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Parthenocarpy Fruit Formation in Cucumber (*Cucumis sativus* L.) with Giberelin Hormone Application on The Lowland of Palopo

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Abstract

This study aimed to observe (1) The formation of parthenocarpy fruit in cucumber with the application of Giberelin hormone and (2) the concentration of Giberelin to form the parthenocarpy fruit on cucumber. This study was held at campus 2 trial land, Faculty of Agriculture Cokroaminoto University, Palopo. The method used in this study was group randomized design method with five treatments and three replications, i.e P0 (without Giberelin application), P1 (200 mg/L Giberelin), P2 (250 mg/L Giberelin), P3 (300 mg/L Giberelin) and P4 (350 mg/L Giberelin). The result showed that the application of Giberelin with 350 mg/L concentration (P4) significantly affected the formation of parthenocarpy fruit on the number of seed produced with 379.96 seeds. The highest number of seeds produced was observed in control treatment (P0) with 496.27 seeds. Furthermore, the fruit fresh weight, diameter, and length had no significant difference

Keywords: giberelin, cucumber, parthenocarpy

A. Introduction

Cucumber is famous vegetable type that is widely consumed by the community, both freshly and processed as *asinan*, pickles, and salad. Cucumber can also be utilized as medicine and cosmetic ingredients (Wulandari, Guritno & Aini, 2014). Therefore, the fruit quality becomes very important especially when meeting with the demands of traditional and modern markets (Rukmana, 2010).

BPS (2018) reported that the production data of cucumber in South Sulawesi Province on the last three years was fluctuative, as 8,810 tons in 2016, decreased at 6,596 tons in 2017, and increased at 7,629 tons in 2018, while the cucumber demand continued to increase along with the public awareness to consume vegetables. Declined cucumber production in Indonesia is because of the cucumber farming cucumber is still considered as a side farming business (Kartikasari, Aini & Koesriharti, 2016).

Efforts applied to increase the cucumber production to meet the market demand is by improving the fruit quality concerned in the color, taste, aroma and seed presence. Consumers generally prefer less fruit seeds (parthenocarpy) than more seeds. The supplementation of growth regulator (ZPT) can be utilized for the formation of fruit without seeds. The application of phytohormones can substitute the role of seeds in stimulating the formation and development of fruit (Saptowo, 2001). The formation of seedless fruit (parthenocarpy) can be induced through a growth regulatory application, such as Giberelin.

Giberelin is one of the ZPT that is commonly used to produce the fruit growth without seeds, which is widely used by the seedless wine producers for grape seed cultivars. Giberelin has been widely used as ZPT to induce the seedless fruit formation (Suswanto, 2002). Some previous studies utilizing Giberelin to induce the seedless fruit formation (parthenocarpy) comprised watermelon (Wijayanto, Yani & Arsana, 2012), tomato (Rolistro, Sunaryo & Wardiyati, 2014), and cucumber (Wulandari *et al*., 2014). This study used the highest concentrations of Giberelin with 350 mg/L referred to the previous study research conducted on watermelon (Wijayanto et al., 2012) as the concentrations of 300 mg/L still produced fruit with plenty seeds.

Based on the explanation above, it is necessary to conduct the study to obtain the formation of parthenocarpy fruit in cucumber, thus improving the quality and quantity of crop production.

B. Methodology

This study was held at the campus 2 trial land, faculty of agriculture, Cokroaminoto University, Palopo, Lamaranginang Street, Batupasi Village, Wara Utara District, Palopo.

Materials used in this study were cucumber seeds, Giberelin, lable, water, and natural fertilizer. Equipments used in this study were pen, book, bucket, camera, ruler gauge, shovel, scoop, chopping knife, bamboo, scale, caliper, and hose.

This study used group randomized design with five treatments and five replications, thus resulting 25 experimental units. Treatments in this study comprised:

P0: Without any treatments (control)

P1: 200 mg/L concentration of Giberelin application

P2: 250 mg/L concentration of Giberelin application

P3: 300 mg/L concentration of Giberelin application

P4: 350 mg/L concentration of Giberelin application

Data obtained were analyzed statistically. Continued analysis on the data was performed whether all treatments indicated significant difference using honestly significant difference test with 5% degree of confidence.

The procedure methods in this study were as follows:

1. Preparation

Materials and equipments preparation was firstly conducted, before crop planting during the study. Land area measurement and crop bed layout adjustments were also conducted against the sunlight direction.

2. Land processing

Land processing was performed by clearing the land area from weeds and other disruptive materials, before crop planting. Soil was processed using shovel to form crop bed. Crop bed was made at the size of 60 cm length, 30 cm width, and 30 cm height with 40 cm distance on each bed.

3. Planting

Cucumber planting was performed directly on the prepared bed. Holes were created on the bed, before planting the cucumber, with two holes on each bed separated at 30 cm distance. Two cucumber seeds were planted on each holes.

4. Giberelin Dilution

The process of Giberelin (Gibgro) dilution included: Giberelin was measured as much as 200 mg, 250 mg, 300 mg, 350 mg and placed in different containers. Measurement results were taken into the Beaker glass. Water was added into the glass until reaching 1000 ml. Diluted results were stored on the supplied bottles.

5. Giberelin Application

Giberelin solution was sprayed onto the female flower. The application process included:

a. Note each flower that would be sprayed with spoid.
b. The spoid hole that contained Giberelin hormone was brought closer to the flower crown hole.
c. Giberelin was sprayed based on the concentration used in the flower crown hole.
d. Mark the sprayed flower with a rope.
e. Second spraying was performed on each flower after 24 hours.
f. 6. Maintenance

Maintenance activities included watering the crops daily in the morning and evening when not raining. Stitching was performed soon or directly after planting until 15 days after planting to replace the dead plants. The installation of stake for crop propagation was performed at 10 days after planting. Weeds around crops were removed mechanically using sickle or other similar equipments or directly removing and clean weeds by bare hand. Pest and disease control was also conducted whether there were visible symptoms of pest and disease attacks on crops using pesticides or traps.

7. Observation

Observations were performed after Giberelin application starting from the first day after the application until the last day on the harvesting period. Observations conducted were based on the parameters determined. Crop diameter and height were observed every week, while the percentage of germination, fruit fresh weight, diameter, length, seed number, and formation percentage were performed during the harvesting period.

Parameter Observation

Observed parameters in this study included:

1. Fruit fresh weight (g)
2. Fruit diameter (cm)
3. Fruit length (cm)
4. Number of seeds (seeds)

C. Result and Discussion

1. Fruit weight

Analysis of variance result indicated significant difference on the fruit weight presented on Figure 1.

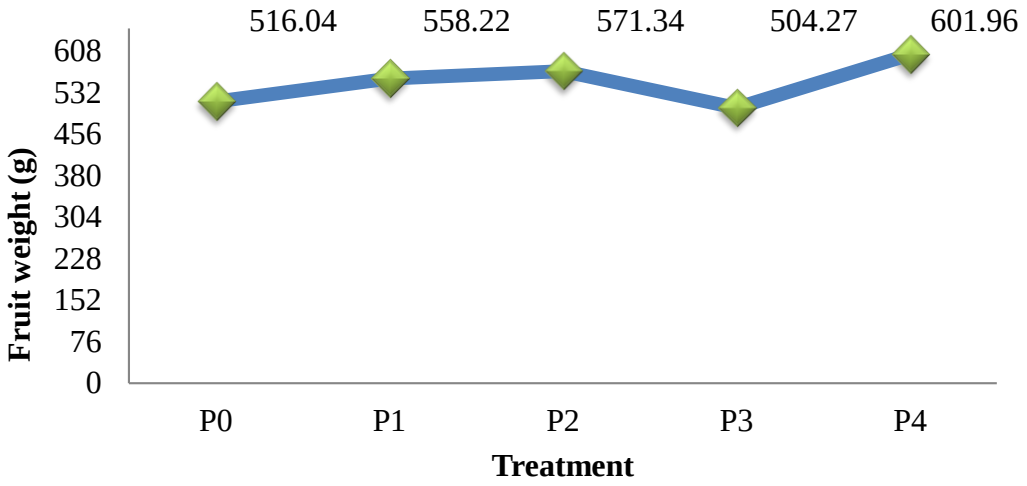

Figure 1. Cucumber average fruit weight on different concentration of Giberelin against parthenocarpy fruit formation.

2. Fruit Diameter

Giberelin application resulted in insignificant different against the fruit diameter of cucumber with the average value is presented on Figure 5.

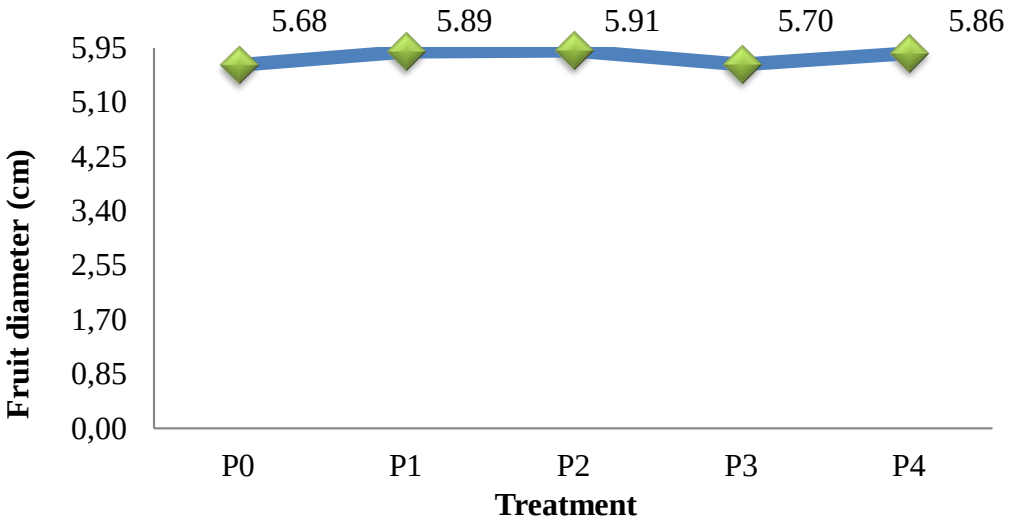

Figure 5. Cucumber average fruit diameter on different concentration of Giberelin against parthenocarpy fruit.

3. Fruit Length

Analysis of variance obtained insignificant different result on the fruit length as presented on Figure 6.

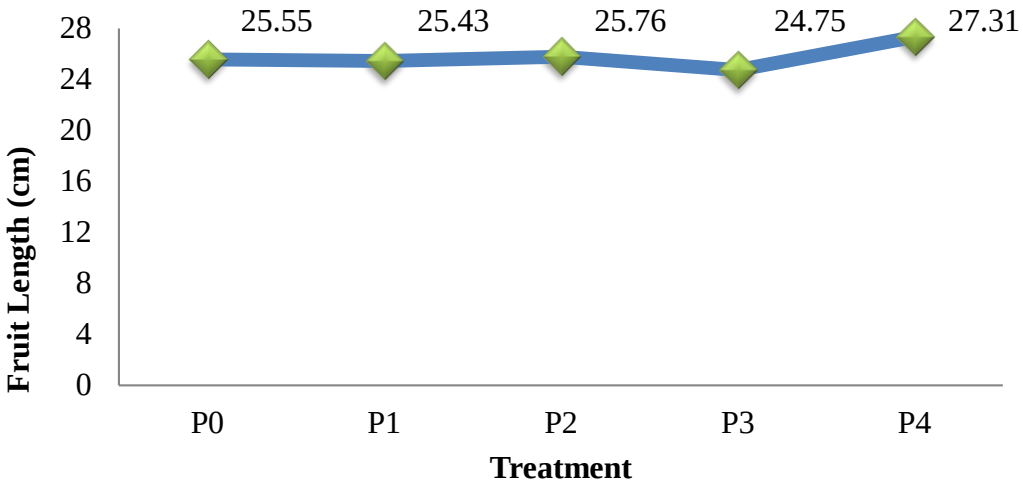

Figure 6. **Cucumber average fruit length on different concentration of Giberelin against parthenocarpy fruit formation.**

4. The number of seeds

The final data of seed total number observation based on the analysis of variance indicated significant difference on each concentration of Giberelin against the parthenocarpy fruit formation. The average value of seed number is presented on Figure 8.

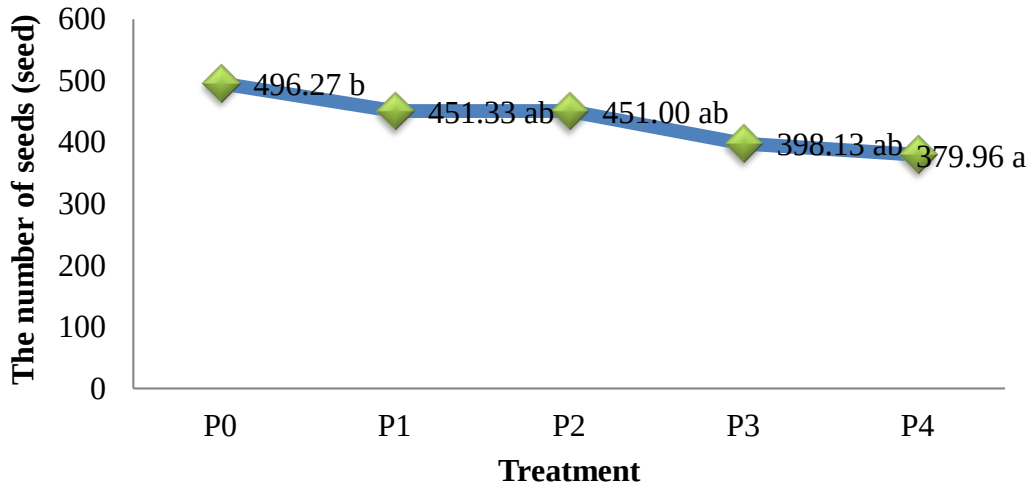

Figure 8. **Cucumber average number of fruit seeds weight on different concentration of Giberelin against parthenocarpy fruit formation. Numbers with the same letter mark shows insignificant different based on the honestly significant difference test with 5% degree of confidence.**

Discussion

Various Giberelin concentrations indicated significant difference based on the analysis of variance against the seed formation of cucumber crop. This is because the application was performed in the female flowers and the entire male flowers were cut during the application, causing the cucumber crop fertilization was inoccured. This is in accordance with the previous studies resulting in the formation of the most concentrated parthenocarpy fruit. Wijayanto, *et al.* (2012) mentioned that Giberelin with the highest concentration (300 mg/L) showed the best significant influence with the lowest number of seeds, i.e 13.667. The seed formation still lasted on each treatment as Giberelin hormone inhibited the embryo development, producing imperfect seeds. In addition, outer factor, namely insects and wind influence could also help pollination process to induce the seed formation. No seeds formed in the fruit produced were caused as the female gamete cells (ovule or seed candidate) were unaffected by male gamete cell (sperm), resulting ovary cells to perform cell cleavage, differentiation, specialization, growth and development with the influence of Giberelin application (Serrani, Fos, Atares, & GarciaMartines 2008).

The highest concentration treatment on P4 was able to provide the highest fruit length and weight among other treatments. The application of Giberelin to the plant will increase the cell size, improving the fruit length and weight. The formation of lighter and smaller fruit is thought to be caused by the unformed seeds in the fruit produced. As described earlier that the seed formation in the fruit should be accompanied by the active synthesis of phytohormones (such as Auxin and Giberelin), thus the metabolite translocation to the fruit can actively synthesizes the phytohormones to become more intensive, resulting larger size of the fruit (Pandolfini, 2009). Although affecting the fruit size, Pandolfini (2009) also reported that the fruit without seeds has an advantage, namely longer shelf life as unpresented seeds will reduce the synthesis of secondary metabolites (such as phenolics), therefore the browning process (browning or damage) in the fruit flesh becomes longer (Maestrelli, LoScalzo, Rotino, Acciarri, Spena, Vitelli, & Bertolo, 2003).

Giberelin with the right concentration will be able to affect the growth of fruit plants, thus producing the best fruit diameter. However, Giberelin influence tends to be less effective to influence the fruit diameter in the cucumber. P3 and P4 treatment indicated the fruit diameter were lower than P2. This was because high concentrations of Giberelin were able to lower the fruit diameter. In addition, P0 and P1 treatment indicated increased fruit diameter as the concentration of Giberelin applied. According to Utama (2015), Giberelin plays a role in stimulating the cell enlargement and division, specifically in the diameter of stem. Nonetheless, stem diameter data showed no significant difference among the treatments. This condition was not separated from the application of Giberelin that was only applied in the female flowers. The same condition also happened in the crop height. The absence of Giberelin treatment against the crop diameter was observed based on the data showing stabilized diameter from the beginning until end of the observation.

D. Conclusion

Giberelin application affects the parthenocarpy fruit formation in cucumber (*Cucumis sativus* L.) based on the number of seeds formed parameter, however having no effect on the fruit weight, diameter and length. The best Giberelin concentration to influence the formation of parthenocarpy fruit in cucumber was found at P4 treatment with 350 mg/L concentration, which was also the highest Giberelin concentration applied. The average number of seeds formed in P4 was 379.96 seeds, indicating the lowest number of seeds among other treatments, while P0 showed the highest number of seeds formed with 496.27 seeds.

