IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 11 Ver. II (Nov. 2016), PP 32-37
www.iosrjournals.org

The Role of Genetic Parameters on The Selection Methods In Brown Rice, Paddy

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Abstract: *Brown rice paddy is one of the germplasm untapped as a source of genetic diversity in breeding programs. This paper aims at describing the role of genetic parameters in determining the appropriate selection method in paddy (Oryza sativa L.) of brown rice. It is a descriptive method with data collection (literature) through books, journals, and scientific articles from previous studies. The finding shows genotype correlation coefficient value is greater than the correlation coefficient phenotypic; the genotypic correlation coefficient values is in line with the value of phenotypic correlation coefficient; and also, the significant values are indicated on genetic diversity, the role of genes and heritability. This study suggest that it be necessary to do research on the brown rice germplasm continuously to keep its existance and to create new varieties of brown rice which can be utilized for human health.*

Keywords: *Brown rice paddy, genetic parameters, heritability, phenotypic and ghenotypic correlation, the role of genes, variability*

I. Indroduction

Brown rice, paddy, is one of the germplasm untapped as a source of genetic diversity in breeding programs. It is a limited, endemic development area in the highlands as upland rice in the old as well as the existence increasingly rare (endangered) due to the types of rice planting new varieties (Muliarta et al., 2004).

Brown rice has long been identified to be beneficial for health, as well as a staple food. Brown rice flour informed contain carbohydrates, fats, fiber, folic acid, magnesium, niacin, phosphorus, protein, vitamins A, B, C, Zn, and B complex are effective in preventing various diseases, such as; colon cancer, kidney stones, beriberi, insomnia, constipation, and hemorrhoids, as well as lower blood glucose and cholesterol. However, brown rice paddy is generally less popular upland rice as a staple food. Moreover, in research fields, brown rice paddy is not a priority for research (Suardi, 2005).

In Indonesia, there are many local varieties of brown rice with its own nutritional content according to a place of growth. However, better brown rice paddy has not received adequate attention in particular tolerant and high yield. A common problem is that its existence is increasingly rare due to the planting of new varieties superior. Meanwhile, the need for brown rice paddy has been increasing. Consequently, it would need to be created new varieties of brown rice ideal race since the source germplasm is still there with the source of numorous genetic diversity (Muliarta, 2014).

Donations for plant breeding in Indonesian agricultural development have shown from their evident from the role of improved varieties produced over the years. Until now, it is estimated to be around 85 per cent of rice areas having been planted with improved varieties. With the increasingly widespread planting of high yielding varieties will urge local varieties, resulting in the shifting of even the extinction of a number of local varieties that have specific adaptations to certain conditions, known as genetic erosion. Thus, in order to avoid sustained genetic erosion, it required gradually rice germplasm collection (Silitonga et al., 1988).

Having shown those such low results of the brown rice that it needs to be improved yield potential of > 7 tonnes / ha, and the early duration <110 days through the formation of varieties of upland rice rancah new type of adaptive in rainfed areas and the planting system gogo rancah. To meet these needs, it requires proper breeding methods to obtain new varieties with better code offspring than those of having been cultivated. Thus, with regard to breeding objectives, it is necessary to study the role of genetic parameters in relation to the selection method with a view variability, heritability, the role of genes and phenotypic and genotypic correlation (Muliarta and Sudharmawan, 2014).

Genetic diversity (variability) can be used as a basis in determining the selection program. According to Bari et al., (1981), the variability in the population is very important because the selection can be made on their variation and selection will be effective when it takes place on a population having a declined variation.

Heritability, out of the variability, can also be used as a basis in determining the selection program. Selection in early generation is done when heritability values are high; however, if lower then the selection of the next generation will succeed because the chances of an increase uniformity in the population (Falconer, 1970).

Selection will be more effective if the characters, the target selection, have high heritability values. Heritability is very important in determining the method of selection and the generation of which should the desired characters be selected. Genetic progress illustrates the extent to which the effectiveness of the selection process. Selection will be effective when it has a high value of genetic progress supported by both the high genetic diversity and high heritability value (Herath, 2009).

