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Research Article

Genetic Diversity Of Age, Plant Height And Number Of Grain Per Panicle Characters Of F3 Generation Derived From Crossing Silopuk With Fatmawati Varieties

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Abstract

Background and Objective: This study aims to determine the population parameters and genetic parameters of population F3 result of selection pedigree red rice cross Silopuk with Fatmawati Superior Varieties using Augmented Design. Silopuk cultivars with red and inlaid rice characteristics while Fatmawati varieties with characteristics of large grain size, high production, high grain number, early age, and white rice. The crosses are expected to produce high, large grain size, a large amount of grain, maturity, and color of brown rice. **Materials and Methods:** The genetic material used is the seed of the generation of F3 (F3-5, F3-12, F3-55, F3-95, F3-118, F3-122) derivatives of red rice crosses Silopuk with Fatmawati and the seeds of the two elders as a comparison with the experimental method using Augmented Design. **Results:** The results of this study indicate the population F3 is between the two elders. The phenotypic diversity of flowering age characters in the F3-122 family is quite narrow. The estimated genetic progression rate with a 5% intensity in the high F3 population on all characters. A different selection of population F3 with 10% selection intensity based on 1000 grain weight of pith grain, plant height and total grain weight per hill obtained 31 selected individuals. Selected individuals will be forwarded to the F4 generation.

Keywords: Heritability, Red rice, Silopuk, Differential selection, Variability

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Introduction

Breeding of rice (Oryza sativaL.) in Indonesia continues to evolve in accordance with the increasing complexity of needs, so the type of the resulting varieties development experience. Kinship is high or the narrow genetic background cause not getting an increased potential for real results, so the rice production enhancement slopping in Indonesia. Rice hybrids and a new type of Rice (PTB) gives hope to overcome the slopping rice varieties yield potential is generated (Susanto et al., 2003).

West Sumatra Province is a province of Indonesia that holds exotic genetic diversity and have a high economic value. One of the germplasm that is found is rice Brown rice. Brown rice is a staple food that has begun to be forgotten that has content exceeds the white rice and known very beneficial for health. Previously, the toughest (2005) States that the content of anthocyanin pigments in the brown rice was able to prevent various diseases such as cancer, cholesterol, and coronary artery disease so that needs to be analyzed further use and its benefits. The color red on anthocyanin pigments is formed from rice that is not only found in the pericarp and the tegmen (layers of skin) but can also be in any part of the grain, even on the petals of the leaves. Nutrition Brown rice is partly located in the outer layers of skin (aleuron) which is easily chipped at the time of milling. If the grain is filled by anthocyanin pigment then the red on the rice will not be lost (the toughest, 2005). The results of the exploration of the content of anthocyanin in West Sumatra on rice Brown rice range from 4.5 mg/g to CyE 431 mg CyE/g (Swasti et al., 2011). Higher densities of the red color indicate the level of content relationships, the more concentrated red color the higher the content of anthocyanin (Reza, 2012).

Characterization of rice against local Red West Sumatra has obtained information about the advantages and disadvantages. The local Red Rice include Silopuk cultivars in Pasaman Barat. Silopuk cultivars have the advantage of the texture of cooked rice with peraamylosa 31.7%, 13.3% proteins. Conversely, the disadvantage is high, plants saplings that many (42 shafts) and age (> 145 days). Efforts to improve the characters the less desirable, among which may be through hybridization or cross with other varieties as a source of elders for the desired traits. Swasti, daughter, and Zainal (2013) in this case have begun to assemble with local Red Cross rice cultivar Silopuk with Superior new type Varieties (VUTB) Fatmawati. Superior varieties of new type (VUTB) have characterized: age, plant height, stem robust, saplings little but productive (14 < stem), the amount of grain the dense (more than 250 grain) with relatively large size (1000 grain weight 29 g) (Balai Besar Research Rice crops, 2004).

Breeding own plant breeding methods on rice can be made through selection, hybridization and selection after hybridization (prosperous, 1992). The research that has been done this is selected after selection pedigree in the form of hybridization. Pedigree selection is performed on the recording of each Member of the population of segregated from the results of a cross. Selection of useful pedigree to declare the two strains are similar to the linked against individual plants of the next generation. Selection pedigree aims to obtain new varieties by combining desirable genes that can be used as selection criteria for example, based on higher plants, 1000 grain weight and the amount of grain that is found on the two genotypes or more, so hopefully, produce offspring that are better and more superior compared to an ancestor.