E. References

BPS. (2018). www.bps.go.id. Accessed on July 20, 2019

Kartikasari, O., Aini N., & Koesriharti. (2016). Respon Tiga Varietas Tanaman Mentimun (Cucumis Sativus L.) Terhadap Aplikasi Zat Pengatur Tumbuh Giberelin (Ga_3). *Jurnal Produksi Tanaman* 4(6): 425-430

Maestrelli A., Lo Scalzo R., Rotino G.L., Acciarri N., Spena A., Vitelli G., & Bertolo G. (2003). Freezing Effect on Some Quality Parameters of Transgenic Parthenocarpic Eggplants. *J. Food Eng*., 56 : 285–287

Pandolfini, T., (2009). Seedless Fruit Production by Hormonal Regulation of Fruit Set. *Nutrients*, 1(2): 168–177

Rolistro, A., Sunaryo., & Wardiyati, T., (2014). Pengaruh Pemberian Giberelin Terhadap Produktivitas Dua Varietas Tanaman Tomat (Lycopersicum esculentum Mill.). *Jurnal Produksi Tanaman.* 2, pp. 457-463

Rukmana, R. (2001). *Budidaya Mentimun.* Kanisius. Yogyakarta

Serrani, J.C., Fos, M., Atarés, A. & GarcíaMartínez J.L., (2007). Effect of Gibberellin and Auxin on Parthenocarpic Fruit Growth Induction in the cv. Micro-Tom of Tomato. *J. Plant Growth Regul*., 26 : 211–221

Saptowo, J.P., (2001). Pembentukan Buah Partenokarpi Melalui Rekayasa Genetik. *Buletin Agbio*. 4(2): 45-49

Suswanto A, (2002). *Semangka dan Anggur Tanpa Biji*. Accessed July 25, 2019

Utama, M.Z.H. (2015). *Budidaya Padi Pada Lahan Marginal: Kiat Meningkatkan Produksi Padi.* ANDI. Padang

Wijayanto, T., Yani, W.O.R., & Arsana, M.W. (2012). Respon Hasil Dan Jumlah Biji Buah Semangka (Citrullus vulgaris) Dengan Aplikasi Hormon Giberelin (GA_3). *Jurnal Agroteknos.* 2(1): 57-62

Wulandari E., Guritno B., & Aini N. (2014). Pengaruh Kombinasi Jumlah Tanaman Per Polybag dan Komposisi Media Tanam Terhadap Pertumbuhan dan Hasil Tanaman Mentimun (*Cucumis sativus* l.) Var. Venus. *Jurnal Produksi Tanaman.* 2(6); 464-473

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Yield Evaluation and Selection of M6 Wheat Mutant adaptive to Medium Land

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Abstract

Wheat is a sub-tropical plant that can adapt well at altitudes of 1000 - 3000 m above sea level and requires relatively low temperatures. At this height, wheat crops in Indonesia are unable to compete with horticultural crops with higher economic value. This causes national wheat production to be very low and results in high wheat imports. Therefore, wheat varieties are needed that can grow and develop in Indonesia in the low to medium plains. The study aimed to test the adaptive mutant population descent in the middle plains to prepare multi-location tests and release of varieties. The benefit of this research is obtaining potential strains from high-temperature adaptive wheat mutants in the lowlands. This research was conducted using a randomized block design with three replications. The treatment consisted of 16 M6 Wheat mutants and four comparative varieties. The results showed that the genotypes of wheat mutants that had high production in M6 propagation in the central plains were N 350 3.7.1 (2.74 t. ha-1), N 350 3.6.2 (2.33 t.ha-1) and N 350 3.1.3 (2.26 t.ha-1). Characters that have high heritability values on M6 Number of stomata, chlorophyll index, plant height, number of tillers, productive tillers, rate of seed filling, panicle length, number of seedlings, empty percentage of florets, hollow seed weight, 1000 seed weight, and production

Keywords: wheat, mutant, selection, medium land, heritability

A. Introduction

Agricultural sector development efforts are always faced with a dynamic domestic and international environment. Therefore, agriculture in Indonesia must have a comparative advantage as a basis for building national and international competitive advantages, so that it can improve the welfare of the community in a sustainable manner (Basir, 2001). The increase in population and per capita income of the Indonesian people has led to the rise in food demand in terms of quantity, type and quality. The diversification program undertaken by the Indonesian government has succeeded in gradually reducing rice consumption, but alternative foods that are widely used by the community are still limited to foods made from imported raw materials such as wheat. The need for wheat in Indonesia, which continues to increase every year encourages the government to meet these needs by introducing.

Wheat crops are only developed in sub-tropical regions because they are plants that can adapt well at altitudes of 1000 - 3000 m above sea level and require relatively low temperatures. At this height, wheat crops in Indonesia are unable to compete with horticultural crops with higher economic value. This causes Indonesia to be the second-largest wheat importer in the world after Egypt. The need for wheat in Indonesia is 100% met from imports, the United States Department of Agriculture (USDA) estimates that Indonesia's wheat imports in 2015-2016 reached 8.10 million tons, up about 8% from the previous year (2014) of 7.48 million tons. With so many imports, Indonesia is the world's second-largest wheat importer after Egypt, which reached 11.50 million tons. Even in 2017, Indonesian wheat imports have reached 11.6 million tons with an import value of US $ 2,771,792,426 (Alnopri, 2004).

The increase in wheat imports that drain the country's foreign exchange must be overcome by a food diversification program by developing climate-appropriate wheat crops in Indonesia. Based on this fact, it is necessary to explore the potential of wheat plants that can grow and develop in Indonesia. If this is not anticipated, Indonesia will become the world's number one wheat importer after Egypt and Brazil.

The problem faced in the effort to develop wheat in the middle and lowlands is the differences in the suitability of the agro-climate conditions which will make the wheat in a high-temperature grip condition. Althuhaish, Miftahdin, Trikoesoemaningtyas, & Sudirman (2014) reported that the climate in Indonesia for the highlands is very different from the low or medium plains. Wheat is cultivated in high-temperature stress conditions with an average temperature (> 29ºC) can inhibit plant growth, the number of tillers and reduce yield and yield components (Althuhaish *et al*. 2014). Potential mutants developed in the lowlands that produce higher production than comparable varieties are N.200 2.5.2, N.250 4.6.2 and N.350 3.6.2 (Dolferus, Xuemei, Richard, 2011).

The research aims to test the adaptive mutation populations of lowland mutants to proceed to the multi-location test and release of varieties. The benefit of this research is obtaining potential strains from high-temperature adaptive wheat mutants in the lowlands. This will help in the supply of foodstuffs from wheat which is highly favoured by all members of the community, both in villages and in cities. Therefore, the development of wheat will support a national program to increase food diversification that will reduce dependence on rice, reduce the volume of wheat imports so that the country's foreign exchange increases.

B. Methodology

This research is a test of descent, selection, and evaluation for multi-location test preparation and adaptation of several genotypes of wheat mutants that are potentially developed and adaptive in the lowlands. Research using the Pedigree selection method using genetic material from the results of previous studies that have been irradiated. The design used was a Randomized Block Design with selected mutant genotypes as treatment. The plot size used was 3m x 5m with three replications. The parameters observed were plant height, number of tillers, number of productive tillers, panicle length, number of spikelets, number of empty spikelets, the weight of seeds per

panicle, the weight of 1000 grains, leaf chlorophyll content, number of stomata, and productivity. Data analysis was performed by analysis of variance followed by BNT0.05 test. To find out the relationship between characters, regression and correlation studies were carried out, while the genetic diversity of mutant genotypes was carried out by heritability analysis. To find out the relationship between characters, regression and correlation analyses were carried out, while the genetic diversity of mutant genotypes was carried out by heritability analysis.

C. Results and Discussion

1. Results

Table 1 propagation of M6 in the stomata number parameter shows that (N 350 3.6.2) g1 has the best average compared to all genotypes and comparison varieties with a value (9.56). The stomata density parameter shows that (N 350 3.13) g3 has the best average (47.55 n.cm-2). Whereas in the Chlorophyll index shows that (N 350 3.7.1) g13 has the best average value compared to the comparative variety (Munal) namely (779.49)

Tabel 1. Average Number of Stomata, Stomata Density and Chlorophyll Index of several M6 wheat genotypes in medium land

Genotype	Jumlah Stomata		Kerapatan Stomata		Indeks Klorofil	
(g1) N 350 3.6.2	9,56	**abcd**	43,68	**bd**	776,39	d
(g2) N 300 3.6.1	5,89		37,04	**d**	766,64	
(g3) N 350 3.1.3	8,56	**abcd**	47,55	**bcd**	771,95	
(g4) D 200	8,56	**abcd**	38,70	**d**	774,99	
(g5) N 350 3.1.4	7,11	**a**	35,39	**d**	767,39	
(g6) N 250 2.5.1	7,00	**a**	34,83	**d**	767,35	
(g7) M 200 1.7.1	7,89	**bd**	42,57	**d**	775,15	
(g8) N 250 4.6.2	6,56	a	32,62		767,87	
(g9) S 300 8.3.1	7,67	**d**	38,15	**d**	768,68	
(g10) S 6.4.1	8,89	**abcd**	42,57	**d**	772,37	
(g11) S 300 7.9.1	7,78	**bd**	39,26	**d**	773,85	
(g12) S 300 2.1	7,44	**d**	33,17	**d**	769,16	
(g13) N 350 3.7.1	8,78	**abcd**	43,57	**bd**	779,49	d
(g14) N 200 2.4.B.6	8,11	**abd**	34,83	**d**	763,50	
(g15) N 200 2.5.2	7,00	**a**	40,36	**d**	774,54	
(g16) N 200 2.3.3	6,33	a	31,52		770,22	
(g17) Dewata (a)	6,89		39,30		767,56	
(g18) Selayar (b)	6,67		34,28		771,46	
(g19) Nias (c)	7,22		35,94		770,91	
(g20) Munal (d)	4,89		24,33		760,33	
NP BNT 5%	1,11		8,74		15,25	

The numbers followed by the same letter in the column (abcd) mean very different from the comparative varieties of Dewa (a), Selayar (b), Nias (c), and Munal (d) at the BNT test level = 0, 05

Plant Height parameters in table 2 show that (N 350 3.6.2) g1 has the best average value compared to comparative varieties (selayar) 70.53 cm) whereas the number of tillers and productive tillers shows that (N 350 3.7.1) g13 has the best value compared to all comparative varieties, namely (7.27 number of tillers) and (6.47 productive breeds).

Table 2. Average plant height, number of tillers and tillers productive of several M6 wheat genotypes

Genotipe	Plant height		Number of tillers		Number of Tillers Productive	
(g1) N 350 3.6.2	70,53	b	7,07	**abcd**	4,80	**abcd**
(g2) N 300 3.6.1	58,33		4,07		3,13	
(g3) N 350 3.1.3	68,93	b	7,13	**abcd**	5,27	**abcd**
(g4) D 200	69,07	b	5,67	**bcd**	4,40	**abcd**
(g5) N 350 3.1.4	64,00		4,40		3,40	**d**
(g6) N 250 2.5.1	58,93		4,87		3,67	**d**
(g7) M 200 1.7.1	70,40	b	6,60	**abcd**	3,20	
(g8) N 250 4.6.2	62,10		5,07		3,87	**d**
(g9) S 300 8.3.1	49,80		4,53		2,33	
(g10) S 6.4.1	62,80		6,67	**abcd**	5,80	**abcd**
(g11) S 300 7.9.1	66,87		5,80	**bcd**	4,13	**abcd**
(g12) S 300 2.1	60,20		5,00		2,07	
(g13) N 350 3.7.1	70,03	b	7,27	**abcd**	6,47	**abcd**
(g14) N 200 2.4.B.6	53,63		4,87		3,20	
(g15) N 200 2.5.2	60,93		5,93	**abcd**	4,13	**abcd**
(g16) N 200 2.3.3	57,93		4,93		3,40	**d**
(g17) Dewata (a)	60,80		4,73		3,20	
(g18) Selayar (b)	57,80		4,20		3,53	
(g19) Nias (c)	64,17		4,53		3,53	
(g20) Munal (d)	61,20		4,27		2,47	
NP BNT 5%	10,13		1,13		0,78	

The numbers followed by the same letter in the column (abcd) mean very different from the comparative varieties of Dewa (a), Selayar (b), Nias (c), and Munal (d) at the BNT test level = 0, 05

The development of the number of productive tillers is primarily determined by environmental factors, especially air temperature, the higher the air temperature tends to slow the growth of the number of productive tillers. This is consistent with the results of research Handoko (2007) that the development of the number of tillers is strongly influenced by the air temperature. The number of tillers in wheat plants is significant, especially the number of productive tillers where the number of productive tillers is the number of tillers so that the number of productive tillers is positively correlated. This is consistent with the opinion of Bowden et al., (2007) that the number of panicles/number of tillers, the correlation value is closest to 1.0 compared to other vegetative parameters.

In the M6 propagation activity (table 3), the flowering age parameters showed that (N 350 3.1.4) g5 had the fastest average flowering age compared to other genotypes (63.00 hst). For harvest age parameters, (N 200 2.5.2) g15 has the most rapid average harvest age (92.00 hst). Whereas the parameter of seed filling rate shows (N 200 2.5.2) g15 has the fastest average speed filling rate compared to all genotypes and comparison varieties, namely (24.33 HST).

The speed of flowering in wheat plants is influenced by the physiological conditions of the plants which are affected by the temperature of the surrounding environment. If the temperature is too high, the age of wheat flowering is faster than in the middle to highlands. This is consistent with the opinion of Glover (2007) that the flowering behaviour and flowering of plants are closely related to the physiological conditions of plants and the influence of environmental factors that specifically include the impact of intensity and duration of irradiation, control of temperature, and water availability on plant growth

environments. The mechanism of flowering age as one of the wheat adaptation efforts is also strengthened by Dolferus (2011) opinion which states that the adjustment of flowering time is an essential mechanism of adaptation of wheat plants to the desired environmental conditions because it can result in avoidance of abiotic stresses, especially heat stress in specific environments.

Table 3. Average Flowering Day, Harvest Day, and Seed Filling Rate for several M6 wheat genotypes

Genotype	Flowering Day		Harvest Day		Seed Filling Rate	
(g1) N 350 3.6.2	64,33	**abcd**	100,33	**abcd**	36,67	**cd**
(g2) N 300 3.6.1	65,33	**abcd**	97,33	**abcd**	34,00	**bcd**
(g3) N 350 3.1.3	68,00	**abcd**	103,67	**abcd**	35,00	**cd**
(g4) D 200	68,67	**abcd**	92,67	**abcd**	35,33	**cd**
(g5) N 350 3.1.4	63,00	**abcd**	96,00	**abcd**	32,67	**abcd**
(g6) N 250 2.5.1	64,33	**abcd**	94,67	**abcd**	30,00	**abcd**
(g7) M 200 1.7.1	65,33	**abcd**	92,33	**abcd**	28,67	**abcd**
(g8) N 250 4.6.2	65,67	**abcd**	94,00	**abcd**	29,00	**abcd**
(g9) S 300 8.3.1	63,67	**abcd**	95,33	**abcd**	32,33	**abcd**
(g10) S 6.4.1	64,00	**abcd**	95,33	**abcd**	29,67	**abcd**
(g11) S 300 7.9.1	64,00	**abcd**	95,00	**abcd**	30,67	**abcd**
(g12) S 300 2.1	65,33	**abcd**	100,00	**abcd**	33,67	**bcd**
(g13) N 350 3.7.1	63,67	**abcd**	94,33	**abcd**	31,00	**abcd**
(g14) N 200 2.4.B.6	65,67	**abcd**	95,33	**abcd**	27,67	**abcd**
(g15) N 200 2.5.2	66,33	**abcd**	92,00	**abcd**	24,33	**abcd**
(g16) N 200 2.3.3	67,67	**abcd**	95,00	**abcd**	30,33	**abcd**
(g17) Dewata (a)	67,67		98,67		30,00	
(g18) Selayar (b)	65,00		95,67		31,33	
(g19) Nias (c)	65,33		97,33		33,67	
(g20) Munal (d)	65,67		105,33		40,00	
NP BNT 5%	4,50		10,54		3,48	

The numbers followed by the same letter in the column (abcd) mean very different from the comparative varieties of Dewa (a), Selayar (b), Nias (c), and Munal (d) at the BNT test level = 0, 05

Indicator of wheat plants approaching the time of harvest, ie panicles begin to change colour to yellow to get the stem. This is following the opinion of Wiyono (1980) stating that if 20% of the panicle is fully cooked, where the grain (seeds) of wheat are hard enough when massaged by hand, the wheat is ready to be harvested.

The panicle length parameter (Table 4) shows that (N 350 3.7.1) g13 has the best panicle length compared to all comparator varieties (9.32 cm). For the parameter number of spikelet, it shows that (N 350 3.7.1) g13 has the highest number of spikelets compared to all comparator varieties (17.56). As for the parameter number of seedlings, genotype (N 350 3.1.3) g3 has the highest number of seeds compared to all comparator varieties (45.17).

Crops that experience stress will experience a decrease in the size of the plant parts produced. This happens because the wheat genotypes that have to stress have relatively fast drying leaves, so the photosynthesis process is not running optimally so that energy and food reserves are not enough available for the growth and development of plant organs. This is in Nur A's opinion (2013) which states that the length of the panicle and the number of spikelets/panicles is determined by the assimilate supply in the vegetative phase as a source of sources for forming panicles in the

generative phase. If the sources are insufficient in the formation of a sink (generative phase), then the structure of spikelets is low.

Table 4. Average Panicle Length, Number of Spikelets per panicle and number of seeds per panicle of several M6 Wheat genotypes.

Genotype	Panicle Lenght		Number of Spikelets per Panicle		number of seeds per panicle	
(g1) N 350 3.6.2	8,98	**abcd**	17,33	**abcd**	41,56	**abcd**
(g2) N 300 3.6.1	7,97		15,00	**c**	31,17	**d**
(g3) N 350 3.1.3	9,01	**abcd**	17,11	**abcd**	45,17	**abcd**
(g4) D 200	8,42	**bc**	16,56	**abcd**	36,00	**acd**
(g5) N 350 3.1.4	7,08		15,83	**abcd**	34,50	**acd**
(g6) N 250 2.5.1	8,10		15,17	**c**	33,83	**acd**
(g7) M 200 1.7.1	8,25	b	15,89	**abcd**	41,22	**abcd**
(g8) N 250 4.6.2	7,38		15,44	**c**	29,56	
(g9) S 300 8.3.1	7,56		14,00	**d**	24,00	
(g10) S 6.4.1	8,33	**b**	15,67	**d**	41,55	**abcd**
(g11) S 300 7.9.1	8,22		16,00	**abcd**	35,00	**acd**
(g12) S 300 2.1	8,07		8,07	8,07	8,07	
(g13) N 350 3.7.1	9,32	**abcd**	17,56	**abcd**	43,44	**abcd**
(g14) N 200 2.4.B.6	8,02		14,83	**c**	30,33	
(g15) N 200 2.5.2	8,14		15,50	c	38,67	**abcd**
(g16) N 200 2.3.3	7,97		15,00	c	33,17	**acd**
(g17) Dewata (a)	8,09		14,78		27,78	
(g18) Selayar (b)	7,82		14,89		34,22	
(g19) Nias (c)	7,92		13,00		28,33	
(g20) Munal (d)	8,07		14,78		27,67	
NP BNT 5%	0,88		2,03		7,03	

The numbers followed by the same letter in the column (abcd) mean very different from the comparative varieties of Dewa (a), Selayar (b), Nias (c), and Munal (d) at the BNT test level = 0, 05

In Table 5 (Propagation M6) shows that the parameter percentage of empty florets, (N 350 3.7.1) g13 has the least rate of empty florets compared to all comparator varieties, namely (3.33 florists). The weighting parameters of the seed showed that (N 350 3.7.1) g13 had the most substantial weight compared to all comparator varieties (1.79 g). For the mass of 1000 grains, it showed (N 350 3.7.1) g13 had the most substantial weight of 1000 seeds compared to all comparator varieties (42.56 g). As for production, (N 350 3.7.1) g13 has the highest output compared to all comparator varieties, namely (2.74 t.ha-1).

The size of the seeds of wheat plants is influenced by the process of gametogenesis and metabolic processes, the inappropriate agro-climate conditions will affect the operation of gametogenesis of wheat plants, and the amount of assimilates produced after gametogenesis helps the plant in seeds to produce optimal seeds. The same thing started by Acevedo et al., (1991) in Al-Karaki (2012) states that each increase of 1oC from 17oC to 24oC in the seed filling phase can reduce the weight of wheat seeds by about 4%. Less efficient accumulation of assimilates from leaves to seeds is also caused by limited water which is in the process of translocation. The reproduction process starts from microsporogenesis and megasporogensis, stigma and pollen viability, blooming flowers, pollination, pollen tube growth, early embryonic growth and development, all of which are very susceptible to heat stress. The failure of each of these processes

results in decreased fertilisation or increased embryo abortion, which causes a decrease in the number of seeds, thereby limiting production (Nasaruddin, Farid, Musa, & Iswoyo, 2018).

Table 5. Average Panicle Length, Number of Spikelets per Panicle and Number of Seeds per Panicle of M6 Wheat Genotypes.

