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Effect of Giving Tofu Dregs Bokashi on Phosphate Dynamics in Ultisols

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Abstract

Ultisols are soil types that are poor in nutrients, one of which is element P, where this nutrient is needed by plants in large quantities. In Ultisols, P nutrients are bound by Al, so the availability of P nutrients for plants is low. Giving organic matter is one way to speed up the process of soil amelioration. Tofu waste is organic waste that contains nutrients and can be used as organic fertilizer that can help improve soil nutrients. Tofu dregs contain organic N, P, K, Ca, Mg, and C which have the potential to increase soil fertility. This study aims to determine the effect of tofu pulp bokashi application on the dynamics of phosphate in Ultisols soil and to obtain the best dose of tofu pulp bokashi on the availability of phosphate in Ultisols soil. The method used in this study was a 1-factor Completely Randomized Design (CRD) with 6 (six) levels of treatment with 3 (three) replications in order to obtain 18 experimental units. Treatment P0 was without giving bokashi, P1 was P fertilizer 200 $kg.ha^{-1}$, P2 was bokashi tofu dregs 12 $t.ha^{-1}$, P3 was bokashi tofu dregs 24 $t.ha^{-1}$, P4 was bokashi tofu dregs 12 $t.ha^{-1}$ and fertilizer P 200 $kg.ha^{-1}$, P5 namely bokashi tofu dregs 24 $t.ha^{-1}$ + fertilizer P 200 $kg.ha^{-1}$. The results of this study showed that the administration of tofu dregs bokashi had a significant effect and the best dose was obtained for increasing pH and available P by giving bokashi tofu dregs 24 $t.ha^{-1}$ and P fertilizer 200 $kg.ha^{-1}$. The best dose to reduce Al-dd is by giving bokashi tofu dregs 24 $t.ha^{-1}$ and P fertilizer 200 $kg.ha^{-1}$

Keywords: P2O5, phosphorous, Al-dd, compost, waste tofu

A. Introduction

One of the materials that can be used as raw material for making bokashi fertilizer is tofu waste, both solid and liquid waste. The waste produced by the tofu factory in the form of soybean husks, dregs, and tofu water can still be used as useful products. In the tofu processing process, waste will be produced in the form of tofu dregs which if not handled immediately can cause an unpleasant odor (Ridayanti, 2011). Tofu pulp contains 43.8% protein, 0.9% fat, 6% crude fiber, calcium 0.32%, phosphorus 0.67%, magnesium 32.3 mg/kg and other ingredients. Tofu dregs which is still fresh cannot be used directly as organic fertilizer. For utilizing tofu dregs, which can be used as a basic material for fertilizers organic in the form of compost (Krisman, 2016).Tofu dregs contain organic N, P, K, Ca, Mg, and C which have the potential to increase soil fertility. The elements contained in organic fertilizer tofu waste are very good plays an important role in growth that plays a role in the formation or growth of the vegetative parts of plants, such as leaves, stems and roots, important in the formation of leaf green matter in the process of photosynthesis, and increase microorganisms in the soil (Sunarsih F., Yetty H dan, Aseptianova, 2018).Under these conditions, the provision of bokashi tofu dregs can increase the organic matter content of the soil and play a role in improving the physical, chemical, and biological properties of the soil, especially in terms of the availability of nutrients for plants.

Soil that is poor in nutrients is Ultisols, especially nutrient P, this nutrient is needed by plants in large quantities. In Ultisols, P nutrients are bound by Al, so the availability of P nutrients for plants is low. The addition of organic matter to the soil is one of the corrective actions for Ultisols. According to Tan (2010), the addition of organic matter is one of the efforts that can be used to overcome nutrient problems in the soil. Organic materials in the decomposition process will release organic acids that can bind Al and form complex compounds, so that Al becomes insoluble. The organic material that can be applied to Ultisols soil is tofu pulp bokashi. Due to the limited information about application of tofu bokashi to the Ultisols, it needs more study to investigate the effect of its application to the soil chemical reaction. Therefore, this study aims to determine the effect of tofu dregs bokashi application on changes in phosphate in Ultisols.

B. Methodology

1. Research Methods

The study was carried out in July – October 2021. This study was arranged in a Completely Randomized Design (CRD) with 1 (one) factor with 6 (six) levels of treatment with 3 (three) replications therefore consist of 18 experimental units. The treatments in this study were P0 = Control (without giving bokashi), P1 = Fertilizer P 200 kg.ha-1, P2 = Bokashi tofu dregs 12 t.ha-1, P3 = Bokashi tofu dregs 24 t.ha-1 , P4= Bokashi tofu dregs 12 t.ha-1 and fertilizer P 200 kg.ha-1, P5= Bokashi tofu dregs 24 t.ha-1 + fertilizer P 200 kg.ha-1.

A total of 5 kg of Ultisols soil from Banjarbaru Region, South Kallimantan, was sieved with a 2 mm diameter then put into polybags. Then, tofu dregs bokashi was added which was made with a mixture of 70 kg of fresh tofu dreg, 10 kg bran, 1 kg brown sugar, and 150 ml EM-4 which was composted for 21 days. The soil was incubated for 2 weeks and observed for pH, Al-dd, P2O5 every week. The soil chemical properties before incubation were pH 5.3, available P 12.25 mg.100g-1, and exchangeable-Al 0.94 mg.100g-1. All the soil chemical analysis based on Balai Penelitian Tanah (2009).

2. Data Analysis

The data obtained were analyzed for variance analysis of variance (ANOVA) and further test using Duncan Multiple Range Test (DMRT) with 95% confidence level.

C. Result

1. Soil pH

Giving bokashi tofu dregs showed an increase in soil pH from the observations of weeks I to II, both pH H2O (actual) and pH KCl (potential), although based on statistical tests it did not show a significant difference between treatments.

Table 1. Soil pH 1-2 weeks

Treatment	pH H_2O		pH KCl	
	1	2	1	2
P0	5.3a	5.3a	3.7a	3.7a
P1	5.1a	5.2a	3.9ab	4.0ab
P2	5.7a	5.8a	3.8a	3.8a
P3	5.6a	5.7a	4.3cd	4.5c
P4	5.2a	5.3a	4.1bc	4.3bc
P5	5.6a	5.6a	4.6d	4.6c

Notes: Numbers followed by the same letter show that they are not significantly different based on the 5% DMRT test. P0 = Control, P1 = P 200 $kg.ha^{-1}$ fertilizer, P2 = bokashi 12 $t.ha^{-1}$, P3 = bokashi 24 $t.ha^{-1}$, P4 = bokashi 12 $t.ha^{-1}$ and P 200 kg fertilizer. ha^{-1}, P5= bokashi 24 $t.ha^{-1}$ + fertilizer P 200 $kg.ha^{-1}$.

2. Available-P

Giving tofu dregs bokashi was able to increase available P than without tofu dregs bokashi administration (P2 & P3 VS P0). The combination of bokashi tofu dregs at a dose of 24 $t.ha^{-1}$ + P fertilizer 200 $kg.ha^{-1}$ was also able to increase the available P of the soil compared to the application of P fertilizer alone.

Available-P

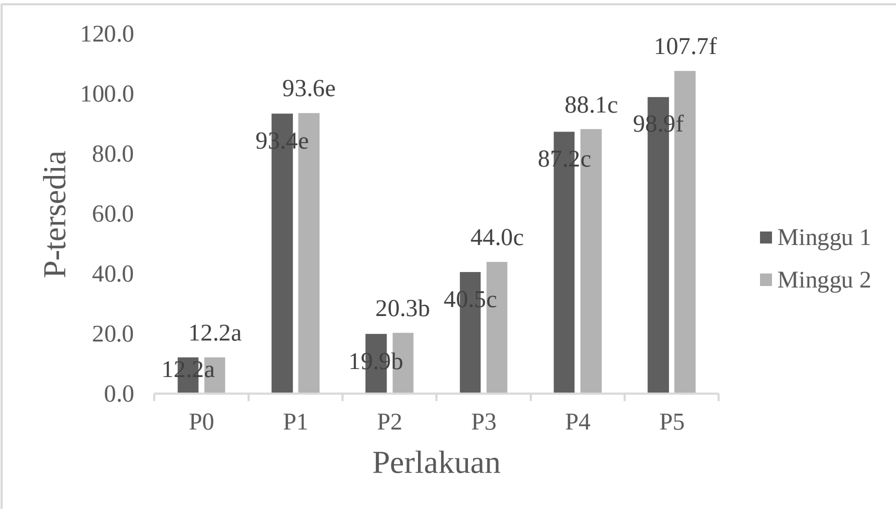

Figure 1. P-tersedia 1-2 weeks

Notes: Numbers followed by the same letter show that they are not significantly different based on the 5% DMRT test. P0 = Control, P1 = P 200 kg. ha^{-1} fertilizer, P2 = bokashi 12 $t.ha^{-1}$, P3 = bokashi 24 $t.ha^{-1}$, P4 = bokashi 12 $t.ha^{-1}$ and P 200 kg fertilizer. ha^{-1}, P5= bokashi 24 $t.ha^{-1}$ + fertilizer P 200 $kg.ha^{-1}$.

3. Exchangeable-Al

Giving bokashi tofu dregs was able to reduce Al-dd at week II compared to control. The combination of bokashi tofu waste 24 $t.ha^{-1}$ with P 200 $kg.ha^{-1}$ fertilizer showed the lowest Al solubility. The application of P 200 $kg.ha^{-1}$ fertilizer can also reduce soil Al-dd.

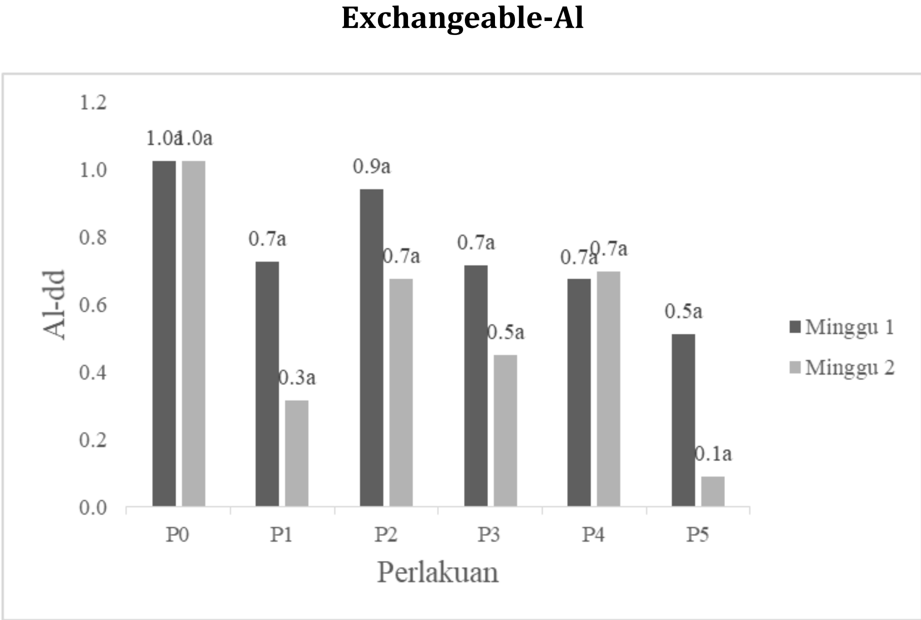

Figure 3. Al-dd 1-2 weeks

Notes: Numbers followed by the same letter show that they are not significantly different based on the 5% DMRT test. P0 = Control, P1 = P 200 $kg.ha^{-1}$ fertilizer, P2 = bokashi 12 $t.ha^{-1}$, P3 = bokashi 24 $t.ha^{-1}$, P4 = bokashi 12 $t.ha^{-1}$ and P 200 kg fertilizer. ha^{-1}, P5= bokashi 24 $t.ha^{-1}$ + fertilizer P 200 $kg.ha^{-1}$.

D. Discussion

According to research by Danial M, Taufieq NAS, dan Sanusi W. (2008), the change of soil pH was caused by the low acidity level of tofu pulp bokashi so that when soil with a low pH is mixed with bokashi tofu pulp with a high pH, it causes a neutral pH or alkaline pH. Thus, the tofu dregs bokashi has sufficient potential to reduce the acidity of Ultisols soil so that the soil becomes suitable soil for growing plants. Changes in soil pH are also caused by the nutrient content in the soil and its availability is quite fast. Provision of nutrients from bokashi tofu dregs is sufficient in providing the needs of the soil. Solid organic fertilizer has slow release properties, meaning that the nutrients in the fertilizer will be released slowly and continuously over a certain period of time. This shows that the pH of the soil will increase slowly over a certain period of time until a neutral pH is reached. The addition of organic matter can increase the pH value of the soil, because organic matter has the ability to bind Al3+ metal, so that the Al3+ hydrolysis reaction does not occur, where from the Al3+ hydrolysis reaction 3 H+ ions are produced which can acidify the soil (Nariratih I, Danamik M M B, Sitanggang G., 2013).

The application of tofu dregs bokashi can increase available-P significantly, this is due to the effect of increasing pH and decreasing soil Al-dd. According to Adiningsih, S. and Rochayati (1988), stated that organic matter applied to the soil can increase the availability of phosphorus and soil pH. According to Tan (1991), this significant change occurred due to the presence of Al which still binds P and causes P to be unavailable. Phosphorus becomes difficult to dissolve in the soil so that P is difficult to be available, this happens because of high amounts of Fe and Al oxide clays, especially highly weathered soils such as Ultisols and Oxisols in the tropics, the clay reacts quickly with Phosphorus to form a series of Phosphorus hydroxy difficult to dissolve. The increased availability of P in the soil was thought to be due to the addition of organic matter, namely bokashi tofu waste. According to Hakim, N. M. Y. Nyakpa., A. M. Lubis., S. G. Nugroho., M. R. Saul., M. Diha., G. B. Hong., dan H. H. Bailey (1986), the effect of organic matter on P availability can be directly through mineralization or indirectly by assisting the release of fixed P. This is reinforced by Fox TR, Commerford NB, McFee WW. (1990), which states that the decomposition products of organic matter in the form of organic acids can form chelation bonds with Al and Fe ions, thereby reducing the solubility of Al and Fe ions, thereby increasing the availability of P is increasing. The increase in available-P soil due to the provision of tofu dregs bokashi is still in the low category according to the soil characteristics criteria by the soil research center (2009).

The increase in available P in the soil was due to the tofu dregs bokashi composed of organic matter capable of producing organic acids that could bind metals such as Al and Fe so that P binding was reduced and made available in the soil.

