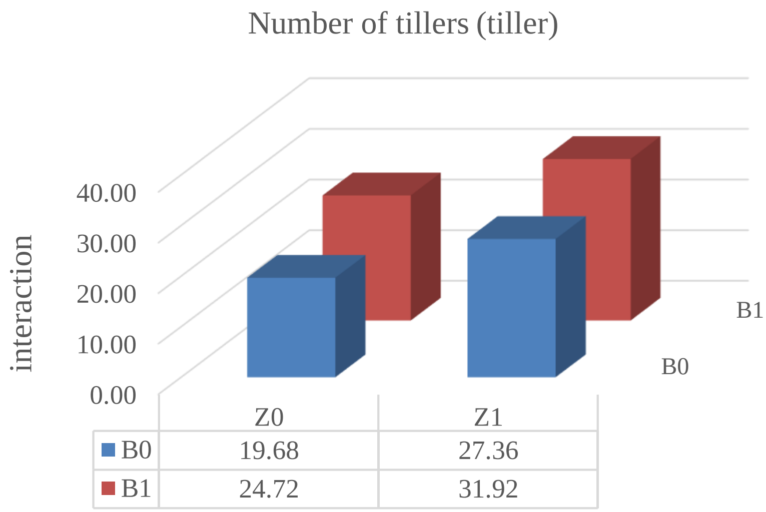

Figure 2. The average number of tillers in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on the production of black rice (tillers)

Panicle length

The results of the variance on panicle length per bucket after harvest (128 days after planting) revealed that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract and their interactions had no significant effect. The best average panicle length (Figure 3) was obtained at the interaction of WHB treatment at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1) resulting in the highest panicle length (26.86 cm).

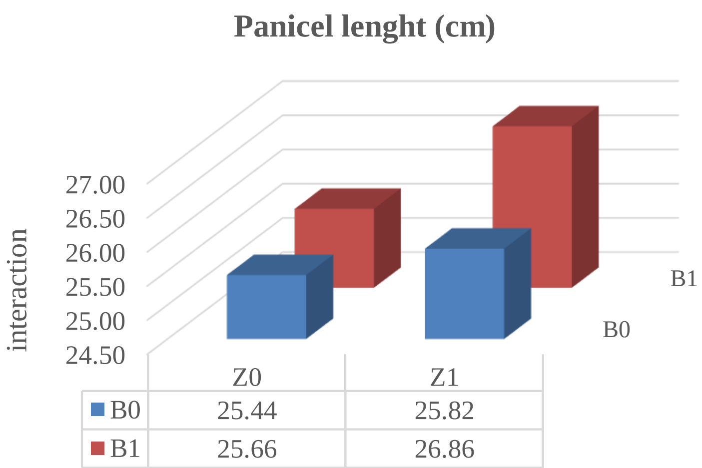

Figure 3. Average panicle length in the treatment of water hyacinth bokashi (WHB) and growth regulator (PGR) from sweet corn extract on black rice production (cm)

Number of pithy grains

The results of the variance of the number of pithy grains per panicle after harvest (128 days after planting) indicated that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract and their interactions had no significant effect, but The best average for the number of pithy grain (Figure 4) was obtained at the interaction of WHB treatment at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1) resulting in the highest amount of pithy grain (102.06 grains).

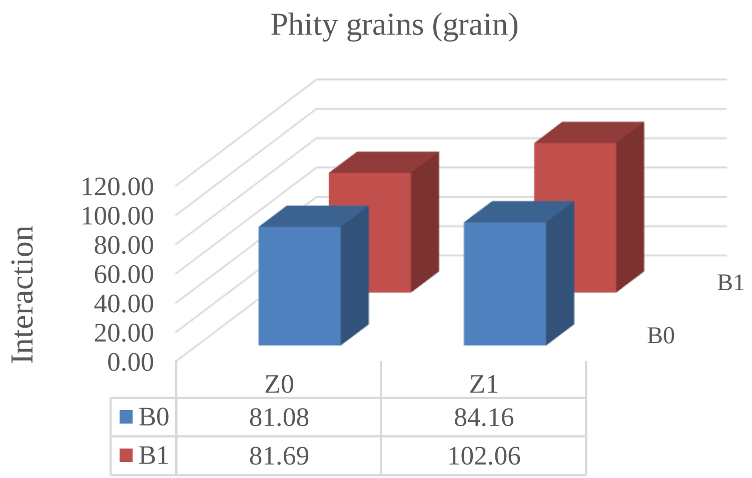

Figure 4. The average number of pithy grains in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on the production of black rice (grain)

Number of not pithy Grain

The results of the variance in the number of not pithy grains per panicle after harvest (128 days after planting) discovered that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract, and their interactions gave no significant effect. The best average number of pithy grain (Figure 5) was obtained at the interaction of WHB treatment at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1) resulting in the highest amount of pithy grain (28.96 grain).