Genotype	Persentase Floret Hampa		Bobot Biji Permalai		Bobot 1000 Biji		Produksi	
(g1) N 350 3.6.2	7,83	**abcd**	1,42	**abcd**	35,44	**abcd**	2,33	**abcd**
(g2) N 300 3.6.1	16,67	**bd**	0,62		23,00		**1,83**	
(g3) N 350 3.1.3	9,78	**abcd**	1,51	**abcd**	35,67	**abcd**	2,26	**ab**
(g4) D 200	11,11	**abcd**	1,08	**abcd**	30,00	**a**	2,01	
(g5) N 350 3.1.4	15,50	**abcd**	0,72		24,00		**1,79**	
(g6) N 250 2.5.1	13,33	**abcd**	0,75		25,50		**1,82**	
(g7) M 200 1.7.1	11,00	**abcd**	1,18	**abcd**	32,67	**ad**	2,06	
(g8) N 250 4.6.2	15,00	**abcd**	0,61		27,00		1,98	
(g9) S 300 8.3.1	16,33	**bd**	0,46		23,44		1,75	
(g10) S 6.4.1	9,22	**abcd**	0,98	**ad**	31,89	**ad**	2,03	
(g11) S 300 7.9.1	8,78	**abcd**	1,51	**abcd**	33,00	**ad**	2,43	**abcd**
(g12) S 300 2.1	14,17	**abcd**	0,85		25,39		1,68	
(g13) N 350 3.7.1	3,33	**abcd**	1,79	**abcd**	42,56	**abcd**	2,74	**abcd**
(g14) N 200 2.4.B.6	11,83	**abcd**	0,80	**d**	26,17		1,86	
(g15) N 200 2.5.2	10,67	**abcd**	1,06	**acd**	30,55	**ad**	2,05	
(g16) N 200 2.3.3	12,11	**abcd**	0,70		22,67		**1,78**	
(g17) Dewata (a)	13,56		0,83		24,33		1,90	
(g18) Selayar (b)	22,00		0,92		28,89		1,91	
(g19) Nias (c)	14,00		0,83		29,67		1,96	
(g20) Munal (d)	17,00		0,61		25,67		2,00	
NP BNT 5%	2,22		0,15		4,42		0,33	

Table 6. Heritability Values of M6 Wheat mutants.

No	Characters	Heritability	Clasification
1	Number of Stomata	71,00	Height
2	Stomata Density	39,71	medium
3	Chlorophyll Index	99,85	Height
4	Plant height	85,13	Height
5	Number of Tillers	67,43	Height
6	Number of Prodictive tillers	84,15	Height
7	Flowering day	0,05	Low
8	Harvest Day	2,50	Low
9	Seed filling rate	70,81	Height
10	Length of Panicle	92,93	Height
11	Percentage of Empty Florets	31,55	Medium
12	Number of grain per panicle	82,93	Height
13	Percentage of Empty Florets	94,11	Height
14	Seed Weight per panicle	95,14	Height
15	Weight of 1000 seeds	93,54	Height
16	Yield	85,99	Height

Table 6 shows that almost all characters have high heritability values. The highest heritability was found in the character of the chlorophyll index with heritability (99.85%). The results of the heritability analysis show that in the M6 product, almost all parameters have a high heritability value. This can then be used as an evaluation material for the selection of temperature stress in the lowlands. This is by the opinion of Hadiati, Murdaningsih, Baihaki & Rostini (2003) that for selection, characters with high heritability must be used because these traits will be easily inherited and selection can be made in the early generations. High heritability values indicate that genetic factors play a role more than environmental factors (Alnopri, 2004).

Characters that have high heritability will increase the effectiveness of selection in endurance testing because the observed characteristics are a reflection of the influence of genetic factors compared to environmental impacts. Quantitative characters that have high heritability will result in selection progress for desirable traits, whereas if low heritability is less useful to be used as a selection material (Basir, 2001).

D. Conclusions

1. Genotipe mutan gandum yang memiliki produksi tinggi pada perbanyakan M6 adalah N 350 3.7.1(2.74 t.ha-1), N 350 3.6.2 (2,33 t.ha-1) dan N 350 3.1.3 (2,26 t.ha-1).

2. Karakter yang memiliki nilai heritabilitas tinggi pada M6 Jumlah stomata, Indeks klorofil, tinggi tanaman, jumlah anakan, anakan produktif, laju pengisian biji, panjang malai, jumlah biji permalai, persentase floret hampa, bobot biji permalai, bobot 1000 biji dan produksi.

E. References

Al-Karaki, G.Z. (2012). Phenological Development-Yield Relationships in Durum Wheat Cultivars under Late-Season High-Temperature Stress in a Semiarid Environment. *ISRN Agronomy Volume 2012, 7 pages*

Althuhaish, A.A.K., Miftahdin, Trikoesoemaningtyas, & Sudirman Y. (2014). Field Adaptation of Some Introduced Wheat (*Triticum aestivum* L.) Genotypes in Two Altitudes of Tropical Agro-Ecosystem Environment of Indonesia. *Hayati Journal of Biosciences;* 21(1):31-38

Alnopri. (2004). Variabilitas Genetic dan Heritabilitas Sifat-sifat Pertumbuhan Bibit Tujuh Genotipe Kopi Rabusra-Aarabika. *Jurnal Ilmu-Ilmu Pertanian Indonesia*, 6 (2): 91-96

Basir, M., (2001). Pemanfaatan Nilai Heritabilitas dan Koefisien Korelasi untuk Menentukan Indikator Seleksi. *Jurnal Agrivigor*, 1 (1) : 1-6

Bowden C., Spargo J., & Evanylo G. (2007). Mineralization and N fertilizer Equivalent Value of Composts. *Compost Sci. Util.* 15(2): 111-118

Dolferus R, Xuemei Ji, Richard A.R. (2011). Abiotic Stress and Control of Grain Number in Cereal. *Plant Sci.*181: 331– 341

Glover B. (2007). *Understanding Flowers and Flowering An Integrated Approach*. New York, USA : Oxford University Press

Handoko. (2007). *Gandum 2000 Penelitian dan Pengembangan Gandum Di Indonesia*. Seameo-Biotrop, Bogor, Indonesia. 118 hlm

Hadiati, S.,H.K., Murdaniningsih, Baihaki A. & Rostini. (2003). Parameter Genetik Karakter Komponen Buah pada Aksesi Nenas. *Zuriat* 14(2):47-52

Nasaruddin, Farid, Musa Y., & Iswoyo H. (2018). Assessment and Selection of M3 Generation ofWheat Mutans Adaptive in Lowland. *IOP Conference Series: Earth and Enviromental Science Vol 157 (2018)012051*

Nur A. (2013). *Adaptasi Tanaman Gandum (Triticum aestivum* L.*) Toleran Suhu Tinggi dan Peningkatan Keragaman Genetik Melalui Induksi Mutasi dengan Menggunakan Iradiasi Sinar Gamma*. [Dsertasi]. Bogor: Sekolah Pascasarjana, Institut Pertanian Bogor

Wiyono, T. N. (1980). *Budidaya Tanaman Gandum*. PT. Karya Nusantara. Jakarta

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Characteristics of Soil Fertility Affecting the Rice Fields Productivity in Bogor Regency

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Abstract

The purpose of this study was to determine the parameters of soil fertility in rice fields and the effect of soil fertility on paddy productivity in Bogor Regency. This research was conducted in the districts of Cileungsi, Darmaga and Leuwiliang, Bogor Regency. The location selection was done deliberately based on the location of rice production facilities with Ciherang and Inpari varieties. Sampling was conducted at several sampling points at each location. Each sub-district was taken 8 samples or 24 in total, then analyzed in the laboratory. Data processing using multiple regression with a dummy. The results showed that the soil in Bogor Regency was generally acidic, where soil fertility characteristics with organic C content were low to moderate, nitrogen was very low to moderate, P was low to high, K was very low to moderate, CEC was moderate to high, and saturation bases (KB) are moderate to high. Soil biology, namely total bacteria, total fungi, total solvent P bacteria, Azotobacter sp., And Rhizobium sp. Are generally low to moderate. Variable characteristics of soil fertility in the form of organic C, Nitrogen (N), K2O HCl 25%, and CEC significantly influence rice productivity. Soil fertility in the three districts is almost the same and does not affect the productivity of rice fields. While the productivity of rice fields with Inpari varieties is higher than those grown by Ciherang varieties. To increase the productivity of rice fields in Bogor Regency, it is recommended to plant Inpari variety rice by applying N fertilizer

Keywords: Soil fertility and rice fields productivity

A. Introduction

Rice is a vital staple food for more than 200 million people of Indonesia, so the rice self-sufficiency program is very important. The establishment of new paddy fields and intensification

programs is an effort by the government so that Indonesia can be self-sufficient in rice. Achievement of the national rice production target is 70.6 million tons of GKG (an increase of 7%) in 2011 and rice stock reaches a surplus of 10 million tons in 2015. The Ministry of Agriculture requires hard work for all agricultural stakeholders and the application of technology to accelerate rice production. The nutrient requirements of each plant are very specific depending on the nature of the soil, climatic conditions and types of plants.

In 2018 Bogor Regency was able to produce 353,150 tons of rice from a harvest area of 85,966 hectares. The existing number is only able to meet 61 percent of the 5.8 million rice needs of the population. Rice production continues to decline while food needs such as rice are getting higher, so it is necessary to take action to monitor the status of soil fertility, so that it can provide fertilizer recommendations in accordance with the location and needs of the crop being cultivated, by conducting a research study on the status of soil fertility in Bogor Regency (Ali, 2019).

For this reason, the empowerment of land resources must also be able to take advantage of the role of biological soil conservation which has a high ability to increase soil fertility. The use of varieties suitable for fertility and climatic conditions will affect rice productivity, so it is necessary to determine varieties with land type and height for each region. In Java in particular, many farmers use several new varieties and local varieties including IR 64, Ciherang, Inpari Sidenuk, Wangi and others.

Based on the description above, it is necessary to evaluate the status of soil fertility in cultivated land, in Bogor Regency so that the supply and food security for Bogor Regency can continue. That is why knowing the status of soil fertility is important in increasing crop production and influencing agriculture in the future. The aim of this study is to find out the parameters of soil fertility in paddy fields, and find out the effect of soil fertility on paddy productivity in Bogor Regency.

B. Literature Review

Soil is a growing medium for plants, as a warehouse and supplier of nutrients. Soil based on particle size is a mixture of sand, dust and clay. The finer the particle, the wider the surface area of the particles per unit weight. Thus, clay is the most extensive surface soil fraction compared to 2 other fractions. It is on the surface of these particles that various soil chemical reactions occur, which then affect soil fertility (Hanafiah & Ali, 2005). Fertile soil is soil that has a deep profile (very deep depth exceeding 150 cm); loose structure; pH 6.0 to 6.5; the content of the nutrients available to plants is sufficient; and there are no limiting factors in the soil for plant growth (Sutedjo, 2002).

The nutrients needed by plants that are provided by the soil to support their growth and reproduction are called soil fertility. Fertile soils have balanced nutrients, water and air and are available according to the needs of plants, both physically, chemically and biologically. The state of soil physics includes texture, structure, effective depth, humidity and soil air system. Soil chemical conditions include soil reaction (soil pH), nitrogen, phosphorus, potassium, cation exchange capacity, base saturation, organic matter, and other nutrients. Whereas soil biology, among others, includes the microbial activity of organic material remodeling in the process of humification and binding of air nitrogen (Damanik, Hasibuan, Fauzi, Sarifuddin & Hanum, 2010)

To increase soil fertility, fertilizer is applied. P and K fertilization has been continuously applied by farmers, so that the soil has high P and K nutrient status. This results in an imbalance of nutrients in the soil and decreased land productivity (Puja, Supadma, & Mega, 2013). On intensive agricultural land with tillage, inorganic fertilizers and intensive pesticides can suppress the development of populations of microorganisms such as microbes and soil fauna which have a very important role in metabolic activities in the soil. Empowerment of soil biological resources can also increase soil productivity by providing appropriate soil media to support the activities of each organism in the soil and can take place sustainably.

C. Methodology

The research was conducted in the v of Leuwiliang, Darmaga and Cileungsi, Bogor Regency. The research was also carried out in the Soil Bogor Research Center's soil laboratory which was conducted from March to August 2019.

1. Population and Sample

The population in this study is rice fields in Bogor Regency. Whereas the samples in this study were rice fields in Leuwiliang, Darmaga and Cileungsi Districts, Bogor Regency. Site selection is done deliberately with the consideration that the location is a production center both from IR 64 and Ciherang varieties. Soil sampling was carried out at several sampling points at each location to obtain an overall sample of 24 sample units.

2. Data Types and Data Sources

Primary and secondary data of this study include:

a) Analysis of soil fertility, such as: pH (H_2O), organic C (%), Nitrogen (N) (%), P_2O_5 Bray (ppm P), P_2O_5 25% HCl (mg / 100 g), exchanged K (cmole / kg), K_2O HCl 25% (me / 100 g), CEC (me/ 100 g), Base Saturation (KB) (%), Total Bacteria (x 10^8), Total Fungi (x10^2), Total Solvent B Bacteria (P x10^3), Azotobacter sp. (x 10^3), Rizobium sp. (x 10^3)
b) Rice fields productivity (ton / ha) based on interviews with farmers, traders, rice mills, retail rice traders and the Agriculture Service officials to accuracy the data obtained

3. Data analysis

The data obtained from the results of laboratory analysis are used to see the level of fertility of rice fields in Bogor Regency. To determine the effect of fertility characteristics in three districts with two rice varieties on rice productivity in Bogor Regency, then using multiple regression analysis, the models to be estimated are:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \ldots\ldots\ldots\ldots + b_{14}X_{14} + d_1D_1 + d_2D_2 + d_3D_3$$

Where :

Y = Soil productivity (ton / ha)

X = namely X_1: pH (H_2O), X_2: C organic (%), X_3: Nitrogen (N) (%), X_4: P_2O_5 Bray (ppm P), X_5: P_2O_5 25% HCl (mg / 100 g), X_6 : K exchanged (cmole / kg), X_7: K_2O HCl 25% (me / 100 g), X_8: CEC (me / 100 g), X_9: Base Saturation (KB) (%), X_{10}: Total Bacteria (Bacteria) x 10^8), X_{11} Total Fungi (x 10^2), X_{12}: Total Solvent Bacteria P (x 10^3), X_{13}: Azotobacter sp. (x 10^3), X_{14}: Rizobium sp. (x 10^3)

D_1 = dummy variety (Ciherang = 0 and Inpari = 1)

D_2 = District dummy (Leuwiliang = 1 and other districts = 0)

D_3 = District dummy (Darmaga = 1 and other districts = 0)

D. Results and Discussion

1. General Conditions of Bogor Regency

Bogor Regency is located at position 6°19' LS and 6°47' LS, and 106°01' and 107°103' BT. The width of Bogor Regency is 2,663.81 km2 and has various types of regional morphology, from relatively low plains in the North to highlands in the South, which is around 29.28% at an altitude of 15-100 meters above sea level, 42, 62% are at an altitude of 100 - 500 meters above sea level, 19.53% are at an altitude of 500 - 1,000 meters above sea level, 8.43% are at an altitude of 1,000 - 2,000 meters above sea level and 0.22% are at an altitude of 2,000 - 2,500 meters above sea level .

2. Soil fertility

Soil has an important role on plant growth and crop production, because the land in addition to functioning as a place / media for growing plants, holding and providing water for plants also plays a role in providing nutrients needed by plants to support plant growth. Land formation is

influenced by various factors such as climate, parent material, topography / relief, organisms and time. Therefore in general the status of soil fertility in a land will be different with different physical environments.

Characteristics of Some Soil Chemical Properties

The results of the analysis of some of the chemical properties of the soil in the rice fields, Bogor Regency can be seen in Table 1. Most of the values of the chemical properties in some locations show very low to moderate. Based on the results of laboratory analysis shows that soil CEC in rice fields in the District of Cileungsi is in the range of 24.28 - 56.76 me / 100 g of land (classified as high - very high), Darmaga District is in the range of 22.60 - 51.11 me / 100 g of land (classified as moderate - very high), Leuwiliang District is in the range of 22.89 - 48.77 me / 100 g of land (classified as moderate - very high). This situation is due to the presence of soil constituent particles dominated by clay fraction which has a large colloidal surface area, so that the soil CEC is also high. From Table 1 shows the results of laboratory analysis and calculation of the number of cations shows that the saturation of the base (KB) of the soil in the rice fields respectively ranged between 47-67%, 61-68% and 61-64% (classified as moderate to high) .

Table 1. Characteristics of some Soil Chemical Properties, Bogor Regency

Soil Chemistry	Cileungsi District		Darmaga District		Leuwiliang District	
	Value	Status	Value	Status	Value	Status
pH (H_2O)	4,12 - 4,93	SM – M	4,20 - 5,19	SM – M	4,48 - 6,03	SM – M
C organic (%)	1,81 - 2,65	R – S	1,43 - 2,80	R – S	1,38 - 2,44	R – S
Nitrogen (N) (%)	0,14 - 0,28	R – S	0,00 - 0,25	SR – S	0	SR
P_2O_5 Bray (ppm P)	0,53 - 18,24	SR – ST	0,00 - 27,41	SR – ST	0	SR
P_2O_5 HCl 25% (me/ 100 g)	6 – 178	SR – ST	9 – 182	SR – ST	49 – 88	T – ST
K Exchanged (cmole/kg)	0	SR	0	SR	0	SR
K_2O HCl 25% (me/ 100 g)	5 – 31	SR – S	10 – 37	R – S	6 – 16	SR- R
KTK/CEC (me/100 g)	24,28 - 56,76	T – ST	22,60 - 51,11	S – ST	22,89 - 48,77	S – ST
Saturation Based (KB) (%)	47 – 67	S – T	61 – 68	T	61 – 64	T

Based on the results of laboratory analysis Table 1 shows that the organic C content of soil in the rice fields in the District of Cileungsi is in the range of 1.81 - 2.65% (classified as low to moderate), Darmaga District is in the range of 1.43 - 2.80% (classified as low to moderate) and Leuwiliang Subdistrict are in the range of 1.38 - 2.44% (classified as low to moderate). Variation of organic C content (organic material) on these lands is due to differences in the type and amount of vegetation that grows on these lands. Munawar (2013) stated that soil organic matter is all the carbon in the soil that comes from the dead plants / plants and animals that have died. Most sources of soil organic matter are plant tissue. Different sources and amounts of organic matter will have different effects on organic material donated to the soil.

Based on the results of laboratory analysis showed that the rice fields in the District of Cileungsi P_2O_5 HCl 25% ranged from 6 - 178 me / 100 g (classified as very low to very high) and P_2O_5 Bray content ranged from 0.53 - 18.24 ppm P (classified as very low to very high), Darmaga District content of P_2O_5 HCl 25% ranging from 9 - 182 me / 100 g (classified as very low to very high) and content of P_2O_5 Bray ranging from 0.00 - 27.41 ppm P (classified as very low to very high), and Leuwiliang District content of P_2O_5 HCl 25% ranges from 49 - 88 me / 100 g (classified as high to very high) and P_2O_5 Bray content ranges from 0 ppm P (classified as very low). This situation is caused because the soil is formed from parent material (rock / mineral) which is poor in P element

and the P content in organic matter is also low As stated by Munawar (2013) that P in the soil comes from the disintegration of P-containing minerals such as apatite, and decomposition organic matter. The solubility of inorganic P compounds and organic P in the soil is generally very low, so that only a small portion of soil P is in the soil solution (total P).