The decrease in Al-dd on Ultisols that was applied to bokashi tofu dregs occurred due to a chemical reaction between tofu dregs and the soil, this also had an effect due to an increase in pH. According to Siregar (2017), in his research, he stated that organic matter applied to the soil produces organic acids that can chelate free Al^{3+} in the soil, so that the exchangeable Al^{3+} decreases. There is a relationship between Al-dd on pH and P-available soil, namely with an increase in soil pH, Al-dd will decrease so that P-available increases. The results showed that there was a decrease in Al-dd levels and an increase in P-available soil after adding tofu dregs bokashi. This generally occurs because of the decomposition process which then produces humic and fulvic acids so that the bound P can be released. Organic matter added to the soil through the decomposition process will produce a lot of organic acids containing phenolic acid and carboxylic acid derivatives (Wahjudin, 2006).

E. Conclusion

Bokashi tofu dregs can increase soil P availability and soil pH. In addition, tofu dregs bokashi was able to lower Al-dd so that P was more available.

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Genetic Diversity *Hopea celebica* an Indonesian endemic species by ISSR Marker

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Abstract

Indonesia is a mega-diversity country with numerous endemic plants distributed throughout its regions. An Indonesias' island with the unique and the highest endemic plant species due to being located in the Wallace area is Sulawesi Island. *Hopea celebica*, an endemic species to Sulawesi Island, is currently categorized as endangered by IUCN. Here, we selected the ISSR primers suitable for the genetic study of *H. celebica* from Luwu and Konawe provenances and investigated their genetic diversity. Ten ISSR primers were employed in primer screening, and fifty *H. celebica* individuals were genetically analyzed for their genetic diversity. The selected ISSR primers for genetic diversity analysis were UBC 810, UBC 813, UBC 814, UBC 820, UBC 822, UBC 823, and UBC 827. The evaluated

H. celebica individuals have high genetic diversity, and this information will be beneficial for designing *H. celebica* breeding and conservation strategies

Keywords: dominant marker, endangered plant, genetic variation

A. Introduction

Indonesia is a mega-diversity archipelago country with high genetic diversity distributed throughout its area. An Indonesias' island with high and unique endemic species flora, and Fauna, is Sulawesi Island, located in a transitional area between Asia and Australia continents (Wallace area) (Sutrisna, T., Umar, M. R., Suhadiyah, S. & Santosa, S., 2018). IUCN states *Hopea celebica* is endemic species to Sulawesi, which is classified as endangered due to fragmentation of population and habitat destruction. This species has been utilized for construction materials, cosmetics, and chocolate (Sudarmonowati. E., Yulita, K. S., Partomihardjo, T., & Wardani, W., 2020).

Propagation of *H. celebica* is commonly performed by seed (generative). The seeds are harvested from the trees; meanwhile, the seedlings are obtained around the adult trees. They must be planted immediately after being harvested because the seeds' viability will significantly decrease if stored long term (Wulandari, A. S., Subiakto, A. & Novan, R., 2015).

Tree breeding is an effort that generates genetic improvements to increase yields, both in quality and quantity, from generation to generation. These programs can be well directed by implementing appropriate breeding strategies based on morphological and genetic diversity to gain improved trees (Gusmiaty, Restu, M., & Ira, P., 2012). Genetic diversity is an influential factor in establishing tree breeding strategies. The genetic characteristics of a tree species grown in an area or different provenances can be distinct, indicated by the nature and peculiarities of a stand. Stands or provenances with good genetic characteristics can be a valuable source for tree breeding activities (Langga, I. F., Restu, M., & Kuswinanti, T., 2012).

Molecular analysis is one of the strategies that can be employed to reduce the breeding cycles (Langga et al., 2012). DNA-based molecular techniques have been widely developed and utilized as practical tools for analyzing plant genomes. Inter Simple Sequence Repeat (ISSR) is a most common molecular marker, which is usually mononucleotide, dinucleotide, or trinucleotide, and the part of the microsatellite that does not code for proteins (non-coding region) (Widiastuti, A., Sobir. & Suhartanto, M. R., 2013). ISSR marker compensates for the limitations of Random Amplified Polymorphic DNA (RAPD) technique, as ISSR is more sensitive in detecting genetic diversity at low level and as simple and cost-effective as RAPD (Bradford, 2008). ISSR markers have been extensively utilized in several forestry species, including *Gmelina arborea*, *Pinus gerardiana* and *Aquilaria* spp (Azhari, H., Azhar, M., & Othman, R., 2015). Studying genetic diversity in *H. celebica* using ISSR markers will be beneficial in the breeding process; thus, it is necessary to determine the genetic diversity of this species in Luwu and Konawe Provenances.

B. Methodology

1. Plant Materials

The samples used were 50 leaves of *H. celebica*. from Luwu (33) and Konawe (17). The samples were a collection from Biotechnology and Tree Breeding Lab, Faculty of Forestry, Universitas Hasanuddin.

2. DNA Extraction

DNA isolation was performed using CTAB (*Cetyl Trimethyl Ammonium Bromide*) method. The DNA extraction were used CTAB method. As many as 0.2 g of each leaf sample without leaf venation were ground until powder and stored in 1.5 ml of microtube. The 700 µl CTAB extraction buffer was added into each microtube to separate DNA from other components and vortexed for 15 seconds. Microtubes were incubated in a water bath at 65°C for 90 minutes. Each sample that had been incubated was added 100 µl of isoamyl alcohol: chloroform (24:1), mixed slowly and then centrifuged at 10,000 rpm for 5 minutes. The supernatant was transferred to a new microtube and 800 µl of isopropanol was added to remove the remaining salt content. The solution was then centrifuged at 10,000 rpm for 10 minutes and the DNA precipitate was dried overnight. The DNA precipitate obtained was purified by adding 500 µl of 1x TE buffer, then centrifuged for

10 minutes at 10,000 rpm. The supernatant was transferred into a new 2 ml microtube and 100 µl chloroform was added. The supernatant solution was then centrifuged at 10,000 rpm for 10 minutes. The supernatant was collected, then added 100 µl sodium acetate and 800 µ1 isopropanol, then centrifuged for 10 minutes at 10,000 rpm. The solution was discarded, and the precipitate was dried overnight, then added 100 µl Buffer TE and stored in a freezer at - 20°C.

3. Amplification of ISSR markers and Primer screening

The selected primers are polymorphic primers that produce clear bands. Different primers and DNA samples in the same condition were required to acquire the optimal condition and variation level of the generated bands from each primer. As much as 10 primers were screened to analyze genetic diversity of *H. celebica* (Table 1).

Table 1. ISSR Primer Name and The Nucleotide Sequence

No.	Primer Name	Nucleotide sequence (5'-3')	Melting Temperature (°C)
1	UBC 810	CTC TCT CTC TCT CTC TT	45,4
2	UBC 813	CTC TCT CTC TCT CTC TA	45,7
3	UBC 814	GTG TGT GTG TGT GTG TC	44,7
4	UBC 820	TCT CTC TCT CTC TCT CA	51,0
5	UBC 822	TCT CTC TCT CTC TCT CC	47,0
6	UBC 823	TCT CTC TCT CTC TCT CG	48,1
7	UBC 824	ACA CAC ACA CAC ACA CG	48,5
8	UBC 827	TGT GTG TGT GTG TGT GG	53,0
9	UBC 830	GAA GAA GAA GAA GAA GAA	52,7
10	UBC 868	GAG AGA GAG AGA GAG AT	43,2

Source: (Kalpana *et al.,* 2012)

The primer screening was conducted by randomly selecting 12 DNA samples and 12 gradient temperatures to determine the accurate primer temperature for DNA amplification. A PCR reaction consisted of 3 µl of working DNA, 1.25 µl primer, 6.25 µl PCR Mix Kappa, and 3 µl DDH2O with 13.50 µl of total reaction. DNA amplification was performed using a PCR machine with the following process: a cycle of initial denaturation at 95°C for 180 seconds, 35 cycles of denaturation at 95°C for 30 seconds, specific primer annealing (the annealing temperature was adjusted to each primer) for 50 seconds, primer elongation at 72°C for 60 seconds, and final elongation at 72°C for 300 seconds, and storage at 4°C.

4. Electrophoresis

The procedure of electrophoresis was: 3.6 grams of agarose was added 180 ml of 1 x TAE buffer and heated at the microwave for 5 minutes, the dissolved agarose was added 1.5 µl gelred and then left until cool down, the solution was poured into the agarose mold and set a comb on it until the agarose became harden, the comb was removed, and then the agarose was put into a tank containing 1 x TAE buffer solution, the DNA samples were inserted into the agarose wells with the ladder at each edge well, the electrophoresis was performed for 60 minutes at 120 volts, and the agarose was visualized in the gel documentation system.

5. Data Analysis

The results were displayed on the agarose in the form of DNA bands. The bands represent alleles at a locus, and each primer used represent a locus. The appeared band is scored as 1 based on its band length, and the absent band is given 0 by manually observing the bands on agarose. The data were then tabulated and analyzed using Darwin 6.5 software to determine the relationship and genetic variation level of the individuals. Heterozygosity was calculated by:

Heterozygosity: $qi = \left(\frac{\text{The individuals with absent allele}}{\text{total sample}}\right)^{1/2}$

$Pi = 1 - qi$

$He = 1 – (pi^2 – qi^{2)}$

Notes: qi = Frequency of absent allele

Pi = frequency of dominant allele

*Polymorphic information content (*PIC) was calculated by (Guo, 2014):

$$PIC = 2 fi (1- fi)$$

Notes: PIC = *polymorphic information content*

Fi = Frequency of the allele

C. Findings and Discussion

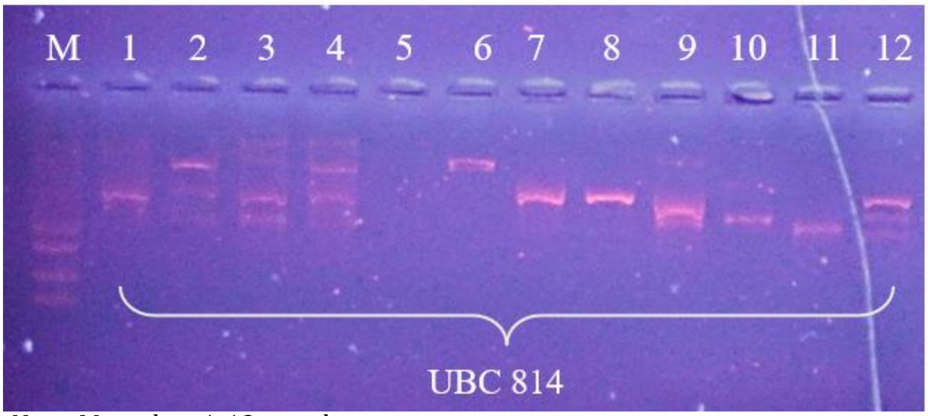
1. Primer screening

Primer screening of 10 ISSR primers on 12 evaluated DNA samples obtained seven polymorphic primers, which generated clear bands, UBC 810, UBC 813, UBC 814, UBC 820, UBC 822, UBC 823, and UBC 827 (Figure 1).

One of the primers that produced clear and polymorphic bands was UBC 814. In order to study genetic diversity, polymorphic primers which generate clear, bright, and polymorphic bands are required (Larekeng, S. H., Restu, M., & Gusmiaty. 2015). Polymorphic bands are not present in all samples (Sinaga, A., Lollie, A. P. P. & Mbue, K. B. 2017). A high percentage of polymorphic bands suggests that each sample examined has high variation, and the number of amplified polymorphic bands is varied. The more polymorphic bands produced, the simpler it is to observe the variation (Larekeng, S. H., Paelongan, R., Cahyaningsih, Y. F., Nurhidayatullah, & Restu, M., 2020a).

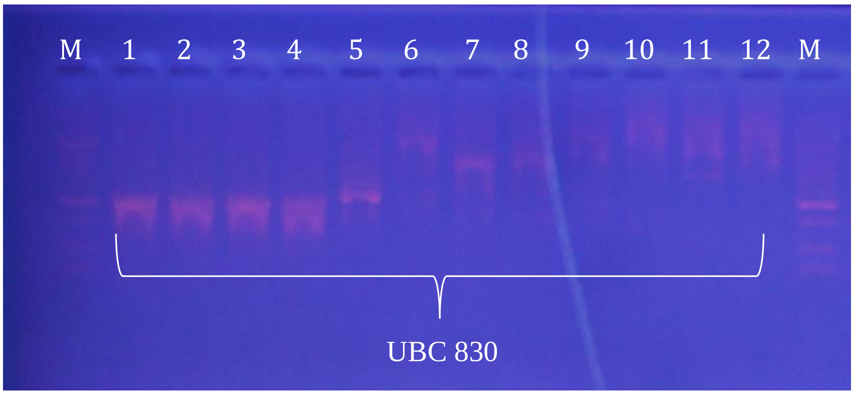
The smear/unclear bands with UBC 824, UBC 830, and UBC 868 are presented in Figure 2. UBC 830, as shown in Figure 2, is a primer that produced less clear and smear bands which caused the primer could not be used for further analysis. (Larekeng *et al.*, 2020a) reported low quality of the PCR amplification might be affected by the unmatched primer to the DNA samples, PCR efficiency, and process.

The distribution of nucleotide base positions in the genome where the primer attached causes variation in the size of DNA bands or polymorphisms in amplified DNA bands. Differences in the profile of amplified DNA bands or variation, particularly the number and size of the bands, are crucial in identifying population diversity (Gusmiaty, Restu, M., & Ira, P., 2012).



Note: M marker, 1-12 sample

Figure 1. Electroforegram of PCR amplification using ISSR UBC 814 primer



Note: M marker (100 bp), 1-12 sample

Figure 2. Electroforegram of PCR amplification using ISSR UBC 830 primer

The suitable ISSR primer will also create higher and more informative polymorphic DNA bands, which is notably valuable for genetic diversity studies (Rohela, G.K., Phanikanth, J., Mir, M.Y., Aftab, A.S., Pawan, S., Sadanandam, A., Kamili, A.N., 2020). Table 2 displays ISSR primer screening and Polymorphic Information Content (PIC) in *H. celebica*. The PIC was calculated manually from the overall PCR amplification scoring and tabulated into Polymorphic Information Content (PIC) formula.

Table 1. ISSR primer name, number of amplified bands and PIC of *Hopea celebica*

No.	Primer Name	*Annealing* Temperature (°C)	Number of Amplified Bands	Note	PIC	
					Luwu	Konawe
1	UBC 810	50.4	12	Polymorphic	0.4	0.5
2	UBC 813	47.4	11	Polymorphic	0.3	0.3
3	UBC 814	41.9	11	Polymorphic	0.2	0.3
4	UBC 820	55.5	12	Polymorphic	0.4	0.4
5	UBC 822	48.7	12	Polymorphic	0.4	0.4
6	UBC 823	45.3	11	Polymorphic	0.3	0.4
7	UBC 827	56.7	12	Polymorphic	0.5	0.5

Table 2 shows that seven ISSR primers had polymorphic bands with 41 to 57 °C of annealing temperatures. The primer attached to DNA template is called annealing, and the number and nucleotide sequence of the primer determine the annealing temperature of the primer (Suryanto 2003). The annealing temperature generally ranges from 36°C to 72°C with a 30-45 second annealing duration. By either deducting or adding 5 °C to the Tm, the annealing temperature of a primer can be optimized (Handoyo dan Rudiretna. 2000).

