

# Genetic Studies on Grain Protein Content and Some Agronomic Characters of Rice by Halfdiallel Crossing System

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**ABSTRACT**— *Diallel method was use to study quantitative characters of rice. The output of the analysis will provide genetic information to select further generation. The results were Grain Protein Content (GPC) and filled grain characters in rice determined by epistatic gene effect. Over dominant had been show in day of harvest while that in plant height was partially dominant, and in panicles length were partially dominant and close to complete dominant.*

**Keywords:** halfdiallel, Agronomic Character, Protein, Rice

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## 1. INTRODUCTION

Conventional breeding, trough hybridization and which followed by selection achieved the significant progress in rice improvement. The improvement of indica rice have resulted short and stiff plant, whose short and erect leaf, faster on ripening and not influenced by photoperiods, high number of tiller and filled grain [1]. This character has economically valuable, but not easily to improve due to quantitative character whose continues distribution, and controlled by multiple or polygenic [2].

As some examples of quantitative characters in rice are grain protein content, harvesting age, number of grains per panicle, number of filled grain per panicle, number unfilled grain per panicle. Those characters have variation that tends to be continuous there for, it is needed an appropriate genetic analysis to estimate the heritability and mode of inheritance to makes selection procedures more effective [3]. The analysis can be used is diallel-crossing system developed by Fisher-Yates-Mather-Jink-Hayman. The diallel crossing analysis tries to rationalize genetic studies for characters whose continuous variation [4].

The advantages of diallel crossing analysis are experimentally systematic approach and the estimation of entire genetics parameters. This is useful to determine the effective selection method in the early generation of crosses [4]. Ones of the diallel crossing system is halfdiallel with all of F<sub>1</sub> and the parent as the studied material [5-6]. The purpose of the research is to obtain genetic information on some agronomic characters and grain protein content in rice.

## 2. MATERIAL AND METHOD

Seven parental genotypes with the diverse genetic backgrounds were used in the studied of halfdiallel cross, there were G39, Poso (PS), Milky rice (MR), Batang Gadis (BTG), Silugonggo (SL) , Logawa (LG) and Ciherang (CH). Screening for the parent had done in the previous research. The seven parental genotypes were crossed each another thus forming 21 genotypes of F<sub>1</sub> generation. The plant material originated from the seeds collection of rice germplasm at Muara Experimental Station, Bogor. Seeds planting location of F<sub>1</sub> and parent was in paddy fields with technical irrigation in the village of Bancarkembar, District of North Purwokerto, Banyumas.

Parental and F<sub>1</sub> genotypes were planting using randomized block design with two replications [7]. Fertilizers applied were urea 1.65 kg and phosphate (20%) 0.85 kg, which spread on the experiment field. The first application was two week after planting and the second one was five week after planting (with half dosage of the first application and addition of one kg KCl). The distance between plants was 25 x 25 cm, and between block 50 cm. Number of clump as the sample were eight clumps. The observation variables were filled grain, plant height (cm), panicle length (cm), Grain Protein Content (%), harvest age (day). The calculation of grain protein content was used kjeldahl method.

The data collections from the F1 and parent genotypes were analyzed using [8] approach modified by [6]. Analysis of variance was conducted to examine differences among genotypes, if there is a significant then it will further analyzed using diallel analysis, to estimate the additive and dominance gene effect with [9] approach. The hypothesis of the presence of epistatic was tested using angular coefficient analysis as described by [10] and [6], was presented in [11], as follows;

$$b = \frac{Cov (Wr, Vr)}{Var Vr}$$

$$Se (b) = \sqrt{\frac{Var Vr - b Cov (Wr, Vr)}{Var Vr (n - 2)}}$$

Hypothesis test:

H0 : b= 1

H1 : b≠ 1

Null hypothesis H0, if b equal to one then there is no nonallelic gene interaction, H1 = alternative hypothesis, if b not equal to one then there nonallelic gene interaction or epistatic, Se (b) = standard error b, Var (Wr, Vr) = variance (Wr, Vr), Wr = covariance parent offspring, Vr = variance offspring and n = number of parent. The estimation of heritability's (broad and narrow sense) was base on [12] formulas.

### 3. RESULTS AND DISCUSSION

#### 3.1 Preliminary ANOVA

Mean Squares due to genotypes was showed significance for the observe characters as shown by the preliminary ANOVA. The significant on preliminary ANOVA in the present halfdiallel study, which were the necessary for further analysis [8,13] (Tabel 1). The characters showed significance in preliminary ANOVA are filled grain number, harvesting age, panicle length, total grain per panicle and grain protein content.