Laboratory analysis results show that rice fields in Cileungsi District contain K_2O HCl 25% ranging from 5 - 31 me / 100 g (classified as very low to moderate) and swapped K content ranges from 0 cmole / kg (classified as very low), Darmaga District K_2O HCl 25% content ranges from 10 - 37 me / 100 g (classified as very low to moderate) and the exchanged K content ranges from 0 cmole / kg (classified as very low), and Leuwiliang District K_2O HCL 25% content ranges from 6-16 me / 100 g (classified as very low content to low) and the exchanged K content ranges from 0 cmole / kg (classified as very low). This situation is caused by the rocks / minerals making up the soil in the area are poor in base cationic content, besides that it can also be caused because in Bogor Regency has high rainfall, so the base cations have been leached.

Soil Biological Characteristics

Soil biological characteristics include soil organic matter, flora and fauna of the soil (especially important microorganisms such as bacteria, fungi and Algae), interaction of soil microorganisms with plants (symbiosis) and soil pollution. Land is said to be fertile if it has high biological diversity and diversity. Soil organisms (microorganisms) are important in soil fertility because: 1) Play a role in the energy cycle. 2) Has a role in the nutrient cycle, 3) Has a role in the formation of soil aggregates. and 4) Determine soil health (suppressive / conducive to the emergence of diseases, especially diseases of soil borne pathogen).

Table 2. Characteristics of some Soil Biological Traits, Bogor Regency

Soil Biology	Cileungsi District		Darmaga District		Leuwiliang District	
	Value	Status	Value	Status	Value	Status
Total Bakteri (x 10^8)	1,5 - 2,4	S	1,7 - 2,7	S	1,8 - 2,6	S
Total Fungi (x 10^2)	1,8 - 26,0	S – T	1,0 - 2,2	S	0,5 - 0,8	R
Total Bakteri Solvent P (x10^3)	0 – 8	S	0 – 2	R	0 – 3	R
Azotobacter (x 10^3)	1 - 24	T	1 - 80	T	1 – 2	R
Rizobium sp (x 10^3)	0 – 17	T	0 - 2	S	0 – 3	S

Bacteria are prokaryotic single-celled organisms with the highest number of groups and are found in each terrestrial ecosystem. Although their size is smaller than actinomycetes and fungi, bacteria have more diverse metabolic abilities and play an important role in soil formation, decomposition of organic matter, remediation of polluted soils, nutrient transformation, mutual integration with plants and also as a cause of disease (Rasti, Hasan, & Simanungkalik, 2007). From the results of the study it can be seen in Table 2 that the total Bacteria of paddy soils in the District of Cileungsi amounted to between 1.5 - 2.4 x 108 (classified as moderate), Darmaga numbered between 1.7 - 2.7 x 108 (classified as moderate) and Leuwiliang amounted between 1.8 - 2.6 x 108 (classified as moderate). While the total landfill fungi in the district of Cileungsi amounted to between 1.8-26 x 108 (classified as moderate), Darmaga numbered between 1.0-2.2 x 108 (classified as moderate) and Leuwiliang numbered between 1.8-2.6 x 108 (classified as medium).

Azotobacter sp. is one of the bacterial inoculants that is important for increasing soil N availability and increasing crop yields. Azotobacter sp. is a rhizobacteria that is always found in cereal plants. From the results of the study it can be seen that Azotobacter sp Sawah soil in the district of Cileungsi amounted between 1 - 24 x 103 (classified as high), Darmaga amounted

between 1-80 x 103 (classified as high) and Leuwiliang amounted between 1-2 x 103 (classified as low).

Rizobium sp. is a group of bacteria capable of providing nutrients for plants, especially legume plants. This bacterium is able to infect plant roots and form nodules that function to take N in the atmosphere and distribute it as nutrients needed by the host plant. From the results of the study found Rhizobium Rice fields in the District of Cileungsi amounted between 0-17 x 103 (classified as high), Darmaga amounted between 1-80 x 103 (classified as high) and Leuwiliang numbered between 1-2 x 103 (classified as low).

3. Rice Field Productivity

Rice productivity is the yield per unit area and time. One effort to increase productivity can be done by improving genetic potential and plant resistance to biotic constraints (pests and diseases) and abiotics (drought and poisoning), improvement of site-specific cultivation (integrated crop management and prescription farming). The acceleration and expansion of dissemination and adoption of technological innovations. Increased national rice productivity is very possible when viewed from the potential development of superior varieties and rice technology readiness in the Agency for Agricultural Research. From the results of the study it can be seen that the productivity of paddy soils in Cileungsi District amounts between 5.5 - 8.75 tons / ha, Darmaga amounts between 5.5 - 7.0 tons / ha and Leuwiliang amounts between 5.5 - 7.5 tons / Ha.

Intensive paddy soil is characterized by yields that can be achieved in excess of 8 tons / ha with one or more growing seasons in one year. In this intensive rice field, there will be a decrease in nutrients available in the soil. The availability of adequate irrigation water throughout the year has encouraged farmers to grow rice continuously on their land. The use of superior seeds stimulates the use of inorganic fertilizers even more, while organic fertilizers are increasingly abandoned due to various obstacles in transportation and procurement.

4. Effect of Soil Fertility Characteristics on Soil Productivity

To determine the effect of fertility characteristics in three districts with two rice varieties on rice productivity in Bogor Regency, a statistical method will be used, namely by using multiple regression analysis, the models to be estimated are:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \ldots\ldots\ldots + b_{12}X_{12} + d_1D_1 + d_2D_2 + d_3D_3$$

To qualify for the multiple regression analysis classic test assumptions are carried out as follows:

1) Test for normality
   The value of skewness ratio and kurtosis ratio of this study are between -2 and +2, so it can be concluded that the data distribution is normal ..
2) Autocorrelation test
   Based on the DW table with α = 5%, n = 24 so that the DW value is at dU <1,777 <(4 - dU), the model in this study does not contain autocorrelation (nonautocorrelation).
3) Multicollinearity test
   The results of the analysis of independent variables have VIF values ranging from 1.550 to 6.393 which are smaller than 10, it can be concluded that this model does not contain multicollinearity.
4) Heterokedastisitas Test
   It is seen that there is no statistically significant when the independent variables are made regression with the dependent variable abresid, it can be concluded that this model does not experience heterocedasticity problems.

After testing the classical assumptions and the results meet the requirements for the BLUE model and from several regression models produced where the independent variables have a

significant influence on the productivity of paddy fields in Bogor Regency is the 12th model. This can be seen from Sig. t where for each variable has a value smaller than the real level with the results of the estimation of the equation model as follows:

$$Y = 1{,}09 + 0.98\ X_2 + 15{,}12\ X_3 - 0.06\ X_7 + 0{,}03\ X_8 + 3{,}14 D_1$$

the results can be interpreted as follows:

1) Test simultaneously (F-stat)

Based on the estimation results, it can be concluded that the simultaneous test (F test) of soil fertility characteristics variables C organic (%), Nitrogen (N), K_2O HCl 25% (me / 100 g), CEC (me / 100 g) and dummy varieties that significantly influence the productivity of paddy fields in Bogor Regency, or can be interpreted as rejecting the H0 hypothesis and accepting the H1 hypothesis. This can be seen from the F value of 10.987 with Sig. of 0,000 which is still smaller than the significant level of 5% (0.05).

2) R-square (R^2)

It appears that the correlation coefficient (R) of 0.827 and the coefficient of determination (R^2) of 0.684 which means that 68.4% of the variable productivity of wetland can be explained by the variable soil fertility characteristics such as organic C (%), Nitrogen (N), K_2O HCl 25 % (me / 100 g), CEC (me / 100 g) and dummy varieties.

Table 3. Model 12th Results of Multiple Regression Processing (t Test) with backward method

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1,090	1,504		,725	,478
C organik (%)	,984	,509	,441	1,933	,069
Nitrogen (N) (%)	15,119	2,608	1,669	5,797	,000
K_2O HCl 25% (me/ 100 g)	-,059	,021	-,464	-2,812	,012
CEC (me/100 g)	,028	,015	,334	1,895	,074
D_1	3,136	,600	1,751	5,224	,000

3) Partial test (t-stat)

a. Every increase 1 % in organic C will increase the productivity of paddy fields by 0.98 tons / ha, assuming the variable Nitrogen (N), K_2O HCl 25% and CEC remain (constant).
b. Every increase 1 % in Nitrogen (N) will increase the productivity of paddy fields by 15.12 tons / ha, assuming the variable C organic, K_2O HCl 25% and CEC remain (constant).
c. Every increase of 1 mg / 100 g K_2O HCl by 25% will increase the productivity of paddy fields by 0.06 tons / ha, assuming Nitrogen (N), organic C variable, and CEC remain (constant).
d. Every increase of 1 me / 100 g CEC will increase the productivity of paddy fields by 0.03 tons / ha, assuming the variable Nitrogen (N), organic C, and K_2O HCl 25% remain (constant).
e. The influence of dummy varieties on the productivity of paddy fields is for
b) Ciherang Variety: Y = 1.09 + 0.98 X2 + 15.12 X3 - 0.06 X7 + 0.03 X8
c) Inpari Varieties: Y = 4.23 + 0.98 X2 + 15.12 X3 - 0.06 X7 + 0.03 X8

E. Conclusions

Based on the results of the above research it can be concluded

1. Soils in Bogor Regency are generally acidic, where soil fertility characteristics with organic C content are low to moderate, Nitrogen is very low to moderate, P is low to high, K is very low to moderate, CEC / CEC is moderate to high, and Saturation is Basic (KB) moderate to high. Soil biology, namely total bacteria, total fungi, total solvent P bacteria, Azotobacter sp., And Rizobium sp. Are generally low to moderate.
2. Variable characteristics of soil fertility in the form of organic C, Nitrogen (N), K2O HCl 25%, and CEC / CEC significantly influence rice productivity. Soil fertility in the three districts is almost the same and does not affect the productivity of rice fields. While the productivity of rice fields with Inpari varieties is higher than those grown by Ciherang varieties.

F. References

Ali, R. (2019). https://www.merdeka.com/peristiwa/kabupaten-bogor-siapkan-tiga-kecamatan-sebagai-lumbung-padi-dunia.html. Selasa, 17 September 2019 02:03

Damanik, M.M.B, B.E.H. Hasibuan, Fauzi, Sarifuddin, & Hanum H,. (2010). *Kesuburan Tanah dan Pemupukan*. USU-Press, Medan

Hanafiah, & Ali K. (2005). *Dasar-Dasar Ilmu Tanah*. Jakarta: Raja Grafindo Persada

Munawar, A. (2013). *Kesuburan Tanah dan Nutrisi Tanaman*. IPB Press, Bogor

Puja, I.N., Supadma, A.A.N. & Mega I.M. (2013). Kajian Unsur Hara Tanah Sawah Untuk Menentukan Tingkat Kesuburan. *AGROTROP*, 3(2): 51-56

Rasti, Hasan E., & Simanungkalit, R.D.M. (2007). *Metode Analisis Biologi Tanah*. Balai Besar Litbang Sumberdaya Lahan Pertanian. Badan Penelitian dan Pengembangan Pertanian. Departeme Pertanian

Sutedjo, M. M. (2002). *Pupuk dan Cara Pemupukan*. Rineka Cipta. Jakarta

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Isolation and Identification of Native Mikoriza Morphology on The Rhizosphere *Gluta rengas* L. in Jompie Botanical Garden

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Abstract

Alitta Forest, located in the city of Parepare, South Sulawesi, has an area of 84 ha, a portion of this forest area is functioned as part of a botanical garden. The jompie botanical garden has an area of 13.5 ha, with a collection of plants reaching 90 species originating from 81 plant clans and as many as 77 species that have been identified. In addition to a collection of high-level plants, jompie botanical gardens also have a diversity of microorganisms that have not been identified, especially microorganisms that symbiosis with plant roots known as mycorrhiza, so the purpose of this study is to identify and identify the abundance of mycorrhizal spores in the jompie botanical garden found in rhizosphere *Gluta renghas* L.. The research began with taking the rhizosphere under the stands of wet trees in the jompie botanical garden, which was then continued to identify and calculate the abundance of spores in the microbiology laboratory of Makassar's research and development environment and forestry. The identification results of mikoiza spores native to the jompie botanical garden show that they are found in two genera, namely; Acalauspora sp consisting of two morphotypes, and the genus Glomus sp consisting of one morphotype, with an average spore abundance of 45.3 per 100 grams rhizosphere

Keywords: fungus, indigenius, acalauspora, rizosphere

A. Introduction

The Jompie Botanical Garden in Parepare, South Sulawesi, is part of Alitta forest. The area of Alitta forest that is part of the Jompie Botanical Garden is 13.5 ha, with 90 species of plants originating from 81 genera. 77 of these species have been fully identified, 10 new species are known to the genus level, and 3 other species have only been identified to the family level. The name Jompie itself is taken from the ancient bugis language which means water that comes out of the soil naturally or can be called a spring (Dinas Lingkungan Hidup dan Lembaga Ilmu Pengetahuan Indonesia Pusat Konservasi Tumbuhan Kebun Raya, 2017).

Gluta renghas L., one of the plants found in the jompie botanical garden, including the Anacardiaceae family. The trunk is about 40 to 50 cm high and emits toxic gums that can cause skin irritation. Rengas wood is included in durable class II wood which is quite durable and strong class II which is quite strong. Wood from Rengas (*Gluta renghas* L.) trees is commonly used by the community as raw material for making cages because it is easier to find and lasts longer when immersed in water (Martawijaya, Kartasujana, Kadir, & Prawiras, 2005).

Figur 1. *Gluta renghas* L, in the Botanical Gardens Jompie

Association of plants with fungi or known as mycorrhizae is a symbiotic interaction of mutualism that is very common in the plant world (Warouw, et al. 2010). Based on the depth of the tissue used by mycorrhiza can be classified into 2 types, namely ectomycorrhizae and endomicoriza. Ectomycorrhizae is a fungus that only lives on the surface area of the root ie the epidermis tissue, whereas endomikoriza is a fungus whose hypotension is able to penetrate plant roots to enter the cortical tissue (Indah, 2009). The results of research conducted in the nickel postmining area were obtained by three types of mycorrhiza, namely: Acaulospora sp, Gigaspora sp, and Glomus sp (Akib, Mustari, Kuswinanti, & Syaiful 2018[a]; Akib, *et al*. 2018[b]).

Five benefits of mycorrhizae for the development of host plants, namely: Increasing nutrient absorption from the soil, as a biological barrier against root pathogen infections, increasing host resistance to drought, increasing growth-promoting hormones, and ensuring the implementation of the biogeochemical cycle. Whereas mycorrhiza get nutritional benefits (carbohydrates and other growing substances) for their living needs from plant roots.

B. Methods

Soil Research was conducted in May-June 2019, in the Microbiology Laboratory of Research Center and Development of Environment and Forestry, Makassar. Rhizosphere sampling was carried out at the jompie botanical garden of Parepare. The selected rhizosphere sample was *Gluta renghas* L., which was taken diagonally.

The technique used in isolation is the pour-filter method, followed by the centrifugation method. The pour-filter technique is to filter the sample using a stratified filter, while the centrifugation technique is a technique used to separate heavy particles and light particles in the sample. The work step of the filter pouring technique is to weigh 100 grams of soil sample and then mix 100 grams of soil sample with 200 - 300 ml of water and stir evenly, then filtered in a set of filters with sizes of 325 µm, 50 µm, 40 µm in sequence from top to bottom. At the top of the filter is sprayed with tap water to facilitate the filter material to escape (Ansiga, Rifa, Rumambi, Kaligis, Mansur, & Kaunang, 2017).

Material that escapes in the bottom filter and the second from the bottom is then transferred into the centrifuge tube. The material is then centrifuged by sentifugation technique. The filter results are added with 60% glucose. The centrifuge tube is tightly closed and centrifuged at a speed of 3000 rpm for 5 minutes. Furthermore, the supernatant solution is poured into 0.5 mm filter paper, rinsed with flowing distilled water to remove glucose. The remaining sediment is put into a petri dish and then mycorrhizal spores are observed using a stero microscope to calculate the number of spore populations in the sample (Ansiga, *et al.* 2017).

Making spore preparations is intended to assist in the identification process. From these preparations, it is expected that morphological information on mycorrhizal spores can determine the genus of mycorrhizal spores contained in the *Gluta renghas* L. identification is carried out using an electron microscope. Spores obtained were collected based on morphological characters of mycorrhizal spores including: spore shape, spore size, spore color, hypha attachment and ornament spores (Ansiga, *et al*. 2017).

Relative abundance is calculated according to the formula:

$$IKR = \frac{(ni)}{(N)} \text{ X } 100\%$$

IKR : Relative abundance index
Ni : Number of mycorrhizal spores in a genus
N : Total number of spores

C. Result and Discussion

The Jompie Botanical Garden of Parepare, is located at an altitude of 5 - 55 m above sea level at the coordinates of 3 ° 59'51,168 S, and 119 ° 38'24,366 E. has an area of about 13.5 ha, soil ph 6-7. With a collection of wallacea coastal plants.

The results of observations in the Laboratory indicate that the mycorrhizal spore types found in rhizosfer *Gluta renghas* L., are *Acalauspora* sp, and *Glomus* sp, and are divided into three morphotypes namely: Small Yellow Rounded (BKK), and Small Clear Rounded (BBK), as well as Small Black Rounded (BHK), which have different morphological characteristics. Morphological characteristics in showed to Ttble 1 and the number of mycorrhizal spores in rhizosfer *Gluta renghas* L. based on morphotype can be seen in Table 2.

Table 1. Morphological Characteristics of Mycorrhizal Spores in the Rengas Rhizosphere

No.	Genus	Morfotipe	Morphology		Diameter
			PVLG	*Meltzer*	
1	*Acalauspora* sp.,	Small Yello Rounded.	Round, yellow, has a liquid inside, thick cell walls, smooth surface.	Round, yellow, has a liquid inside, rough surface, thin cell walls. Meltzer doesn't react	262,5

2.	*Acalauspora* sp.,	Small Clear Rounded	Round, clear in color, has fluid in it, thick cell walls, smooth surface.	Round, clear in color, has fluid in it, thick cell walls, rough surface. Meltzer doesn't react.	185,6
3.	*Glomus* sp.,	Small Black Rounded	Round, black, thin cell walls, smooth surface, have has liquid inside.	Round, black, thin cell walls, rough surface, have liquid inside. Meltzer doesn't react.	242,2

Table 2. Number of Mycorrhizal Spores in rhizosfer Rengas (Gluta renghas L.) Based on Morphotypes

No.	Genus	Morfotipe	Abundance (spora/100 g rhizosfer)
1.	Acalauspora. Sp	Small Yello Rounded	48
2.	Acalauspora. Sp	Small Clear Rounded	38
3.	Glomus. Sp	Small Black Rounded	50

Acalauspora sp., has a round, irregular and elliptical shape with two layers of spore walls. Spore color varies from yellow, brownish orange, dark red, to brownish red. Acalauspora sp., has a saccule that is round to irregular in color ranging from yellow, transparent, transparent pink, to white (Lily, 2018). Spora of Acalauspora sp., contained in the rhizosphere of *Gluta renghas* L. can be seen in Figure 1.