Selection on the characters having high heritability estimation would be more effective than low heritability's. The predictive value of genetic progress needs knowing in order to see how big the success achieved in the framework of the development program improvement genetic trait. Without genetic diversity, breeding programs cannot run properly. Genetic diversity in each of agronomic characters of rice can be compared in the coefficient of genetic diversity (KKG) (Welsh, 1991).

The selection method is an effective process to obtain characters considered as a very important and high success rate. Helyanto (2000) states that if a character has a relatively high genetic diversity, the diversity of the characters among individuals in a population will be high as well; thus, the selection will be easier to obtain the desired properties.

II. Research Methodology

This study applies a descriptive method with data collection (literature) through books, journals, and scientific articles from previous studies. Data collected with the identification of discourse and books, articles, papers, internet or other information related to the writing of this particular topic. The data having been obtained are reviewed, combined (synthesis) and conducted a literature review to establish the results of the study are systematic, coherent and intact.

III. Results And Discussion

Hybridization aims to obtain desirable genetic combinations through the cross of two or more different older's genotype. The offspring of this hybridization will occur segregation in F1 when the parent is heterozygous. This segeretion shows the genetic diversity, which must be selected and evaluated according to their needs (Ferdy, 2008).

Selection is the basis of the whole process of plant breeding and an improvement of plants to obtain new varieties. Variability or genetic diversity showed the genetic diversity criteria. Variability or extensive genetic diversity is a requirement for effective selection program. Selection of a desired character will be easier if the high genetic variability. In addition, the flexibility can be obtained in the election of a superior genotype (Bari et al., 1982). The data from the evaluation of genetic variation will show character improvements. Selection will be more meaningful if the character is inherited (Wahyuni, 2004).

a. Phenotypic and Genotypic Correlation

Muliarta (2009) has conducted research on the correlation of phenotypic, genotypic and finger cross and its implications on the selection of brown rice paddy. Finding shows that genotype correlation coefficient value is greater than the correlation coefficient phenotypic and genotypic correlation coefficient values in line with the value of phenotypic correlation coefficient.

Correlation among the characters; the grain yield, grain weight per panicle, weight of 100 grains, the total number of grains per panicle, number of grains contain per panicle, panicle length, number of tillers per hill, the total number of tillers per hill, plant height and anthocyanin content of rice expressed with genotypic and phenotypic correlation coefficients are shown in Table 1.1.

Table 1.1 : Ghenotypic and phenotypic correlation matrix of brown rice paddy.

Characters	TT	TJA	JAP	PM	JGB	TJG	B100	BGPR	H
ANT	-0,67* -0,63*	0,25ns 0,24ns	0,39* 0,20ns	0,55* 0,51*	-0,47* -0,46*	-0,47* -0,46*	-0,66* -0,65*	0,07ns 0,06ns	0,06ns 0,05ns
TT		-0,14ns -0,10ns	-0,10ns -0,07ns	0,59* 0,45*	0,50* 0,39*	0,56* 0,44*	0,88* 0,63*	-0,07ns -0,04ns	-0,07ns -0,04ns
TJA			0,86* 0,74*	0,52* 0,46*	0,50* 0,48*	0,45* 0,42*	0,18ns 0,16ns	0,95* 0,93*	0,95* 0,93*
JAP				0,56* 0,50*	0,55* 0,53*	0,50* 0,46*	0,22ns 0,20ns	0,96* 0,94*	0,96* 0,94*
PM					0,86* 0,76*	0,10ns 0,09ns	0,85* 0,80*	0,75* 0,67*	0,75* 0,67*
JGB						0,88* 0,77*	0,82* 0,76*	0,75* 0,69*	0,75* 0,69*
TJG							0,82* 0,70*	0,70* 0,64*	0,70* 0,64*

B100								0,44* 0,39*	0,44* 0,39*
BGPR									1,00* 1,00*

Description: The value in the segment; the diagonal line states that genotypic correlation coefficient (top) and phenotypic correlation coefficient (bottom) are * = Significant (p <5%). ns = not significant (p> 5%). H = Results per hectare; BGPR = weight of grain per clump; B100 = Weight of 100 grains; TJG = total number of grains per panicle; JGB = Number of grains per panicle contain; PM = Long panicles; JAP = number of productive tillers per hill; TJA = Total number of tillers per hill; TT = Higher plants, ANT = anthocyanin content of rice.