**Table 1** Preliminary Analysis of Variance (MS) halfdiallel Cross in five character of rice

variable	filled grain	plant height (cm)	panicle length (cm)	grain protein content (%)	harvest age (day)	
df	MS	MS	MS	MS	MS	
replication	1	16.161	224.465	1.272	0.207	3.018
treatment	27	1679.398 *	303.464 *	6.532 *	2.495 *	59.716 *
Error	27	264.315	36.639	1.716	0.948	29.573

\*:p≤ 5%

#### 3.2 Test Hypothesis for Simple Model Additive-Dominance.

The validity of simple model additive-dominant hypothesis strengthened or emphasized by the regression coefficient [8]. When the present of nonallelic genes interaction was test with angular coefficient of b values of the regression line between Wr (covariance parent offspring) and Vr (variance offspring). If b equal to one, then there is the absent of nonallelic genes interaction.

Results Of t test for b coefficient in Table 2 for the characters of harvesting age, plant height, and panicle length, not showed the significant from one, while for protein content and the number of filled grain for b value shows highly significant from one. Values of b with showed significance was an indication of the occurrence of epistatic [8, 11]. According to [13] while studied the panicle character showed that number of filled grain was exhibited non-allelic gene interaction or epistatic. A further study of F<sub>2</sub> showed the skewness of distribution curve there is the occurrence of epistasis. Based on the test of F<sub>2</sub> population (data not shown), indicate the action of duplicate recessive epistatic control the character of protein content. The absent of gene interaction on the character of harvest age, panicle length and plant height is the requirement of the first assumption on the diallel cross (no interaction of genes).

**Table 2** The estimations genetic parameter of the agronomics character and protein content from halfdiallel analysis.

Genetic parameters	harvest age (day)	plant height (cm)	panicle length (cm)	filled grain	Protein (%)
b(Wr,Vr)	0,45 ns	0,78 ns	0,74 ns	0,35 **	0,06 **
D	15,84 ns	178,79 ns	2,80 ns	779,23 ns	1,71 ns
H <sub>1</sub>	78,51 ns	127,91 ns	2,81 **	1263,34 ns	5,49 **
H <sub>2</sub>	76,55 ns	117,97 ns	1,87 **	836,02 ns	3,87 **
F	7,87 ns	-47,23 ns	-1,30 **	-108,74 ns	3,26 **
h <sup>2</sup>	14,26 ns	127,49 ns	3,51 ns	-27,09 ns	-0,20 **
E	14,31 ns	21,67 ns	0,85 ns	127,73 ns	0,46 ns
(H <sub>1</sub> /D) <sup>1/2</sup>	2,23	0,85	0,99	1,27	1,79
H <sub>2</sub> /4H <sub>1</sub>	1502,44	3772,29	1,32	264043,99	5,30
h <sup>2</sup> /H <sub>2</sub>	0,19	1,08	1,87	-0,03	-0,05
h <sup>2</sup> bs	0,63	0,87	0,78	0,87	0,68
h <sup>2</sup> ns	0,26	0,84	0,75	0,84	0,06

\*\*= Significant at 5%; ns = not significant

### 3.3 Heritability

Estimation of broad sense heritability (h<sup>2</sup>bs) on characters show a high value, this the indication of the genetic influence more dominance in the observed characters. Estimation of broad sense heritability for characters filled grain (0.87), ages of harvests (0.63), panicle length (0.78), plant height (0.87), and grain protein content (0.68). Estimation of narrow sense heritability was high on characters filled grain (0.84), plant height (0.84), and panicle length (0.75) while harvested age (0.26) classified as medium. This is the same result from the previous research [14] for plant high, [15] for plant hight and panicle length, [16] for broad sense heritability of harvest ages, [17] in protein content in broad sense heritability. The high heritability in narrow sense and broad sense was made it easier to operate breeding program due to high correlation between genetic and the phenotype.

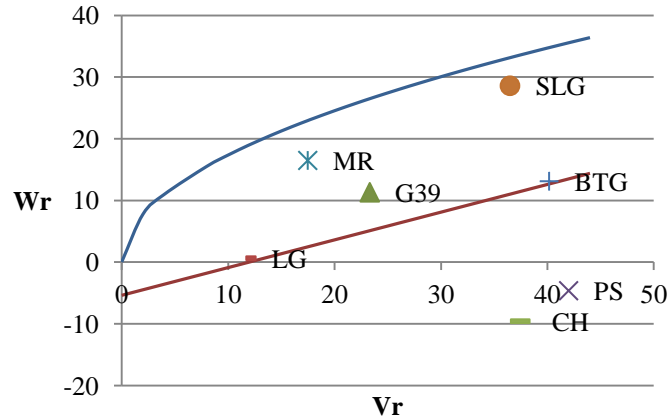
The estimation of narrow sense heritability was high indicates the influence of additives variance. While the estimate value of narrow sense heritability of grain protein content is low 0.06 this affected by the low additive variance and height dominance variance. It can be seen from significant value of dominant variance in the character of grain protein content (H<sub>1</sub> = 5.49), and did not showed significant of the variant due to additive effect (D = 1.71).