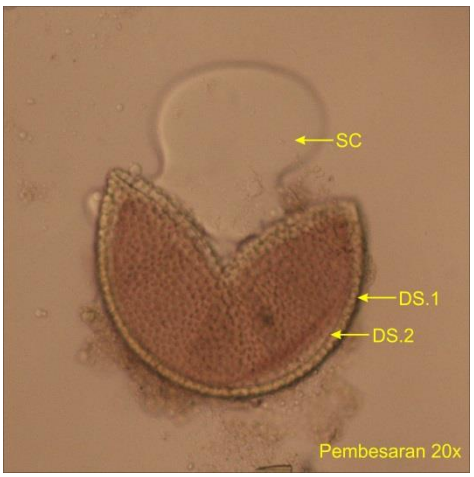

Figure 1. Spora of Acalauspora sp., in the Rengas rhizosphere (*Gluta renghas L.*) (SC: Shacull, DS: Cell wall)

Glomus Sp, characterized by round and oval shapes, the color of the genus Glomus. Sp varies from yellow, reddish yellow, brownish yellow, yellowish brown, light brown, dark brownish black, purple and black. In addition, spores can be produced singly or in groups forming aggregates (Lily, 2018). Spores of Glomus. Sp contained in the rhizosphere of *Gluta renghas* L. can be seen in Figure 2.

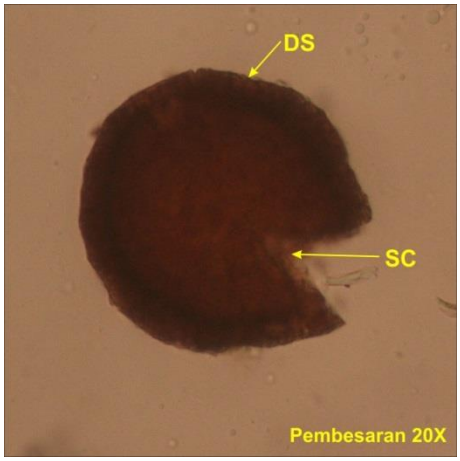

Figure 2. Spores of Glomus sp., in the Rengas rhizosphere (Gluta renghas L.) (SC: Shacull, DS: Cell wall)

D. Conclusions

The spore type of native mycorrhizal found in rhizosphere of *Gluta Renghas* L. is *Acaluspora* sp., and *Glomus* sp., Type of *Acalauspora* sp., is more common than Glomus, sp. Based on morphotypes, there are three morphotypes namely; small yellow rounded, small clear Rounded, and small black rounded. With a small round black morphotype is more common than other types of morphotype. The abundance of mycorrhizal spores in the rhizosfer of *Gluta renghas* L. is an average of 45.3 spores per 100 g of rhizosphere.

E. References

Akib, M. A., K. Mustari, T. Kuswinanti, & S.A. Syaiful, (2018[a]). Abundance of Arbuscular Mychorrizal Fungi in Rehabilitation Area of Nickel Post-Mining Land of Sorowako, South Sulawesi. *IOP Conf. Series: Earth and Environmental Science* 157, 012022

Akib, M. A., K. Mustari, T. Kuswinanti, & S.A. Syaiful. (2018[b]). Exploration of Native Mycorrhiza on Rhizosphere of Gleichenia Linearis in Nickel Post-Mining Rehabilitation Area of Sorowako, Indonesia*. Int. J. Curr. Res. Biosci. Plant Biol*. 5: 30-36

Ansiga, E. Rifa. A. Rumambi. D. Kaligis. I. Mansur, & W. Kaunang. (2017). Eksplorasi Fungi Arbuskula (FMA) pada Rizozfir Hijau Pakan. *Jurnal,* Zootek, 37: 167-178

Campbell, N.A., J.B. Reece, M.L. Cain, S.A. Wssermen, P.V. Minorsky, & R.B. Jackson. (2008). *Biologi Edisi kedelapan Jilid 2.* Erlangga. Jakarta

Dinas Lingkungan Hidup dan Lembaga Ilmu Pengetahuan Indonesia Pusat Konservasi Tumbuhan Kebun Raya. (2017). *Mengenl 51 Jenis Tumbuhan Berpotensi dan Bermanfaat Kebun Raya Jompie Parepare.* Kota Parepare. Sulawesi Selatan

Gussuwana, I., D. Yoza, & M. Mardhiansyah. (2015). Karakteristik Pohon Sarang Lebah dan Preferensi Lebah Bersarang di Hutan Kepungan Sialang Desa Gunung Sahilan Kecamatan Gunung Sahilan Kabupaten Kampar Provinsi Riau. *Jurnal.* JOM Faperta, 2

Istigfaiyah, L. (2018). Identifikasi dan Karakterisasi Mikoriza pada Tegakan *Gmelina arbore. Skripsi.* Prograsm Studi Kehutanan. Fakultas Kehutanan. Universitas Hasanuddin

Martawijaya, A., I. Kartasujana, K. Kadir, & A.S. Prawiras. (2005). *Atlas Kayu Indonesia Jilid I,* CV. Miranti. Bogor

Indah, N. (2009). *Taksonomi Tumbuhan Tingkat Tinggi*. JEMBER.: FP MIPA IKIP PGRI

Prayudyaningsih, R. & R. Sari. (2016). Aplikasi Fungi Mikoriza Arbuskula (FMA) dan Kompos untuk Meningkatkan Pertumbuhan Semai Jati (*Tectona grandis linn.F.*) Pada Media Tanah Bekas Tambang Kapur. *Jurnal Penelitian Kehutanan Wallaceae*. 5: 37-46

Roy, P.O.P., N. Rahmawati, E.H. Khardinata, & A. Sahar. (2014). Efektivitas Beberapa Jenis Fungi Mikoriza Arbuskular Terhadap Pertumbuhan Tanaman Karet (*Hevea brassiliensis Muell. ARG.*) di Pembibitan. *Jurnal Online Agroteknologi*. 2: 919-932

Warouw, V. & P.R. Kainde. (2010). Populasi Jamur Mikoriza Vesikular Arbuskular (MVA) pada Zone Perakaran Jati. *J. Eugenia*. 16: 38-45

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A Review of Technology Innovation in Increasing Rice Production

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Abstract

Rice is the main commodity in Indonesia so it needs to be supported by technological innovation in the context of increasing production. Currently, the Agricultural Research and Development Agency has created technological innovations to increase rice production because it is necessary to disseminate information on technological innovations so that all users can know and take advantage of these innovations. The purpose of writing this paper is to provide information and an overview of some of the current agricultural technological innovations in Indonesia that contribute to increasing rice production in Indonesia. Several agricultural technology innovations are currently being implemented such as new superior varieties technology, planting jajar legowo, Salibu rice cultivation system, hazton rice cultivation, SRI rice cultivation technology, integrated planting calendar, and integrated crop management. These technological innovations have had an impact on increasing rice production in Indonesia

Keywords: agricultural technology, innovation, rice, yield

A. Introduction

Rice is an important and strategic commodity so that future rice production must be increased in line with an increase in population. In 2020, Indonesia's population is estimated at 263 million and

in 2005 it increased to 275 million. For this reason, the government has established a P2BN program that is committed to increasing rice production by 5% every year. All businesses ranging from the expansion of the planting area through expansion of the area as well as the increase in the crop index increased productivity and post-harvest efficiency have been carried out. The result was that in 2008 Indonesia achieved self-sufficiency in rice again (Indonesian Center for Rice Research, 2009)

From 2005 to 2014, the average rate of productivity growth of 1.05 percent per year was relatively higher when compared to the growth rate of rice harvested area of 0.58 percent per year. This condition indicates that the main source of growth in world rice production is growth in productivity. This has implications for resource

Land to support the growth of world rice production is increasingly limited, so the hope of improvement is increasing. Rice production in the future remains the growth of productivity. Considering that productivity is largely determined by technological progress, to achieve sustainable growth in world rice production requires adequate funding and investment in research and development. (Agricultural Research and Development Agency 2015)

The purpose of writing this paper is to provide information and an overview of some of the current agricultural technological innovations in Indonesia that contribute to increasing rice production in Indonesia.

B. Inovation in Increasing Rice Production

Increased agricultural production is a result of the use of techniques or methods in farming. It is impossible to expect high yields using only plants and animals or the same methods. There must be changes made, both to agricultural inputs and the methods used when agriculture is to be developed in the sense that its production is to be increased. For agricultural development to continue to meet the growing human needs, there must always be changes. When the change stopped, then agricultural development stopped. Production stops rising or can decrease due to declining soil fertility or increased damage by increasingly rampant pests.

It does not also mean that each working method, each type of production input is higher. Improving just one or a few small parts of existing farming aspects can cause increased production. There are limiting factors that cause the use of a new method to produce different results when the new method is applied elsewhere without any adjustments. A new technique that is often referred to as innovation must be able to increase yield or reduce costs very prominently to be accepted by the community or most farmers.

It cannot be denied that the role of technology is very strategic in supporting increased agricultural production. As it is known that an increase in rice production from 54.1 million tons of paddy in 2004 to 60.3 million tons of paddy in 2008 (an average of 2.8% per year) even reached 5.2% per year during the period 2006-2008. So that making Indonesia back to self-sufficiency in rice in 2008 after being achieved in 1984 was an impact of the application of technology. (Sembiring, 2008)

Affirmation of the role of technology in achieving food production was also stated by Sumarno (2006) who stated that the spectacular increase in rice production in the last 35 years was the contribution of the application of more advanced technology called Green revolution technology.

According to Mosher (1981) and Mubyarto (1989) who put technology as a condition for the development of agriculture, it is even emphasized that technology is constantly changing. If there is no change in technology, then agricultural development will stop. Production stops at an increase, it can even decrease due to declining soil fertility or due to increased damage by increasingly rampant disease pests. This view of technological change can be interpreted as adaptive technology to the local biophysical conditions and socio-cultural environment.

Innovation will become the needs of farmers if innovation can solve the problems being faced by farmers. So that the correct identification of problems becomes very important, there are at least

two reasons, namely: (a) what we consider to be a problem, is not necessarily a problem faced by farmers, (b) if the problem turns out to be true is a problem of farmers, the solution is not necessarily in accordance with the conditions of farmers.

C. The Role of Various Technology Innovation in Increasing Rice Production

1. New Superior Varieties

New superior varieties (VUB) of lowland rice is a solution to increase rice production because VUB has a higher yield potential than local varieties. According to suprihatno, Darajat, Satoo, Bahaeki, Widiarta, Indrasari, Lesaman & Sambiring (2007), superior varieties are one of the components of innovative technology to increase rice productivity, both through increasing the potential or yield, as well as increasing its resistance to biotic and abiotic stresses. Furthermore, according to Suryana & Prajogo (1997) superior varieties have more uniform plant growth advantages so that the harvest becomes synchronous, higher yields, higher yield quality and in accordance with consumer tastes, and plants will have high resistance to pest and disease disorders and adaptability high on the environment so that it can reduce the use of inputs such as fertilizers and pesticides.

According to Suprihatno *et al.,* (2007), superior varieties are one of the components of innovative technology to increase rice productivity, both through increasing the potential or yield, as well as increasing its resistance to biotic and abiotic stresses. Furthermore According to Abdullah, Tjokrowidjoyo & Sularjo (2008), VUB lowland rice needs to be developed in Indonesia, because 1) lowland rice is the main supplier of national production so that planting VUB will increase productivity, production and income of farmers, 2)

The Ministry of Agriculture, in this case, the Agency for Agricultural Research and Development in supporting the increase in rice production, the Ministry of Agriculture has released more than 100 superior varieties of rice (Indonesian Center for Rice Research, 2009). It is expected that the release of these superior varieties can be actualized by their genetic potential through the development of cultivation technology with the Integrated Plant and Resource Management (PTT) Approach. The contribution of superior varieties in increasing rice productivity reaches 75% if integrated with irrigation and fertilizing technology (IAARD, 2007)

2. Legowo Jajar Planting System

Legowa is a planting technique by adjusting the spacing between clumps and between rows, resulting in compaction of rice clumps in rows and widening the distance between rows. In the two-row rows legowo system, all rice groves are in the margins of the crop. As a result, all these clumps of rice have benefited from border effects.

The step to increase production and productivity is to modify plant spacing by using legowo spacing. According to Suriapermana et al, 2000). The legowo planting system is a form of technological engineering to optimize rice productivity with population regulation so that the plants get growing space and optimal sunlight. Some advantages of how to plant jajar legowo include (1) increasing plant population, (2) reducing rat and snail pest attacks and (3) reducing iron poisoning (Departemen Pertanian, 2008).

At this time the super jowo legowo technology has been developed, jajar legowo super can increase production to 13.9 tons / ha. Jajar Legowo Super Technology is an integrated cultivation technology for irrigation based on planting jajar legowo 2: 1. This super technology is produced by Balitbangtan after going through research and studies at various locations in Indonesia. In addition to using the 2: 1 jowo legowo planting system as the basis of application in the field, an important part of Jajar Legowo Super technology is 1). New Superior Variety (VUB) of high yield potential, 2) Biodecomposer, given before tillage, 3). Biofertilizer as seed treatment and balanced fertilization based on Soil Test Equipment (PUTS), 4) Control of Plant Pests (OPT) using vegetable pesticides and inorganic pesticides based on threshold control, and 5). Agricultural tools and machinery,

especially for planting (jarwo transplanters) and harvesting (combine harvester). (Agricultural Research and Development Agency, 2015)

3. System Of Rice Intensification (SRI)

SRI is one of the innovations in rice cultivation methods developed since the 1980s by the French priest and agriculturalist, Fr. Henri de Laulanie, who has been stationed in Madagascar since 1961. Initially, SRI was short for "Systeme de riziculture intensive" and first appeared in the Tropicultura Journal in 1993. At that time, SRI was only known locally and its distribution was limited. Since the late 1990s, SRI began to go global as a result of efforts not to give up Prof. Norman Uphoff, former director of the Cornell International Institute for Food, Agriculture and Development (CIIFAD). In 1999, SRI was tested for the first time outside Madagascar, in China and Indonesia (Stoop , Uphoff, & Kassam, 2002).

The objectives of the SRI development are: (a) to make efficient use of production input and water utilization; (b) improving the quality / fertility of paddy fields through the provision of organic material intake; (c) developing environmentally friendly rice farming. (d) increase farmers 'knowledge and skills about SRI rice farming and (e) increase farmers' income and welfare.

According to Berkelaar (2001), Kuswara (2003), Wardana, Juliardi, Sumedi & Iwan (2005), Uphoff (2002), Rochaedi (2005), Prayatna and Sony (2007), there are several important components in the application of SRI, including:

1) Seedlings are moved to the field (transplanted) earlier (young seedlings). In general, SRI recommends planting young seedlings when they are 8-15 days old. Transplanting when young seedlings can reduce shocks and increase the ability of plants to produce stems and roots during vegetative growth, so that stems appear more in number in a single family or grain of rice produced by panicles. Besides that, in order to get the maximum number of tillers and root growth.
2) Seeds are planted individually rather than in clusters. This is so that plants have enough space to spread and deepen rooting. Plants do not compete too tightly to get growth space, light or nutrients in the soil so that the root system becomes very good.
3) Wide planting distance. SRI recommends a wide spacing of at least 25 cm x 25 cm so that plant roots do not compete and have enough space to develop so that maximum tillers can be reached.
4) Soil conditions remain moist but not flooded (intermittent irrigation). SRI recommends intermittent irrigation techniques to create oxidized root conditions, to increase soil fertility and obtain long and dense plant roots. With SRI, the inundated condition is only maintained during vegetative growth. Furthermore, after disposal, paddy fields are flooded with 1-3 cm of water (as is conventional practice). Rice fields are completely irrigated starting 25 days before harvest.
5) Weeding. SRI recommends 2-3 times weeding using gasrok or lalandak, in addition to cleaning weeds, improving soil structure and increasing soil aeration.
6) Organic Materials (compost): SRI recommends the use of organic material (compost) to improve soil structure so that rice can grow well and nutrients are supplied to plants properly.

Based on the results of the study of Stoop *et al*. (2002) in Wardana *et al*. (2005), the application of SRI by farmers in Madagascar, in the 1980-1990 period was able to achieve rice yields of 10-15 tons per hectare. Very high rice yields are obtained from infertile paddy fields, without the use of inorganic fertilizers and less irrigation water. Whereas normal production in the same area only reaches 2 tons per hectare. In other areas of Madagascar for five years, hundreds of farmers harvested 8-9 tons per hectare (Berkelaar, 2001). Rice cultivation using the SRI method developed in several Eastern Indonesian regions has proven to be able to increase land productivity from 5.0 tons/ha to 7.4 tons / ha (Sato, 2007)

4. Salibu Rice Cultivation

Ralibu rice cultivation is a variant of return cultivation technology, which is the stump after harvesting the main crop which is about 25 cm high, maintained for 7-10 days or left until a new shoot comes out. If the shoots that come out are less than 70% then it is not recommended to do the cultivation of cranium. If the shoots grow> 70% then cut back uniformly to a height of 3-5 cm, then maintained well until harvest. Some of the benefits that can be obtained from the application of the cultivation of crossing rice are saving, labor, time, and cost, because there is no cultivation of land and replanting, besides it suppresses the habits of farmers burning straw after harvest (Erdiman, Nieldanina & Misran, 2013).

Cultivation of cross-bred rice can increase rice productivity per unit area and per unit time, and increase the harvest index from once to two to three times a year. If compared with conventional rat technology, salibum capable of producing several more and more uniform tillers, and productivity.

5. Hazton Rice Cultivation

The Hazton technology was initiated and has been implemented in several districts in West Kalimantan Province and/or other provinces/districts in Indonesia. Hazton technology is a way to grow rice using old seeds 25-30 days after seedling with many dense seeds that are 20-30 stems per planting hole. The other components are more or less the same as Integrated Crop Management (PTT) recommended by the Agricultural Research and Development Agency. This technology was discovered in West Kalimantan in 2012, with various stages of the field testing it turned out that Hazton Technology was able to lift rice productivity in West Kalimantan. Before the farmers used Hazton Technology, rice productivity was only obtained as much as 3.1 tons of Dry Grain (GKG) per hectare, and even that was already very high and had used a complete technology package such as seeds, organic fertilizers, and inorganic fertilizers as recommended. After the farmers are familiar with Hazton Technology, the productivity potential can increase up to 8 - 16 tons of Dry Grain (GKP) or 6.88 - 13.76 tons of paddy per hectare. While

The results of the Hazton Technology trial at the Indonesian Center for Rice Research ranged from 4 - 9 tons/ha. Hazton Technology is a technology that is very simple, easy to apply in the field and does not change the technique of rice cultivation at the farm level so far that farmers initially only used rice seeds 2-3 stems per planting hole with Hazton Technology, farmers planted seeds with 20-30 stems per planting hole. Some of the advantages of Hazton Technology after being developed in the field are 1). Higher productivity, 2). Easy to plant, 3). Little or no replacing, 4). Little or no weeding, 5). Faster harvesting (2 weeks) than on a regular system, 6). Grain is more pithy and low empty/drunk, 7). Relatively resistant to pest attacks (golden snails, orong-orong), difficult drainage, and iron poisoning problems, 8). Percentage of high head rice (low broken rice), 9). Adaptability in the field is relatively high, and 10). More efficient in the use of inorganic fertilizers. While the weaknesses of Hazton Technology are: 1). Seed requirements are higher than the usual method and 2). Use a wider nursery (Dirjen Tanaman Pangan, 2015).

6. Integrated Crop Management PTT

Integrated crop management (PTT) is an approach in managing land, water, plants, plant pests (OPT), and climate in an integrated and sustainable manner to increase productivity, farmer income, and environmental sustainability. The principle of PTT includes four elements, namely integration, interaction, dynamic and participatory. The technological component in PTT is divided into two, namely the basic technology component consisting of (1) modern varieties, (2) quality and healthy seeds, (3) efficient fertilization, and (4) IPM in accordance with the target pest, and selected technology components consisting of (1) crop management, (2) young seedlings, (3) organic fertilizer, (4) intermittent irrigation, (5) liquid fertilizer, and (6) harvest and post-harvest handling (Ministry of Agriculture, 2008).