In the genotypic, there is a real positive correlation among grain yield with the results of anthocyanin, the total number of productive tillers per hill, panicle length, number of grain contains and the total number of grains per panicle, weight of 100 grains and grain weight per clump. In addition, there is no real correlation on the character of results with high anthocyanin content of rice and crops.

Phenotypically, there is a real positive correlation among grain yield with the results of anthocyanins, total number of tillers, and the number of productive tillers per hill, panicle length, number of grain contains, the total number of grains per panicle, weight of 100 grains and grain weight per clump.

Jacob (2012) has conducted research on results-estimate-genetic parameters and yield-component-strains of local rice from Banten. Based on the analysis of genetic correlation among the characters results (weight of filled grain per panicle) and yield components, there are three real characters positively correlated, ie the number of tillers, number of panicle and 1000 grains weight. These indicate the positive correlation tangible result of environmental factors controlled. Hence, the breeders can select the desired characters effectively and efficiently.

Sutaryo and Sudaryono (2010), in a study of the diversity of phenotype and some genetic parameters yield and agronomic characters of six-hybrid rice on a sour dry land, stated that there are real correlations between the character of the results and component results. It is easier for program selection, ie to measure or observe difficult character selected in early generations or at early growth. Character number of filled grain per panicle, plant age, plant height and number of productive tillers each shows the genetic and phenotypic correlation to grain yield. While the character of panicle length and 1000 each grain weight shows no the genetic and phenotypic correlation with grain yield. These details have been analyzed and presented in the following table 1.2.

Table 1. 2 Correlation of genetic (rg), phenotipic (rp) among the grain yield and the other characters

No.	**Hasil gabah (t/ha)**	**rg**	**Rp**
1	Amount of grains content per panicle	0,05*	0,03*
2	Plant Age (day)	0,25 *	0,19*
3	Plant Height (cm)	0,12*	0,08*
4	Number of productive tillers	0,07*	0,04*
5	Panicle Lenght (cm)	0,04 tn	0,04 tn
6	Weight 1000 grains (g)	0,03 tn	0,02 tn

Description : * = significantly different at the level of 5%; tn = unsignificantly different

b. Genetic Diversity (Variability)

Genetic diversity derived from a gene mutation, recombination (crossover). It is separation and grouping alleles randomly during meiosis, and changes in chromosome structure. This diversity led to changes the amount of genetic material causesing changes the phenotype (Crowder, 1997).

Muliarta (2008) in his study on the genetic diversity and heritability of brown rice paddy in different growing environments states that the genetic diversity of the quantitative characters of brown rice paddy is broad, either on the environmentally technical irrigated rice, upland or gripped by drought.

A character is catagorized into a broad genetic diversity criteria when genetic diversity is twice as many the standard deviation as the genetic diversity, while, the genetic diversity is catagorized into narrow when it is less than or equal to two times the standard deviation of genetic diversity (Pinaria et al., 1997). The extent of genetic diversity obtained in the genotype evaluated genotypes consists of different genotypes.

Genotype experimented is the origins of crosses elders (Piong, Figures, and Kenya) different genetic backgrounds. Hanson (1963) adds the magnitude of the diversity of genotypes is highly dependent on the genetic makeup of the population as the number of segregating loci, gene frequencies in the gene locus and the role of intra and inter-locus.

Information in regard to estimated value of the parameters (the genetic variance, phenotypic variance, and heritability) is very useful in breeding programs aiming to obtain cultivars expected (Haeruman et al., 1990). Wide genetic variability is one of the conditions the success of the selection of the desired character

(Wicaksana, 2001). The broad variability characters show a prospects of effective improvement efforts through selection by providing flexibility in the choice of genotypes intended, and digging through the combination - new genetic combinations.

c. Role of Gene

An estimation of the role of the gene controlling a character needs executing. This is caused by the relationship between the role of genes and the effectiveness of breeding programs so that the goals and objectives rather than breeding reached, and the determination of appropriate selection methods are set against a character (Welsh, 1991).

