AGRONOMIC PERFORMANCE AND RESPONSE OF GORONTALO UPLAND RICE VARIETIES TO SEVERAL PESTS AND DISEASE

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Abstract

Upland rice is one of Indonesia's local genetic resources, and one of the provinces with several upland rice cultivars is Gorontalo Province. A study evaluating agronomic performance and the response of new local varieties is necessary for first conservation purposes and to assist the selection process in the rice breeding program. This study aimed to evaluate the agronomic performance and response of local Gorontalo upland rice to pests and diseases. The study used a randomized block design with five treatments of local Gorontalo rice genotypes: Ponelo, Pulo, Ponda, Buruna Kuning, and Pale Da'a. Each treatment was repeated three times. The research results showed that the agronomic performance, such as plant height, harvest age, and number of filled grains, significantly differs among varieties. Agronomic performance, such as the number of filled grains and flowering age, has a high and positive correlation with the weight of 1000 grains. The number of filled grains has a positive correlation with flowering age. Response of all varieties to pests and disease is moderate until high based on the symptoms of damage due to bacterial leaf blight, brown planthopper, stem borer, and black rice bug.

Keywords: local varieties, upland rice, agronomic characteristics, pests and disease

1. INTRODUCTION

Rice is the leading staple food in Indonesia (Bantacut, 2014). National rice needs in 2018 were 30 million tons, and to secure food reserves, the government imported 2.2 million tons of rice (Saragih, 2023). Various efforts have been made to meet domestic rice needs, including exploring local genetic resources (Widyayanti et al., 2020). Local rice can potentially be a source of genes in breeding to

develop excellent rice varieties (Sadimantara et al., 2018). One of Indonesia's wealth of rice germplasm is upland rice (Mau et al., 2017). The genetic richness of local upland rice is spread throughout the archipelago. Nine accessions from Jambi (Bobihoe et al., 2022), 17 from South Sumatera (Sasmita & Kodir, 2020), 82 from Java island (Sutoro et al., 2015), 53 from Kalimantan island and 11 from East Nusa Tenggara (Afza et al., 2020), five from Central Sulawesi (Saidah et al., 2022), nine from Gorontalo Province (Buri et al., 2020).

Upland rice production is generally lower than lowland rice because it is usually planted in a limited environment (Kikuta et al., 2016). Almost all provinces in Java had a productivity rate of above 40 quintals per hectare, while most provinces outside Java were less than that (Ruslan, 2021). One limited factor is pests and diseases (Jamal et al., 2023). Another factor is the high percentage of empty grain, which is a significant factor in the low productivity of rice (Parida et al., 2022).

Many local varieties of upland rice are being lost. Exploring and preserving local upland rice from various regions is necessary to avoid landrace erosion (Sutoro et al., 2015). Exploration includes search and collection activities followed by identification, characterization, documentation, and evaluation (Afza, 2016). A study assessing agronomic performance and response of new local varieties is necessary for first conservation purposes and to assist the selection process in rice breeding programs. This study aimed to evaluate the agronomic performance and response of local Gorontalo upland rice to pests and diseases.

2. MATERIAL AND METHODS

This research was conducted in Bulotalangi village, East-Bulango subdistrict, Bone Bolango Regency, from January to May 2018. The study used a randomized block design with five local rice cultivars: Ponelo, Pulo, Ponda, Buruna Kuning, and Pale Da'a. Each treatment was replicated three times. The plot area of each treatment is 4m x 4m with a spacing of 25cm x 25cm.

The agronomic performance observations of plants included plant height, number of productive tillers, flowering age, harvest age, panicle length, number of filled grains, number of empty grains, and the weight of 1000 grains. Pengamatan respon terhadap hama dan penyakit dilakukan berdasarkan *standard evaluation system for rice* (SES) 5th Edition (IRRI, 2013a). Pengamatan dilakukan pada empat jenis hama dan penyakit tanaman padi yaitu: bacterial leaf blight, stem borer, brown planthopper, and black rice bug. Data were analyzed using analysis of variance (ANOVA) and continued with the 5% level of significant difference test using the Duncan's Multiple Range Test (DMRT) and cluster analysis using *K-means* clustering with R-Studio version 4.3.3.

3. RESULTS AND DISCUSSION

3.1. Agronomic performance

The agronomic performance of five local upland rice varieties is shown in Table 1. Plant height, flowering age, and number of grain contents showed significant differences among upland rice lines ($P<0.05$). The number of productive tillers, flowering age, panicle length, number of empty grains, and weight of 100 seeds were not significantly different.