The results of PTT applications on irrigated paddy fields carried out by the Indonesian Center for Rice Research since 1999 in Sukamandi show that the increase in rice yields obtained varies according to the level and scale of the area of business. At the level of research and demonstration with the limited area (1 - 1.25 ha), it can increase yields on average 37%. This increase was then reduced to 27% and 16%, respectively at the assessment level with an area of 1-5 ha and the implementation level at 30 PTT locations with an area of 50-100 ha. Also, with PTT grain yield and rice quality also increased, the cost of rice farming was reduced, health and environmental sustainability were maintained (IAARD, 2007).

7. Planting calendar

Indonesia faces various challenges in maintaining rice self-sufficiency. Among the high population growth, the conversion of fertile paddy fields to other crops with higher sale value, the construction of residential areas, offices and industrial estates, increased inter-farm competition, limited water resources, floods and drought due to climate change (climate change) because of global warming, (Suyamto and Zaini, 2010)

A planting calendar is made to be used as a reference for farmers in planting annual crops. Plant calendars are made by combining maps of climate forecasts, water availability and planting classification. Plant calendars are then matched with cropping patterns carried out by farmers in the field so that they have high accuracy (Subagyono, 2007). Planting calendar map is a map that illustrates the potential pattern and planting time for food crops, especially rice, based on the potential and dynamics of climate and water resources.

The Ministry of Agriculture of the Republic of Indonesia through the Agro-climate Research Institute (Balitklimat) has since 2012.

D. Conclusions

Technological innovation is one step that can encourage increased rice production. Several agricultural technology innovations are currently being implemented such as new superior varieties technology, planting jajar legowo, Salibu rice cultivation system, hazton rice cultivation, SRI rice cultivation technology, integrated planting calendar, and integrated crop management. In its implementation in the field, technological innovation is partly acceptable in the community and some are still in the development stage. Hope in the future there will be new technological innovations whose application is easy so that they can be accepted in the community and have a real impact on increasing rice production.

E. References

Abdullah B, S Tjokrowidjoyo & Sularjo. (2008). Perkembangan dan Prospek Perakitan Padi Tipe Baru di Indonesia. *Jurnal Penelitian dan Pengembangan Pertanian*, 27 (1) : 1-9

Agricultural Research and Development Agency . (2015). *Outlook Komoditas Pangan Strategis Tahun 2015-2019*. laporan analisis kebijakan tahun 2015. Badan Litbang Pertanian. Jakarta

Badan Litbang Pertanian. (2007). *Pengelolaan Tanaman Terpadu (PTT) Padi Sawah Irigasi Petunjuk Teknis Lapang*. Badan Penelitian dan Pengembangan Pertanian. Jakarta

Barkelaar, D. (2001). SRI, THE SYSTEM OF RICE INTENSIFICATION: LESS CAN BE MORE. Buletin ECHO Development Notes. Accessed on http://www.doc-developpement-durable.org/file/Culture-plantes-alimentaires/FICHES_PLANTES/riz/SRI,%20System%20of%20rice%20intensification.pdf

Departemen Pertanian. (2008). Sekolah Lapang Pengelolaan Tanaman Terpadu (SL-PTT) Padi. Panduan Pelaksanaan. Departemen Pertanian. Jakarta

Dirjen Tanaman Pangan. (2015). *Petunjuk Teknis Budidaya Padi Teknologi Hazton Tahun 2016*. Dirjen Tanaman Pangan, Kementerian Pertanian. Jakarta

Erdiman, Nieldanina, Misran. (2013). Inovasi Teknologi Salibu Meningkatkan Produktivitas Lahan, Mendukung Swasembada Pangan Berkelanjutan. Balai Pengkajian Teknologi Pertanian Sumatera Barat

IAARD. (2007). Prospect and Direction of Agricultural Commodities Development; An Observation of Land Resources Aspect. Indonesian Agency for Agricultural Research and Development, Jakarta

[Indonesian Center for Rice Research] (2009). *Peningkatan Produksi Padi Melalui IP Padi 400*. Balai Besar Penelitian padi. Sukamandi

Katam.litbang.pertanian.go.id, (2017). *Kalender Tanam Terpadu*. Badan Litbang Pertanian. Kementerian pertanian. Jakarta

Kuswara. (2003). *Dasar Gagasan dan Praktek Tanam Padi Metode SRI (System Rice Istensification)-Pertanian Ekologis*. Yayasan FIELD Indonesia

Mosher, A.T. (1981). Menggerakan dan Membangun Pertanian. Yasaguna, Jakarta.

Mubyarto. (1989). Pengantar Ekonomi Pertanian. LP3ES, Jakarta

Prayatna & Soni. (2007). *Pertanian Organik : Mengapa Harus SRI (System of Rice Intensification).* Dinas Pertanian Kabupaten Tasikmalaya, Kerjasama dengan KTNA Kabupaten Tasikmalaya.

Rochaedi. (2005). *Usahatani Ramah Lingkungan : Air Hemat, Tanah Sehat, Produksi Meningkat Melalui Metode SR*I. Lembaga Pengembang SRI Jawa Barat. Garut

Sato S, (2007). SRI Mampu Tingkatan Produksi Padi Nasional. Accessed on http://www.kapanlagi.com/h/0000182474.html

Sembiring, H. (2008). Kebijakan Penelitian dan Rangkuman Hasil Penelitian BBPadi dalam Mendukung Peningkatan Produski Beras Nasional. Apresiasi Hasil Penelitian Padi 2007. Accessed on http://www.litbang.pertanian.go.id/special/padi/bbpadi_2008_p2bn1_03.pdf

Stoop, WA, Uphoff, & Kassam. (2002). A Review of Agricultural Research Issues Raised by the System of Rice Intensification (SRI) from Madagascar: Opportunities for Improving Farming Systems for Resource-Poor Farmers. Agricultural Systems, 71: 249–274

Subagyono. (2007). Konservasi Air Untuk Adaptasi Pertanian Terhadap Perubahan Iklim. Bunga Rampai Konservasi Tanah dan Air. Pengurus Pusat MKTI. Jakarta

Sumarno. (2006). Sistem produksi padi berkelanjutan dengan penerapan revolusi hijau lestari. Buletin Iptek Tanaman Pangan 1(1): 1-15

Suprihatno, B., A.A. Darajat, Satoo, S.E. Bahaeki, N. Widiarta. S.D. Indrasari, O.O. Lesmana & H. Sambiring. (2007). *Deskripsi Varietas Padi*. Balai Besar Penelitian Tanaman Padi. Sukamanadi

Suryana dan U.H Prajogo. (1997). Subsidi Benih dan Dampaknya Terhadap Peningkatan Produksi Pangan. Kebijaksanaan Pembangunan Pertanian. Analisis Kebijaksanaan Antisipatif dan Responsif. Pusat Penelitian Sosial Ekonomi Pertanian. Badan Litbang Pertanian

Susilawati. (2011). Potensi Ratun Galur-Galur Padi Terpilih untuk Lahan Sawah. *Prosiding Seminar Nasional. BB Padi.* 2012

Suyamto dan Z. Zaini. (2010). Kapasitas Produksi Bahan Pangan pada Lahan Sawah irigasi dan tadah Hujan. Dalam Analisis Sumberdaya Lahan Menuju Ketahanan Pangan Berkelanjutan. Penyunting Sumarno dan N. Suharta. Badan Penelitian dan Pengembangan, Jakarta

Uphoff N. (2002). *Opportunities for Increasing Yields by Changing Management Practices: The System of Rice Intensification in Madagascar*. Agroecological Innovations. Earthscan Publications Ltd. London

Wardana P I, Juliardi, Sumedi, & S. Iwan. (2005). *Kajian Perkembangan System Of Rice Intensification (SRI) di Indonesia*. Kerjasama Yayasan Padi Indonesia dengan Badan Litbang Pertanian. Jakarta

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Selection of Chilli Pepper (*Capsicum frutescens* L.) for Salinity Tolerance in Seed Germination

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Abstract

The obstacle of chilli pepper development in saline is that there is no salinity tolerant variety, so it is necessary to assemble tolerant varieties. Information on tolerant genotypes, selection criteria and determination of new selection methods at the germination level are needed to make it easier for breeders to select prospective tolerant varieties early. This study aims to determine tolerant genotypes, appropriate selection criteria and NaCl concentrations used for selection at the germination level. The study was arranged based on a completely randomized design with two factors: NaCl concentration and some chilli pepper genotypes. NaCl solution concentrations consist of five concentrations of N0: 0 g L^{-1} (EC 291 µS/cm, SAL 0,10), N1: 2 g L^{-1} (EC 3,71 ms/cm, SAL 2,0), N2: 4 g L^{-1}(EC 6,60 mS/cm, SAL 3,60), N3: 6 g L^{-1} (EC 9,56 mS/cm, SAL 5,40) and N4: 8 g L^{-1} (EC 12,45 mS/cm SAL 5,40). The second factor is the genotype of chilli pepper consisting of 22 genotypes. The results showed that the most tolerant genotypes were G4, G7 and G15. Characters that can be used as selection criteria at the germination level are the percentage of germination, radical and hypocotyl length. The concentration of 8 g NaCl L^{-1} is effectively used to select tolerant genotypes

Keywords**:** chilli pepper, germination, tolerant, salinity, selection

A. Introduction

Chilli Pepper (*Capsicum frutescens* L.) is one of the vegetable commodities that has a high economic value, because of its large enough role to meet domestic needs, export commodities and the food industry (Hartuti & Sinaga 1997), so that it included in one product that is quite strategic. In certain seasons, chilli pepper prices are significant enough to affect inflation. This price fluctuation occurs almost every year and is disturbing the public. The government's effort to overcome the change of chilli pepper prices is an effort to increase the chilli pepper planting area and stabilize the price of chilli pepper. Chilli pepper needs for large cities with a population of one million or more around 66,000 tons/month. In the festive season or religious holidays, the need for chilli pepper usually increases by about 10-20% of regular needs. The level of national chilli pepper productivity in 2015 was around 7.49 tons/ha. To supply the needs of chilli pepper for urban communities, a chilli pepper harvest area of about 11,000 ha/month is needed. Not to mention the pepper needs for rural towns or small cities and processed raw materials (Pusdatin, 2016).

Chilli pepper production, according to Saptana, Daryanto, Daryanto & Kuntjoro, (2010), is influenced by productivity and area of arable land. The chilli pepper harvested area for the period 2011-2015 tended to increase with an average growth of 5.54%. The growth of the planted area in Java was 6.87% while outside Java, it was 4.07% (Pusdatin, 2016). The growth of the harvested area has not been able to overcome the shortage of chilli pepper supply, so it is still very much needed to increase the area and increase the productivity of higher chilli pepper.

Chilli pepper is included in the group of plants that are sensitive to salinity (Lessani & Marscher, 1978). Efforts that can be made to increase the productivity of chillies in saline land are by using salinity tolerant superior varieties. Superior varieties are one of the factors that influence the success of production (Syukur, Sujiprihati, Yunianti, & Kusumah, 2010). At present, there are no commercially produced lines or varieties of commercial chilli pepper tolerance. Types that are tolerant to environmental stress in generally have low production, and conversely, superior varieties are usually more productive if planted on fertile land. In tomato plants, salinity tolerant varieties are wild varieties that are used as elders as a source of tolerance (Saranga, Cahaner, Zamir, Marani, & Rudic, 1992). According to Kusumainderawati, Retnaningtyas, Suwarno, Sugiartini & SUnaryo (2001), chilli pepper lines and superior hybrid varieties are more productive on fertile and sufficiently irrigated lands. Therefore, to increase the productivity of chilli pepper in saline land, it is necessary to assemble types of chilli pepper that are tolerant of salinity stress and high yields through hybridization between saline tolerant parents and high yield parents.

Assembling salinity tolerant varieties requires the existence of donor parents who have the tolerance to salinity and information about genetic control (gene action). Tolerance of environmental stress is a quantitative character with complex genetic phenotypes and controls. Basic understanding of genetic tolerance in plants is a prerequisite for developing superior genotypes. Alia, Baihaki, Hermiati, & Yuwariah. (2004) state that the pattern of inheritance, genetic variability and heritability of a character are genetic parameters related to the selection process and the incorporation of essential characteristics in a genotype. Sekesi in the initial stages of germination will facilitate further completion. Salinity selection at the germination level is expected to make efficient the stages of the selection method used. Accuracy in determining the selection method will largely determine the success of plant assembly.

B. Methodology

This experiment was arranged based on a Completely Randomized Design with two factors: NaCl concentration and several chilli pepper genotypes. NaCl solution concentration consists of 5 levels that modified from Kaouther, Elouer, Aloui, & Hannachi (2012) and Kaouther, Nina, Rezwan, & Cherif (2013) research results of namely 0 g L^{-1} (EC 291 µS/cm, SAL 0,10), 2 g L^{-1} (EC 3,71 ms/cm, SAL 2,0), 4 g L^{-1}(EC 6,60 mS/cm, SAL 3,60), 6 g L^{-1} (EC 9,56 mS/cm, SAL 5,40) and 8 g L^{-1} (EC 12,45 mS/cm SAL 5,40). EC and SAL was obtaining from media analysis according to NaCl concentration.

The second factor is the genotype of chilli pepper consisting of 22 genotypes. The experiment consisted of three replications, each unit consisting of one petri dish containing 20 seeds.

A total of 20 seeds per genotype were germination until a radicle (± 1 mm) appeared. The sprouts were growing in Petri dishes containing three layers of saturated opaque paper NaCl solution according to the treatment. Control as a comparison only saturated with Aquadest as the optimal germination media. The procedure gave for 14 days.

Petri dishes containing sprouts were incubating at room temperature (27-30^{o}C). Variables observed were vigour index (calculated as percen of germination, which grew normally strong and synchronously; radicle and hypocotyl length and fresh weight at 14 days after treatment (DAT). Based on these data, a reduced concentration of 50 (RC50) will be calculated, which is the concentration of NaCl which can cause growth inhibitions up to 50%. The observational data analysed with the F test variance. If the difference showed a significant effect at 5% level followed by the Duncan Multiple Range Test (DMRT) using the SAS 9.1 test facility.

C. Results and Discussion

Seed germination is one of several criteria that can be used to tolerate salinity stress. Increased salinity stress decreases the percentage of germination in Tomato, cucumber, shallots and chilli plants (Kurniasih & Toekidjo, 2008; Bojovic, Gorica, Marina, & Milan, 2010; Abari, Nasr, Hojjati, & Bayat 2011; Hassen, Nina, Rezwan, & Cherif, 2014). Bojovic *et al*. (2010) explain that salinity stress can primarily reduce the percentage of germination and delay the emergence of sprouts.

Tabel 1. Per sen Germination

Genotype	Concentration of NaCl					average	DMRT G	DMRT N
	N0	N1	N2	N3	N4			
G1	100,00 a	33,33	11,11	22,22	0,00	33,33	5,972	2,847
G2	100,00 a	91,67	72,22	69,45	41,67	75,00	6,662	3,176
G3	100,00 a	75,00	80,56	75,00	33,33	72,78	6,295	3,001
G4	100,00 a	91,67	91,67	75,00	86,11 a	88,89 a	6,511	3,104
G5	100,00 a	66,67	75,00	66,67	75,00 b	76,67	6,791	3,238
G6	100,00 a	52,78	88,89	86,11	66,67 c	78,89	6,877	
G7	100,00 a	83,33	83,33	83,33	63,89	82,78 a	6,964	
G8	97,22 a	41,67	11,11	5,55	0,00	31,11	7,028	
G9	100,00 a	50,00	50,00	58,33	50,00	61,67	7,093	
G10	100,00 a	63,89	77,78	58,33	36,11	67,22	7,201	
G11	100,00 a	83,33	58,33	58,33	41,67	68,33	7,201	
G12	100,00 a	91,67	86,11	91,67	61,11	86,11 a	7,244	
G13	100,00 a	97,22	83,33	83,33	47,22	82,22 a	7,287	
G14	100,00 a	33,33	5,55	0,00	0,00	27,78		
G15	100,00 a	94,45	66,67	75,00	91,67 a	85,56 a		
G16	97,22 a	19,45	5,55	0,00	0,00	24,44		
G17	100,00 a	66,67	83,33	25,00	0,00	55,00		
G18	100,00 a	88,89	100,00	77,78	55,55	84,44 a		
G19	100,00 a	83,33	86,11	0,00	16,67	57,22		
G21	100,00 a	58,33	36,11	16,67	0,00	42,22		
G25	94,44 a	77,78	69,45	58,33	72,22 bc	74,44		
G31	100,00 a	100,00	66,67	75,00	55,56	79,44 b		
Average	99,50 a	70,20 b	63,13 c	52,78 d	40,66 e	65,25		

Increasing salt concentration will inhibit water absorption by plant roots, where plants need water for photosynthesis, absorption of nutrients and other metabolic processes in plants so that

increasing salt concentration will impede plant growth. The mechanism of inhibition of germination and growth of nurseries with NaCl is related to inadequate water absorption or may be derived from toxic effects on embryos (Azza, El-Quesni, & Farahat, 2007).

Table 1 shows that at concentrations of NaCl 0 grams (without the addition of NaCl in germination media), the average number of germinated seeds for all genotypes did not differ where 100 percent of sprouts grew except in G8, G16 and G25. At a concentration of 8 grams of NaCl per Liter (N4), the most germinating genotypes were G4 and G15, and differed from other genotypes based on the Duncan multiple range test. The difference in the level of salinity stress has a very significant effect on the percentage and time of germination (Zhani, Elouer, Aloui, & Hannachi 2018).

Tabel 2. Radicle Length

Genotype	Concentration of NaCl							average		DMRT G	DMRT N
	N0		N1	N2	N3	N4					
G1	3,42		2,77	3,34	0,88	0,69		2,22	c	0,433	0,206
G2	4,49	ab	4,30	2,05	2,05	0,00		2,58	ab	0,456	0,217
G3	3,54		2,89	2,05	1,81	1,49	bc	2,35	b	0,472	0,225
G4	3,40		2,92	2,55	1,77	2,44	a	2,62	ab	0,483	0,230
G5	3,87		2,90	1,49	1,05	0,91		2,04		0,492	
G6	3,77		2,52	1,60	1,63	1,35	c	2,18		0,498	
G7	4,55	ab	3,47	2,06	2,31	1,55	bc	2,79	ab	0,504	
G8	1,23		1,08	1,13	1,90	1,22	d	1,31		0,509	
G9	3,08		3,25	2,24	0,28	0,00		1,77		0,514	
G10	4,24	b	2,84	1,84	1,48	1,36	c	2,35	b	0,522	
G11	1,77		1,88	1,63	0,80	0,97		1,41		0,522	
G12	3,59		3,21	2,32	2,22	1,84	bc	2,64	ab	0,525	
G13	3,88		2,81	1,75	1,72	1,38	c	2,31	b	0,528	
G14	4,03	c	2,53	1,30	2,93	1,05		2,37	b		
G15	4,79	a	4,30	2,11	1,54	0,00		2,55	ab		
G16	1,73		3,55	1,00	3,02	0,94		2,05			
G17	4,31	b	2,55	0,24	0,00	0,00		1,42			
G18	2,92		1,71	1,67	0,00	0,00		1,26			
G19	3,95		2,63	2,02	1,97	1,17		2,35	b		
G21	4,16	b	4,74	1,75	0,00	0,19		2,17			
G25	2,92		2,66	2,25	1,59	0,00		1,88			
G31	2,98		4,23	3,89	1,70	1,89	b	2,94	a		
Average	3,48 a		2,99b	1,92c	1,48d	0,93e					

Based on the average amount of germination at all concentrations of NaCl, genotypes G4, G7, G12, G13, G15 and G18 have higher germination percentages and are significantly different from other genotypes. G7, G12, G13 and G18 have the average number of high germination for all concentrations but are markedly different from the highest genotype at the highest NaCl concentration (N4) (Table 1). The response of various cayenne peppers to salinity differs between genotypes (Niu & Rodriguez, 2010). The salinity treatment showed a real influence on the germination parameters, i.e. the percentage of hypocotyl length germination and germination root. Water containing NaCl is an external factor that has a dominant role against germination. In chilli,

decreasing salinity stress loses the percentage of germination (Bojovic *et al*., 2010; Abari *et al*., 2011).