The success of DNA amplification is controlled not only by the primer sequence but also by the PCR conditions, including the primer annealing temperature. Gusmiaty et al. (2012) explained that the annealing temperature in the PCR process has a significant impact on the primer attachment process, with even a one-degree change in the temperature causing it fails to anneal.

Table 2 shows the PIC range from 0.2 to 0.5. The highest PIC observed in Luwu provenance (0.5) using UBC 827, indicating that the primer has a high polymorphism level. UBC 814 had the lowest PIC (0.2), which proved to have a low polymorphism level. UBC 827 and UBC 810 had the highest PIC of 0.5 in Konawe Province. In contrast, UBC 813 and UBC 814 primers had the lowest ones (Missio, R., Caixeta, E., Zambolin, E., Zambolin, L., Cruz. C., & Sakiyama, N., 2010) stated the higher PIC of the primer, the better the primer is employed as a molecular marker.

The PIC is a parameter that reflects the informative level of the primer. PICs are classified as PIC≤0.25 (low polymorphism or having a low informative level), 0.25≤ PIC ≤ 0.5 (moderate polymorphism), and PIC ≥ 0.5 (high polymorphism or the primer is very informative) (Hidayat, R. A., Depamede, S. N., & Maskur., 2015).

2. Analysis of Genetic Diversity

The heterozygosity and number of bands are genetic diversity parameters. These parameters were manually calculated from the total scoring results of PCR band amplification and tabulated into the Expected Heterozygosity (He) formula. Table 3 depicts the number of bands and He of all evaluated samples.

Table 3. Number of bands and He

No	Primer	Total of Band	Number of Bands		He	
			Luwu	Konawe	Luwu	Konawe
1	UBC 810	19	10	9	0.5	0.4
2	UBC 813	7	5	2	0.5	0.5
3	UBC 814	12	4	8	0.5	0.5
4	UBC 820	15	7	8	0.5	0.5
5	UBC 822	8	4	4	0.5	0.5
6	UBC 823	12	7	5	0.5	0.5
7	UBC 827	10	5	5	0.4	0.4

Table 3 displays the band number produced by seven ISSR primers. The highest number of bands was by UBC 810 (19 bands). The primer with the lowest bands was UBC 813, which generated seven bands. The number of bands in a genetic diversity analysis considerably influences diversity in a population. Genetic variety reflects a plant population. A population with high genetic diversity indicates that the population's adaptability level is higher (Mis'al., 2017).

Every sample used with ISSR primers is treated as a character unit. and the produced ISSR band is scored as 1 (present band) or 0 (absent band), which is set into a binary matrix (Ardiyani, M., Sulistiyaningsi, L. D., & Esthi, Y. N., 2014). The genetic diversity and relationship with molecular markers are stable and not affected by the environment (Tar'an, B., Zhang, B., Warkentin, T., Tullu. A., & Vandenberg, A., 2005).

He of *H. celebica* from Luwu and Konawe Provenances ranged from 0.4 to 0.5 (Table 3). Only UBC 827 had the lowest He of 0.4 in Luwu provenance, whereas only UBC 810 and UBC 827 had the lowest He of 0.4 in Konawe provenance. These findings imply that *H. celebica* in both provenances has a high level of variation and resistance. Only 2 of 7 primers had the lowest He. Weising (2005) reported ISSR marker is a dominant marker that can only detect two homozygous alleles at each locus and is not sensitive to heterozygous alleles. resulting in a maximum He value of 0.5.

3. Genetic relationship in the populations

High genetic diversity is an essential factor in developing new superior varieties, and increasing genetic diversity can be accomplished by hybridization. Therefore,improving plant genetics necessitates germplasm with high genetic diversity (Rameshkumar R, Pandian S, Rathinapriya P, Selvi CT, Satish L, Gowrishankar S., 2019).

The genetic distance of *H. celebica* in Table 4 ranges from 0.27 to 1.00. The farthest genetic distance was 1.00 between individuals 3 and 31. The closest genetic distance was 0.27 between individuals 26 and 28 compared to others. The closer the genetic distance between individuals in a population, the lesser variation in the population. Contrastly. the higher the genetic distance of individuals in a population, the more diverse the individuals (Pandin, 2009).

Genetic distance describes the variance in a population induced by genetic mixing derived from crossbreeding. Decreasing individuals number in population might also contribute to inbreeding (Gusmiaty et al., 2016). A factor that can maintain the gene and genotype frequencies (genetic stability) in natural populations is random mating (Widyatmoko, A. Y. P. B. C., Lejo, E. S., Prasetyaningsih, A. & Rimbawanto, A. 2010).

The relationship between individuals depicted by the dendrogram is correlated to the genetic distance of the individuals. Close relatives have a low genetic distance, whereas distant relatives have a high genetic distance (Lucic, I., Rakonjan., Mataruga., Babic., Ristic., & Drinic, 2011). A dendrogram was created utilizing the similarity coefficient of each random primer used for clustering analysis (Figure 4). A dendrogram classifies populations that are geographically isolated but genetically related. The genetic relationship illustrated in Figure 4 shows that the 50 individuals were clustered into three main clusters with a different individual numbers. Cluster I had two sub-clusters, with the first and the second sub-clusters consisting of 13 and 11 individuals, respectively. Cluster II was divided into two sub-clusters. The first sub-cluster had 11 individuals, and the second one had eight individuals. Cluster III consisted of 2 sub-clusters, four individuals (sub-cluster 1) and three individuals (sub-cluster 2).

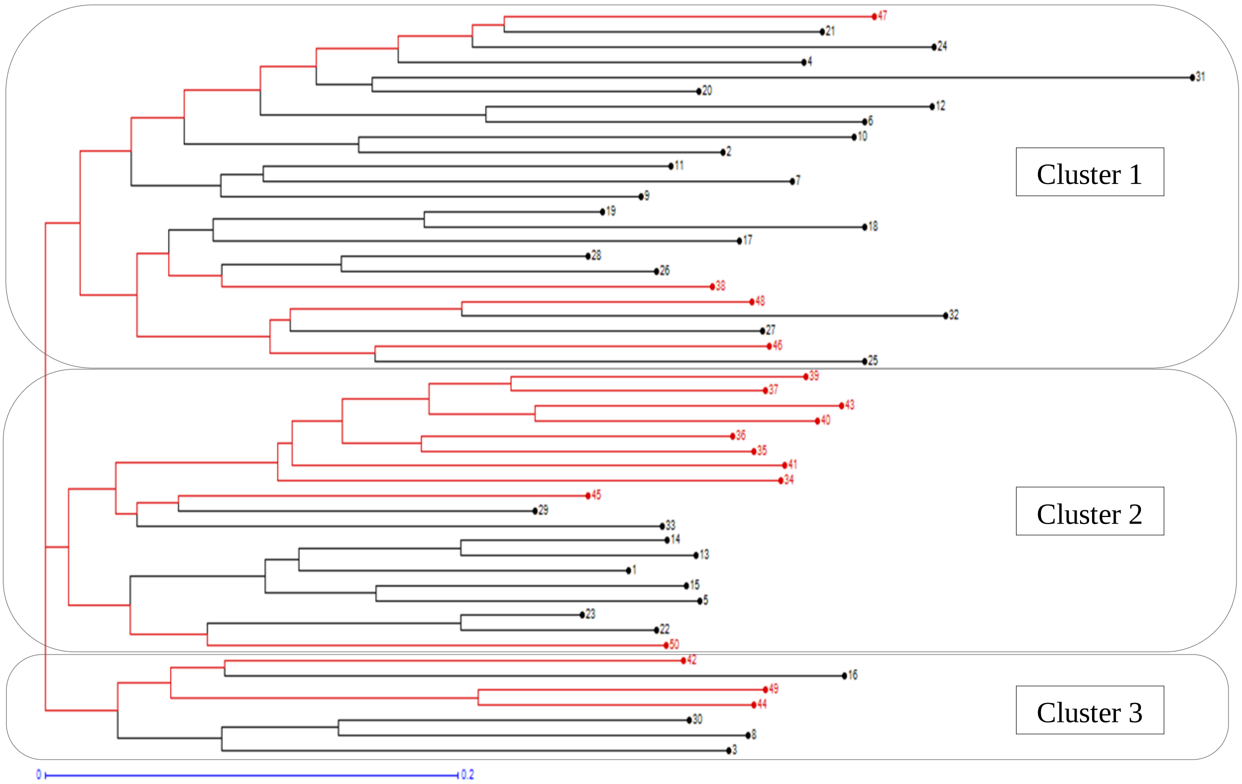
Understanding genetic diversity and relationships are critical for genetic conservation and tree breeding. This information is required for ex-situ conservation to determine the number of populations and individuals within the population that must be collected to maintain the basics of genetic diversity established. Diversity is vital in breeding programs because it can form specific genetic characteristics for gene selection of the desired traits, some case in Duabanga moluccana (Larekeng, S.H., Yusniar, Restu, M., Rismawati, Cahyaningsih, Y.F., Arsyad, M.A., Nirsatmanto, Arif. 2020b). Meanwhile. it is required for in-situ conservation to determine the number of individuals and locations (Sharma, R; Santosh S. and Sushil K., 2018).