Table 1 Agronomic performance of local Gorontalo varieties of upland rice

Variety	PH	NPT	FA	HA	PL	NFG	NEG	W1000G
Ponelo	113.50 a	24.33 a	71.76 a	146.67 a	26.53 a	100.73 a	40.13 a	26.50 a
Pulo	104.73 c	23.33 a	68.00 a	133.33 c	24.23 a	86.93 b	42.93 a	21.87 a
Ponda	107.83 b	21.67 a	71.00 a	131.67 c	24.70 a	103.71 ab	44.30 a	23.77 a
Buruna Kuning	113.03 a	24.67 a	67.33 a	140.67 ab	23.83 a	84.95 b	39.83 a	21.80 a
Pale Da'a	108.37 b	22.67 a	67.33 a	135.00 bc	26.57 a	89.45 b	43.18 a	21.13 a

The numbers followed by the same letter in the same column were not significantly different according to Duncan's test at the 0.05 level. PH: plant height (cm), NPT: number of productive tiller, FA: flowering age (days), HA: Harvest age (days), PL: panicle length (cm), NFG: number of filled grains, NEG: number of empty grains, and W1000G: weight of 1000 grains (gram).

The plant height of the five local Gorontalo upland rice varieties (104.73-113.50. Table 1) is in the medium category based on the classification from the International Rice Research Institute (short < 90 cm), (medium 90-125 cm) and (high > 125 cm) (IRRI, 2013a). The plant height is one of the significant predictor variables (20.6%) for estimating rice yield per hill and rice yield per square meter (Liu et al., 2023). Furthermore, the character of medium plant height makes Gorontalo's local upland rice more resistant to lodging because plant height is highly correlated to lodging, especially in plants that receive high nitrogen fertilization during the maximum tillering phase until mature (Wu et al., 2022).

Harvest age is different between varieties (Table 1). The harvest time for the five local Gorontalo upland rice varieties (131-146 days after planting) is in the medium category (125-150 days after planting). The classification of rice harvest age is based on the criteria set by the Balai Besar Penelitian Tanaman Padi, namely ultra-early (<90 days), very early (90-104 days), early (105-124), medium (125-150 days) and late (>150 days) (Dewi et al., 2012).

The number of filled grains shows significant differences among varieties (Table 1). The number of filled grains was determined by environmental and genetic. According to Yono et al. (2018), environmental factors are more influential than genetic factors. Parida et al. (2022) explain that genetic factors are related to the genetic inability to fill the grain due to weak starch synthesizing enzymes due to high ethylene content, low accumulation of cytokinin and Indole 3 acetic acid (IAA) content, which can increase grain filling, insufficient endosperm cell division for nucleus multiplication for seed filling.

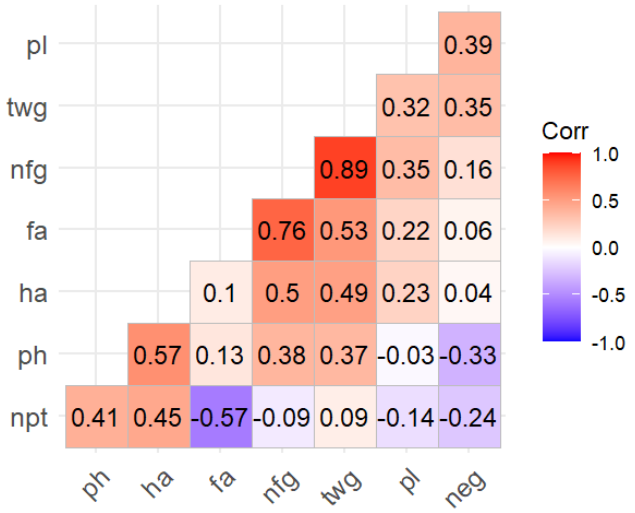


Figure 1. Pearson correlation analysis of agronomic performance of five Gorontalo local upland rice varieties. ph: plant height, npt: number of productive tiller, fa: flowering age, ha: harvest age, pl: panicle length, nfg: number of filled grains, neg: number of empty grains, and twg: weight of 1000 grains.

Correlation analysis shows that the performance of weight 1000 grains has a significant and positive correlation with the number of filled grains (r = 0.89) and flowering age (r = 0.53). The number of filled grains correlates significantly with flowering age (r = 0.76). The results of this study indicate that the grain weight of these five varieties influences flowering time and seed filling. The high number of filled grains represents the completeness of the grain-filling process (Li et al., 2019). Flowering and post-flowering age affect grain yield indirectly via grain number and number of filled grains per panicle (Zhao et al., 2020).

3.2. Respons to pests and disease

Response of five local Gorontalo upland rice varieties to bacterial leaf blight (*Xanthomonas oryzae*), white stem borer (*Scirpophaga innotata*), brown planhopper (*Nilaparvata lugens*), and black rice bug (*Scotinophara coarctata*) was shown in table 2. Significant differences in the response of the

varieties were shown in bacterial leaf blight (P<0,05), whereas stem borer, brown planthopper, and black rice bug didn't show significant differences among varieties.

