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Agronomic Character Variability Among Upland Rice Genotypes (*Oryza sativa* L.)

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ABSTRACT

Rice production still has to be increased to meet the domestic needs of consumer preferences. Therefore, it is necessary to develop rice genotypes that have agronomic characteristics which can encourage high production. The objective of this research is to examine the variability of agronomic performance as well as the genotypic and phenotypic variability of agronomic traits among rice lines and cultivars. Materials included six promising lines and four cultivars. Urea, SP-36, and KCl fertilizers are used, as well as equipment for sacks, envelopes, fungicides, and pesticides. The research was based on an experiment with a randomized block design. This research was conducted at the Experimental Field of Agriculture Faculty, Universitas Brawijaya in Jatimulyo, Malang, from March to July 2022. According to the data, there is variation in the agronomic performance of the examined genotypes. Based on the coefficient of genotypic variation value, none are classified as high. All characters had a high category of variation based on phenotypic variance.

Keywords: Cultivar, genotypic variance, phenotypic variance

Introduction

As an agricultural country, Indonesia makes rice one of the important crops that continue to be developed. Rice is a plant that is the main food source for most people in Indonesia. On the Asian continent, the type of rice plant that grows is *Oryza fatua* Koening. While the *Oryza glaberima* Steund rice type comes from the African continent, particularly West Africa (Futakuchi et al., 2021). The type of rice plant that is commonly consumed today as the main food is *Oryza sativa* L. Rice cultivation is not only applied to paddy fields, but also to rainfed or dry land by utilizing dry land rice types or also called upland rice. According to Courtois et al. (2013), upland rice is a rice plant that has a characteristic with a root system that is deeper and thicker than other types of rice. Irrigation in upland rice is prioritized for the germination phase to early vegetative with conditions after irrigation that do not have a water layer above the soil (Zhang et al., 2021). Irrigation in upland rice fields has the advantage of being efficient in water use. The interval and irrigation are set to a lesser amount. Upland rice cultivation produces less methane gas, runoff, and pollution from fertilizers than lowland rice cultivation (Wang et al., 2016). Upland rice can grow well in areas with an altitude of 0-1800 m above sea level. Meanwhile, the required temperature ranges from 19℃ to 27℃ (Raboin et al., 2014). Upland rice plants grow ideally on land with good porosity. Tillage is applied to form land with good aeration in the root zone from a depth of 20 cm to 30 cm (Linh et al., 2015).

Promising lines are currently being intensively developed to increase production and improve environmental adaptability so that they can be cultivated on various types of land

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(Sadimantara et al., 2016). One of them is dry land. However, the analysis of the genotypic variability of rice is considered to be lacking. Variations between rice genotypes on morphological and agronomic characters vary (Anis et al., 2016). Therefore, it is important to carry out this research to determine the genotypic variability of morphological characters between several genotypes of rice to study and analyze the agronomic performance and genotypic variability of rice.

Material and Methods

The data was collected in the experimental field of Universitas Brawijaya, located in Jatimulyo, Lowokwaru District, Malang City, East Java Province. The research was carried out from March to July 2022. The materials used were 10 genotypes of rice plants, urea, SP-36, KCl, sacks, envelopes, fungicides, and pesticides. The promising lines used were 23A-56-22-20-05, 19I-06-09-23-03, 23A-56-20-07-20, 21B-57-21-21-23, PBM UBB 1, and 23F-04-10-18-18. The varieties used are Rindang, Danau Gaung, Inpago 8, and Inpago 12. This research used the RBD (Randomized Block Design), with 3 repetitions. Data analysis used software such as Microsoft Excel for tabulation and data processing, Opstat was used to analyze the coefficients of genotypic and phenotypic variation, and Smart stat was used for the analysis of variance. The value of the genotypic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV) was determined according to Singh and Chaudary (1979) as follows.

$$\text{GCV} = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100\%$$

$$\text{PCV} = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100\%$$

According to Anderson and Bancroft (1952), genetic variability is high when the genotypic variance is greater than twice the standard error of genotypic variance [$\sigma_g^2 > 2\ \text{SE}\sigma_g^2$], while genetic variability is low when the genotypic variance is less than twice the standard error of genotypic variance [$\sigma_g^2 < 2\ \text{SE}\sigma_g^2$]. Likewise with phenotypic variability. The formula for determining the standard error value of genotypic and phenotypic variance is as follows.