A study, conducted by Yuliarta et al., (2003), was about an effort to get drought-resistant brown rice paddy through the method of "Back Cross" seen in Table 1.3 below:

Table 1.3 The average root length and root dry-weight in the offspring of crossbred, two parents and two elder crosses the median value and the possible nature of the genes controlling root-length and root dry-weight based on the analysis of Potence Ratio.

Male and Female Cross	Root Length					
	Offspring	Elders			Grade of Potece Ratio	Description
		Female	Median grade	Male		
Pujut / Kenya	48,3	40,1	43,85	47,6	1,19	More Dominant /preponderance
Piong/ Kenya	48,9	36,2	41,90	47,6	1,11	More Dominant
Sri/Kenya	49,1	42,3	44,95	47,6	1,57	More Dominant
Angka / Kenya	48,8	38,3	42,95	47,6	1,23	More Dominant
	Root Dry-weight					
Pujut / Kenya	9,08	4,061	6,539	9,016	1,010	Dominant
Piong/ Kenya	9,472	5,628	7,322	9,016	1,269	More Dominant
Sri/Kenya	9,100	3,912	6,464	9,016	1,032	More Dominant
Angka / Kenya	9,239	4,850	6,933	9,016	1,107	More Dominant

There are dominant or over-dominant (more dominant) in the inheritance of the role of genes indicated by the drought trait root length and root dry weight in brown rice paddy; yet it depends on the combination of the pair crosses (Table 1.3) (Muliarta et al 2003a). The roles of genes on cross combinations among Pujut / Kenya; Piong / Kenya; Sri / Kenya and Figures / Kenya, are dominant over the length of the root as well as the root dry weight except in the cross Pujut / Kenya in which it shows the role of dominant genes. This suggests that the genes controlling drought characters represented by root length and root dry-weight (donor parents) is dominant / dominant more. Therefore, in the conduct of back cross, the results of hybridization between elders repeatedly (tetua berulang) and elders donors in the form of F1 does not need to be done selfing beforehand when performing a back cross which means a back cross with recurrent parents can be done on a population of F1.

According to Li et al., (1995), differences in the effects of general combining power raised by each genotype on the properties observed are due to the role of genes additive, additive x additive, and a high level of interaction additives. The table shows that the variance grade additives multiples approaching is twice that of the general combining ability variance, while the grade of the dominant variance equal to the variance of specific combining ability. Of the 12 characters observed in this study, additive and dominant genes play a role in the appearance of the observed charatcters. In Table 1.3, of the 12 quantitative trait observed in brown rice paddy, it appears the roles of the dominant genes are more important than the role of additive genes. Eleven characters revealing the role of dominant genes, more important, are plant-height, panicle-length, number of pups productive, non-productive and the total number of pups per panicle, number of grains contained, vacuum and the total number of grains per panicle, weight of 100 grains, grain weight per panicle as well as grain yield per hectare. As for the age of flowering, additive gene appears more important role than that of the dominant genes.

Knowledge of the role of genes is associated with the determination of the method of selection on the material being handled (Salazar et al., 1997). According to Basuki (1995), if the role of additive gene is more important than the dominant gene's in controlling a character, then mass selection is applied more effectively to the material; conversely, if the role of the dominant genes is more important than the role of additive gene in controlling a character, the formation of varieties hybrid will be faster.

d. Heritability

Table 1.4 The means, variance of phenotype, variance of genotype and heritability hopes of characters, total number of tillers per hill (fruits) and plant height (cm) on the genotype results of selection of back cros in the brown rice paddy (Muliarta, 2008)

