Agronomic traits performance of some promising lines of local upland rice (*Oryza sativa* L.) from SE Sulawesi grown under shading conditions

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Abstract. Rice is primarily eaten by countries like Indonesia in Asia. The demanding rice rise every year and the Indonesian government is trying to satisfy the need for rice. The development rice tolerant to shade is one of the promising choices. The aim is to characterize the performance of upland a new rice cultivar. The study was conducted at the Experiment Farm, Department of Agronomy, University of Halu Oleo. Arrange in a split-plot design and repeated four times. The different shade levels as main plot and rice lines different as subplot. The shade level consists of four levels (*N*0=0%, *N*1=25-50%, *N*2=50-75% and *N*3 > 75%). The upland rice lines were *G*1=*GS*11-1, *G*2=*GS*11-2, *G*3=*GS*12-1, *G*4=*GS*12-2 and *G*5=Lipigo as a control variety. The results indicated that shade significantly increased the plant height, leaf area and unfilled grains number. However, the shade level affected productive tiller and grain weight to decrease.

1. Introduction
Rice is still a main source of carbohydrate intake [1,2]. It consumes 90% in Asia and mostly in Southeast Asia, including Indonesia. The population of Indonesia's increase continue and rice demand continuously growing every year [3-6], and it needs to be self-sufficient [7,8]. The government of Indonesia have many policies to increase rice production while reducing the level rice consumption [9-12].

Several programs were taken to ensure rice sustainability and maintain the level of rice stock by increasing production, decreasing level consumption, and developing local food sources [13]. Efforts to increase rice, among others, improve the quality of seeds to grow well [14,15], develop new rice cultivars through cross-breeding [16,17], or radiation techniques, and develop upland rice as an alternative to increasing production. Development of upland rice can also be done to plant upland rice as intercrops so that it can be planted under plant stands [18-20]. The development of rice under plant stands will result in a lack of light to hampered the plant growth and production [21-23]. Therefore, rice cultivars that are tolerant to low light conditions are very important, and the potential land under plant stands can be utilized for rice cultivation.

2. Materials and methods
The study was conducted at the Experiment Farm, Department of Agronomy, University of Halu Oleo. Materials used were seed of rice promising lines: GS11-1, GS11-2, GS12-1, GS12-2, check variety
(Lipigo), Nitrogen phosphorus and potassium fertilizers, polybag, paranet, label, and plastic sample. The rice lines used were obtained from the crossing between local upland rice and superior lowland rice variety. Research is arranged in a split-plot design with four replications. Shade treatments arranged as main plots while upland rice lines were arranged as subplots. The plot size was 2x3 m² with 25 cm x 25 plant distance. Fourteen-day old seedlings were transplanted by maintaining only one seedling per hill. Standard agronomic practices were done to get a good rice crop. Five plants per replication per entry were selected randomly to collect the vegetative data on the plant height, leaf number, numbers of tillers per plant, leaf area. On the generative data were collected of flowering date, harvesting date, grain number, percentage filled grains and unfilled grains, and also grain weight.

3. Results and discussion

3.1. Results

3.1.1. Plant height and leaf area. The result was that shade treatment had a significant effect on plant growth, especially on plant height and leaf area parameters (table 1). In plant height parameters, shade treatment resulted in increased plant height. The rise in plant height is in line with the rise in the level of shade. With higher levels of shade, the increase was greater. The difference in plant height increases with increasing age of the plant. For leaf area parameters, shade treatment also has significantly effect on the leaf area.

| Shade level | Plant height (cm) 42 DAP | Plant height (cm) 84 DAP | Leaf area (cm²) 42 DAP | Leaf area (cm²) 84 DAP |
|-------------|--------------------------|--------------------------|------------------------|------------------------|
| N₀          | 57.59 c                  | 85.13 c                  | 19.13 b                | 46.49 b                |
| N₁          | 57.76 c                  | 93.69 b                  | 20.46 b                | 50.02 b                |
| N₂          | 60.43 b                  | 108.86 a                 | 21.21 b                | 52.53 b                |
| N₃          | 64.60 a                  | 112.98 a                 | 25.30 a                | 66.63 a                |

Note: Number follow the same superscript was no significant difference in DMRT 0.05

Plants always try to make adjustments to the ever-changing environmental conditions, either by avoiding them or by developing tolerance. The increase in plant length and leaf area is a mechanism that occurs when plants are shaded and facing stress due to lack of light. This situation also occurs in cocoa, coffee or banana. Different plant cultivars also respond differently to shade. In tolerant cultivars, generally there were no significant differences in plant height and leaf area in shaded conditions or not. Meanwhile, in sensitive cultivars, the presence of shade caused a significant difference between the two parameters.