$$\text{SE}\sigma_g^2 = \sqrt{\frac{2}{r^2}\left[\frac{(\text{MS}_{\text{genotipe}})^2}{\text{df}_{\text{genotipe}}+2}\right] + \left[\frac{(\text{MS}_{\text{error}})^2}{\text{df}_{\text{error}}+2}\right]}$$

$$\text{SE}\sigma_p^2 = \sqrt{\frac{2}{r^2}\left[\frac{(\text{MS}_{\text{genotipe}})^2}{\text{df}_{\text{genotipe}}+2}\right]}$$

Results and Discussion

Observations of quantitative characters on ten genotypes of rice were plant height, flag leaf length, total tillers, a total of productive tillers, inflorescence emergence, time to maturity, panicle length, the weight of 1000 seeds, yield per plot, yield per hectare and weight of milled dry grain.

Analysis with F values at the level of 5% and 1% for each variable is respectively significant. The value of variation needs to be analyzed to assess whether the study is homogeneous. This was also conveyed by Diwangkari et al. (2016) that the consistency of the treatment in each block is lacking, this can guarantee that the accuracy is also lacking so that the error value becomes large. The coefficient of variation was obtained from 0.71% to 9.25% (Table 1).

Table 1. Analysis of variance and CV value

No.	Character	MS	X	CV (%)
1.	Plant height (cm)	1498.89**	77.22	4.61
2.	Flag leaf length (cm)	100.88**	23.28	5.54
3.	Total tillers	78.82**	18.98	9.25
4.	Total of productive tillers	72.41**	17.84	8.94
5.	Inflorescence emergence (DAP)	76.74**	91.10	1.74
6.	Time to maturity (DAP)	4.30**	118.33	0.71
7.	Panicle length (cm)	30.87**	22.14	4.63
8.	Weight of 1000 seeds (g)	66.77**	25.89	6.72
9.	Yield per plot (kg.plot^{-1})	42.45**	9.18	7.14
10.	Yield per hectare (ton.ha^{-1})	10.61**	4.59	7.14
11.	Milled dry grain (ton.ha^{-1})	9.50**	4.00	5.18

Note: Plot: 15.75 m^2, **: indicate significant at the 5% and 1% levels, respectively, DAP; days after planting

Table 2. Genotypic and phenotypic variation

No.	Character	σ_g^2	$2SE\sigma_g^2$	Criteria	σ_p^2	$2SE\sigma_p^2$	Criteria
1.	Plant height (cm)	495.41	426.12	High	499.63	140.83	High
2.	Flag leaf length (cm)	33.07	28.69	High	33.63	9.40	High
3.	Total tillers	25.24	22.45	High	26.27	7.18	High
4.	Total of productive tillers	23.28	20.61	High	24.14	6.62	High
5.	Inflorescence emergence (DAP)	24.74	21.85	High	25.58	7.03	High
6.	Time to maturity (DAP)	1.19	1.26	Low	1.43	0.34	High
7.	Panicle length (cm)	9.93	8.79	High	10.29	2.83	High
8.	Weight of 1000 seeds (g)	21.25	19.03	High	22.26	6.04	High
9.	Yield per plot (kg.plot^{-1})	14.01	12.07	High	14.15	3.98	High
10.	Yield per hectare (ton.ha^{-1})	3.50	3.02	High	3.54	1.00	High
11.	Milled dry grain (ton.ha^{-1})	3.15	2.70	High	3.17	0.90	High

Table 3. GCV and PCV value comparation

No.	Character	GCV (%)	Criteria	PCV (%)	Criteria
1.	Plant height (cm)	29	Rather low	29	High
2.	Flag leaf length (cm)	25	Relative low	25	High
3.	Total tillers	26	Rather low	27	High
4.	Total of productive tillers	27	Rather low	28	High
5.	Inflorescence emergence (DAP)	5	Relative low	6	Low
6.	Time to maturity (DAP)	1	Relative low	1	Low
7.	Panicle length (cm)	14	Relative low	14	Medium
8.	Weight of 1000 seeds (g)	18	Relative low	18	Medium
9.	Yield per plot (kg.plot^{-1})	41	Rather low	41	High
10.	Yield per hectare (ton.ha^{-1})	41	Rather low	41	High
11.	Milled dry grain (ton.ha^{-1})	44	Rather low	44	High

The value of genotypic variation was grouped into two types based on the comparison of the value of the genotypic variance with twice the standard error of the genotypic variance (Table 2).