Tabel 1.4 Means Score, Phenotypic Variance, Genotypics Variance and heritability

Total number of tillers per hill					
Genotype/reterative	Means	σ_P^2	σ_G^2	h^2	Criteria
G2(A1)/1	21,47	50,25	18,32	0,36	Medium
G2(A1)/2	17,81	52,43	23,92	0,46	Medium
G2(A1)/3	17,57	58,57	29,94	0,51	High
G17(P15)/1	16,82	63,76	22.95	0,36	Medium
G17(P15)/2	19,31	78,38	41,32	0,53	High
G17(P15)/3	14,39	36,59	9,25	0,25	Medium
Plant Height					
Genotype/reterative	Means	σ_P^2	σ_G^2	h^2	Criteria
G3(A2)/1	107,12	55,42	27,65	0,50	High
G3(A2)/2	104,49	60,60	31,92	0,53	High
G3(A2)/3	117,96	75,86	48,45	0,64	High
G13(P4)/1	109,71	86,21	56,82	0,66	High
G13(P4)/2	106,87	59,99	30,17	0,50	High
G13(P4)/3	98,84	72,03	40,51	0,56	High
G17(P15)/1	104,48	95,44	66,06	0,69	High
G17(P15)/2	93,12	115,38	85,56	0,74	High
G17(P15)/3	92,59	160,99	129,46	0,80	High

Description: σ_P^2 = variance of phenotype; σ_G^2 = variance of genotype; h^2 = heritability
Criteria of heritability: 0 – 20 (low) ; 20 – 50 (middle) ; >50 (high).

High heritability values were very instrumental in improving the effectiveness of selection. In a a high heritability character (Table 1.4), the selection will take place more effectively due to small environmental influences; consequently, the genetic factors are more dominant in plant genetic appearance. At the low heritability character of estimation values, the selection will run relatively ineffective, since the appearance of plant phenotype is more influenced by environmental factors than by genetic factors.

Heritability can be used as a basis in determining the selection programs. Selection in early generation is done when high heritability values; conversely, if it is lower then the selection of the next generation will succeed because the chances of an increase in diversity in the population (Falconer, 1970).

Sutaryo and Sudaryono (2010) claimed the high heritability estimation play a role in improving the effectiveness of selection. In a high heritability character, the selection would be effective because the influence of the environment is so small that genetic factors are more dominant in appearance plant genotype. On the low heritability characters grade, selection will take place relatively less effective, since the appearance of the vphenotype is affected more by environmental factors than to genetic factors. In Table 1.5, it can be seen that high heritability estimates are found in the character of grain yield (0.92), the plant age (0.68), plant height (0.63), the number of productive tillers (0.95) and the number of filled grain per panicle (0, 95). While, the length of panicle and 1000 grains weight have a moderate (0.21) and low (0.09) of heritability estimation.

Table 1.5 Heritability Estimation Grade in tested Characters

No.	Characters	Heritability Estimation Grade	Criteria
1	Results (ton/ha)	0,92	High
2	Plant Age (day)	0,68	High
3	Plant Height (cm)	0,63	High
4	Total number of productive tillers / hill	0,95	High
5	Total number of filled grain per panicle	0,95	High
6	Lenght (cm)	0,21	High
7	Weight 1000 grains (g)	0,09	Low

IV. Conclusion And Suggestion

There is a significant correlation among the grain yield and the results of anthocyanin, the total number of productive tillers per hill, panicle length, number of grain contains and the total number of grains per panicle, weight of 100 grains and grain weight per panicle in brown rice paddy. Roles of genes on cross combinations among Pujut / Kenya; Piong / Kenya; Sri / Kenya and Figures / Kenya are more dominant on the length of the root as well as the root dry-weight except in the cross Pujut / Kenya showing the role of dominant genes. Characters with a high heritability values in grain yield, plant age, plant height, number of productive tillers per hill, and the number of filled grain per panicle are more easily directed to a method of back cross selection, pedigree on the implications of the selection breeding methods used and the method of bulk selection method for low heritability values.

Acknowledgement

We thank to Indonesia Endowment Fund for Education (LPDP) having funded this research, as well as the lecturers at the Faculty of Agriculture, University of Mataram who have provided guidance, suggestion and constructive feedback.

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