Table 2. Genetic distance of Hopea celebica in all provenaces

Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
2	0,48																																															
3	0,60	0,58																																														
4	0,64	0,62	0,67																																												
5	0,33	0,54	0,65	0,52																																										
6	0,71	0,60	0,76	0,58	0,67																																								
7	0,64	0,71	0,67	0,60	0,60	0,68																																						
8	0,60	0,58	0,50	0,67	0,74	0,53	0,56																																				
9	0,43	0,40	0,53	0,58	0,50	0,67	0,47	0,65																																		
10	0,68	0,42	0,71	0,65	0,79	0,73	0,57	0,52	0,64																																
11	0,42	0,65	0,60	0,55	0,63	0,71	0,45	0,70	0,43	0,60																														
12	0,74	0,55	0,68	0,43	0,77	0,40	0,71	0,58	0,70	0,58	0,57																													
13	0,33	0,48	0,50	0,64	0,41	0,71	0,64	0,80	0,43	0,68	0,50	0,74																												
14	0,36	0,63	0,67	0,62	0,35	0,68	0,46	0,75	0,44	0,72	0,50	0,78	0,21																											
15	0,39	0,45	0,58	0,62	0,31	0,80	0,71	0,68	0,60	0,83	0,74	0,82	0,48	0,48																										
16	0,68	0,67	0,73	0,65	0,55	0,88	0,88	0,73	0,75	0,80	0,68	0,78	0,79	0,74	0,56																									
17	0,67	0,53	0,57	0,50	0,62	0,73	0,63	0,71	0,47	0,79	0,78	0,76	0,56	0,55	0,41	0,54																								
18	0,70	0,79	0,88	0,67	0,74	0,76	0,67	1,00	0,65	0,81	0,50	0,79	0,70	0,67	0,68	0,60	0,57																							
19	0,50	0,57	0,70	0,55	0,56	0,52	0,55	0,60	0,43	0,60	0,50	0,74	0,67	0,50	0,57	0,68	0,44	0,30																						
20	0,52	0,50	0,71	0,39	0,50	0,45	0,48	0,52	0,55	0,62	0,52	0,58	0,68	0,59	0,67	0,70	0,68	0,52	0,36																					
21	0,58	0,56	0,73	0,41	0,73	0,50	0,76	0,73	0,38	0,80	0,58	0,67	0,68	0,65	0,78	0,71	0,54	0,47	0,37	0,30																				
22	0,36	0,67	0,62	0,83	0,50	0,73	0,57	0,71	0,55	0,77	0,44	0,75	0,36	0,38	0,58	0,70	0,79	0,71	0,68	0,62	0,80																			
23	0,44	0,58	0,62	0,74	0,57	0,64	0,57	0,71	0,55	0,69	0,44	0,75	0,36	0,38	0,50	0,80	0,68	0,62	0,52	0,54	0,70	0,15																		
24	0,56	0,65	0,71	0,50	0,52	0,60	0,75	0,71	0,47	0,79	0,67	0,76	0,78	0,64	0,76	0,69	0,67	0,57	0,33	0,47	0,38	0,79	0,79																	
25	0,73	0,62	0,78	0,70	0,76	0,58	0,70	0,56	0,68	0,74	0,64	0,71	0,73	0,62	0,71	0,88	0,63	0,67	0,45	0,57	0,65	0,83	0,65	0,63																
26	0,52	0,60	0,65	0,58	0,58	0,56	0,79	0,65	0,56	0,82	0,62	0,70	0,43	0,52	0,40	0,75	0,47	0,53	0,52	0,64	0,63	0,55	0,36	0,73	0,47															
27	0,69	0,76	0,73	0,67	0,79	0,65	0,67	0,55	0,74	0,70	0,62	0,60	0,69	0,67	0,68	0,81	0,60	0,64	0,54	0,63	0,71	0,63	0,63	0,90	0,50	0,57														
28	0,44	0,42	0,52	0,65	0,57	0,73	0,74	0,62	0,55	0,62	0,60	0,67	0,36	0,52	0,33	0,80	0,47	0,62	0,52	0,69	0,70	0,54	0,38	0,79	0,57	0,27	0,56													
29	0,55	0,53	0,48	0,59	0,53	0,57	0,59	0,63	0,57	0,50	0,55	0,60	0,42	0,49	0,47	0,62	0,52	0,63	0,61	0,63	0,69	0,44	0,44	0,84	0,72	0,50	0,52	0,38												
30	0,57	0,55	0,47	0,71	0,54	0,70	0,52	0,37	0,60	0,58	0,57	0,73	0,74	0,70	0,55	0,56	0,76	0,89	0,65	0,50	0,78	0,67	0,67	0,76	0,62	0,80	0,68	0,67	0,53											
31	0,76	0,88	1,00	0,73	0,90	0,71	0,87	0,69	0,86	0,67	0,76	0,88	1,00	0,90	1,00	0,83	1,00	0,85	0,65	0,56	0,50	0,89	0,89	0,82	0,87	1,00	0,79	1,00	0,83	0,75										
32	0,60	0,79	0,63	0,67	0,74	0,76	0,78	0,63	0,76	0,81	0,70	0,79	0,70	0,58	0,68	0,87	0,71	0,88	0,70	0,62	0,73	0,71	0,71	0,71	0,67	0,65	0,55	0,71	0,70	0,68	0,69									
33	0,62	0,68	0,55	0,75	0,52	0,74	0,75	0,73	0,65	0,85	0,62	0,92	0,62	0,67	0,52	0,62	0,70	0,73	0,69	0,70	0,71	0,56	0,56	0,80	0,67	0,57	0,79	0,56	0,45	0,60	0,89	0,82								
34	0,67	0,79	0,69	0,71	0,70	0,78	0,64	0,77	0,63	0,68	0,53	0,72	0,73	0,65	0,72	0,84	0,75	0,54	0,47	0,55	0,68	0,55	0,61	0,67	0,71	0,70	0,63	0,68	0,51	0,79	0,74	0,69	0,56							
35	0,64	0,78	0,83	0,85	0,74	0,60	0,54	0,67	0,68	0,66	0,57	0,78	0,71	0,50	0,70	1,00	0,82	0,67	0,50	0,66	0,74	0,59	0,52	0,82	0,62	0,60	0,60	0,45	0,54	0,70	0,71	0,67	0,60	0,47						
36	0,64	0,63	0,67	0,77	0,74	0,68	0,54	0,67	0,68	0,52	0,43	0,70	0,64	0,56	0,70	0,83	0,82	0,75	0,57	0,66	0,83	0,45	0,38	0,82	0,69	0,68	0,60	0,52	0,54	0,63	0,90	0,75	0,60	0,53	0,31					
37	0,66	0,71	0,68	0,93	0,75	0,77	0,56	0,76	0,69	0,67	0,45	0,79	0,66	0,64	0,71	0,83	0,91	0,68	0,66	0,67	0,83	0,33	0,40	0,91	0,78	0,77	0,61	0,60	0,50	0,57	0,73	0,76	0,55	0,37	0,33	0,33				
38	0,64	0,62	0,56	0,70	0,76	0,68	0,70	0,67	0,68	0,74	0,64	0,81	0,55	0,69	0,62	0,76	0,50	0,56	0,55	0,65	0,65	0,74	0,65	0,88	0,70	0,47	0,50	0,39	0,52	0,71	0,87	0,78	0,58	0,71	0,62	0,69	0,70			
39	0,52	0,75	0,71	0,83	0,71	0,64	0,57	0,71	0,64	0,69	0,44	0,75	0,60	0,59	0,92	0,90	1,00	0,81	0,68	0,62	0,70	0,38	0,46	0,79	0,91	0,82	0,70	0,69	0,63	0,67	0,67	0,71	0,63	0,55	0,45	0,45	0,27	0,74											
40	0,70	0,62	0,65	0,84	0,73	0,92	0,68	0,83	0,67	0,64	0,48	0,85	0,63	0,68	0,69	0,82	0,81	0,83	0,70	0,79	0,91	0,50	0,50	0,90	0,76	0,75	0,79	0,57	0,59	0,62	0,90	0,83	0,52	0,45	0,55	0,35	0,31	0,76	0,43										
41	0,66	0,64	0,84	0,70	0,69	0,77	0,70	0,84	0,54	0,73	0,52	0,79	0,72	0,70	0,64	0,75	0,74	0,68	0,59	0,67	0,67	0,67	0,60	0,74	0,78	0,69	0,68	0,60	0,61	0,64	0,91	0,76	0,61	0,49	0,52	0,39	0,53	0,78	0,53	0,38									
42	0,69	0,60	0,64	0,83	0,72	0,74	0,67	0,55	0,65	0,56	0,62	0,68	0,77	0,73	0,76	0,52	0,70	0,73	0,62	0,70	0,81	0,63	0,70	0,80	0,75	0,74	0,64	0,70	0,52	0,44	0,79	0,73	0,71	0,69	0,73	0,60	0,61	0,67	0,63	0,52	0,68								
43	0,76	0,75	0,71	0,91	0,71	0,82	0,65	0,71	0,82	0,77	0,60	0,75	0,76	0,72	0,58	0,80	0,89	0,81	0,76	0,77	1,00	0,46	0,46	1,00	0,83	0,73	0,70	0,54	0,56	0,50	0,89	0,81	0,63	0,55	0,45	0,45	0,27	0,83	0,46	0,29	0,53	0,48							
44	0,57	0,82	0,58	0,81	0,54	0,70	0,62	0,58	0,60	0,75	0,65	0,82	0,65	0,70	0,64	0,67	0,76	0,89	0,74	0,83	0,89	0,58	0,67	0,88	1,00	0,70	0,76	0,67	0,53	0,45	0,88	0,89	0,52	0,72	0,63	0,63	0,64	0,52	0,58	0,69	0,64	0,44	0,58						
45	0,64	0,56	0,67	0,54	0,48	0,60	0,69	0,67	0,52	0,66	0,57	0,63	0,64	0,69	0,56	0,57	0,55	0,50	0,43	0,52	0,57	0,59	0,59	0,64	0,69	0,52	0,47	0,52	0,37	0,56	0,81	0,83	0,47	0,53	0,63	0,69	0,64	0,54	0,72	0,61	0,45	0,53	0,59	0,56					
46	0,74	0,55	0,79	0,62	0,77	0,50	0,81	0,58	0,60	0,75	0,57	0,55	0,74	0,78	0,73	0,67	0,65	0,58	0,57	0,58	0,56	0,75	0,67	0,65	0,43	0,40	0,52	0,58	0,60	0,73	0,88	0,58	0,60	0,66	0,70	0,70	0,79	0,71	0,75	0,77	0,50	0,52	0,75	0,82	0,48				
47	0,60	0,58	0,75	0,33	0,57	0,65	0,78	0,75	0,53	0,71	0,70	0,68	0,70	0,67	0,68	0,73	0,57	0,63	0,50	0,43	0,33	0,90	0,81	0,43	0,67	0,65	0,82	0,62	0,70	0,68	0,69	0,63	0,73	0,77	0,75	0,92	1,00	0,78	0,90	0,91	0,68	0,82	0,90	0,79	0,50	0,58			
48	0,50	0,58	0,50	0,56	0,74	0,65	0,67	0,50	0,65	0,71	0,50	0,68	0,50	0,58	0,68	0,87	0,57	0,75	0,60	0,52	0,60	0,62	0,52	0,71	0,44	0,41	0,45	0,43	0,63	0,68	0,85	0,38	0,64	0,77	0,67	0,58	0,76	0,44	0,71	0,74	0,76	0,73	0,81	0,89	0,67	0,47	0,63		
49	0,57	0,82	0,68	0,71	0,69	0,70	0,71	0,58	0,70	0,67	0,65	0,73	0,83	0,78	0,64	0,67	0,76	0,79	0,65	0,75	0,78	0,67	0,67	0,76	1,00	0,70	0,60	0,67	0,53	0,55	0,88	0,79	0,76	0,72	0,63	0,56	0,71	0,62	0,58	0,77	0,50	0,52	0,67	0,27	0,56	0,73	0,79	0,89	
50	0,60	0,67	0,62	0,83	0,57	0,73	0,65	0,62	0,73	0,77	0,68	0,75	0,68	0,66	0,42	0,80	0,68	0,81	0,60	0,69	0,90	0,46	0,38	0,89	0,74	0,55	0,56	0,46	0,56	0,50	0,89	0,62	0,56	0,68	0,52	0,45	0,47	0,74	0,62	0,43	0,53	0,48	0,31	0,50	0,52	0,67	0,81	0,62	0,58

Notes:

(yellow)	Closest genetic distance
(red)	Furthest genetic distance



Note : *H. celebica* luwu Provenance
H. celebica Konawe Provenance

Figure 4. Dendogram of genetic relationship in Hopea celebica from 2 provenances

Planning for future tree breeding activities needs to be continued. These efforts are carried out by developing seed orchards from different populations and the selected parent trees to maintain genetic variation and produce genetically superior plants. High genetic variations allow the populations to be more adaptable to the environmental changes, and eventually, the biodiversity will be protected (Mulyadiana, 2010).

D. Conclusion

There were seven ISSR primers used for genetic diversity analysis of *H. celebica* were UBC 810, UBC 813, UBC 814, UBC 820, UBC 822, UBC 823, and UBC 827. The genetic diversity of 50 samples *H. celebica* from Luwu and Konawe was high.

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Variation of the Amount of Seeds per Planting Hole to the Response of Lettuce Plant with DFT Hydroponic System

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Abstract

Lettuce is a vegetable plant whose needs always increase every year according to population growth. Therefore, it is necessary to make efforts to increase the production of lettuce by increasing the number of seeds per planting hole using the DFT hydroponic system. This study aims to determine the effect of the number of seeds per planting hole on the growth and yield of lettuce plants and to determine the number of seeds per planting hole that produces the highest growth and yield of lettuce plants. Implementation This research was conducted from August to September 2021. Located in the Community Food Barn, the Department of Food Security and Fisheries, Banjar Regency. The method used in this study was a completely randomized design (CRD) with treatment S1 (control), S2 (2 seeds per planting hole), S3 (3 seeds per planting hole), and S4 (4 seeds per planting hole). The treatment was repeated 4 times to get 16 experimental unit Based on the results of the research, it can be seen that the number of seeds per planting hole has an effect on the growth and yield of lettuce.The best treatment was found in S4 which had the highest value at an average plant height of 36.25 cm, an increase in plant height at 28 DAP of 11.61 cm, an average number of leaves of 22.06 strands, and an average yield harvest of 153.75 grams. DFT hydroponic cultivation of lettuce resulted in optimal production of 4 seeds per planting hole. Useful research for the efficiency of lettuce production using hydroponics. In addition to production efficiency, it is necessary to consider plant competition to utilize existing resources for optimal growth

Keyword: DFT hydroponic system, lettuce, number of seeds per planting hole

A. Introduction

The need for vegetables in Indonesia is always increasing every year. Increased demand for vegetables in accordance with population growth. The need for vegetables in Indonesia will continue to increase in accordance with population growth. Based on statistical data, the value of imported fruit and vegetables in 2019 was 770 Tons (BPS, 2018). Lettuce economic opportunities can be seen from the growing number of hotels and international-standard foreign restaurants that serve many foreign dishes such as salads and hamburgers (Cahyono, 2019). Lettuce is a type of green vegetable that is consumed by its leaves. Many benefits are obtained from eating lettuce for health. Lettuce has a commercial value and demand from the market for lettuce commodities will continue to increase in line with an increase in population, an increase in people's income and an increase in people's preference for lettuce (Samadi, 2014).

To overcome the increasing market demand for lettuce, it is necessary to make efforts to increase crop yields by increasing the number of seeds in one planting hole. Due to the increase in the number of seeds one planting hole, the yield will increase compared to one seed in one planting hole. One of the efforts to increase the plant population is to increase the number of plants per planting hole. The plant yields obtained have an inseparable relationship with plant density and are also determined by the number of plants in one planting hole (Susilowati, 2011).

Planting vegetables using a hydroponic farming system. The hydroponic system is agriculture without using soil that only relies on water as a medium for delivering nutrients. This system does not require a large area of land, but the number of plants that can be planted is greater. Hydroponics is agricultural cultivation without using soil media, so it is only carried out using water as a soil substitute medium. Hydroponic vegetable crops are more attractive to consumers because they are cleaner and have less dirt, so it can shorten the time for consumers to clean them. The nutritional content of hydroponic vegetables is better maintained because the nutrients in circulating water are always maintained to meet their needs (Syamsul, 2014).

The hydroponic system used is the deep flow technique (DFT). The DFT system is a hydroponic system in which the flow of nutrients flows continuously and circulates, and the nutrients that flow remain that settle so that the roots are in a pool of nutrients. One of the most effective and effective hydroponic farming systems productive is DFT (Junia & Sarido, 2017). Several studies have shown that the use of DFT hydroponics produces good quality plants because they are able to provide oxygen and water requirements that are suitable for growing vegetables (Fitmawati, Isnaini, Siti FN, Sofiyanti, & Rodesia MR., 2018). The use of the DFT system on leaf vegetables shows high oxygen levels in the water which are useful for the respiration process or plant respiration which affects the number of leaves and the wet weight of the plant (Asyiah, 2013). The advantage of this DFT system is that nutrients can still meet the needs of plants even when the electricity goes out, because the nutrients are still stagnant. DFT hydroponic systems are generally used to grow leafy vegetables, both those that have taller growths such as kale or those that expand such as lettuce. This study aims to determine the effect of the number of seeds per planting hole on the growth and yield of lettuce plants and to determine the number of seeds per planting hole that produces the highest growth and yield of lettuce plants.

Plant competition within a species can be seen from the distance between plants, where in fact the fiercest competition occurs between plants of the same species, so that large stands of a single species are very rarely found in nature. Competition between plants of this kind affects their growth because they are generally detrimental. Competition occurs when organisms of the same species or of different species use natural resources. In using natural resources, each competing organism will fight for something that is needed for life and growth. Competition carried out by organisms can compete for the needs of space (place), food, nutrients, water, light, air, pollination agents, dispersal agents, or other ecological factors as the resources needed by each organism to live and thrive growth (Gopal & Bhardwaj, 1979).

B. methodology

This research was conducted from August to September 2021. Located in the Community Food Barn, the Department of Food Security and Fisheries, Banjar Regency. The materials used in this study were lettuce seeds, rockwool, nutrition AB Mix, flannel, and water. Tools that used namely hydroponic installation, thermohygrometer, TDS&EC meter, netpot, label paper, camera, analytical scale, tray, ruler, and stationery.

1. Research Design and Procedure

This study used a completely randomized design (CRD). The types of treatments tested included the number of seeds per planting hole in lettuce (S). The treatment given, namely S1/control (1 plantper planting hole), S2 (2 plants per planting hole), S3 (3 plants per planting hole), and S4 (4 plants per planting hole). There were 4 treatments which were repeated 4 times, so that there were 16 experimental units. Each experimental unit contains 4 sub samples.

Seeding is done by planting lettuce seeds on rockwool media. Rockwool is first cut into cubes which are then put into a tray. Putting the seeds into rockwool according to the treatment being tested, namely 1 seed, 2 seeds, 3 seeds, and 4 seeds per tray. The seedlings were watered until all the rockwool was wet, but not submerged. Place a tray of indoor plants until the seeds germinate, which is about 2-4 days. Move plants that have germinated to the enlargement. The nursery needs to be distinguished from the place of enlargement, because Nurseries require high humidity conditions of up to 90%. Meanwhile, the magnification is around 70-80%. In addition, the nursery does not require a lot of space. A damp corner of the house can be used as a location for placing nursery trays (Trubus Editor, 2019). Caring for the seedling is done by wetting the *rockwool* periodically by pouring water on the tray every day. Watering the plant is done slowly through the side of the container. Water is poured until all the rockwool is wet again, but the seeds are not submerged. Watering is carried out for 14 days until the seeds are ready to be transplanted. Good seeds will grow 2-4 days after sowing. About 10-14 days later, 2-4 true leaves grow. That is a sign that the seeds are ready to be transplanted to the youth table or directly to the production table (Trubus Editor, 2019).

After the plants are treated for 10-14 days, the seedlings or seeds that have grown can be transferred to a hydroponic installation for enlargement. The characteristics of the seeds are ready to be transferred, namely there are 3-4 true leaves and the seeds are about 7-14 days old depending on the type of plant and the speed of growth (Trubus Editor, 2019). The transfer process was carried out by placing the seeds into a*netpot* that had been given flannel according to the experimental unit, namely 4 treatments which were repeated 4 times so that 16 experimental units were obtained, each experimental unit contained 4 sub samples. When transplanting, the seeds certainly do not have long roots to reach nutrients. If so, the solution needs to be added to the axis (Trubus Editor, 2019).