Pedigree selection is done at the early generation or F2 generation as generation F2 high levels of segregation occurs and is determined by the value of genetic parameters primarily genetic diversity and the value of heritability. The second component, which should be wide or high. Data research results of wisdom (2015) on generation F2 showed high character plants, 1000 grain weight and the amount of grain has an extensive range of genotype and heritability are high, so it can be used as selection criteria and easy to rectified where its value in a row is 0.95; 0.88 and 0.89. Heritability is a picture of the magnitude of genetic contribution on a character. The value of high heritability guess indicates that genetic factors play a role more than environmental factors, while a low heritability value otherwise. On conditions of high heritability, generally, the selection can be done on the early generations. The value of diversity is the variability of a putative genotype that is selected. The character has a value of guess the vast variability, there is great diversity so that the success of the higher selection (Pinaria et al., 1995).

Genetic material was used in this experiment retrieved from pedigree on F2 population selection using the selection differential 20% elected 28 genotypes based on selection criteria weighting 1000 grains and number of grain. Genotype was elected to be inherited on the generations F3. The F3 generation population is still an early generation, then to determine the genetic variability and heritability using Augmented Design. Environmental variability is suspected of a variety of elders or the range of varieties comparison.

The design of Augmented according to Shepar (1994) can be used to overcome the limited individual seed is selected so that the stick allows testing without any genotype of Deuteronomy. The design of Augmented or draft magnification is used because the seeds obtained from the previous generation slightly so that it can't be done, and the repetition to the control Silopuk cultivar and superior variety Fatmawati can be repeated for analysis. In addition, on generation F3 segregation levels are still high in certain properties so that it can not be repeated. According to Allard (1960), a heterozygous genotype that when done continuously own pollination so, heterozygous individuals will be reduced by half at every generation inherited genetic variability and heritability Red Cross rice F3 results and get the desired recombinant genotypes from the results of a cross for forwarded generation next.

Materials and Methods

Plant Material and Culture Conditions

The method of research used an experimental method by using the design Augmented in the rack. The genetic material used are six genotypes in populations selected F3-5, 12-F3 F3-F3-55, 95-118, F3, and F3-122 and two varieties in comparison. Varieties comparison is repeated three times. Each genotype was planted two rows in one swath of the experiment with size 0, 8 m x 6 m with planting distance 40 cm x 20 cm thus there is 48 plants per hiding. The seeds were planted one seed per planting hole. Observations are were done 24 samples in each genotype. Method implementation starts with land preparation, seeding, seed selection, planting, maintenance (watering, fertilizing, weeding and pest control and disease) and harvest.

Data Analysis

Observations made during the flowering age, character age harvest, plant height, number of grain per panicle. Prediction of population parameters genetic and genetic parameters.

Results and Discussion

Parameter Population

Based on t-test results at 5% level of both elders, the varieties Fatmawati and cultivar Silopuk obtained different mean values significantly different in all characters. From these results, it is known that on the character of a significantly different indicate the distant genetic distance between the elders Fatmawati with Silopuk so that the chances of obtaining recombinants will be greater. The average data of elders and the t-test, mean, range, variety and standard deviation of population F3 are presented in Table 1.

Table 1. Average, Range and Test-t, Average, Range, Variety and Standard Deviation Population F3

Character		Check		Population F3				
	Average	Average	Test-t	Average	Range	Varian	2xStandart Deviation	Character
UB	62,33	90,73	75,64*	75,87	62-95	106,00	20,60	Browd
UP	101,00	150,00	∞*	111,33	101-127	98,91	19,90	Browd
TT	109,13	146,43	18,83*	123,43	88-170	421,00	41,04	Browd
JAT	13,20	18,60	15,97*	14,75	6-27	15,48	6,78	Browd

Based on Table 1. the characters observed in the F3 population obtained the mean value of all observed characters are between the middle values of the two elders except in the percentage character of the number of grains per panicle per panicle higher than the two parent averages. Characters with a middle value greater than the elder are still likely to be selected because the range is beyond the range of the two elders. This is due to the still occurrence of segregation in population F3. The population of F3 has a very wide range with low data distribution up to the higher of the two parents, so the chance of selection for the desired character can be done.