3.1.2. Productive tillers. The findings have also shown that the shade has effect on tillers number is greatly. The higher the level of shade, the smaller the number of tillers become. However, various varieties responded differ to the decrease in the number of tillers (table 2). There was an interaction effect between shade and cultivar differences on the number of tillers. The most drastic decrease in the number of tillers due to increased shade occurred in G1 and G5 cultivars. Meanwhile the decrease occurred in other cultures. This indicated that the G2-4 culture was more tolerant so that there was no drastic decrease in the number of tillers. The pattern of productive tiller follows the pattern of tiller
number that reported in the previous study.

### Table 2. The shade and cultivar interaction on productive tillers number.

| Lines/Cultivar (G) | Shade level (N) | Mean (N) |
|-------------------|-----------------|----------|
|                   | N₀   | N₁   | N₂   | N₃   |       |
| G₁                | 5.25 a | 5.17 a | 3.33 b | 2.72 b | 4.12  |
|                   | r    | q    | q    | p    |       |
| G₂                | 6.9 q | 5.33 b | 3.75 c | 2.42 d | 4.60  |
|                   | s    | q    | q    | p    |       |
| G₃                | 2.97 b | 4.17 a | 2.40 b | 2.42 b | 2.99  |
|                   | s    | q    | qr   | p    |       |
| G₄                | 3.75 a | 3.92 a | 3.00 ab | 2.58 b | 3.31  |
|                   | s    | qr   | q    | p    |       |
| G₅                | 10.67 | 8.67 b | 5.28 c | 3.60 d | 7.06  |
|                   | p    | p    | p    | p    |       |
| Mean (G)          | 5.91 | 5.45 | 3.55 | 2.75 |       |

Note: Number follow the same superscript was no significant difference in DMRT 0.05

#### 3.1.3. Unfilled grains and grain yield per hill

Based on ANOVA, the shade treatment significantly affected upland rice lines to produce unfilled grain and grain yield per hill. The percentage of unfilled grains tend to increase with increasing of shade level. While grains yield per hill tend to decrease with increasing of shade level (figure 1 and figure 2).

![Figure 1. Number of unfilled grains per panicle.](image1)

![Figure 2. Upland rice grain yield per hill.](image2)

The production parameters show that increasing shade intensity can increase the percentage of unfilled grain. The higher the level of shade, the bigger the unfilled grain percentage. It is directly or indirectly affects production. Crop production decreased with higher levels of shade. It was because shade reduces the tiller number and filled grain percentage, thereby simultaneously reducing the production capacity. Each cultivar showed a different response due to shade. Each cultivar's different responses to this shade can be used as a genetic source for selection and obtaining shade-tolerant plants.

#### 3.2. Discussion

The shade levels generally have affected the vegetative growth and productivity of four types of lines tested. The results of this study correlated with other research on soybean [24-26], maize [27,28], banana [29,30], and also finding by Viji on rice [31]. On the other research report, grain yield was
significantly reduced by 41 and 80 per cent at 20 and 40 per cent shade levels [32]. Similar decreases in low light intensity productivity were recorded earlier [32-34]. Both grow with the rise of the shade in the height of the plant and the area of the leaf. With the rise in shade level, there was a decrease in the active tiller. The unfilled percentage of grain in the unfilled grain parameter was higher at a higher degree of shade.

4. Conclusions
From the result it can be concluded that the shade level would increase the plant's height and leaf area. But, conversely, the increase in the amount of shade would decrease. The shade treatment can lower productive tiller, and grain weight. Although the treatment of shade greatly affects the rise in unfilled grains.

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