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Grain yield and yield attributes response of four upland rice (*Oryza sativa* L.) promising lines to shade stress

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Abstract. The purpose of this research was to investigate a response of four promising lines of upland rice (*Oryza sativa* L.) on low-light environments. The study was carried out at the Agronomy Field Laboratory, Faculty of Agriculture, Halu Oleo University Kendari and arranged on split plot design on two factors. The different shade level placed as the main plot and different promising lines as subplot. The observed variables were number of productive tillers, panicle length, the number of unfilled grains and grain yield (t ha^{-1}). The results indicate that both the shade levels and upland rice promising lines affected the grain yield and yield attributes. The shade levels tend to decrease grain yield and increase unfilled grain. The GS12-1 lines recorded as a better promising line, especially for the panicle length and grain yield (t. ha^{-1}).

1. Introduction

Rice (*Oryza sativa* L.) considered the most important staple food, and it supplies more than half of the world's food requirement. Rice contributes a nutritionally significant amount of thiamine, riboflavin, niacin, and zine to the diet (Food and Agriculture Organization [1-4]. The promising program is by developing upland rice to increase rice production, included increase quality and viability of seed [5-11], breeding program [12-19], development hybrid rice [20-21], and increase local food consumption [22].

The development of upland rice as an intercropping plant often faces various obstacles, exceptionally low light intensity [23-24]. The larger the staple crop, the wider the level of the canopy so that upland rice gets relatively low light intensity. The light deficit in upland rice plants disrupts metabolic processes, which has implications for the decreased rate of photosynthesis and carbohydrate synthesis. The fastest influence of shading stress is the decrease in carbohydrate content [25].

One of the strategies for plants in the light competition was through the development of shade tolerance. Plant development of its ability to increase utilizing light efficiently [26]. Shade tolerance associated with many factors, including photosynthesis level, pigment biosynthesis process, and traits of morphological and physiological [26-28]. Indeed, even numerous examinations have been done to assess the shade consequences for crops (19, 29-30], but still a little information available on the effects of shade treatments on grain yield and yield attributes of upland rice lines. Yet at the same time somewhat data accessible on the impacts of shade on grain yield and yield characteristics of upland rice

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lines. Subsequently, the point of this examination was to break down the reaction of grain yield and yield qualities of four promising lines of upland rice to conceal pressure.

2. Materials and methods

The study was carried out in Agronomy Laboratory, Faculty of Agriculture, Halu Oleo University Kendari, during the growing season in 2018. The experiment was conducted with four shade levels (0, 20, 40 and 60 per cent) and four promising lines of upland rice (GS11-1 (G1), GS12-1 (G2), GS44-2 (G3), GS16-1(G4) developed from the cross between paddy rice and local upland rice, and one local upland rice as a check variety. Shade was imposed by using shade nets of appropriate shade levels. The experiment was arranged in split plot design. The shade levels placed as the main plot and the different of upland rice lines placed as sub plots. The number of replications was three. The parameter observed was the total grains yield, panicle length, grains number per panicle, filled grains number, unfilled grains number per panicle, and 1000-grain weight. Data analysed using analysis of variance and further test using Duncan Multiple Range Test (DMRT).

3. Results and discussion

3.1. Number of productive tiller and panicle length

The results showed that the interaction between shade levels and upland promising lines have highly significant effect on yield attributes like productive tillers number, panicle length, unfilled grains per panicle, and filled grains per panicle. In general, number of productive tiller and panicle length tend to decrease with the higher shade levels. The highest average number of productive tillers was recorded on G4 lines (Table 1), while the highest panicle length was obtained on G1 lines (Table 2).