The AB Mix nutrients used are crystalline nutrients that can be extracted with a mixture of water into 5 liters of nutrient A and 5 liters of nutrient B. The hydroponic water reservoir is filled with water first to the brim, then pours each nutrient A and nutrient B with the same amount the flat one. Entering AB Mix nutrients until the concentration reaches ±800 ppm and the EC value is ± 1.5 mS/cm.

Every week the tub water is measured using a TDS&EC meter to measure and keep the EC value in the range of 1.5 mS/cm - 2 mS/cm. The concentration was measured every week using a TDS&EC meter to determine and keep the nutrient concentration in the tank in the range of 780 ppm - 820 ppm.

The parameters observed in this study were divided into two, namely daily and weekly parameters. Daily parameters include observations of temperature (^{o}C) and humidity (%). The weekly parameters included observations of plant height, widest leaves, number of leaves, and yields.

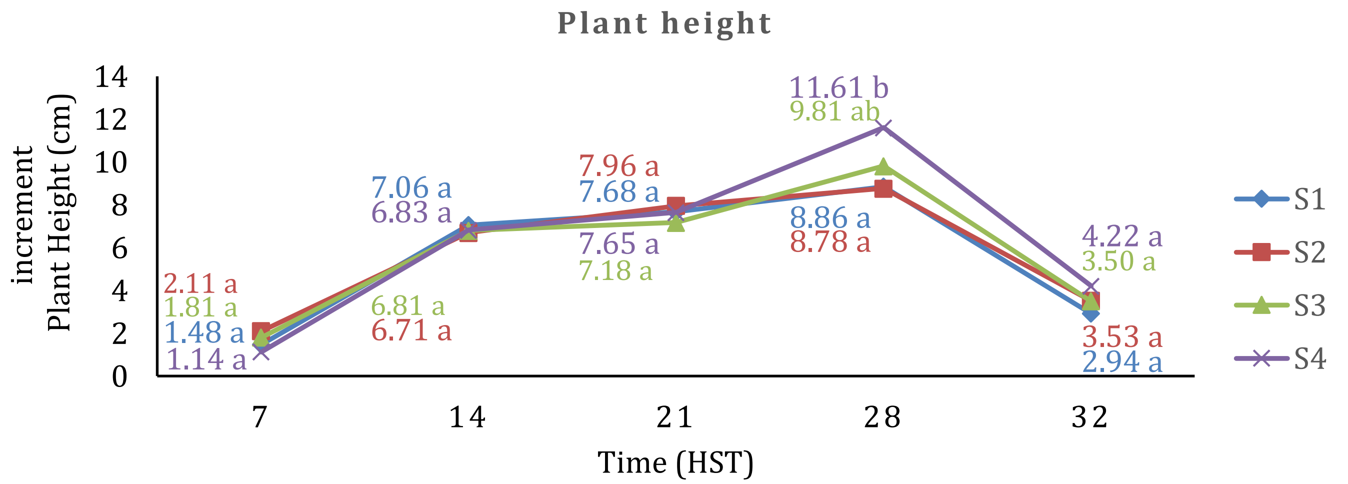
2. Data analysis

To see the effect of the number of seeds per planting hole on the growth and yield of lettuce, analysis of variance (Anova) was carried out. Prior to the analysis of variance, the homogeneity test was carried out first variance using the Bartlett Test. If the analysis of variance showed that the number of seeds per planting hole had a significant effect on the observed variables (P 0.05), then a different treatment test was conducted using the DMRT test at the level of 5%.

C. Results and Discussion _

1. *Results*

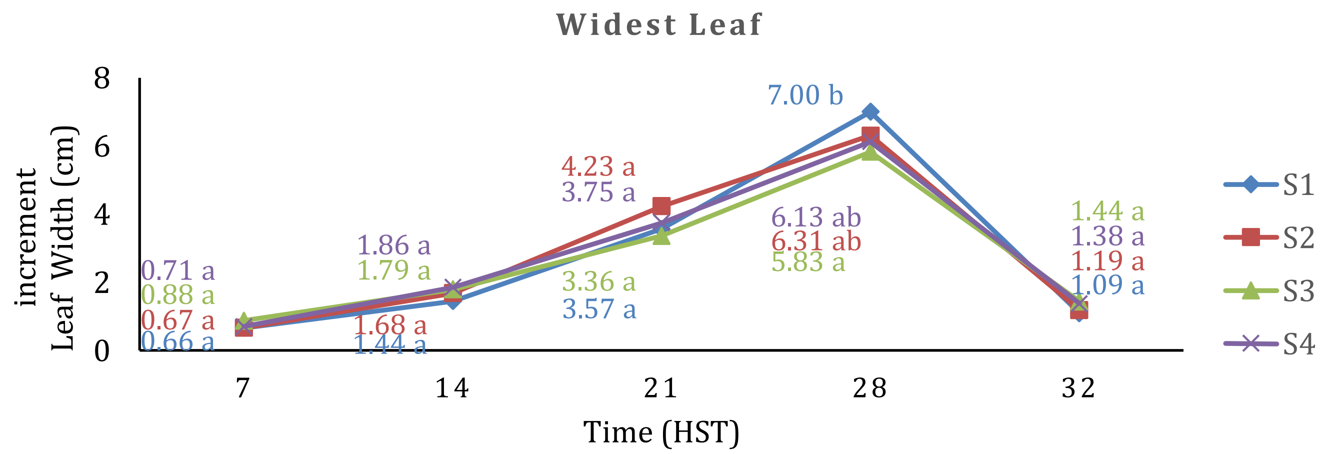
The results of the analysis of plant height variance at 7, 14, 21, and 32 DAP showed that the variation in the number of seeds per planting hole was not significantly different from the increase in lettuce height and at 28 DAP it was significantly different to the increase in lettuce height. Lettuce plant height increase can be seen in picture 1 below:



Picture 1. Graph of average plant height on a lettuce plant
Note: Numbers followed by the same letter are not significantly different. Based on DMRT test at 5% level. S1 = 1 plant per planting hole (control) , S2 = 2 plants per planting hole , S3 = 3 plants per planting hole , and S4 = 4 plants per planting hole.

Based on picture 1, it is known that at 7, 14, 21, and 32 DAP the increase in plant height in S1, was not significantly different from S2, S3, and S4. At 28 DAP, S1 was not significantly different from S2 and S3, but significantly different from S4. The highest increase in plant height was in S4 with 4 seeds per planting hole of 11.61 cm at 28 DAP.

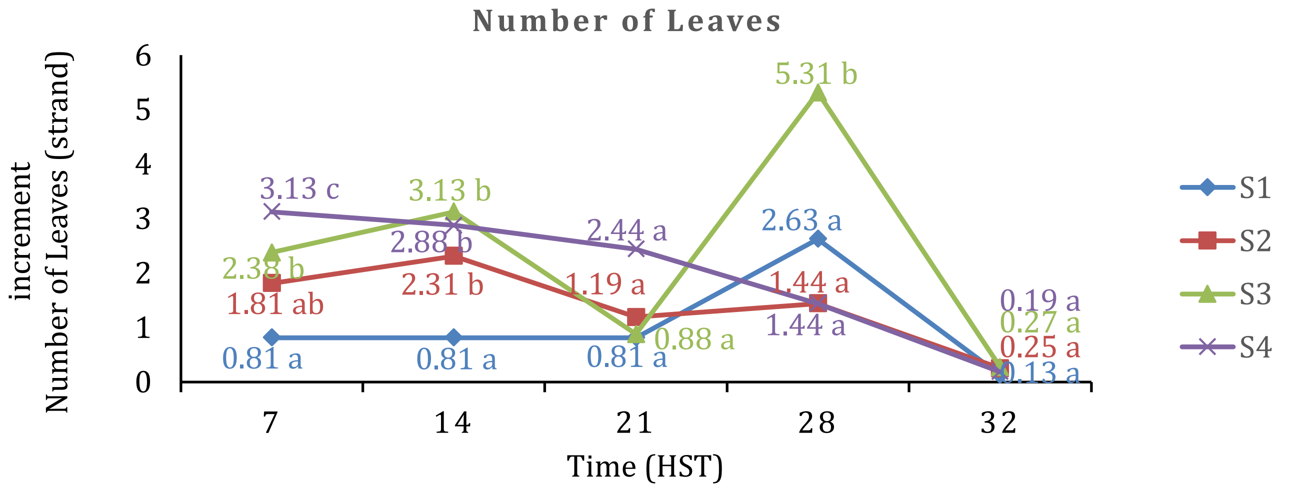
The results of the calculation of the analysis of plant leaf width at 7, 14, 21, and 32 DAP showed that the variation in the number of seeds per planting hole was not significantly different from the increase in lettuce leaf width and at 28 DAP it was significantly different to the increase in lettuce leaf width. The increase in the width of the lettuce leaves can be seen in picture 2 below:



Picture 2. Graph of the widest leaf mean on a lettuce plant
Note: Numbers followed by the same letter are not significantly different. Based on DMRT test at 5% level. S1 = 1 plant per planting hole (control), S2 = 2 plants per planting hole, S3 = 3 plants per planting hole , and S4 = 4 plants per planting hole.

Based on picture 2, it is known that at 7, 14, 21, 28 and 32 DAP the increase in leaf width of S1, was not significantly different from that of S2, S3, and S4. The highest increase in leaf width was found in S1 with 1 seed per planting hole of 7.00 cm at 28 DAP.

The results of the calculation of the analysis of the number of leaves at 21 and 32 DAP showed that the variation in the number of seeds per planting hole was not significantly different to the increase in the number of lettuce leaves, at 14 and 28 DAP it was significantly different, and 7 DAP was very significantly different to the increase in the number of lettuce leaves. The increase in lettuce leaf width can be seen in picture 3 below:

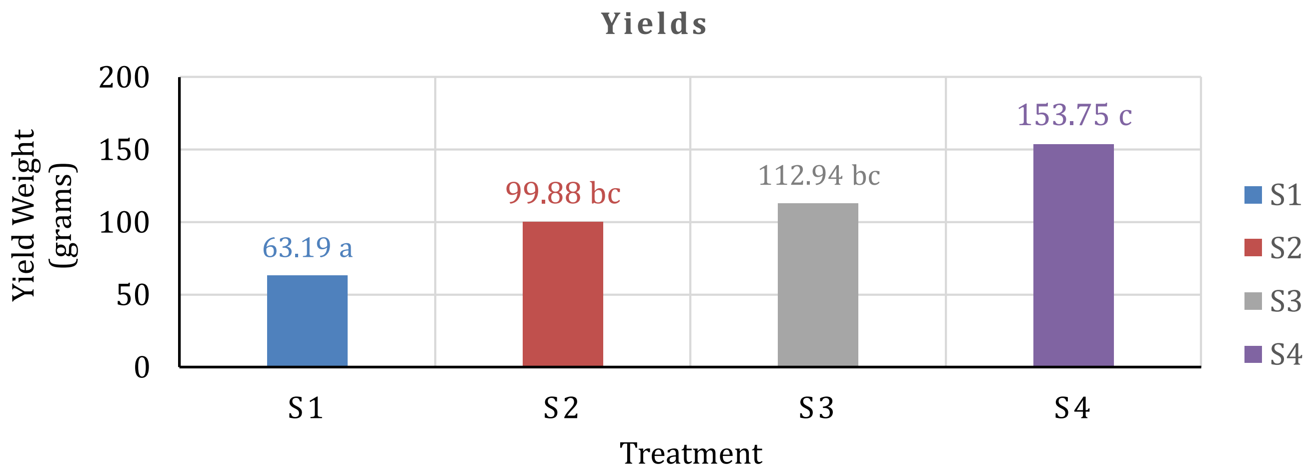


Picture 3. Graph of the average number of leaves on a lettuce plant

Note: Numbers followed by the same letter are not significantly different. Based on DMRT test at 5% level. S1 = 1 plant per planting hole (control), S2 = 2 plants per planting hole, S3 = 3 plants per planting hole, and S4 = 4 plants per planting hole.

Based on picture 3, it is known that at 7 DAP the increase in the number of S1 leaves was significantly different from S2, S3, and very significantly different from S4. at 14 DAP the increase in the number of S1 leaves was significantly different from S2, S3, and S4. At 21 and 32 DAP, S1 was not significantly different from S2, S3, and S4. At 28 DAP, S1 was not significantly different from S2 and S4, but significantly different from S3. The highest increase in the number of leaves was found in S3 with 3 seeds per planting hole of 5.31 cm at 28 DAP.

The results of the calculation of the analysis of the variance of lettuce yields showed that the variation in the number of seeds per planting hole was very significantly different from the weight of the lettuce yields. The weight of the lettuce crop yields can be seen in picture 4 below:



Picture 4. Graph of average yield on lettuce tanaman
Note: Numbers followed by the same letter are not significantly different. Based on DMRT test at 5% level. S1 = 1 plant per planting hole (control), S2 = 2 plants per planting hole, S3 = 3 plants per planting hole, and S4 = 4 plants per planting hole.

Based on the harvest data in picture 4. S1 treatment was significantly different from S2 and very significantly different from S3 and S4. The highest average yield weight of all treatments was 4 planting hole seeds (S4). The weight of the harvest from S1 to S4 was 63.19 grams, 99.88 grams, 112.94 grams, and 153.75 grams.

2. *Discussion*

The use of the DFT hydroponic system makes it possible for plant roots to absorb nutrients properly because nutrients continue to pool and soak plant roots so that plant roots do not scramble to take food. The DFT hydroponic system is a hydroponic system that provides nutrients in the form of water in the form of puddles. The nutrient solution needed by the plant is flowed as high as 4-6 cm periodically in the pipe so that it can soak the plant roots with the nutrient solution. The flow of nutrient solution in the planting pipe is then collected back in the nutrient reservoir and pumped back through the distribution pipe into the planting pipe continuously. The use of the DFT system also makes the oxygen needs of plants alwaysfulfilled so that the growth of lettuce plants is good and not hampered (Chadirin, 2007). The DFT system has advantages such as low nutrient requirements and sufficient oxygen availability due to the presence of an air cavity with a water pump that supports a good aeration system for plants. The risk of lack of movement of water during a power outage will not occur due to the presence of air voids in DFT hydroponics, so that oxygen needs in the short term can be met (Mansyur, AN, S. Triyono, & A. Tusi. 2014).