The high criteria included plant height, flag leaf length, total tillers, total of productive tillers, inflorescence emergence, panicle length, weight of 1000 seeds, yield per plot, yield per hectare and weight of milled dry grain. While the low criteria are the character of time to maturity. While the grouping of genotypic variability based on the GCV value is divided into 2 criteria, relatively low and rather low (Table 3). Relative low criteria consisted of flag leaf length, inflorescence emergence, time to maturity, panicle length, and weight of 1000 seeds. The rather low criteria consisted of plant height, total tillers, total of productive tillers, yield per plot, yield per hectare, and weight of milled dry grain.

Phenotypic variability in the observed characters was categorized based on the comparison of the phenotypic variance value with twice the standard error of the phenotypic variance (Table 2) and based on the value of the phenotypic coefficient of variation (PCV) (Table 3). The grouping of phenotypic variations based on the comparison of the phenotypic variance value with twice the standard error value of the variance resulted in a high variation category for all characters. While the grouping of phenotypic variation based on the coefficient of phenotypic variation is divided into three categories, low, medium, and high. The low category consists of inflorescence emergence and time to maturity. The medium category consisted of panicle length and weight of 1000 seeds. While the high category consisted of plant height, flag leaf length, total tillers, total of productive tillers, yield per plot, yield per hectare, and weight of milled dry grain.

Variability in characters can occur due to the influence of genotypic and phenotypic factors or even environmental influences (Nihad et al., 2021). Therefore, the coefficients of genotypic and phenotypic variation in each of the observed characters need to be analyzed. The grouping of genotypic variability based on GCV values is divided into 2 criteria, relatively low and rather low, which are determined from the range of values according to Faidah et al. (2020). The rather low criteria consisted of plant height, total tillers, total productive tillers, yield per plot, yield per hectare, and weight of milled dry grain. The genotypic variability based on the comparison of the variance value with twice the standard error and based on the range of GCV values has differences. Based on the value of variance, the variability is low only at the time of maturity and other characters are classified as high. This is different from grouping based on GCV values, that none of the characters are classified as having high variability. The grouping of phenotypic variations based on the comparison of the value of the phenotypic variance with twice the standard error value of the variance is different based on the PCV value. Based on the value of the variance, all characters have a high variation category. While the grouping of phenotypic variation based on the coefficient of phenotypic variation is divided into three, low, medium, and high.

Figure 1. Variation of Performance in 10 Genotypes

The high values of GCV and PCV indicate that these characters are dominantly influenced by genetic factors. Meanwhile, the low GCV and PCV values indicate that the variability of these characters is thought to be more influenced by environmental factors. This is also stated in the study of Barman et al. (2020), that environmental factors affect the growth of rice plants for several characters with different cultivars such as root length characters and color pigments in leaves. In the research, the values of genotypic and phenotypic variation are relatively similar. The coefficients of genotypic and phenotypic variation are relatively the same or close to indicate that the contribution of genetic variability in influencing the phenotypic variability of a plant is greater than the influence of environmental factors (Andriani & Damanhuri, 2018). High genetic variability will affect the amount of genetic advance (Fehr, 1987). The existence of high genetic variability for certain characters allows for effective selection that will be useful in plant development. According to this research, agronomic characteristics differ between upland rice genotypes (Figure 1). Furthermore, this information can be used in the evaluation and development of rice promising lines.

Conclusion

The observed genotypes show variations in the performance of agronomic characters. The high genotypic variability based on the value of the genotypic variance includes plant height, flag leaf length, total tillers, a total of productive tillers, inflorescence emergence, panicle length, weight of 1000 seeds, yield per plot, yield per hectare and weight of milled dry grain. Meanwhile, there are no characters that are classified as high according to the GCV value. Phenotypic variability based on the phenotypic variance value resulted in a high variation category for all characters. Meanwhile, based on the PCV valve, the category of high phenotypic variation consisted of plant height, flag leaf length, total tillers, a total of productive tillers, yield per plot, yield per hectare, and weight of milled dry grain. More qualitative character analysis can be added for future research.

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