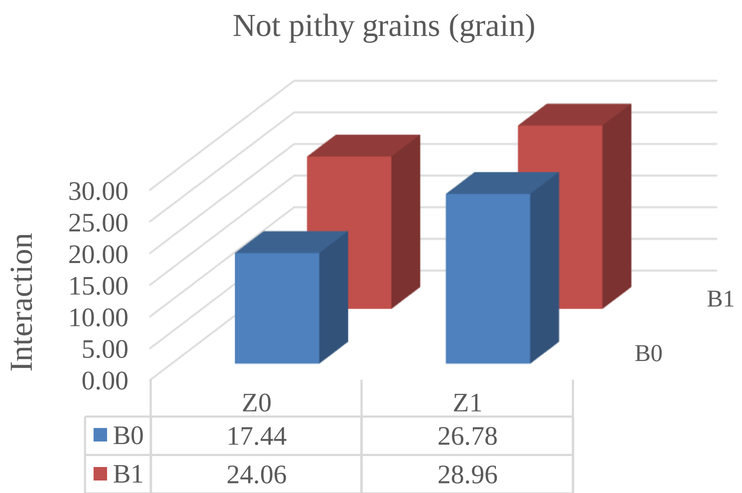

Figure 5. The average number of not pithy grains in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (grain)

Weight of 1000 grains(g)

The results of the variance of 1000 grains per bucket after harvest (128 days after planting) confirmed that the interaction treatment of water hyacinth bokashi (WHB) with growth regulators (PGR) from sweet corn extract had a significant effect. The results of the HSD test at the 5% level in Table 3, show that the treatment of WHB at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1) produced 1000 grains of grain with the highest number (34.80 g) and The lowest yield was obtained at a dose of 0 t ha^{-1} WHB treatment with PGR extracted from sweet corn at a dose of 0 ppm (b0z0) producing 1000 grains (25.60 g).

Table 3. Average of 1000 grains in the treatment of water hyacinth bokashi (WHB) and growth regulator (PGR) from sweet corn extract on black rice production (g)

Interaction	Average value	different value	HSD (α = 0,05)
B0Z0	25,60	b	2,09
B0Z1	34,40	a	
B1Z0	34,00	a	
B1Z1	34,80	a	

Note: Numbers followed by the same letter are not significantly different in HSD α = 0,05

Grain weight per bucket (g)

Table 4. Average grain weight in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (g)

WHB	**Average value**	**different value**	**HSD (α = 0,05)**
B0	52,10	***a***	13,37
B1	64,60	***b***	
PGR	**Average value**	**different value**	**HSD (α = 0,05)**
Z0	47,40	***a***	13,37
Z1	69,30	***b***	

Note: Numbers followed by the same letter are not significantly different in HSD α = 0,05

The results of the variance of grain weight per bucket after harvest (128 days after planting) revealed that the single treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract had a significant effect, while the interaction treatment had no significant effect. The results of the HSD test at the 5% level in Table 4, show that the single treatment of WHB at a dose of 2 t ha^{-1} (b1) and PGR extracted from sweet corn at a dose of 1.5 ppm (z1) resulted in the highest grain weight respectively (64.60 and 69.30 g). While the best treatment interaction was the interaction of WHB at a dose of 2 t ha^{-1} with PGR extracted from sweet corn at a dose of 1.5 ppm (b1z1), resulting in a grain weight of 76.00 g (Figure 6)