Table 2. Percent of local upland rice varieties attacked by pests

Variety	Bacterial leaf blight	Stem borer	Brown planthopper	Black rice bug
Ponelo	16,67 c	25,00 a	16,67 a	33,33 a
Pulo	33,33 b	33,33 a	41,67 a	41.67 a
Ponda	16,67 c	25,00 a	33,33 a	41.67 a
Buruna Kuning	50,00 a	41,67 a	25,00 a	33.33 a
Pale Da'a	16,67 c	33,33 a	33,33 a	33.33 a

The numbers followed by the same letter in the same column were not significantly different according to Duncan's test at the 0.05 level.

Symptoms of bacterial leaf blight show significant differences among varieties. The lowest symptom is 16,67% (Ponelo, Ponda, and Pale Da'a), and the highest is 50% (Buruna Kuning). The value of symptom 16,67% is categorized as moderately susceptible. The value 50% is classified as susceptible until highly susceptible based on IRRI standard (highly resistant until moderately resistance (0-5%), moderately susceptible (6-25%), susceptible until highly susceptible (>25%)) (IRRI, 2013b). The severity of bacterial leaf blight symptoms in rice is controlled by genetics and environment. The presence of resistance genes (*Xa*) such as *Xa*1, *Xa*4, *Xa*7, *Xa*10, and *Xa*13 can reduce the symptoms and severity of the disease (Rasmiyana et al., 2019). Environmental factors such as air humidity, pH of soil, and air temperature can worsen damage symptoms (D. Lestari et al., 2023).

3.3. Cluster analysis.

Cluster analysis aims to group test varieties into several clusters based on the similarity of characters, which is determined by the proximity of a variety to the nearest centroid point.

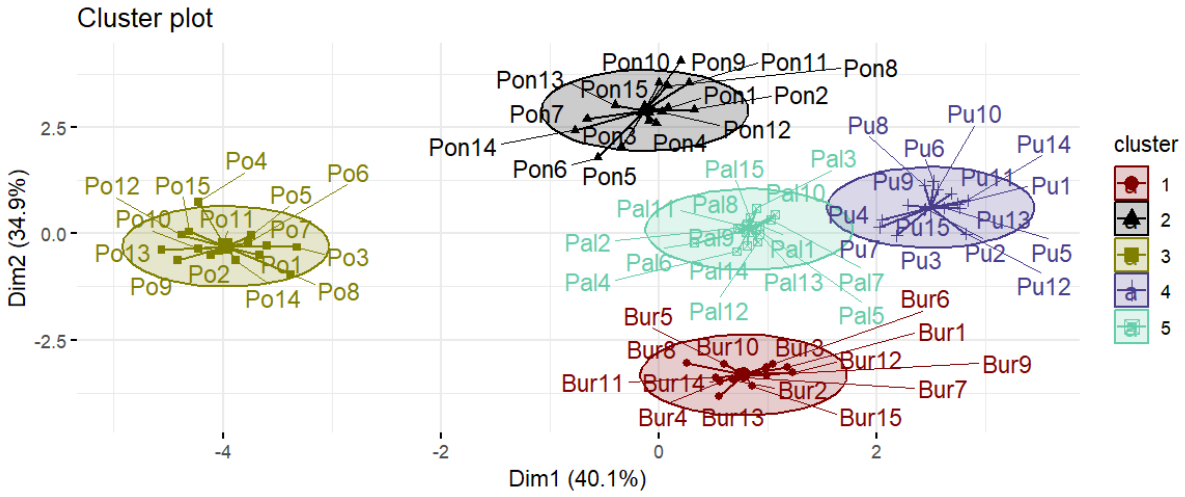


Figure 1. *K-means* cluster analysis of five local Gorontalo upland rice varieties based on agronomic performance and response to pests and diseases. Po: Ponelo, Pu: Pulo, Pon: Ponda, Bur: Yellow Buruna and Pal: Pale Da'a

K-means cluster analysis of five local Gorontalo upland rice varieties shows that each variety forms its cluster centroid point. This result indicates that these five varieties have distinct character

differences. However, based on the cluster plot, the pale da'a and pulo clusters are in one section, while Ponelo, Ponda, and Buruna Kuning are each in different sections. This result indicates that Pale Da'a and Pulo still have close characters, while Ponelo, Ponda, and Buruna Kuning are very different. The results of this analysis assumed that these five varieties have high genetic diversity, as it is known that Indonesia has high plant genetic diversity. High genetic diversity is most important for improving rice varieties and overcoming the stagnation of rice production in Indonesia (Anas et al., 2022). The assumption that these five local upland rice varieties have high genetic diversity can be strengthened by the significant differences in plant height and harvest age between the varieties (Table 1). Plant height and harvest age are classified as rice characters with a narrow level of genetic diversity (Yono et al., 2018). So, if there are fundamental differences in plant height and harvest age between cultivars, it can be strongly suspected that they are genetically very different/separate clusters (Figure 1)

4. CONCLUSION

The differences in the agronomic performance of five local upland rice in Gorontalo are plant height, harvest age, and number of filled grains. Response of all varieties to pests and disease is moderate until high based on the symptoms of damage due to bacterial leaf blight, brown planthopper, stem borer, and black rice bug.

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