Tabel 3. Hypocotil length

Genotype	Concentration of NaCl							average		DMRT G	DMRT N
	N0		N1	N2	N3	N4					
G1	4,17	a	3,55	4,67	1,14	2,30	cd	3,16	a	0,383	0,183
G2	3,20	d	3,85	2,30	1,86	0,00		2,24		0,404	0,192
G3	3,88	ab	3,46	2,34	1,96	2,40	cd	2,81	abc	0,418	0,199
G4	3,76	ab	1,31	0,70	0,18	3,20	a	1,83		0,427	0,204
G5	2,70		2,39	1,47	1,23	1,35		1,83		0,436	0,208
G6	2,54		2,59	1,76	1,70	0,97		1,91		0,441	0,210
G7	3,08		2,97	2,03	1,48	1,82		2,27	d	0,447	0,213
G8	2,18		1,50	0,76	1,11	1,37		1,38		0,451	0,215
G9	3,15		3,25	2,89	0,68	0,00		1,99		0,455	0,217
G10	3,18		2,62	2,08	1,52	1,55		2,19		0,462	0,220
G11	2,23		2,73	2,97	2,11	1,92	e	2,39	c	0,462	0,220
G12	2,92		2,98	2,16	1,90	2,29	cd	2,45	c	0,465	0,221
G13	2,25		1,74	1,58	0,00	0,00		1,11		0,467	0,223
G14	3,22	d	3,20	2,46	2,13	2,67	bc	2,73	bc		
G15	3,55	bc	3,51	2,30	3,25	3,00	ab	3,12	ab		
G16	2,15		1,73	0,77	1,66	1,18		1,50			
G17	3,61	bc	2,59	1,90	0,00	0,00		1,62			
G18	3,65	bc	4,25	2,72	2,04	0,00		2,53	c		
G19	3,18		2,95	2,17	2,24	2,11	d	2,53	c		
G21	2,81		3,41	1,33	0,00	0,53		1,62			
G25	3,28	c	3,07	2,06	1,43	0,00		1,97			
G31	3,71	b	2,88	1,92	2,17	1,54		2,44	c		
average	3,11		2,84	2,06	1,44	1,37					
	a		b	c	d	d					

At 8 grams NaCl concentration (N4) the average percentage of seed germinated below 50 percent so that this concentration can be used as an effective concentration for the selection of chilli pepper to salinity at the germination level.

The longest radicles at an average of all concentrations are G2, G4, G7, G12, G18, and G31. The genotypes with the longest radicles at 0 g L-1 (N0) NaCl concentrations were G2, G7, and G15. At the highest NaCl concentration of 8 g L-1 (N4), the longest radicle genotype was G4 and significantly different from the other genotypes (Table 2). Plant tolerance to salinity stress is different for each variety (Aini, Mapfumo, Rengel, & Tang 2012).

Tolerant plants have better radicular length compared to sensitive plants. The mechanism of growth inhibition and seedling growth with NaCl may be related to the radicles due to insufficient air movement or may cause toxic effects on the embryo (Azza *et al.,* 2007). The results of the study by Katsuhara & Kawasaki, (1996) stated that research on root growth in salt stress is caused by turgor pressure for cell growth because the osmotic potential of the media grows lower than the osmotic potential in cells, and salt cells. The limited information on salinity tolerant chilli varieties

is the basis of research, so the results of the study will get a variety of salinity tolerant plants and in the future how to increase crop production in saline land.

Tabel 4. Fresh Weight of sprouth

Genotype	Concentration of NaCl						average		DMRT G	DMRT N
	N0		N1	N2	N3	N4				
G1	5,09		3,57	3,11	2,76	2,15	e	3,33		0,204	0,097
G2	4,88		5,34	4,28	3,21	1,36		3,81	d	0,215	0,102
G3	6,10		5,80	3,87	1,52	2,30	d	3,92	d	0,222	0,106
G4	7,01	de	5,80	4,58	3,52	3,06	a	4,79	a	0,227	0,108
G5	4,88		3,67	3,26	1,84	2,45	d	3,22		0,232	
G6	6,40	g	4,12	3,36	2,50	2,76	bc	3,83	d	0,235	
G7	8,28	b	4,68	4,62	3,78	2,35	d			0,238	
G8	1,54		1,08	1,54	4,28	2,60	cd	2,21		0,240	
G9	2,00		5,80	2,12	2,42	1,30		2,73		0,242	
G10	5,04		4,83	4,23	3,36	2,30	d	3,95	d	0,246	
G11	6,10		6,25	2,15	4,12	2,76	bc	4,28	b	0,246	
G12	6,86	ef	4,15	2,67	1,44	1,24		3,27		0,247	
G13	7,16	d	4,28	3,21	2,45	2,91	ab	4,00	cd	0,249	
G14	1,84		3,77	2,30	2,30	1,84		2,41			
G15	8,68	a	5,64	3,82	3,36	2,91	ab	4,88	a		
G16	2,60		2,76	2,45	2,28	2,00		2,42			
G17	4,58		4,43	3,00	1,47	1,60		3,02			
G18	6,58	fg	6,40	3,97	2,45	1,45		4,17	bc		
G19	6,20		5,19	3,67	1,84	1,54		3,69	e		
G21	6,25		5,19	2,35	1,36	0,95		3,22			
G25	7,77	c	5,85	3,36	1,98	0,60		3,91	d		
G31	2,15		3,67	2,24	2,91	2,45	d	2,68	a		
Average	5,36		4,65	3,19	2,60	2,04					
	a		b	c	d	e					

The results of hypocotyl length in Table 3 show that the genotypes with the longest hypocotyl are G1, G3, and G4 in no add NaCl concentration (N0). Based on the average for all levels, the genotype with the longest hypocotyl is the genotypes G1, G3 and G15. At the high NaCl concentration of 8 grams L^{-1} (N4), the genotypes that had the longest hypocotyl were G4, and G15 (Table 3). Salinity hurts the growth of chilli plants caused by osmotic stress and the toxicity of sodium chloride. Salt stress strengthens the parameters of germination, root length and plamula (Hassen, Maher & Cherif, 2014; 2004; Khan, Ayub, Pervez, Bilal, Shahid, & Ziaf, 2009).

More tolerant genotypes will promote better growth at high-stress levels than sensitive genotypes that support starting growth compared to the increased concentration of NaCl given. Fresh weight of sprouts is one indicator of the growth of better germs. NaCl (N0) is G15 and significantly different from other genotypes. The genotypes with the best average fresh weight of sprouts at all concentrations were G4, and G15. As for the highest NaCl concentration (N4), the best fresh weight is the genotypes G4, G13 and G15 (Table 4). Genotype with good germination will produce good plant growth too (Nerson, 2007). The results of the research of Siregar Rosmayati, & Julita (2010) reported that administration of 0-750 ppm NaCl did not show any significant

difference at the beginning of the nursery, but supported a considerable increase in height after being added to 400 ppm NaCl at planting. It is indicated that germination mostly determines the initial growth of plants. If germination growth inhibited, then further growth will also be frustrated. Therefore salinity must be selected which starts at the initial stage of germination

D. Conclusions

The results showed that the most tolerant genotypes were G10 and G12. Characters that can be used as selection criteria at the germination level are the percentage of germination, radical and hypocotyl length. The concentration of 8 g NaCl L-1 is effectively used to select tolerant genotypes.

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F. References

Abari A K, Nasr, M H., Hojjati, M. & Bayat, D. (2011). Salt Effects on Seed Germination and Seedling Emergence of Two Acacia Species. *African Journal of Plant Science*, 5 (1), 52-56

Aini, N.; Mapfumo, E.; Rengel, Z.; & Tang, C. (2012). Ecophysiological responses of Melaleuca species to dual stresses of water logging and salinity. *International J. of Plant Physiol. and Biochem*. 4 (4) : 52 – 58

Alia Y, Baihaki A, Hermiati N, & Yuwariah Y. (2004). Pola Pewarisan Karakter Jumlah Berkas Pembuluh Kedelai. *Zuriat*. 15 (1): 24- 31

Azza M. A.M., El-Quesni F.E.M. & Farahat, M.M. (2007). Responses of ornamental plants and woody trees to salinity. *World Journal of Agricultural Science*. 3(3), 386395

Bojovic, B., Gorica, Đ., Marina T. & Milan. (2010). Effects Of NaCl On Seed Germination In Some Species From Families Brassicaceae and Solanaceae. *Kragujevac Journal Science*. 32: 83-87

Hassen A., Maher S., & Cherif H. (2014). Effect of Salt Stress (NaCl) on Germination and Early Seedling Parameters of Three Pepper Cultivars (*Capsicum annuum* L.). *Journal of Stress Physiology & Biochemistry*, 10(1) : 14-25

Kaouther Z, Nina K., Rezwan A., & Cherif H. (2013). Evaluation of Salt Tolerance (NaCl) in Tunisian Chili Pepper *(Capsicum frutescens* L.) on Gowth, Mineral Analysis and Solute Synthesis. *Journal of Stress Physiology & Biochemistry*, 9(1) : 209-228

Kaouther Z, Elouer M.A., Aloui H., & Hannachi C. (2012) Selection of a Salt Tolerant Tunisian Cultivar of Chili Pepper (*Capsicum frutescens*). *EurAsian Journal of BioSciences*, 6: 47-59. DOI:10.5053/ejobios.2012.6.0.6

Katsuhara M, & Kawasaki T. (1996). Salt Stress Induced Nuclear and DNA Degradation in Meristematic Cells of Barley Roots. *Plant and Cell Physiology*. 2(37) : 169-173

Khan H.A., Ayub C.M., Pervez M.A., Bilal R.M, Shahid M.A., & Ziaf K. (2009). Effect of Seed Priming with NaCl on Salinity Tolerance of Hot Pepper *(Capsicum annuum* L.) at Seedling Stage. *Soil & Environ*, 28(1):81-87

Kurniasih, T. & Toekidjo, (2008). The performance of several rice (*Oryza* spp) varieties on drought and salinity stress conditions (in Indonesia). *Ilmu Pertanian.* 15 (1) : 49 – 58

Kusumainderawati, E.P., Retnaningtyas E., Sarwono, Sugiartini E., & Sunaryo. (2001). Uji adaptasi galur harapan calon varietas unggul cabai merah. *Prosiding Seminar Hasil Penelitian/Pengkajian,* BPTP Jawa Timur

Lessani H., & Marschner H. (1978). Relation between salt tolerance and long-distance transport of sodium and chloride in various crop species. *Austalian Journal of Plant Physiology.* 5:27-37

Nerson H. (2007). Seed Production and Germinability of Cucurbit Crops. *Seed Science and Biotechnology*, 1(1), 1-10

Niu G. & Rodriguez D.S. (2010). Rapid Screening for Relative Salt Tolerance among Chile Pepper Genotypes. *HortScience*, 45(8):1192-1195

[Pusdatin] Pusat data dan sistem informasi pertanian. (2016). Outlook komoditas pertanian sub sektor hortikultura : Cabai

Saptana, Daryanto A., Daryanto H.K. & Kuntjoro. (2010). Strategi Manajemen Risiko Petani Cabai Merah Pada Lahan sawah dataran rendah di Jawa Tengah. *Jurnal Manajemen dan Agribisnis* 7 (2) : 115-131

Saranga Y., Cahaner A, Zamir D., Marani A., & Rudich J. (1992). Breeding tomatoes for salt tolerance: inheritance of salt tolerance and related trait in interspesific population. *Theor Appl Genet,* 84 (3-4): 390-396

Siregar L.A.M, Rosmayati, & Julita, (2010). Uji Beberapa Varietas Tomat (*Lycopersicum esculentum* Mill.) terhadap. *Jurnal Ilmu Pertanian KULTIVAR*, 4(2):1-8

Syukur M, Sujiprihati S, Yunianti R, Kusumah DA. (2010). Evaluasi daya hasil cabai hibrida dan daya adaptasinya di empat lokasi dalam dua tahun. *Jurnal Agronomi* 38(1):43-51

Zhani, K. Elouer M.A., Aloui H., & Hannachi C. (2018). Selection of a Salt Tolerant Tunisian Cultivar od Chili Pepper (*Capsicum frutescens*). *Eurasia J Biosci*, 6: 47-59

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Genetic Characterization of Maize Kisar Var. Kuning Genjah and Maize Var. Bisi-II-Hibrida Based On Molekular RAPD Marker

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Abstract

The variety of maize in Southwest Maluku (MBD) has an ability to grow in the extremely dry land, especially at Kisar island, because those areas were dominated by dry land. Dry resistance very useful to be used for genetical characterization in order to provide accurate data about the character of local maize Kisar var. Kuning Genjah. To identify the characteristics at the genome level of this local maize variety, one of the molecular methods that can be applied was RAPD molecular method. The advantage of the RAPD marker is it's technically simpler and fast in testing, does not require DNA sequence information, hence this marker becomes widely used, it only requires a small sample of DNA, the primary is commercially available and does not use radioactive compounds. The aim of this study was to find out the bands profile that has the potential to be used as a marker of dry resistance. The method applied was RAPD (Random Amplified Polymorphic DNA) using OPA-02, OPA-07, and OPC-12 primers and produces 22 DNA bands. The measurement of bands by estimating the molecular weight based on marker exponential regression. The polymorphic percentage was 90.9% between var. Kuning genjah and var. BIZI-II-Hybrid. The percentage of polymorphism showed the potential of bands that can be used as molecular markers for markers of dry resistance that can be utilized in plant breeding

Keywords**:** genetic, maize kisar and BISI-II-Hibrida, RAPD

A. Introduction

Maize (*Zea mays* L.) is a staple food in the world besides rice and wheat.In Indonesia, some region such as Madura, Gorontalo, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), Minahasa, Maluku and Papua consumemaize as a staple food. In Maluku, maizehas been cultivated as a local commodity which is not less competitive compare to other local commodities. The cultivation area of maize in Maluku are divided into three, namely cultivation area I, covering West Southeast Maluku Regency (maize as staple food); cultivation area II, covering Southeast Maluku Regency, Aru Islands and Central Maluku (maize as a side business); and cultivation area III, including West Seram Regency, Buru Regency and North Seram District (maize as a commercial business) (Susanto & Sirappa, 2005). The maizeoccupies the second largest commodity cultivated in Maluku, which is 6.463 ha, mainly in West Southeast Maluku, West Seram, Buru and Central Maluku (Pesireron and Senewe, 2011).

The maize varieties in Southwest Maluku (MBD)growing at the range of tolerance to the dry land, especially at Kisar Island, because the area is dominated by dry land. Most of the land is dry land overgrown with forest plants, shrubs, grasslands, and shifting cultivation (Susanto and Sirappa, 2005). The maize in this area is really diverse in variety and morphology than maize in general. Specific local maize varieties found on Kisar Island, Southwest Maluku Regency are yellow, kuning genjah, red-pomegranate brown-cob, red-pomegranate white-cob, blood-red, white, and red (Susanto & Sirappa, 2005). The variety ofmaize used in this study wasvar.kuning genjah.

The characteristic genome level of local maize Maluku can be determine with the RAPD method (Random Amplified Polymorphic DNA). The RAPD marker is technically simple and fast to testing, does not require DNA sequence information, used widely, the requirement for only a small of DNA, the primary is commercially available and does not use radioactive compounds (Zulfahmi, 2013).The primers selected are often used in molecular research on maize or those that are closely related, the selection was done by using the RAPD method with a high level of polymorphism, high rates, and producing a clear band pattern. Several studies on the genetic characterization of maize had been repoted, i.e. the characteristics and kinship of local Bebo maize from Sangalla Tana Toraja, South Sulawesi with carotenoid syn 3 origin from simmyt based on molecular markers simple sequence repeat (SSR) (Siga, Juhriah, Masniawati, & Asnadi, 2015). Genetic variation and relationship between Turkish Flint Maize landraces by unclear RAPD markers (Okumus, 2007) and morphological and molecular characterization of strawberry and yellow popmaize (*Zea mays* L. Everta group) (Indhirawati, Purwantoro, & Basunanda, 2015). Considering the investigation, the author are interested to identify the morphological character of maize Kisar var Kuning Genjah and band profile (DNA band pattern) of the maize Kisar var Kuning Genjah with maize var. BISI-II-Hybrid using RAPD marker.

B. Methodology

The study was conducted from Mei 2016 tothe end of January 2017 in Kisar Island (Ambon) and Biotechnology center research and Bioindustry Indonesia (PPBBI), Bogor. The sample used was maize Kisar (*Zea mays* L) var. Kuning Genjah from Kisar Island which was cultivated in Ambon and a control var. BISI-II-Hibrida The tools used in this study were, millimeter block, stationery, camera, scissor, mortar and pastel, eppendorf tube, vortex, incubator, fume hood, centrifuge, refrigerator, freezer, laminar air flow cabinet or blower, analytical scale, tweezers, autoclave, oven, 0.5-10µl micropipette, 10-100µl micropipette, 100-1000µl micropipette, 2-20µl micropipette, 500-5000µl micropipette, NanoDrop Spectrophotometer, PT-100 MODEL PCR machine (MJ Research) thermocycler, 1.5% agarose gel, uv transluminator. The materialsused in this study were label paper, aluminium foil, wrapping, medicinal plastic, cotton, gauze, tissue, ice crystal, dish soap, dishwashing sponge, brown envelope, glove, mask, liquid nitrogen, poly (1-ethenylpyrrolidin-2-one) (PVPP), extraction buffer, β-mercaptoethanol 1%, chloroform: isoamil alcohol (24: 1), cold

isopropanol, TE buffer, Na-acetate, absolute ethanol, 70% ethanol, RNase, 70% alcohol, TAE buffer, KAPA2G Fast ReadyMix PCR reagent, Nuclease-free water.