The S1 treatment had the highest value in the increase in leaf width at 28 DAP by 7 cm. However, the lowest were in mean plant height, average leaf width, average number of leaves, and average yield. The S2 treatment had the highest value on the widest leaf average of 15.22 cm. However, the lowest was the increase in plant height at 28 DAP, and the increase in the number of leaves at 28 DAP. The S3 treatmenthad the highest value in increasing the number of leaves at 28 DAP of 5.31 strands. However, the lowest wasat the widest leaf average, and leaf width increased at 28 DAP. The S4 treatment had the highest value at an average plant height of 36.25 cm, an increase in plant height at 28 DAP of 11.61 cm, an average number of leaves of 22.06 strands, and an average yield of 153.75 grams. However, the lowest was the increase in the number of leaves at 28 DAP which was the same value as the S2 treatment.

Based on the advantages and disadvantages above, the most recommended variation in the number of seeds per planting hole is S4 because it has many advantages compared to other treatments, namely having the highest average plant height value, increasing plant height at 28 DAP, average number of leaf size, and average yield. Even though it had the lowest value for increasing the number of leaves at 28 DA, it had the second highest value on the widest leaf average of 14.97 cm after S2 treatment which had a value of 15.22. S3 and S2 treatments were better than S1 (control) treatments because they had fewer shortcomings, but S4 treatment was the best treatment of all treatments because they had many advantages and the fewest disadvantages compared to other treatments. The use of 3 plant seeds per planting hole gave higher yields than the treatment of 1 seed and 2 seeds per planting hole. It is suspected that there is no competition in plant growth and there is no competition for growing space for stems or leaves in obtaining sunlight. The more the population, the more production will increase (Gintara, 2019).

Lettuce plants in all treatments had an average plant height range of 31-36 cm and an average leaf width of 14-15 cm. The plant height was in accordance with the described morphology, but some treatmentson the widest leaf average did not fulfill it. Lettuce is a type of leaf vegetable plant and is classified as an annual plant (short-lived). Plants grow short with a height ranging from 20-40 cm or more, depending on the type and variety. Leaf lettuce plant height ranges from 30-40 cm and head lettuce plant height ranges from 20-30 cm. Lettuce leaves have broad petioles and pinnate veins. The petiole is strong and smooth. The leaves are soft and crunchy when eaten, and have a slightly sweet taste. Leaf lettuce generally has a length of20-25 cm and a width of 15 cm or more. The stems are sturdy, sturdy, booky, and strong with diameters ranging from 5.6-7 cm (stem lettuce), 2-3 cm (leaf lettuce), and 2-3 cm (head lettuce) (Cahyono, 2019).

The unfulfillment of the appropriate plant width is thought to be caused by temperatures and humidity that are less or more than the optimal growth conditions for lettuce. At the time of the research, the temperature and humidity around the hydroponic building ranged from 28-38 ^{o}C and 41-91%. Lettuce plants need an environment to grow in the highlands (mountains) with cool and cool temperatures, namely at a temperature of 15-29 ^{o}C and a fairly high humidity (Rh) of 60-80%, as well as an open place or sufficient sunlight. Plant growth is affected by air temperature. For example, the process of germination, sprouting, flowering, and so on. High air temperatures of more than 20 ^{o}C can cause lettuce plants cannot grow properly (grow imperfectly), because high air temperatures are more than the maximum limit desired by plants can cause the photosynthesis process of plants to not run perfectly or even stop, resulting in production. starch (carbohydrates) also stops, while the process of breathing (respiration) increases even more. As a result, the production of starch as a result of photosynthesis is used more for respiratory energy (respiration) than for plant growth, so that plants are not able to grow perfectly. Thus, at high temperatures,lettuce plants do not grow fertile, the plants are thin, and the production is low, and the quality of the leaves is also low. Very high air temperatures cause plants to lose a lot of water due to evaporation (transpiration) that exceeds the limit. Low air temperature also causes lettuce plants cannot grow well and productivity is low. Lettuce plants are grown in areas that have temperatures in accordance with the desired plants (15-20^{o}C), then the plants can carry out photosynthesis properly for the formation of carbohydrates in large quantities, so that energy sources are more available (enough available) for the respiratory process, plant growth (enlargement and formation of new cells, and leaf formation), and production (good leaf quality). High air humidity of more than 90% adversely affects plant growth, namely plants grow imperfectly, plants are not fertile, leaf quality is bad. High humidity does not match what plants want, causing the leaf mouth (stomata) to be closed so that the absorption of carbon dioxide gas CO^2 is disrupted. This causes CO2 gas levels cannot enter the leaves, so the CO2 gas levels needed by plants for the photosynthesis process are inadequate. Finally, the process of photosynthesis does not go well so that all growth processes in plants decline. Air humidity also affects the process of nutrient absorption by plants, which is followed by increased plant growth. Low air humidity makes it difficult for plants to absorb nitrogen (N) and phosphorus (P) nutrients. Likewise, if the humidity is too high, nitrogen (N) is also difficult for plants to absorb. As a result, plants grow infertile and poor leaf quality (Rukmana, 2016).

The concentration of nutrients and the value of the EC meter which is always maintained to thespecified value makes plant growth and yields better. Light intensity and setting EC values affect the yield and quality of lettuce (Stagnari, F., Galieni, A., & Pisante, M., 2015). The quality of the nutrient solution can be controlled based on the EC value. The higher the concentration of the solution, the more concentrated the salt content in the solution, so that the ability of the solution to conduct electric current is higher, which is indicated by a high EC value. Electrical conductivity in solution affects plant metabolism, namely in terms of photosynthetic speed, enzyme activity and the potential for absorption of ions by roots. The concentration of the nutrient solution will also determine the duration of the use of the nutrient solution in a hydroponic system (Sutanto, 2002).

Based on observational data, the percentage of harvests, namely S1 to S2 worth 58.06%, S1 to S3 worth 78.73%, and S1 to S4 worth 143.31%. The comparison of S3 with S4 is 64,58 %. Therefore, the use of S4 (4 seeds per planting hole) is highly recommended because it has the highest increase compared to other treatments. Only by increasing the number of seeds to 4 seeds per planting hole can increase crop yields by 143.31 %. Using 4 seeds per planting hole can make the production process more efficient because in one harvest it can produce twice as much as 1 seed per planting hole, so it can save on maintenance costs (electricity, nutrition, rockwool, etc.).

D. Conclusion

Based on the research conducted, it can be concluded that all treatments affect the growth and yield of lettuce plants. However, from all treatments that were tested per plant and the best results were in S4, namely 4 seeds per planting hole because it had the highest value at an average plant height of 36.25 cm, theincrease in plant height at 28 DAP was 11.61 cm, the average number of leaves is 22.06 strands, and the average yield is 153.75 grams and the addition of the number of seeds per planting hole makes the yield of hydroponic lettuce plants increase. The highest yield was found in the S4 treatment (4 seeds per planting hole).

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The Effectiveness of Various Aromatic Vegetable Extracts to Control Fruit Fly (*Bactrocera dorsalis*) Pests in Chili

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Abstract

Chili is one of the most valuable horticultural commodities, yet production is declining year after year. Fruit fly pests, which cause losses of 30-60%, are a stumbling block to growing chili production. Several types of aromatic vegetable extracts were used in this investigation, including clove leaves, babadotan, citronella leaves, and basil leaves, all of which have been found to contain methyl eugenol components. The goals of this study were to find the most efficient form of aromatic vegetable extract for usage as a fruit fly pest attractant and to see how different aromatic vegetable extracts affected the intensity of fruit fly pests. The treatments were set up in a completely random order and were repeated three times. Planting chilies, creating aromatic vegetable extracts, making traps, deploying traps in the field, estimating the number of trapped fruit fly populations, and finally assessing the results were all part of this study. P1 = clove leaf extract, P2 = babadotan leaf extract, P3 = citronella leaf extract, and P4 = basil leaf extract are the therapies that will be provided. Bactrocera dorsalis was identified as the captured fruit fly species. The clove leaf extract treatment had the most fruit flies captured (35.67), while the babadotan leaf extract had the least (29.76), but none of the treatments were substantially different

Keywords: chili, effectiveness, vegetable extracts, methyl eugenol, *Bactrocera dorsalis*

A. Introduction

Chili is one of the vegetable commodities that has a number of advantages, which is why it is extensively grown by Indonesian farmers. The demand for chili in everyday life continues to rise, driving up the price of chili on the market. According to the Central Statistics Agency, chili production in Southeast Sulawesi Province decreased from 25,595 quintals to 11,068 quintals from 2016 to 2018. (BPS Sultra, 2020). Pests, illnesses, and weeds are examples of OPT (Plant Disturbing Organisms) that can make expanding chile production difficult.

Fruit flies are one of the major pests responsible for the fall in chile production, and they have become a national issue since, in addition to producing low production, they also act as a trade barrier, forcing other nations to reject export commodities (Kardinan, 2019). Symptoms of the initial attack, which include puncture marks in the form of black spots on the female ovipositor. The eggs that have been deposited into the fruit will hatch into larvae, which will eat the entire contents of the fruit and cause fruit rot, as well as being very easy to fall when handled, causing significant quality and quantity loss. Fruit fly infestations can result in yield losses of 30-60%. (Sunarno, 2011).

Clove leaf is one of the most widely cultivated plants in Indonesia, especially in Kolaka Regency. Clove plants are producers of essential oils containing several chemical compounds such as eugenol, eugenol acetate, kariophyllene, sesquiterpenol, and naphthalene, which have long been known for their potential as vegetable insecticides (Setiawati, W., Rini, M., Neni, G., Tati, R., 2008). Basil leaves are also reported as one of the plants that produce methyl eugenol in their leaves and flowers, ranging from 50% to 55% (Kardinan, 2019). Efendy, T.A., Rafida, R., Sunar, S., (2010) also reported that methyl eugenol compounds were found in celery plants. Setiawati et al. (2008) stated that plant-based pesticides containing essential oils containing methyl eugenol and eugenol were babadotan, ghost pine, cloves, slobber, jeringau, galangal, basil, lemongrass, betel leaf, suren leaf, and tembelekan.

Plant extracts are still infrequently used in research without going through the distillation process. Various undistilled fragrant vegetable extracts were utilized in this investigation, with the goal of luring fruit flies into the trap and killing them before they laid eggs on chilies. Based on this description, the authors are interested in and feel compelled to conduct research in this area, specifically to determine the type of aromatic vegetable extract that is most effective as a source of attractant for fruit fly pests, as well as the effect of these vegetable extracts on the intensity of fruit fly attacks on chili.

B. Methology

1. Research Methods

This is an experimental investigation that used different aromatic vegetable extracts that were shown to contain methyl eugenol molecules. A completely randomized design (CRD) with four treatments and three replications was utilized in the study. P1 = clove leaf extract, P2 = babadotan leaf extract, P3 = citronella leaf extract, and P4 = basil leaf extract, were the four treatments employed. The type and number of fruit flies trapped, and the intensity of fruit fly bites on chili plants, are all observed factors.

Land preparation and processing are the first steps in the chili planting process. Weeds are removed from the area, which is then hoed and loosened before being divided into 12 beds, each measuring 1 x 6 meters. The spacing is 60 × 60 cm, which means each bed has 20 plants. Each plot is covered with black plastic mulch to keep weeds at bay and keep the soil moist. Chili seeds were sowed in pot trays and transplanted into beds at the age of 3 WAP (21 days). Stakes are installed three days after the plants are planted.

The fruit flies were captured and placed in a death bottle containing 70% alcohol. Calculating the average number of fruit fly populations caught from each replication in the traps installed can be used to estimate the number of fruit fly populations. The total fruit, the number of infected fruits, and the number of uninfested fruits were calculated, and the absolute attack intensity formula was used to quantify the intensity of the fruit fly pest attack:

$$P = \frac{a}{a+b}\ x\ 100\%$$

Where :
P = Percentage of fruit fly attacks
a = Number of large chilies that are attacked
b = Number of healthy chili (Hidayat, 1982).

2. Data Analysis

The data obtained were analyzed using ANOVA (*Analysis of Variance*) and continued with the BNJ test at a 5% significance level.

C. Result

1. Number of Trapped Fruit Flies Population

The results of the study on the number of fruit flies trapped in each of the four types of aromatic vegetable extracts are shown in Table 1 below:

Table 1. Average number of trapped fruit flies

Types of Vegetable Extracts	Average (tail)
Clove leaf extract	35.67
Babadotan leaf extract	29.67
Lemongrass leaf extract	33.33
Basil leaf extract	31.33

Treatment with different vegetable extracts affected the number of fruit fly catches in chili plantations. The highest average number of fruit fly catches was found in the clove leaf extract treatment, which was 35.67, and the lowest in the babadotan leaf extract treatment, which was 29.67, but all treatments did not show a significant difference. The results of observing the average number of fruit flies with the use of various aromatic vegetable extracts can be visualized in graphic form as :

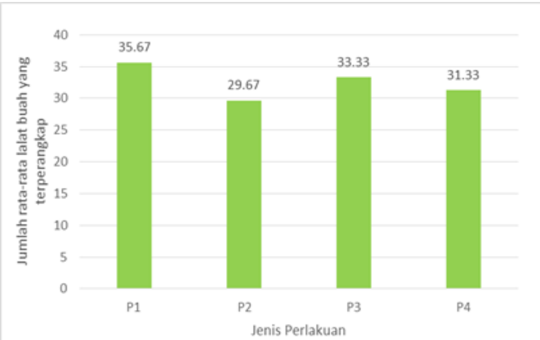

Figure 1. Average number of fruit fly catches

3. Intensity of Fruit Flies on Red Chili

The application of various aromatic vegetable extracts showed differences in the level of attack on chili, which can be seen in Table 2.

Table 2. Intensity of fruit fly attack

Treatment	Total Fruit	Attacked	Persentage	Attack Intensity (%)	Attack Category
P1	1340	20	1.49	0.19	ringan
P2	1237	18	1.46	0.18	ringan
P3	1285	14	1.09	0.14	ringan
P4	1076	40	3.72	0.46	ringan

Source: Primary data after processing, 2022.

Table 2 shows the highest attack intensity at P4, which is 0.46%, and the lowest at P3, which is 0.14%. There was no significant difference in the intensity of fruit fly attack on all types of aromatic vegetable extract treatments and they were included in the category of mild damage.

D. Discussion

The number of fruit fly catches using aromatic vegetable extracts from the highest to the lowest yields was the treatment of clove leaves, fragrant lemongrass leaves, basil leaves, and babadotan leaves. Treatment with babadotan leaf extract showed the lowest catch of all treatments, namely 29.67 fish, while treatment with clove leaf extract showed the highest yield of 35.67 fish. Differences in the content of methyl eugenol compounds in each aromatic vegetable extract caused differences in the number of trapped fruit fly populations. The content of methyl eugenol in clove leaves was higher than the other three plants. According to Bhuiyan, M.Z.I., J. Begum, N.C. Nandi and F. Akter (2010), the main component in clove oil is 70–96% eugenol ($C^{10}H^{12}O^{2}$), while in citronella leaf, the main component is citronellal ($C^{10}H^{18}O$) of 32–45%. Melisa and Muchtaridi (2017) found that the eugenol content in babadotan was only 0.4%. This is why the treatment of babadotan extract (Ageratum conyzoides) has the least amount of catch. The higher the methyl eugenol content, the more fruit flies are attracted to the compound.