Selection is directed to characters that are superior to the two parents such as red, brownish rice. The ideal plant height, 1000 grain weight of heavy pine grain and high weight. The average character of harvest age and height of varieties of Fatmawati plant belong to maturity criteria and ideal plant height, on the contrary in Cultivar Silopuk. Silopuk cultivars average harvest age characterized as deep and high crop average so high that the character becomes a weakness of local varieties that need to be improved in the plant breeding program. In population F3 the range of harvest age characters obtained ranged from 101-127 HST or 115-141 HSS and plant height characters obtained ranged from 88-170 cm from the soil surface, which means the segregation still occurs in the characters.

The result of Hikmah (2015) research is known that the plant height character obtained from population F2 ranges from 90cm to 145cm from the ground surface. The character of plant height from generation F2 to F3 is changing because in this F3 population still occurs segregation causing different high character, also due to long flooding at the time of vegetative phase causing an increase of plant height because nutrition for the crop is available. These results are in line with Kawano et al. (2009) research that flooding will stimulate stem elongation as one of the escape strategies against flooding to help meet the needs of oxygen and carbon dioxide to support aerobic respiration and photosynthesis.

The data in Table 1. shows that the average population of F3 in all observed characters is between the two parent's average. The character of flowering age and harvest age is an important character for determining selection criteria in plant breeding. The average value obtained on the character of flowering age and harvest age of F3 population is between the two elders. The mean for flowering age and harvest ages were 75.87 HST or 89.87 HSS and 111.33 HST or 125.33 HSS were classified according to IBPGR-IRRI (1980). Characteristic of plant height and stem length is also included in the assembly program of red rice varieties with ideal plant height according to the selection criteria. The average height of the plant and the length of the stem of the F3 population are between the two elders of 123,43cm and 87,94cm belong to the medium criterion.

Based on Table 1. the phenotypic diversity of population F3 on all characters is quite wide, ranging from 15.48 to 421.00. This diversity is caused by two possibilities of environmental and genetic factors. According to Crowder (1983), a population has a wide variability not necessarily wide genetic variability because the genetic appearance through its phenotype influenced by environmental factors. Genetic variability occurs due to the effect of genes and the interactions of different genes in the population. Extensive genetic variability will provide wide variability if the genetic and environmental interactions are narrow.

Genetic Parameters

Estimation of Components of Variety and Heritability

Various components include genetic variation (σ ^ 2 G), environmental variety (σ ^ 2 E), and phenotypic range (σ ^ 2 P). While the components to know the value of heritability guess is the genetic variety and variety of phenotype. The estimation of heritability and heritability components is performed to determine the proportion of diversity caused by genetic and environmental factors. Heritability in the broad sense (σ ^ 2bs) is the ratio between the total genetic variety and the various phenotypes. Meanwhile, by definition, the ability of a plant to inherit a particular character to the offspring according to Gratitude (2015). Heritability greatly determines the success of selection in an appropriate environment, because heritability can give an idea of whether a trait is influenced by genetic or environmental factors. High heritability values suggest that the phenotype character appearance is due to genetic variation and genetic factors. Thus the character is easily inherited or improved. While heritability values that include moderate criteria mean genetic factors and environmental factors as great as affect the appearance of the character phenotype. The estimation of variability, heritability prediction, and genetic variability coefficients are presented in Table 2.

Based on Table 2 character of flowering age and harvesting age has 1.00 heritability value with the high criterion, meaning the appearance of flowering age and harvest age is entirely influenced by genetic or genetic variation. The degree of diversity in the character of harvest age and flowering age is homogeneous and classified as early as Fatmawati. In addition to the character of flowering age and harvesting age of plant height and long stems are high criteria 0.66 and 0.62. This suggests that plant height characters are also more influenced by the genetic variety. When compared to the population of F2, the height of the plant has increased or the increment is high in the high character of the grown flower plant. This is because the flooding is too long and irregular so it adds height to the height character of the plant.