### 3.4 The direction and size of dominance

The quantification which is characters have low-value that will be dominance against high-value when the value of r (Wr + Vr, Yr) is positive, and vice versa the quantification which is character have high-value to low-value will be dominance if the value of r (Wr + Vr, Yr) is negative (Table 3).

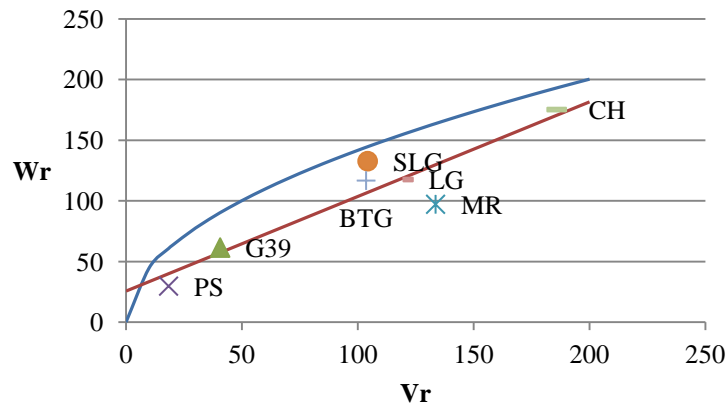
Table 3. The value (Wr + Vr) from the three characters did not show significant in b coefficient

Parental	harvesting ages	plant height	Panicle length
G39	34.64	102.05	1.71
Poso	37.38	47.98	4.52
Milky rice	33.97	230.70	3.82
Silugonggo	65.08	236.91	7.26
Batangadis	53.29	220.25	4.69
Logawa	12.35	237.25	3.26
Ciherang	27.89	367.06	3.17



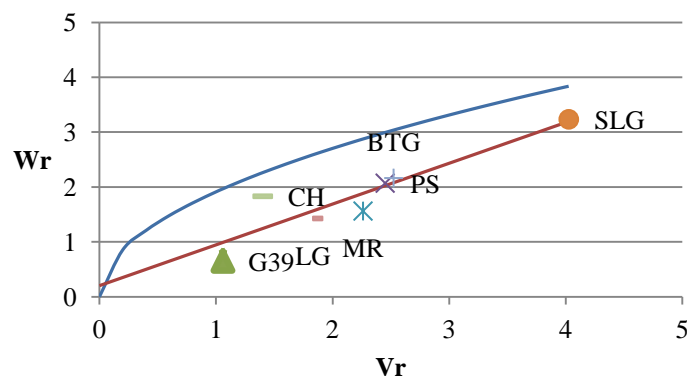
**Figure 1** Relations covariance (Wr) and variance (Vr): the character of harvest age

For the character of harvest age (Figure 1.) the regression line was cut under the origin is the indication the present of overdominance gene action some of the cross this have agreement with the result of  $(H_1/D)^{1/2}$  with value 2,23 more than one. Mean and degree of dominance at the characters of harvest age of seven parental shown in figure 1 the closer to the central axis shows the higher number of dominant genes in the parental, while the furthest indicates the number of dominant genes that the less [12]. Early-maturity is control by recessive gene in rice [18] with showed in Silugongo and Batang gadis as the furthest from centre of coordinate with day of mature 114 day.



**Figure 2** Relations covariance (Wr) and variance (Vr): plant height

Plant height is control by at least two groups gene of which exhibit dominance. The distribution of dominance genes in the parent is show in figure 2, the nearest genotype to centre of the coordinate are the genotype of the largest dominance genes. According to the figure 2 the genotype, which is the most dominance genes, is Poso (47.98) while the upper end from the centre coordinates are Ciherang (361.06), which exhibit the largest number of recessive genes.



**Figure 3** Relations covariance ( $W_r$ ) and variance ( $V_r$ ): panicle length

Panicle length have high levels partially dominance which is close to complete dominance that shown by the value of  $H_1$  is almost equal to D value and from the regression line was cut above the origin this is reported by [19]. The Seven crossing genotype exhibit diverse dominance level in the character of panicle length the most dominance parent of which contain the highest dominant genes is G39 (1.71) and the parent has the least dominant genes is Silugonggo (7.26) (Figure 3.).

#### 4. CONCLUSION

The grain protein content character affected by epistasis, harvesting age affected by overdominant, while plant height was determine by partially dominant and panicle length was determined by partially dominant closed to perfect dominance. The estimation of heritability has a range from high to low. High estimation of broad sense heritability were found in all observer character, the estimate value of narrow sense heritability was showed low in grain protein content, medium was found in harvest age and low were in the other observed character.

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