The use of various aromatic vegetable extracts in controlling fruit fly pests on chili plants has several advantages, namely it is easy to obtain, environmentally friendly and does not cause contamination of chili fruit because it comes from natural ingredients. The difference in the ability of each attractant to attract fruit flies occurs because of the different active ingredients. The results showed that all the aromatic vegetable extracts used in this study could be used to control fruit fly pests on chili plants.

The trapped fruit fly population is decreasing every day. This is due to the reduced content of methyl eugenol due to evaporation of the essential oil. Effendy et al. (2010) stated that the number of trapped fruit fly imago is decreasing day by day along with the evaporation of methyl eugenol or eugenol from the attractant used. But it can be done by changing the extract every 4-5 days as long as the chili plants bear fruit. This will be very beneficial for farmers in reducing the population of fruit fly pests so that the productivity of crops obtained by farmers returns to normal (Humaira, Tasik, S.B., Masriatun, 2013).

The application of various aromatic vegetable extracts can reduce the intensity of fruit fly pests on red chili plants. The highest attack intensity was found in the basil leaf extract treatment, which was 0.46%, and the lowest was in the citronella leaf extract treatment, which was 0.14%. However, the four treatments did not show significant differences but had an effect on the intensity of fruit fly pests. This is because the four aromatic vegetable extracts each contain methyl eugenol compounds that can attract fruit flies, so they are less likely to attack chili plants. The low intensity of fruit fly attacks can also be caused by the distance between the traps. Hasanah (2018) stated that the distance of the traps that are too close can make fruit flies very easily trapped and do not attack chili fruit.

The number of red chili plants did not show a significant difference because the age of the plant was uniform, and the nutrients obtained by each plant were the same, while the number of trapped fruit fly imago was influenced by the percentage of methyl eugenol and eugenol content in the plant extracts used. The higher the methyl eugenol content in the vegetable extract, the more fruit flies were trapped. This will reduce the intensity of attacks on chili plants, so that the productivity of chili will increase. This is in accordance with the results of Hasanah's research (2018), which states that the lower the intensity of the attack, the higher the production yield.

E. Conclusion

The following conclusions were reached based on the findings of a study on the usefulness of several fragrant vegetable extracts in controlling fruit fly pests (*Bactrocera dorsalis*) on chili: The quantity of fruit flies captured in chili crops was considerably reduced when aromatic vegetable extracts made from clove leaves, basil leaves, babadotan leaves, and fragrant lemongrass leaves were used. The vegetable extract that traps the most fruit flies is clove leaf extract, which is 35.67 individuals.

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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

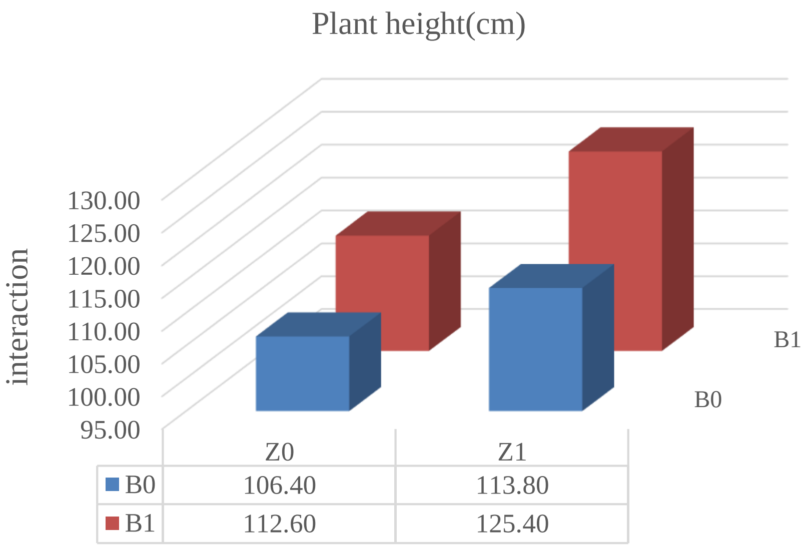

Figure 1. The average plant height in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (cm)

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

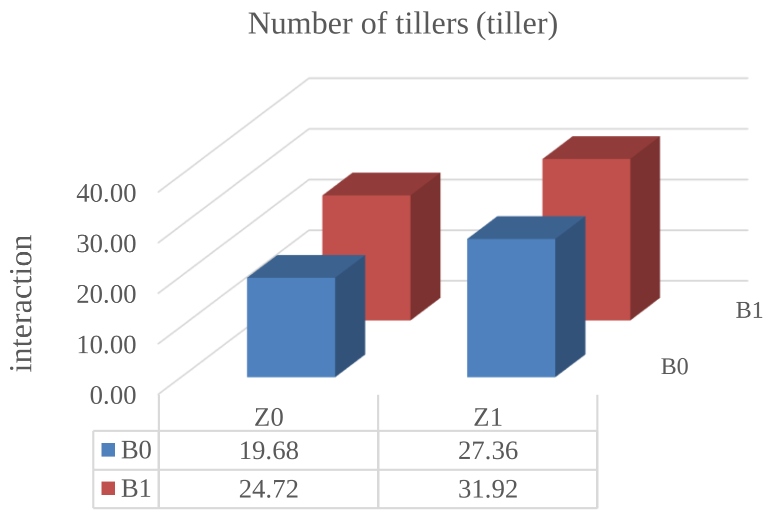

Figure 2. The average number of tillers in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on the production of black rice (tillers)

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).

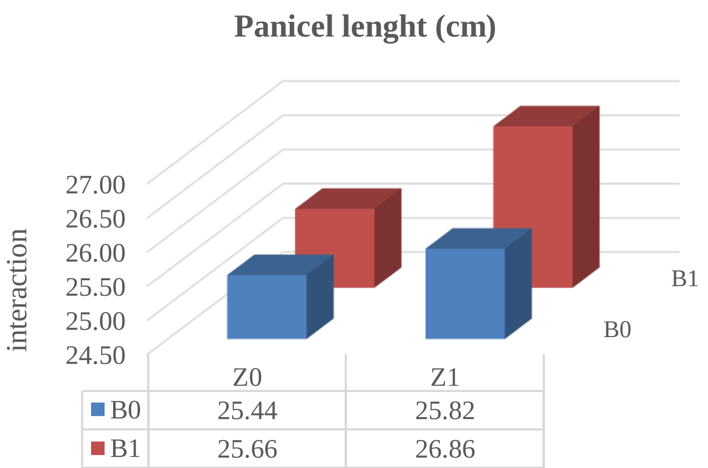

Figure 3. Average panicle length in the treatment of water hyacinth bokashi (WHB) and growth regulator (PGR) from sweet corn extract on black rice production (cm)

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).

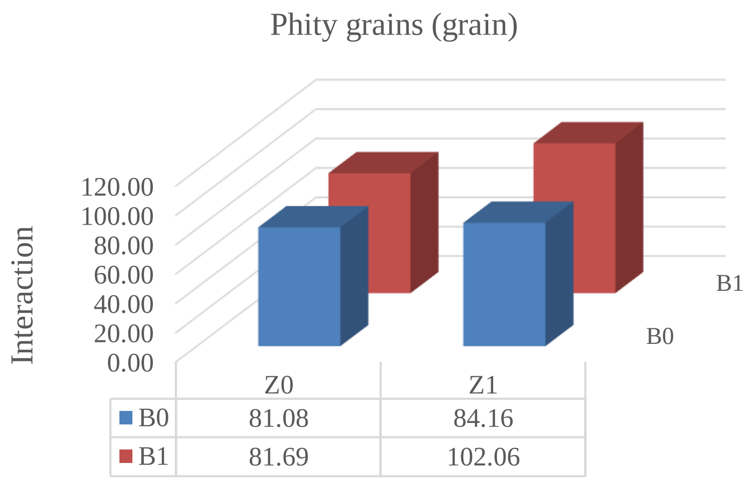

Figure 4. The average number of pithy grains in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on the production of black rice (grain)

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).

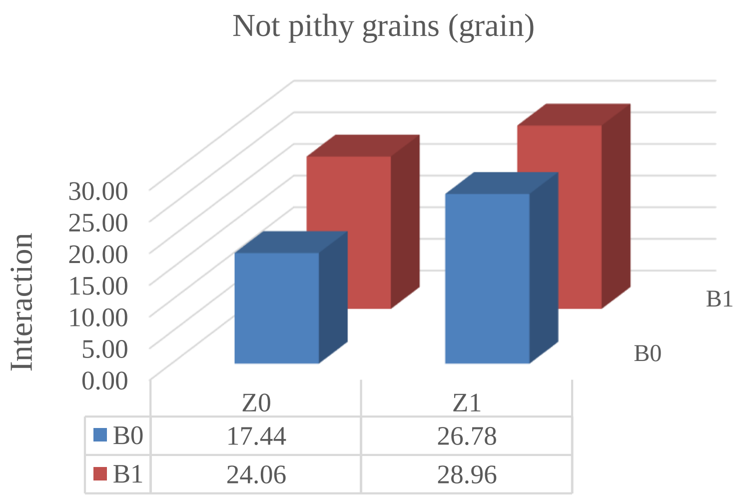

Figure 5. The average number of not pithy grains in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (grain)

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)

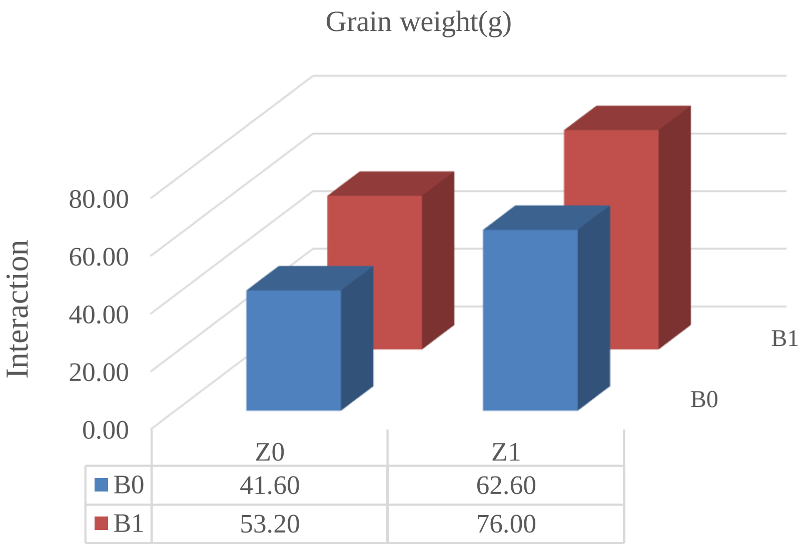

Figure 6. Average grain weight in the treatment of water hyacinth bokashi (WHB) and growth regulators (PGR) from sweet corn extract on black rice production (g)

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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Growth and yield respons of mungbean to different level of organic and inorganic fertilizer in North Sumatera

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Abstract

Integrated nutrient management is an alternative for the sustainable and cost-effective management of soil fertility by combined apply of organic with inorganic fertilizer resulting in rising soil fertility and productivity. This study aims (i) to determine the growth and yield respons of mungbean to different level of organic and inorganic fertilizer, and (ii) to measuring the effectiveness of organic fertilizer on mungbean production. The research was conducted at Pasar VI Kwala Mencirim Village, Sei Bingai District, Langkat Regency, North Sumatra in December 2020 to April 2021. This study used a Non-Factorial Randomize Complete Block design consisting of seven treatments and four replications, namely P0 (without fertilizer), P1 (100% dose of NPK fertilizer), P2 (75% dose of NPK fertilizer), P3 (50% dose of organic fertilizer + 75% NPK fertilizer) P4 (100% dose of organic fertilizer + 75% NPK fertilizer), P5 (150% dose of organic fertilizer + 75% NPK fertilizer), and P6 (1 dose of organic fertilizer + 100% NPK fertilizer). Plant height observations were carried out at 4, 6, and 8 weeks after planting and production observations were at harvest. Analysis of varian (ANOVA) was used to determined the effect of fertilizers treatment and followed by Duncan Multiple Range Test (DMRT) at 5% confidence interval for significant differences between treatment on plant growth and production. Organic fertilizer effectiveness was calculating using the Relative Agronomy Effectiveness (RAE). The results showed that organic fertilizer had a significant effect on mungbean growth and yield compared to controls. The highest mungbean production in P6 treatment of 1209 Kg/ha while the control treatment was 512 Kg/ha. Organic fertilizer was effective to increase mungbean production.

The highest relative agronomic efficiency (RAE) was 438% in the treatment of organic fertilizer fertilizer at P6 of 100% dose of organic fertilizer +100% NPK fertilizer

Keywords: mungbean, organic fertilizer, inorganic fertilizer, North Sumatera

A. Introduction

The use of inorganic fertilizer since green revolution has been increased to enhance crop production in agriculture. It gives a benefit on improved yields of crops however, unforeseen environmental impacts of soil health impacted negatively over the years (Chen, 2006; Farjana, S., Islam, M.A. and Haque, T., 2019). Organic fertilizers are environmentally friendly and improve soil health, water-holding capacity, high cation exchange capacity and low bulk density; and they foster a diverse population of beneficial soil microorganisms (Bulluck, L.R., Brosius, M., Evanylo, G.K. and Ristain, J.B. 2002; Akhter, A., Islam, M.A. and Karim, M.R. 2019).

Mungbean are one of the food crops that are a source of vegetable protein with protein content of 22% and ranks third after soybeans and peanuts (Purwono dan Hartono, 2005). Mungbeans are early maturing, drough tolerant, relatively few desease variations, can be planted on less fertile land and selling proce is relatively high and stable. Based on data from the central statistics agency (2020), the production of mungbean in North Sumatera was 1119 kg ha^{-1}. Based on variety description, the yield potential of Vima 1 mungbean variety is 1380 kg ha^{-1} (Balitkabi.litbang.go.id). Various factors cause a decrease in mungbean production including low soil fertility, land conversion, unsupportive climate factors, and inappropriate cultivation practices.

Efforts to increase the productivity of mungbean can be done by improving the efficiency of fertilization and the number of plants per planting hole. Integrated nutrient management is an alternative for the sustainable and cost-effective management of soil fertility by combined apply of organic with inorganic fertilizer resulting in rising soil fertility and productivity. This study aims (i) to determine the growth and yield respons of mungbean to different level of organic and inorganic fertilizer, and (ii) to measuring the effectiveness of organic fertilizer on mungbean production.

B. Literature Review

Organic fertilizers are fertilizer derived from dead plants, animal dung, and/or animal parts, and/or other organic wastes that have gone through an engineering process in solid or liquid form and can be enriched with mineral materials, and/or beneficial microbes to increase nutrient content and soil organic matter, as well as improving the physical, chemical and/or biological properties of the soil (Ministry of Agriculture, 2019).

