Performance of the agronomic traits of six advanced promising lines of red rice (*oryza sativa l.*) grown on the paddy field

G R Sadimantara¹,  E Febrianti¹, LO Afa¹, S Leomo², Muhidin¹ and C W Brahmiyanti³

¹Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University, Kampus Anduonohu JL. HEA Mokodompit, Kendari 93232, Indonesia
²Department of Soil Science, Faculty of Agriculture, Halu Oleo University, Kampus Anduonohu JL. HEA Mokodompit, Kendari 93232, Indonesia
³Department of Agronomy, Faculty of Agriculture, Hasanuddin University, Jl. Perintis Kemerdekaan KM 10, Makassar, 90245, Indonesia

Email: gusti5@yahoo.com

Abstract. Rice in Indonesia is still the main staple food, and every year the demand has increased. Indonesian governments have policies to reach self-sufficiency. The strategic programs to increase rice production were through breeding programs. The research was conducted on paddy fields in the village of Ranomeeto District of South Konawe. The study was carried out from October 2018 to April 2019. This study aimed to determine the differences in the agronomic traits in the aspect of vegetative and generative character from some new types of advanced red rice promising lines grown on the paddy field. The experiment was laid out based on Randomized Complete Block Design (RCBD), which consisted of six red rice lines (GS12-1, GS12-2, GS44-1, GS44-2, GS16-1, GS16-2) and one check variety (trisakti). Each treatment was repeated four times, so there were 28 experimental units. Parameters observed were plant height, leaf number, leaf area, number of tillers, panicle length, total grain number, 1000-grain weight, filled grain percentage, unfilled grain percentage and dry weight per m². The results showed that there were differences in the agronomic traits of the promising rice lines GS12-1, GS12-2, GS44-1, GS44-2, GS16-1, GS16-2, and trisakti variety on paddy field. The new type of advanced red rice promising lines can well be adapted on paddy fields obtained in GS16-1 lines, followed GS16-2 lines and GS44-2 lines.

1. Introduction
Rice (*Oryza sativa L.*) is a source of carbohydrates for some of the world's population. Rice has been feeding the Southeast Asian population for well over 4000 years and has been the staple food of about 557 million people [1]. Rice in Indonesia is still the main staple food [2–5] and every year the demand has increased [6–8]. Indonesian governments have policies to reach self-sufficiency [9,10], through increasing rice production and lowering consumption [11–15]. The strategic programs to increase rice production were through the development of upland rice [6,9,16], increase seed viability [4,17,18] and breeding program [10,19,20]. Another program also through lowering level of rice consumption and promote local food [9,21].
Rice is semi-aquatic, adapted to a wide range of hydrology, from aerobic in upland to anaerobic and flooded fields in waterlogged lowland, to even deeply submerged soils in the flood-prone area. Rice plants can grow on dry land and wetland. Dryland has limited water availability so that upland rice planted on dry land must have drought-tolerant characteristics [22]. Water availability is an important factor in rice cultivation systems, but the high-water demand is now faced with problems of drought and water scarcity, among others, due to climate factors and competition for water use[23].

Drought is a major limiting factor in rice production [24] because it can reduce the amount of filled grain [25]. Breeding and adoption of rice cultivars with enhanced yield potential and short growth duration is a common objective of the breeders. But yield in rice is correlated with different yield contributing traits as well as environmental factors [26]. Also, grain yield-related to other characters such as growth duration, and yield components [27].

The productivity of rice plants can be improved by developing superior varieties through plant breeding programs. Several upland rice lines have assembled through crossbreeding between superior lowland rice and local upland rice cultivars. The crossing-derived lines have been tested on dry land through yield ability and multilocation tests. The objective of this study was to evaluate six advanced promising lines of red rice with the view of selecting those that have better the agronomic traits performance as well as the highest potential production on the paddy field.

2. Methods

The present study was carried out on paddy fields of Ranomeeto Village, South Konawe Regency and the Laboratory of the Agronomy Unit of the Department of Agrotechnology, Faculty of Agriculture, University of Halu Oleo. The study was carried out from October 2018 to April 2019. Six crossing-derived lines of rice and one check variety were evaluated for their agronomic and yield traits performance in a randomized complete block design with four replications. The seeds were directly planted on the paddy field trial plots of 5 x 2 m each. Fertilizers used were Urea and NPK Phonska (15:15:15).

Data were collected from five randomly selected plants of each rice line. Eleven agronomic and yield traits were recorded, i.e., plant height (cm), leaf number, leaf area, tiller number plant-1, effective tiller number plant-1, flag leaf length, flag leaf width, panicle length, filled grain panicle-1, unfilled grain panicle-1, fresh weight, dry weight and 1000 grain weight. Collected data were analyzed using variance analysis. If there is a significant effect on the analysis of variance, further tests were carried out based on the Duncan Multiple Range Test (DMRT). All data were subjected to analysis using cropstat version 7.2.

3. Results and discussion

3.1. Vegetative character

The results of the study showed that there were differences in the agronomic traits and yield among the advanced promising lines and check variety. The difference may strongly influence by several components of the yield. The cause of the difference is due to environmental and genetic factors inherited from each parent. These two factors interact during the plant life cycle and if the influence of environmental conditions is more dominant than genetic factors, there may be varied forms in several plants that grow in different locations [28].