Table 1. Effect of interaction between shade levels and four upland rice promising lines on the number of productive tillers

Rice lines	Shade levels							
	N0		N1		N2		N3	
G1	8.00 p	a	6.42 pq	a	5.83 pq	b	5.42 q	b
G2	8.92 p	a	7.08 pq	a	7.00 pq	a	5.75 q	ab
G3	8.08 p	a	7.83 pq	a	6.58 pq	ab	5.50 q	ab
G4	8.83 p	a	7.70 p	a	7.08 p	a	717 P	a
G5	5.08 p	b	1.83 q	b	1.92 q	c	2.83 q	c

Note: The numbers followed by similar letters in the similar column (p, q, r) and the similar same row (a, b, c) are not significantly different at DMRT 0.05

Based on ANOVA result that the effect of interaction between shade levels and upland rice promising lines obtained highly significant on the number of unfilled grains. It found that the highest number of unfilled grains was recorded on the G4 (GS44-2) lines with 60% shade level (Figure 1).

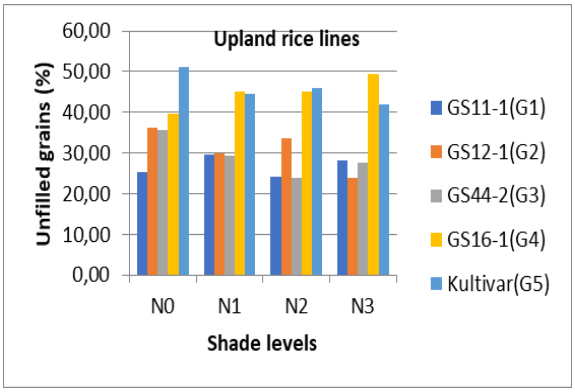

Figure 1. Unfilled grains number per panicle on various shade levels

Table 2. Effect of interaction between some upland rice promising lines and shade levels on panicle length

Rice lines	Shade levels							
	N0		N1		N2		N3	
G1	40.35 p	a	22.36 q	b	24.70 q	a	25.94 q	b
G2	27.99 p	b	26.54 p	ab	2654 p	a	24.47 p	b
G3	30.61 p	b	24.32 q	ab	24.63 q	a	23.30 q	b
G4	27.52 p	b	28.84 p	a	25.88 pq	a	23.08 q	b
G5	30.60 p	b	28.88 p	a	24.82 q	a	28.27 p	a

Note: The numbers followed by similar letters in the similar column (p, q, r) and the similar same row (a, b, c) are not significantly different at DMRT 0.05

3.2. Grains yield (t ha $^{-1}$)

Analysis of variance result indicates that the interaction effect was found not significantly difference on the grain yield. The genetic differences among upland rice affect the grain yield (Figure 2).

The environmental factors greatly affect plant growth and development. In addition to environmental factors, genetic factors influence plant responses. Tolerant genotypes have relatively high photosynthetic activity capabilities in low light conditions so that they can produce photosynthates that are adequate for vegetative growth of plants [31]. The highest grain yield (t ha^{-1}) obtained in the GS12-1 (G2) lines. The average grain yield of GS12-1 (G2) lines supported by the moderate number of unfilled grains per panicle. Genetic variation among upland rice lines used in this study may lead to the differences in yield of grain yield.

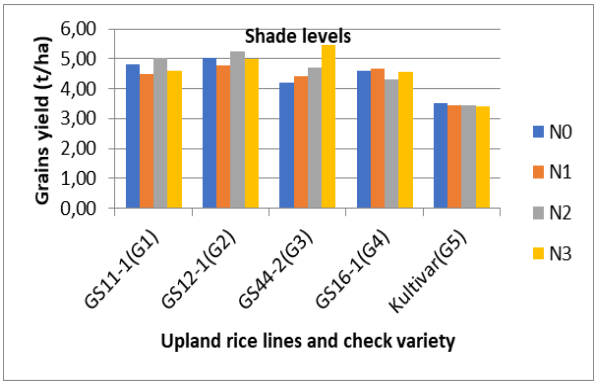

Figure 2. Grain yield of four upland rice promising lines on various shade levels

4. Conclusions

It concluded that both the shade levels and upland rice promising lines had affected the grain yield and yield attributes. The shade levels tend to decrease yield of grain and increase the unfilled grain. The GS12-1 lines recorded as a better promising line, especially for the panicle length and grain yield (t. ha^{-1}).

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