Combined use of organic and inorganic fertilizers plays a significant role in sustaining soil fertility (Ali, M.E., Islam, M.R. and Jahiruddin, M. 2009) and the use of organic fertilizers together with inorganic fertilizers, has a higher positive effect on microbial biomass and enhances soil health (Elkholy, M.M., Samira, E., Mahrous and El-Tohamy, S.A. 2010) and improves the use efficiency of recommended inorganic fertilizer and reduces its cost (Ali et al. 2009; Abedi, T., Alemzadeh, A. and Kazemeini, S. 2010). Organic fertilizers also creating more air space and water retention within the soil and enhances soil nitrogen content, enhanced nutrient availability, releasing nutrients at a slower and more consistent rate, improves nutrient mobilization and Protect the soil against rain and wind erosion (Akhtar et al. 2009).

Finding of several researchers showed that integrated use of chemical and organic fertilizer has proved to be significantly increases maize productivity (Efthimiadou, A., Bilalis, D., Karkanis, A. and Williams, B.F. 2010; Gemechu, B., Etana, A., Senbeta, F. and Tolossa, D. 2017; Wapa, J.M. Kwari, J.D. and Ibrahim, S.A.2014). A study by Mahmood, F., Khan, I., Ashraf, U., Shahzad, T., Hussain, S., Shahid, M., Abid, M. and Ullah, S. (2017) showed that mixed use of organic with inorganic fertilizers significantly ($p < 0.05$) increased maize yield than individual use of organic or inorganic fertilizer. Ayeni and Adetunji (2010) also reported that the integrated use of poultry manure along with NPK fertilizer was more successful in rising nutrient availability and maize yield than sole application of any of the fertilizer materials on sandy soil, loam texture with high proportion of coarse sand (84%). Similarly, Brar, B.S., Singh, J., Singh, G. and Kaur, G. (2015) reported that integrated use of inorganic fertilizer along with organic fertilizer (100% NPK + FYM) was improved soil physical conditions and increased in soil organic carbon might have resulted in higher maize yields. Another research by Abbas, G., Abbas, Z., Aslam, M., Malik, A. U., Ishaque, M., and Hussain, F. 2011 which also combined organic and inorganic fertilizer in mungbean reported that combination of organic and inorganic fertilizer were excellent for obtaining the maximum grain yield of mungbean.

C. Methodology

1. Research design

The research was conducted on farmers field in Pasar VI Village, Kwala Mencirim, Sei Bingai District, Langkat Regency, North Sumatra starting in December 2020 to April 2021. This study used a Non-Factorial Randomize Complete Block design consisting of seven treatments and four replications, namely P0 (without fertilizer), P1 (100% dose of NPK fertilizer), P2 (75% dose of NPK fertilizer), P3 (50% dose of organic fertilizer + 75% NPK fertilizer) P4 (100% dose of organic fertilizer + 75% NPK fertilizer), P5 (150% dose of organic fertilizer + 75% NPK fertilizer), and P6 (1 dose of organic fertilizer + 100% NPK fertilizer). Organic fertilizer was given at the planting time to the palnting hole. Inorganic fertilizers Urea, SP36, and KCl as inorganic fertilizer were given at 7 days after planting (DAP) and 30 DAP. Fertilizer dose showed in table 1.

Table 1. Dose of organic and inorganic fertilizer treatment

Code	Treatment	Dose of organic fertilizer t ha^{-1}	Dose of inorganic fertilizer (kg ha^{-1})		
			Urea	SP36	KCl
Control	None fertilizer	0	0	0	0
P1	100% NPK	0	50	100	50
P2	75% NPK	0	37,5	75	37,5
P3	50% organic + 75% inorganic	0,5 t/ha	37,5	75	37,5
P4	100% organic + 75% inorganic	1 t/ha	37,5	75	37,5
P5	150% organic +75% inorganic	1,5 t/ha	37,5	75	37,5
P6	100% organic + 100% inorganic	1 t/ha	50	100	50

2. Population and sample

This study used seven treatments (Table 1) and four replications. So that it has 28 experimental plots. The number of replications according to the formula (p-1)(u-1)≥15. Repeat 4 times where (7-1)(4-1)≥15.

3. Technique of data collection

Data were collected from each plot. Plant height observations were carried out at 4, 6, and 8 weeks after planting and production observations were at harvest. Plant height was measured in centimeters from the surface of soil to the tip of the highest leaf. After harvesting, the total biomass in plot was tied in bundles and brought into laboratory for weighment and the biological yield plot^{-1} was recorded in kilograms. Similarly on the basis of yield plot^{-1} the yield ha^{-1} was calculated. The seed yield (kg ha^{-1}) was worked out by using the following formula:

$$\text{Seed yield (kg ha}^{-1}\text{)} = \frac{\text{Yield plot}^{-1}\text{ (kg) x 10000}}{\text{Plot size (m}^2\text{)}}$$

4. Instruments

The materials used in this research were Vima 1 Varieties of mungbean, organic fertilizer, Urea, SP36, and KCl fertilizer and inorganic fertilizer (N, P, K fertilizer). The tools used include cultivation tools, namely hoes, rakes, sprayers, meters, scales, etc.

5. Technique of data analysis

Analysis of varian (ANOVA) was used to determined the effect of fertilizers treatment and followed by Duncan Multiple Range Test (DMRT) at 5% confidence interval for significant differences between treatment on plant growth and production. Organic fertilizer effectiveness was calculating using the Relative Agronomy Effectiveness (RAE) with formulation:

$$\text{RAE} = \frac{\text{Tested fertilizer yield} - \text{control yield}}{\text{Standart fertilizer yield} - \text{control yield}} x 100\%$$

(Matchay, 1984)

D. Findings and Discussion

1. Findings

1.1. Organic fertilizer quality

Before application, the quality of organic fertilizer was analized in the laboratory. The result showed in Table 2.

Table 2. the result of organic fertilizer quality

Parameter	Unit	Value	Method
Water content	%	18,89	SNI 7763:2018
Organic C content	%	15,54	SNI 7763:2018
Total N	%	0,67	SNI 7763:2018
C/N	-	23,19	SNI 7763:2018
P_2O_5	%	3,76	SNI 7763:2018

K_2O	%	0,72	SNI 7763:2018
Total Fe	ppm	14.627,89	SNI 7763:2018
Fe available	ppm	7,62	SNI 7763:2018
Zn	ppm	182,32	SNI 7763:2018
Hg	ppm	0	SNI 7763:2018
Cd	ppm	0	SNI 7763:2018
Pb	ppm	16,44	SNI 7763:2018
As	ppm	0	SNI 7763:2018
Cr	ppm	td	SNI 7763:2018
Ni	ppm	td	SNI 7763:2018
pH	-	7	SNI 7763:2018
Eschericia coli	Mpn/g	(-)	SNI 7763:2018
Salmonella sp.	Mpn/g	(-)	SNI 7763:2018

1.2. Soil Characteristic

Soil analysis before the test was carried out at the North Sumatra AIAT Laboratory. The results of soil analysis (Table 3) showed that the total N content of the soil is moderate, the available P and K of the soil are low, the content of Ca is low and Mg is high, the content of micronutrients is sufficient, and the pH of the soil is acidic. These results indicate that the soil at the research site still lacks P and K nutrients, and N nutrients still need to be increased so that the growth and yield of mung bean can be maximized. The application of organic fertilizer is expected to increase soil fertility by increasing the availability of soil nutrients to increase the growth and production of mungbean. While the nutrients N, P, and K will be met by the application of inorganic fertilizers.

Table 3. Soil characteristic in site location

Type of analysis	Unit	Value	Method
Organic C	%	4,39	spektrofotometer
Total N	%	0,50	Kjeldahl
P available	ppm	1,65	spektrofotometer
K-exchange	me/100g	0,29	AAS
pH	-	5,50	Elektrometri
Al-exchange	me/100g	0,11	Titrimetri
Ca	me/100g	4,08	AAS
Mg	me/100g	3,79	AAS
Cu	ppm	2	AAS
Zn	ppm	4	AAS
Mn	ppm	9	AAS
Fe	ppm	27	AAS
Texture			Hidrometer
Sand (%)	%	80,41	
Silt (%)	%	17,14	
Clay (%)	%	2,45	
CEC	me/100g	27,78	destilation

1.3. Plant height (cm)

The effect of applying organic and inorganic fertilizer on plant height was observed at 4, 6, and 8 weeks after planting. The results of ANOVA and DMRT analysis on plant height are shown in Table 4. The results of ANOVA analysis showed that the application of combined organic and inorganic fertilizer significantly affected plant height at 4, 6, and 8 weeks compared to the control treatment. The highest plant height was in the P6 treatment at 4, 6, and 8 weeks with a dose of 100% dose of organic fertilizer and 100% dose of NPK fertilizer.

Table 4. Result of statistical analysis of plant height (week after planting)

Code	Treatment	Plant height		
		4 WAP	6 WAP	8 WAP
P0	0 fertilizer	18.5a	31.75a	38.75a
P1	100% NPK	21.1b	35.5b	49c
P2	75% NPK	20.6b	34ba	41.5b
P3	50% OF + 75% IOF	22.6b	38.75c	50.25c
P4	100% OF + 75% IOF	23.9c	41.125c	52.75d
P5	150% OF + 75% IOF	25.5c	42.125d	54.5d
P6	100% OF + 100% IOF	28.1d	47.625e	55.25e

Note : numbers with the same letters in the same column are not significantly different based on Duncan's Multiple Range Test (α0.05).

1.4. Yield (kg ha^{-1})

The results of ANOVA analysis and DMRT further testing on maize production showed that the application of organic and inorganic Fertilizer had a significant effect on Mungbean yield compared to the control treatment (without fertilizer) with the calculated F value higher than the F table value. The highest mungbean production was found in the P6 treatment of 1209 Kg ha^{-1} and the lowest was in the control treatment of 512 Kg ha^{-1}. The results of the Anova and DMRT tests on the effect of organic and inorganic fertilizer on mungbean production are shown in Table 5.

Table 5. Result of statistical analysis of mungbean production

Code	Treatment	Yield Kg $plot^{-1}$	Yield Kg ha^{-1}
P0	0 fertilizer	1.3a	512a
P1	100% NPK	1.7b	671b
P2	75% NPK	1.5b	610b
P3	50% OF + 75% IOF	2.0c	806c
P4	100% OF + 75% IOF	2.1c	854c
P5	150% OF + 75% IOF	2.5d	1,018d
P6	100% OF + 100% IOF	3.0e	1,209e

Note : numbers with the same letters in the same column are not significantly different based on Duncan's Multiple Range Test (α0.05).

1.5. Relative agronomy effectiveness (RAE)

Relative agronomic effectiveness (RAE) is a measure of the effectiveness of a fertilizer. A fertilizer be agronomic effective if it has a relative agronomic effectiveness value > 95%. With a relative agronomic effectiveness value of more than 95%, it means that the fertilizer can increase yields greater than the treatment without fertilizers and compared to standard inorganic fertilizers.

The RAE value of the organic fertilizer treatment tested on the P2, P3, P4, P5, and P6 treatments, respectively 62, 185, 215, 318, and 438, which means that the P3, P4, P5 and P6 treatment passed effectiveness test criteria for organic fertilizer. Meanwhile, RAE of P2 was 62%, which is <95%, meaning that it does not meet the RAE value. The results of the calculation of RAE for all treatments are shown in table 6.

Table 6. Relative agronomy effectiveness (%)

Code	Treatment	RAE (%)
P0	0 fertilizer	-
P1	100% NPK	-
P2	75% NPK	62
P3	50% OF + 75% IOF	185
P4	100% OF + 75% IOF	215
P5	150% OF + 75% IOF	318
P6	100% OF + 100% IOF	438

2. Discussion

In this test, the use of combined fertilizers of organic and inorganic fertilizers can increase plant growth and yield of mungbean compared to the control treatment. The best dose of organic fertilizer was P6 treatment with dose of Organic fertilizer 1 ton ha^{-1} and 100% dose of inorganic fertilizer with a productivity of 1,209 kg ha^{-1}. This result is close to the average yield based on the variety description, which is 1,380 kg ha^{-1} (balitkabi.litbang.go.id). The yield of this research was higher than other research with the same variety in Belu District, NTT where the Vima 1 mungbean productivity only 923.73 kg ha^{-1} (Seran, Y. L., Kote, M., dan Benu, F. (2011). A study by Mahmood et al. (2017) showed that mixed use of organic with inorganic fertilizers significantly ($p < 0.05$) increased maize yield than individual use of organic or inorganic fertilizer.

The real effect of organic fertilizer treatment on the growth and production of mungbean is related to differences in soil fertility produced physically, chemically and biologically, and due to differences in doses of organic fertilizers given. It can be seen in the results of the DMRT test, where the higher dose of organic fertilizer, the growth and production of mungbean was also increases. The research of Syofia et al. (2014) showed that the application of solid and liquid organic fertilizers on mungbean increased plant growth and yield. The productivity of mungbean with solid and liquid organic fertilizer reached 1160 kg ha^{-1}. Combined use of organic and inorganic fertilizers plays a significant role in sustaining soil fertility (Ali et al. 2009) and the use of organic fertilizers together with inorganic fertilizers, has a higher positive effect on microbial biomass and enhances soil health (Elkholy et al. 2010) and improves the use efficiency of recommended inorganic fertilizer (Ali et al. 2009; Abedy et al. 2010).

According to soil characteristic (Table 1). The soil in site location is in acidic condition, still lacks P and K nutrients, N nutrients still need to be increased, and soil texture is sandy loam, where this condition is not favorable for plant growth. The crop production is inseparable from the quality of the soil and the availability of nutrients and their management (Rajiman, 2020). Sutanto (2002) stated that organic fertilizers improve the physical properties of the soil by making the soil loose and loose so that it is better aerated and easily penetrated by plant roots. In sandy textured soils it will increase the binding between particles and increase the water binding capacity. Soil chemical properties are improved by increasing cation exchange capacity and nutrient availability, while the effect of organic matter on soil biology is to increase the energy needed for the life of soil microorganisms. Kriswantoro, H., E. Safriani., dan S. Bahri. (2016) reported that the higher dose of organic fertilizer increasing the growth and yield of the plant. Organic fertilizers improve soil conditions, provide nutrients for plant growth. According to Kresnatita, S., Koesriharti, & Santoso, M. (2013), good soil conditions will create a suitable growing environment for plant growth. Research on horticultural crops shows that soil that is given organic fertilizer and added a little inorganic fertilizer can have a positive effect on plant growth and yield.

Conclusion

The application of Organic fertilizers could increase mungbean growth and production compared to control treatment. Based on the calculation of relative agronomic effectiveness (RAE) it is known that all treatments of Organic fertilizers have RAE > 95%. The optimum dose of Organic fertilizer was 1ton ha^{-1} combined with 100% dose of inorganic fertilizer.

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