The results of the DMRT test showed that the growth characters of some advanced red rice promising lines grown on paddy field significantly different on plant height, leaf number, leaf length, number of tillers per hill, and number of effective tillers, except leaf width (table 1).

| Rice lines | Plant height (cm) | Leaf number (sheet) | Leaf length (cm) | Leaf width (cm) | No. tillers per hill | No. effective tillers per hill |
|------------|------------------|--------------------|------------------|----------------|---------------------|-------------------------------|
| GS12-1     | 84.37a           | 78.35a             | 47.19a           | 1.13           | 19.10ab             | 15.05a                        |
The highest plant height was recorded from GS11-1 lines (84.37), while others were GS16-2 (82.55 cm), GS16-1 (82.47), GS11-2 (81.77), GS44-1 (78.08) and GS44-2 lines (77.14). The difference in plant height is due to genetic factors of the rice lines. All cultivars gained different plant height at maturity due to various internodal lengths. The cultivars having longer internodes, produced taller plants. The findings are in agreement with those of other research stated that longer internodes increased plant heights in rice [29]. Genetic differences between different varieties also caused variation in plant lengths. The differences in genetic structure are one of the factors that cause differences in plant height performances [30]. The plant height traits in the production stage are one of the selection criteria for rice, but high growth does not guarantee high productivity levels [31].

The mean leaf number of six advanced red rice promising lines was recorded differed. The highest number of leaves was obtained in GS11-1 (78.35) followed by GS44-2 lines (77.00), GS11-2 lines (66.20), GS16-2 lines (63.00) and GS16-1 (61.40). The number and size of leaves are influenced by genotype and environment. The position of the leaves in plants mainly controlled by genotypes, which also has a significant effect on the leaf growth rate, final dimensions and capacity to respond to better environmental conditions. Conversely, the leaf area ratio decreases with increasing plant age. This happens because the number of leaves continues to increase so that the leaves located at the bottom will be shaded by the upper leaves, thus affecting the light that will be used in the photosynthesis process.

The highest number of effective tillers per hill was found in GS16-1 lines (15.65), which not significantly different from check variety. High and low growth and yield of plants are influenced by two factors, namely internal, which includes genetic traits or plant derivatives, and external, namely environmental factors such as soil climate and biotic factors [32].

### 3.2 Generative character

Yield components of six advanced red rice promising lines obtained differed based on panicle length, grains number, filled grain percentage, unfilled grain percentage, 1000 grain weight, and dry weight per m² (table 2). The DMRT result shows that GS16-1 lines have the longest panicle length compared with other red rice lines and check variety, but was not significantly different with GS44-2, GS12-1, GS12-2, and GS16-2 lines (table 2). The GS16-1 lines found to be the cultivar with highest number of grains total but were not significantly different from all other red rice promising lines. The highest percentage of filled grain was obtained from GS12-2 lines, which was significantly different from check variety. The heaviest dry weight grains recorded on GS16-1 lines, which were significantly different from other red rice lines.

**Table 2. Mean of six yield characters by advanced red rice lines and variety**

| Rice lines /variety | Panicle length (cm) | Total grain number (seed) | Filled grain (%) | Unfilled grain (%) | 1000 grain weight (g) | Dry weight per m² (g) |
|---------------------|---------------------|---------------------------|-----------------|-------------------|----------------------|-----------------------|
| GS12-1              | 26.21ab             | 145.37a                   | 68.35ab         | 31.65bc           | 25.13a               | 430.00b               |
| GS12-2              | 26.73ab             | 137.33a                   | 68.39ab         | 31.61bc           | 23.25a               | 450.50b               |
| GS44-1              | 24.10b              | 128.45a                   | 62.95bc         | 37.05ab           | 25.88a               | 440.13b               |
| GS44-2              | 24.88ab             | 130.32a                   | 64.77bc         | 35.23ab           | 25.50a               | 472.13ab              |
| GS16-1              | 27.06a              | 153.40a                   | 65.06b          | 34.94b            | 26.13a               | 574.00a               |
| GS16-2              | 25.23ab             | 143.10a                   | 60.05c          | 39.95a            | 24.38a               | 467.13ab              |
| Trisakti            | 20.86c              | 89.48b                    | 75.26a          | 24.74c            | 24.75a               | 559.00a               |

Note: Number followed by the same letter in the same column (a,b,c) are not significantly different by DMRT.
The observation of the weight of 1000 grains of rice showed that all red rice lines had no significant effect (table 2). The difference in weight of each cultivar is presumed to be due to the inherent nature of the genes. Genetic traits that can grow and adapt to extreme environments are believed to be able to produce better grain weight, on the other hand, the nature of genes that are not able to grow and adapt to extreme environments results in less grain weight.

Tables 2 show that the results of the analysis of the percentage of filled grain and the percentage of unfilled grain showed that the red rice lines had a significant effect on all treatments, with the highest average percentage of filled grain was GS12-2 lines, and the lowest percentage of filled grain was GS16-2 lines (60.05%). The high percentage of unfilled grain is caused by long panicles and a large number of grains per panicle as large sinks \[33,34\], only supported by several tillers, so they are unable to meet nutrient and carbohydrate needs.

4. Conclusion
It can be concluded that in terms of growth components and potential production of six advanced red rice promising lines can adapt well to paddy fields because the results of the agronomic traits and yield are not much different compared with check variety.

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