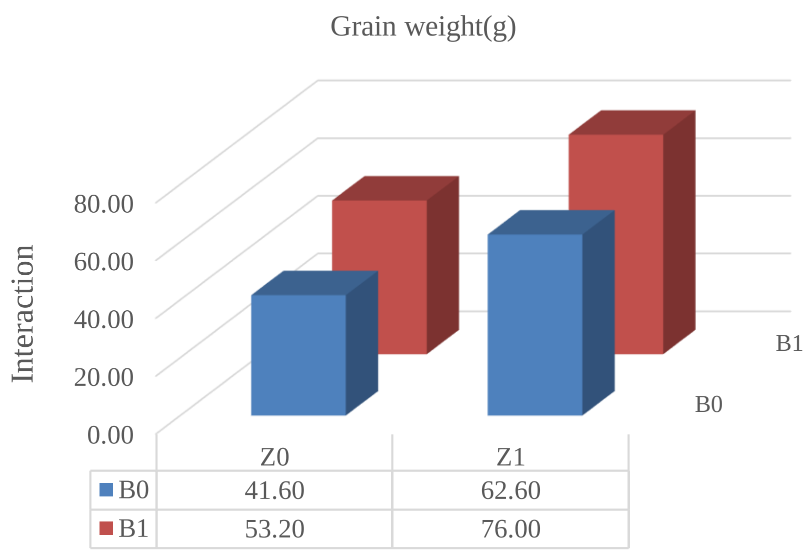

Figure 6. Average grain weight in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (g)

D. Discussion

Water hyacinth is a type of plant that grows in freshwater waters with contents including 1.681% N, 0.275% P, 14.286% K, 37.654% C, with a C/N ratio of 22.399, Remosova, 1999 (Asrijal, A. Muin Pabinru, 2005); therefore, it is an ideal raw material for bokashi production to increase the availability of soil nutrients. To maximize the function of water hyacinth bokashi, growth regulators are employed to stimulate plant uptake of soil nutrients. The experimental results of water hyacinth bokashi (BEG) and growth regulators (PGR) from sweet corn extract produced the highest plant heights of 119.00 and 119.60 cm, respectively (Table 1). The treatment also produced the highest number of tillers 28.32 and 29.64, respectively (Table 2), and resulted in the highest grain weight of 69.30 and 64.60 g, respectively (Table 4). Furthermore, the interaction between BEG dose 2 t ha^{-1} with PGR, extracted from sweet corn at a dose of 1.5 ppm (b1z1), obtained the most weights of 1000 grains (34.80 g), whereas the lowest yield was obtained at BEG treatment at a dose of 0 t ha^{-1} with PGR extracted from sweet corn at a dose of 0 ppm (b1z1) resulted in a weight of 1000 grains (25.60 g) (Table 3). This was because the content of BEG and PGR had a significant effect on plant height, the number of tillers, and grain weight. While the interaction between BEG and PGR was significant at the weight of 1000 grains. According to (Jayaningsih, E. D., Suwarno, W. B., Nindita, A., & Aswidinnoor, D. H., 2020), the characteristics of panicle length, number of secondary branches, and grain density per primary branch have a significant direct correlation and influence on the character of the total number of grains per panicle. According to (Rahmawati, 2020), plant height, number of leaves, leaf width, plant fresh weight, plant fresh weight per plot, and fresh weight per hectare, treatment with water hyacinth bokashi obtained the best results.

Rice Cempo Ireng has the peak viscosity and the highest breakdown viscosity (Arifa et al., 2021). Colchicine with a concentration of 750 ppm was effective in inducing mutations causing phenotypic changes in most plant characters in both genotypes (Prabawa & Purba, 2019). Characteristics of the number of productive tillers per clump from 15.8 to 25.9, early harvest age from 115.2 to 121.9 days after sowing, and productivity >5.4 t ha^{-1} (Kuncoro et al., 2021). The use of BEG with PGR resulted in a sifnificant improvement with a production of 76.00 g per bucket, or 12.16 t ha^{-1} of harvested dry grain.

E. Conclution

The best yield of water hyacinth bokashi (BEG) treatment obtained an average production per bucket of 64.60 g, if converted to hectares, the yield was 10.34 tons ha^{-1} (planting distance 25 x 25 cm). The best yields of growth regulators (PGR) treatment obtained an average production per bucket of 69.30 g, if converted to hectares, the yield was 11.09 tons ha^{-1} (planting distance 25 x 25 cm). The best yield of the interaction between growth regulators (PGR) and water hyacinth bokashi (BEG) resulted in an average production per bucket of 76.00 g, if converted to hectares, the yield was 12.16 tons ha^{-1} (planting distance 25 x 25 cm).

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