Table 2. Comparative Assessment of Variety, Variability, Heritability Due Value, and Genetic Diversity Coefficient

Chracter	GenotypeVarian	2x Variability Genetic	Character	Fenotype Varian	Heritability	Character	KKG (%)
UB	94,25	33,58	Browd	93,43	1,00	High	12,79
UP	39,29	14,00	Browd	39,29	1,00	High	5,63
TT	52,04	32,70	Browd	78,98	0,66	High	5,86
JGT/M	217,98	281,24	Narrow	488,27	0,45	Mrdium	5,09

Based on the study of Hikmah (2015) about population F2 result of pedigree selection of crossword between Silopuk cultivars with superior varieties of Fatmawati showed high plant character has heritability value with the high criterion that is 0,94. Based on these criteria can be seen that the character of plant height is more dominant influenced by genetic factors. From the comparison can be seen that the character of the plant height is inherited well in derivatives

The total number of grains per panicle has a heritability value of 0.45 with medium criteria. Based on these criteria the total number of grain per panicle is influenced by the same genetic and environmental factors. This means that these factors have the same effect on the phenotypic appearance of the total grain number per panicle. The heritability value of the total grain character per panicle may change according to the dominant character that influences it, as do the other characters who share the same criteria. This is in line with the study of Hikmah (2015) on population F2 Selection selectionPedigrics between Silopuk cultivars with superior varieties Fatmawati showed that the character of panicle length and total grain per panicle with high heritability value that is 0.88 and 0.82. From the results obtained is known to decrease heritability value on the character of total grain per panicle from 0.82 to 0.45 with high criteria being medium. The occurrence of the heritability decrease is expected due to the environmental influence of low light intensity during the generative phase. Suhartatik et al., (2008) states that if light ruptures in the reproductive stage can reduce the number of grains.

Based on Table 2. KKG in F3 population ranged from 5.09% - 12.79% with medium to narrow criteria. KKG values that belong to narrow criteria are found in all characters except in the character of the flowering age. Thus the level of segregation on the character with the criterion is still high so the chances for the selection is very large to get a superior individual. In addition, individual selection is still effective in F3 populations for the purpose of early generation or handling of lines of hope that will be new rice varieties of new-breed selected from cultivar selection of Silopuk cultivars and superior varieties of Fatmawati.

Genetic variability is caused by two possibilities, namely genetic and environmental factors. Table 2. Demonstrates genetic variability quite narrow to wide. Large genetic variability is present in all characters except the total number of grains per panicle is narrow. Based on this segregation in population F3 is still high so that selection is still effective to do. According to Crowder (1983), a population has a wide variability not necessarily wide genetic variability because the genetic appearance through phenotype influenced by environmental factors. Genetic variability occurs due to the effect of genes and the interactions of different genes in the population. The wide genetic variability will provide wide variability if the genetic interactions and the environment are broad as well.

The Value of Genetic Progress

Based on Table 3 can be seen the value of genetic progress at the selection intensity of 5% of population F3 ranged from 4.23% - 307.52% with low to high criteria. Of all the characters evaluated the long character of panicles and the weight of 1000 pine rice grains are classified as low criteria of 4.23% and 6.99%. While the other characters are high criteria so there is still a great chance to do the selection.

Table 3. The Value of Genetic Progression of Population F3 with Selection Intensity 5%

Character	Genetic Progress(%)	Character
UB	254,05	High
UP	72,80	High
TT	86,98	High
JGT/M	155,22	High

Given the heritability value for plant characters, it will allow plant breeders to calculate the value of their genetic progress, meaning that selection by a character with high heritability values takes a shorter time to obtain the desired individual. Genetic progress is an increase in the value of the character observed when selection is made to the character. If the value of a character's genetic progress is high, then there is a great opportunity for improvement of the character through selection (Mangoendidjojo, 2007).

According to Indra (2016) Characters with criteria of low to moderate genetic advancement are thought to have genetic similarity or homogeneity and it is suspected that the controlling genes or their alleles are homozygous so that the selection for the character with the criterion can be terminated in his generation. While the character with high genetic progress criteria is still possible to improve the character so that the opportunity to continue continued as selection criteria.

Color Selection of Rice Population F3

Selection is done to increase the frequency of genes that are desired in the next generation. Selection in this study was conducted to obtain genotypes that have red rice and has a character superior to both parents. The genotypes with red rice in this F3 population consisted of 121 genotypes or 84%, indicating that in the F3 population there was still segregation in the color of the rice. The families that are still categorized as F3-12 is 29.17%; F3-5 that is 16.67%; F3-95 is 16.67% and F3-122 is 25%. While in the family F3-5 and family F3-118 shows all the red rice.

The population of F3 consisting of 6 families obtained by the F3-5 and F3-118 families has shown that all individuals have red rice, so it can be said that the family is homozygous for the color properties of rice. In contrast to the F3-12, F3-55, F3-95, and F3-122 families, respectively, yielded red as much as 70.83%, 83.33%, 83.33%, and 75%. This is in line with Andrianto's (2015) study which states that the genotypes on populace F3 have red rice of 124 genotypes or 83%. Not all individuals produce red rice in the F3 population since the genes expressed on each individual vary so as to cause diversity, it can be explained that the selected genotype in F2 generation is still heterozygous for the color character of rice so it will segregate on F3.