The sample preparation began with washing the leaves of maize and then being dried using tissue paper. The dried sample was cut and the leaf bone was removed to facilitate the smoothing process. The equipments used were previously wet sterilized using an autoclave and followed by dry sterilized with an oven to avoid contamination. The leaf samples of maize were mashed until smooth by using a mortar while being added to liquid nitrogen. Then 0.1 gram (poly1-ethenylpyrrolidin-2-one) (PVPP) was added to the mortar. Samples and PVPP were added liquid nitrogen slowly then the sample was groundedfurther. Adding liquid nitrogen continuously during the smoothing process. Approximately 0.1 gram sample was then transfered into a cold eppendorf tube and put it into liquid nitrogen. DNA isolation started with 5 mL of the extracted buffer and 500 µL β-mercaptoethanol 1% which both had been heated were mixed, then shaken with vortex and incubated for 30 minutes at 65ºC. Every 5 minutes the tube was shaken tofasten the reaction. The sample was left to cool in a fume hood, then 5 mL of chloroform solution: isoamilalcohol (24: 1) was added. Samples were centrifuged at a speed of 11.000 rpm for 10 minutes at 25ºC. The supernatant was removed, then added 5 mL of chloroform solution: isoamilalcohol (24: 1), shaken with vortex and centrifuged again at a speed of 11.000 rpm for 10 minutes at 25ºC. The supernatant was removed and then 1x volume of cold isopropanol was added. The sample was homogenized by flipping the tube and then stored in a refrigerator (4ºC) for 30 minutes then centrifuged again at a speed of 11.000 rpm for 10 minutes at 25ºC. The obtained supernatant was removed while the obtained pellets were dried. After drying, the pellet was dissolved with 1 mL TE buffer and then shaken. One-tenth of 3M's volume of Na-Acetate pH 5.2 and 2.5 mL absolute ethanol were added and shaken until a collection of white DNA fibers was seen. Samples were stored in a freezer -20ºC for 30 minutes or overnight. Samples were centrifuged at a speed of 12.000 rpm for 10 minutes at 4ºC. The supernatant obtained was removed and the pellets were dried. Pellets were washed with 70% ethanol as much as 100 µL. The mixture is centrifuged again at a speed of 8,000 rpm for 5 minutes at 25ºC. The supernatant was removed and the pellets were dried in a laminar airflow cabinet or the blower was activated. The dried pellet was added a TE buffer solution of 30 µL and homogenized to a pellet and a homogeneous solution.

The RNase around 1/10 of the volume of DNA was added to the DNA. The 3 µL of RNase was added to DNA and incubated at 37°C for 30 minutes. Test the quantity and quality of DNA using Absorbance (A) measured at wavelengths of 230 nm, 260 nm, and 280 nm. Ratios of A260: A280 and A260: A230 were used for DNA purity measurements.

The amplification carried out on the PT-100 MODEL (MJ Research) thermocycler. In the tube, 0.2 ml added 12.5 µl of Fast ReadyMix KAPA2G PCR reagent, 1 µl of 10 µM primer, 2 µl of DNA template, and 9.5 µl of Nuclease-free water (total the reaction of 25 µl).

PCR was programmed as follows: pre-denaturation at95^{o}C for 3 minutes, denaturation at 95^{o}C for 15 seconds, annealing at 35^{o}C for 15 seconds, extension at 72^{o}C for 15 seconds, post-extension at 72^{o}C for 7 minutes. The PCR reaction was carried out in 45 cycles. The 18 primers was used to amplification, namely OPA-02, OPA-04, OPA-07, OPA-11, OPA-14, OPA-17, OPB-06, OPB-08, OPB-13, OPC- 04, OPC-05, OPC-08, OPC-12, OPC-15, OPC-19, OPD-04, OPJ-02, OPN-09. The PCR results were electrophoresed on 1.5% agarose gel for 90 minutes then visualized under UV transluminator and photographed with black and white polaroid. Data analysis used the descriptive by giving a score as the presence (1) or absence (0) of a DNA band.

C. Results and Discussion

The morphological character can be identified physically. The character will provide data information that is intended as one of the distinguishing characteristics of other plants. Based on the morphology observation both of maize kisar var. Kuning Genjah and maize var. Hibrida such as vegetative and generative characters can be identified. Observation on these two characters was

conducted on maize plants at the age of fruiting. Vegetative characters (Table 1) observed were leaf color, leaf apex, leaf lamina direction on the stem, stem color, total leaf number, leaf length, leaf width, and plant height. For generative characters (Table 2) observed were cob length, cob shape, cob width, seed row arrangement, number of seed rows, seed color, grain length, grain width, and grain thickness.

Table 1. Vegetative characteristics of maize Kisar var. Kuning Genjah and maize var. BISI- II Hibrida.

Characteristics	Kisar Kuning Genjah	Bisi II-Hibrida
Leave colour	Green	Green
Leave apex	Acute	Acute
Leave Lamina	Melengkung	Melengkung
Stem colour	Green to reddish	Green to yellowish
Total number of leaves	11. 13	11. 15
Leaf length (cm)	43,2-85,5	38-96
Leaf width (cm)	4,2-7,25	4,5-7,4
Plant hight (cm)	189,3-220	215- 245

Table 2. Generative characteristics of maize Kisar var. Kuning Genjah and maize var. BISI- II- Hibrida

Characteristics	Kisar Kuning Genjah	BISI-II-Hibrida
Cob shape	Conical cylindrical	Conical cylindrical
Cob length(cm)	6,9. 13,5	21.21,9
Cob width (cm)	3. 4	5,7. 5,9
seed row arrengement	curved	straight
Number of seed row	13.14	16.18
Seed colour	Kuning genjah	Yellow
Grain lenght(cm)	0,6 - 0,8	0,8 - 1,2
Grain width(cm)	0,3-0,6	0,5-0,9
Grain thickness (cm)	‘0,5 - 0,7	0,9 - 1,2
Cob width (cm)	3 - 4	5,7 - 5,9

The morphology character comparison is recessive, there was no difference between the same type of plants. stated that morphological character more effectively to measure diversity on plant based on the phenotype in the vegetative and generative phases (Kuswandi, Sobir, & Suwarno, 2014). The morphological character both of the maize Kisar var Kuning genjah and the maize var BISI-II-Hybrid showed similarity in vegetative (Table 1) and generative (Table 2). The identical characterson vegetative phasewere leaf color, leaf apex, the direction of leaf strands on the stem, the total number of leaves and leaf width. The different characterswere stem color, leaf length, and plant height. The identical character on generative phase was cob shape. The different characters include cob length, cob width, seed row arrangement, number of seed rows, seed color, grain length, grain width, and grain thickness.

The observation of maize Kisar var. Kuning Genjah and maize var. BISI-II-Hibrida were carried out in separate place, thus the environment has given side-effect in morphological characters (Singh, Srivastava, Srivastava, & Srivastava, 2011). Therefore, morphology identification only shows the character as a natural character or a character that has been affected by the environment, hence it was difficult to be distinguished morphologically. Based on morphological character observed, there was a difference between the maize Kisar var. Kuning Genjah and maize var. BISI-II-Hybrid. It can be due to maize var. BISI-II-Hybrid is a result of plant breeding from crossing maize superior elders and produce a variety with superior character, whereas the difference in morphology can be

seen clearly, however, both of maize have some similar character. Genetic assay has been done to identify diversity and distinguish character through morphological observations.

The process isolation of DNA was purification of DNA sample by separating DNA compounds from impurities such as RNA, phenol compound and other polysaccharides. Furthermore, calculated the quantity and quality of DNA in RAPD-PCR process using nanodrop spectrophotometer. For quantitative test, the DNA concentration used for amplification was the Ambonesia sample (KG) with a concentration of 62,8 ng/µl and BISI II Hybrid with a concentration of 86 ng/µl. In addition, the DNA sample used had purity level of A260/ 280 1,83 for the Ambonesia sample (KG) and 1,81 for the BISI II Hybrid sample, A260/230 2,55 ratio for the Ambonesia sample (KG) and 2,41 for the BISI II Hybrid sample. Through this test, the results of total DNA genomic electrophoresis from both types of maize can be seen (Figure 2).

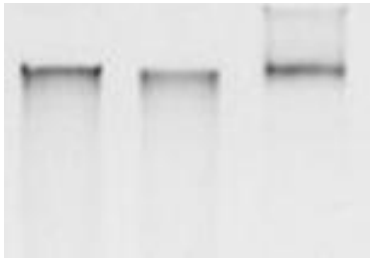

Figure 1. Genome profile of DNA Ambonesia KG & Bisi II Hibrida.(M) Marker Lambda DNA, (1) Ambonesia KG sample, (2) BISI II-Hibrida sample.

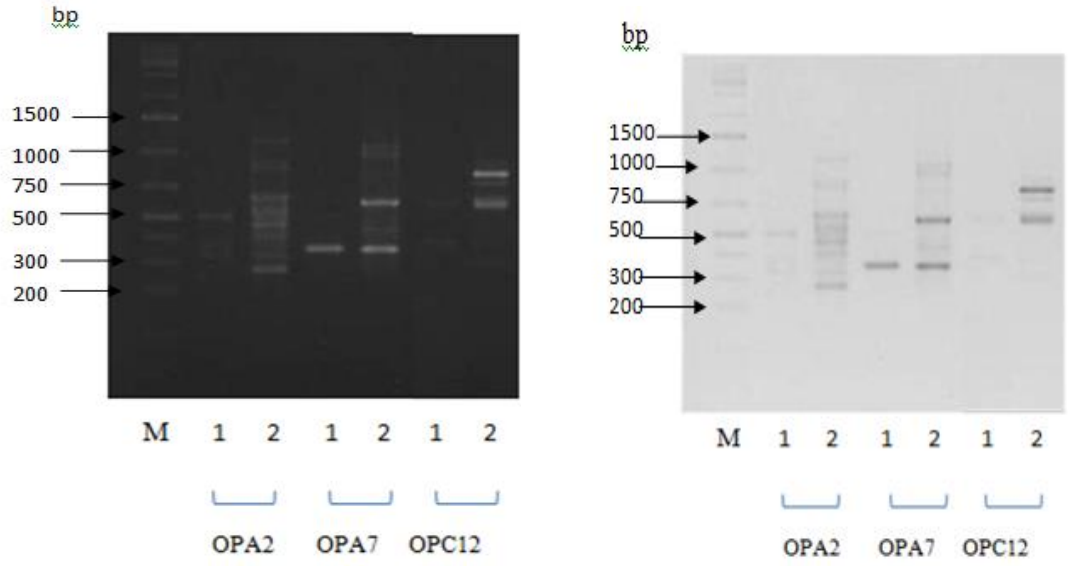

Figure 2. Maize DNA banding pattern using OPA-02, OPA-07, and OPC-12. primers -2-hybrid. Description: (M) marker 1 kb pluss ladder thermo, (1) maizeKisar var. Kuning Genjah sample, (2) maize var BISI-2-Hibrida sample.

In the RAPD-PCR reaction of 18 primers tested, only 3 primers amplified the DNA of both plants properly. The amplification result revealed the profile of DNA bands from maize Kisar var. Kuning Genjah and maize var. BISI-II-Hybrid using 3 primers namely OPA-02, OPA-07 and OPC-12 (Figure 2). From those results, another step to determine the DNA band size in each primer had to be calculated manually using a ruler on a computer screen and using Microsoft Excel in processing data to estimate the DNA band size produced in each primer with a regression approach. The

regression approach is used to estimate the DNA band size from the amplification results based on marker ladder. The estimation of using this approach must be close to precision as if the size of the DNA band is the same as the marker ladder. After getting the estimated size of the bands then validated to determine whether the size is close to precision or not. The non-linear (exponential) graph is chosen as a model in estimating DNA band size because it has an R-value that is close to precision (0.991) and higher than other graphs, hencefrom the graphic showed the regression equation of $y = 4472.e^{-0.96x}$, then it can be used to estimate the size of each ribbon by determining the distance of each band first as a variable x. From the results of the regression analysis, polymorphic bands and monomorphic bands can be determined.

The results of total DNA genome amplification (Figure 1) show thick and clear bands, hence the use of the research method based on the Orozco Castillo method is able to isolate genomic DNA properly. The qualitative testing of DNA also shows that isolated DNA is pure. The results of DNA band amplification can be clearly seen to facilitate the scoring of DNA bands (Figure 2). The resolution of each DNA band from electrophoresis is not always clearly visible, depending on the number of fragments amplified in the plant genome. The difference in DNA band intensity was influenced by the distribution of the primary attachment site in the genome, the purity and concentration of the genome in the reaction. (Sembiring, Putri, & Setiado, 2015). The purity of DNA was determined by the level of contamination of proteins in solution larutan (Sinaga, Putri, & Bangun, 2017). DNA molecules are pure if the ratio A260 to A280 ranges from 1,8 – 2,0. If the ratio smaller than 1,8, there is still contaminant of protein or phenol in the solution. If the ratio value greater than 2,0, there is still RNA contaminant in the solution.

The result of the qualitative test showed that the A260/280 DNA sample used was pure DNA with 1,83 for the maize kisar var. Kuning Genjah and 1,81 for maize var. BISI-II-Hybrid. Meanwhile, for A260/230 DNA sample contaminated with polysaccharide compounds, namely 2,55 for Kisar maize var. Kuning Genjah and 2,41 for maize var. BISI-II-Hybrid. In DNA isolation stage to separate DNA from other compounds such as polysaccharide can be done by adding reagents such as NaCl. The contaminant can interfere with enzyme activity and DNA amplification process. The purity DNA is closely related to concentration DNA sample to be tested in the RAPD-PCR. If the DNA concentration is high, the purity DNA will below, it means the impurities in the DNA are in large quantities. Conversely, if the DNA concentration is low, the DNA purity will be high due to the little amount of impurity. The number of bands produced is dependent on primer to recognizing the homolog in the DNA mold (Rahayu & Handayani, 2010). The size of DNA product bands amplification ranges from 263-1200 bp for the three different primers .

Table 3 Score of DNA bands, size (bp), and polymorphic percentage

No.	Primer	Amount of band		Size (bp)
		Monomorphic	Polimorphic	
1.	OPA-02	-	10	498; 1200; 944; 891; 618; 525; 433; 386; 307; 263
2.	OPA-07	-	7	496; 331; 1144; 1029; 578; 425; 328
3.	OPC-12	2	3	567; 365; 809; 273; 567
Polimorphyc (%)		2	20	

Polymorphism is amplification description that obtained from difference in DNA fragment studied and scoredits different sequence to show any variation(Oktavia, Munir, Suryatingtyas, & Kuswanhadi, 2011). The number of polymorphic DNA bands in genetic diversity analysis influences the diversity ona population, because the number of polymorphic DNA bands will be more capable to clearly describe the situation of plant genomes and reduce the bias due to the non-representation of the genome parts of (Kawengian, Lengkong, & Mandang, 2016).

The percentage of polymorphism bands analysis was calculated to gain a percentage of the polymorphism bands formed in each primer was used (Carsono, Lukman, Damayanti, Susanto & Sari, 2014) In this study, the percentage of polymorphism was 90.9%. Based on DNA amplification that the maize var. BISI-II-Hibrida was contributed more polymorphic bands compared to maize Kisar var.Kuning Genjah. Itcan be due to the maize var. BISI-II.Hibrida is a plant breeding product with significant character such as superior elders controlled crosses and controlled environment conditions, meanwhile maize Kisar var Kuning Genjah is local maize which still retained its own natural character and is not plant breeding product. High polymorphic percentages indicate a high genetic variation of maize BISI-II-Hybrid. Maize Kisar var. Kuning Genjahis very different from BISI-II-Hybrid maize both morphologically and genetically. Genetic variations are very influential in the selection process in plant breeding strategies. Thus, the higher genetic variation the chance to obtain gene sources that characterize the desired plant is higher(Hijria, Boer, & Wijayanto, 2012)

D. Conclusions

The results showed that maize Kisar var. Kuning Genjah is very different to maize var. BISI-II-Hibrida, and DNA band profile from the RAPD analysis using the three primers showed 22 DNA bands with a high genetic variation of 90,9% in size of 263-1200 bp.

E. References

Carsono, N., Lukman, P.N., Damayanti, F., Susanto, A.N., & Sari, S.(2014). Identifikasi Polimorfis Marka-marka Molekuler yang Diduga Berkaitan dengan Karakter Daya Hasil Tinggi pada 30 Genotip Padi. *Chimica Et Natura Acta, 2*(1), 66-71

Hijria, Boer, D., & Wijayanto, T. (2012). Analisis Variabilitas Genetik dan Heritabilitas Berbagai Karakter Agronomi 30 Kultivar Jagung (*Zea mays* L.) Lokal Sulawesi Tenggara. *Penelitian Agronomi, 1*(2), 174-183

Indhirawati, R., Purwantoro, A., & Basunanda, P. (2015). Karakterisasi Morfologi dan Molekuler Jagung Berondong Stroberi dan Kuning (*Zea mays* L.) Kelompok Everta Group. *Vegetalica, 4*(1), 102-114

Kawengian, Y.B., Lengkong, E. & Mandang, J. (2016) Keragaman genetik beberapa varietas kentang (Solanum tuberosum L.) berdasarkan penanda random amplified polimorphic DNA (RAPD). Bioslogos, 6 (2), 60–67

Kuswandi, Sobir, & Suwarno, W.B. (2014). Keragaman genetik plasma nuftah rambutan di Indonesia berdasarkan karakter morfologi. *J Hort, 24*(4), 289-298

Oktavia, F., Munir, M., Suryatingtyas, H., & Kuswanhadi. (2011). Karakterisasi sidik jari DNA isolate Corynespora cassiicola yang berasal dari berbagai sentra perkebunan karet di Indonesia. *Indonesian J Nat Rubb Res, 29*(2), 118-129

Okumus, A. (2007). Genetic variation and relationship between Turkish flint maize landraces by RAPD markers. *American Journal Agricultural Biological Sciences, 2*(2), 49-53

Pesireron, M., & Senewe R.E. (2011). Appearances of 10 strains/Maize Varieties Composite and Hybrids on Dryland Agroecosystems in Maluku. *Jurnal Budidaya Pertanian* 7: 53-59

Rahayu, S.E., & Handayani, S. (2010). Keragaman genetik pandan asal Jawa Barat berdasarkan penanda inter simple sequence repeat. *Makara, Sains, 14*(2), 158-162

Sembiring, I.M.S., Putri L.A.P., & Setiado, H. (2015). Aplikasi penanda lima primer rapd (Random Amplified Polimorphic DNA) untuk analisis keragaman genetik andaliman (*Zanthoxylum acanthopodium* D.C.) Sumatera Utara. *Agroekoteknologi, 4*(1), 1748-1755

Susanto, A.N & Sirappa, M.P. (2005). Prospek dan strategi pengambangan jagung untuk mendukung ketahanan pangan di Maluku. *Jurnal Litbang Pertanian,* vol. 24(2): 70 – 79

Siga, Y.C., Juhriah, Masniawati A., & Asnadi, M. (2015). Karakterisasi dan kekerabatan jagung lokal bebo asal Sangalla Tanah Toraja Sulawesi Selatan dengan jagung carotenoid syn 3 asal cimmyt berdasarkan marka molekuler simple sequence repeat (SSR). from http://repository.unhas.ac.id/handle/123456789/16734

Sinaga, A., Putri, L.A.P., & Bangun M.K. (2017). Analisis pola pita Andaliman (Zanthoxylum acanthopodium D.C) berdasarkan primer OPD 03, OPD 20, OPC 07, OPM 20, OPN 09. *Agroekoteknologi FP USU, 5*(1), 55-64

Singh, D.R., Srivastava A.K., Srivastava A., & Srivastava R.C. (2011). Genetic diversity among three Morinda species using RAPD and ISSR markers. *Indian Journal of Biotechnology, 10*(3), 285-293

Susanto A.N., & Sirappa M.P. (2005). Prospek dan strategi pengembangan jagung untuk mendukung ketahanan pangan di Maluku. *Jurnal Litbang Pertanian, 24*(2), 70-79

Zulfahmi. (2013). Penanda DNA untuk analisis genetik tanaman. *Jurnal Agroteknologi, 3*(2), 41-52