The result of the research (Hikmah, 2015) states that the pattern of segregation of rice color characters follows a ratio of 3: 1 where, the segregation pattern identifies that the color characteristics of rice is controlled by one gene with two alleles and supported by opinion (Reddy, 1996; Suardi, 2005). states that anthocyanin pigments are controlled by stump genes. The red rice color character is presumed to have a dominant allele against the white rice allele. In F2 the selection is based on the color of brown rice so that the derivatives in the F3 generation indicate that many individuals produce red rice both between families and within families, even families that all produce red rice such as F3-5 and F3-118 families.

F1 plants are the result of a cross between two homozygous elders, so this plant has a 100% heterozygous gene. Pollination alone will decrease the proportion of heterozygous genotypes to half so that in the generation of F2 heterozygous plants have a proportion of 50%, whereas 25% homozygous genotypes such as male parent and 25% such as female elders. F2 plants are allowed to pollinate themselves then the proportion of heterozygous plants in the generation of F3 will decrease to 25% and homozygous will increase. Pollination itself will continue to decrease the heterozygous genotype, so in the next generation almost all genotypes will be homozygous or genetic purity has been achieved.

Individual Selection Based on Differential Selection

Differential guessing values are closely related to the intensity of selection. The differential selection value is the difference between the median selection of the selected population and the initial population selection value and converted into a percent (%). The weighting character of 1000 grain of pithy rice, plant height and grain weight were used as selection criteria to obtain superior individuals compared to their parents. With more than one criterion it will increase the chances of getting a superior individual on all characters. The mean of the selected population and the selected population, as well as the differential estimates at the 5% selection intensity, are presented in Table 16.

Based on the results of the research obtained in population F3 with direct selection for a total weight of total grain per higher clumps obtained on the selection criteria of 1000 grain weight of pith grains, plant height and total grain weight per hill. As for the weighted character of 1000 grains of higher pine rice was obtained on the selection criteria of 1000 grain weight of pithy rice. Furthermore, higher plant height is obtained on the selection criteria of 1000 grain weight of pithy rice, plant height and total grain weight per hill. It shows that the selection of weighted grains of 1000 grain of pine in population F3 differential value of the selection obtained based on the weighting criteria of 1000 pine grain is 23.72% means that the selection based on 1000 weights is expected to increase 23.72% weight 1000 grains on next generation.

This result is in line with Andrianto research (2015) which states that F3 population differential selection value on the selection criteria of 1000 grain weight is 27.97%. Thus, the selection based on the weight of 1000 grain of pungent grain increases other characters in selected genotypes such as plant height, long panicle and grain weight of contents per hill. Selection based on weight of 1000 grain of pithy rice and plant height obtained by differential selection value 0,5% and -23,1% respectively and multicharacter selection based on 1000 grain weight of pith grain, plant height and total grain weight per hill of differential value of selection obtained were 0.2%, -16.5% and 28.78% respectively. The result of differential selection has a negative or left-pointed value on the selection curve for the plant height character indicating that the selection leads to a shorter plant.

Individuals selected based on differential selection with 10% selection intensity with three selection criteria obtained 31 selected individuals based on weight selection criteria 1000 grain of pine rice, weighting criteria 1000 grain of pithy rice and plant height and weighting criteria 1000 grain of pith grain, plant height and grain weight total per hill.

The number of individuals selected based on the three selection criteria is 36 individuals. However, the same 3 individuals found in the selection criteria of 1000 grain weight of pithy rice and plant height ie, individuals F3-122-39; F3-122-4 and F3-12-20 and 2 individuals on the selection criteria of 1000 grain weight of pith grains, plant height and total grain weight per hill ie individuals F3-12-48 and F3-12-56 so that the number of individuals selected is 31 individual. On the weighting criteria of 1000 pine rice grains, 12 individuals were selected. The weight criteria of 1000 grains of pithy rice and plant height were obtained by 12 individuals and on selection criteria based on the weight of 1000 grain of pithy rice, plant height and total grain weight per hill were also obtained, 12 individuals

Conclusion

Selected genotypes may be used as genetic material for further testing in F4. In addition, F3 families can also analyze nutritional content.

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