Production And Quality Of Upland Red Rice Under The Shade Stress

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Abstract : Red rice is a vital commodity as a source of carbohydrate and also as nutritive food because it contains anthocyanins as an antioxidant. The content of anthocyanin will determine the quality of red rice. Upland red rice can be planted as an intercrop to maximize land use on estate crops or forestry. Planting rice as an intercrop will face stress due to a lack of light, and will decrease production capacity, but the anthocyanin content will increase. This research conducted in Agrotechnology Field Experiment, Faculty of Agriculture, Halu Oleo University, arrange in a split design. The different of shade placed as main plot of as follows; N_0 = without shading, N_1 = 25% shading level, N_2 = 50% shading level, and N_3 = 75% shading level. The different upland rice cultivar placed as subplot consists of K_1: *Paebiu Tamalaki Kosebo*, K_2: *Paebiu Kolopua,* K_3: *Ranggo Hitam,* K_4*: Pae Ndalibana,* K_5*: Pae Dara,* K_6*: Rangka Milama and* K_7*: Pae Besu*. The results showed that the differences in shade levels have a significant effect on the filled grain percentage, potential production, and anthocyanin content.

Index Terms: Anthocyanin, Antioxidant, Filled grain, Empty grain, Upland red rice

1 INTRODUCTION

Rice is a vital commodity in Indonesia and also the primary source of carbohydrate [1],[2]. The rice needed expecting to increase as much as the increase in population. The program to increase rice production included increasing productivity and maintenance of the existing production program such as increasing seed quality [3],[4] development new variety [5],[6] and also development upland rice [7],[8],[9]. Besides source of food, rice also producing functional food in the form of red rice. Besides the source of food, rice also producing functional food in the form of red rice. Red rice has nutritive value and contains anthocyanins that function as an antioxidant [10],[11]. Red rice can be developed as alternative food [12] and consume without going through a process of scraping or removing the bran from the rice endosperm [13]. Rice is only ground into broken rice with the skin so that the epidermis is still attached to the endosperm, so it has a high nutritional value [14]. Anthocyanin pigment acts as an antioxidant compound in preventing and treating several diseases such as cancer [15], diabetes, hypertension, cholesterol, and coronary heart disease [16]. Besides, the selling value of red rice is higher when compared to ordinary rice, so that can increase the farmers' income. Upland red rice can be planted as an intercrop to maximize land use on estate crops or forestry. Planting rice as an intercrop will face stress due to a lack of light [17].

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stress due to lack of light will increase anthocyanin levels. Several research results show that the treatment of low light intensity by providing shade can effect on the anthocyanin levels in some plants, such as pak-choi [18], fruit peel [19] soybean [20] and *Gynura pseudochina* [21]. This study aims to determine the shading effect on the yield and the anthocyanin content.

2. MATERIAL AND METHODS

This research conducted in the Agrotechnology Field Experiment, Faculty of Agriculture, Halu Oleo University, and arranged in split-plot design. The differential shade as the main plot and the cultivar different as sub-plot. The shade level treatment consist as four levels, i.e. N_0 = without shading, N_1 = 25% shading level, N_2 = 50% shading level, and N_3 = 75% shading level. The different cultivar tested are K_1: *Paebiu Tamalaki Kosebo*, K_2: *Paebiu Kolopua,* K_3: *Ranggo Hitam,* K_4*: Pae Ndalibana,* K_5*: Pae Dara,* K_6*: Rangka Milama and* K_7*: Pae Besu*. Several generative were examine included the filled grain percentage, potential production, and anthocyanin content. The data were analyzed using the analysis of variances (ANOVA). Further tests using Duncan's multiple range test (DMRT).

3. RESULT AND DISCUSSION

3.1 Results

3.1. 1. Filled Grain, Empty Grain and Yield

The results showed that differences in shade levels and different cultivar have a significant effect on filled grain percentage and empty grain percentage (Table 1). The higher the shade level the percentage of the empty grain. Conversely, the higher the shade level, the lower the filled grain percentage. On the parameter of potential production, the rice production per clump decreases with the increase of shade levels.

***Table 1**. Shading effect on on the percentage of filled grain, empty grain and grain yield.*

No	Treatment	Empty Grain (grain)	Full Grain (grain)	Grain Number per Clump	Empty Grain Percentage	Full Grain Percentage	Grain Yield
1	N_0	235.64	718	953.64	24.71	75.29	18.14^{d}
2	N_1	323.54	575.68	899.22	35.98	64.02	16.36^{c}
3	N_2	296.19	561.46	857.65	34.54	65.46	15.47^{bc}
4	N_3	293.14	480.01	773.15	37.92	62.08	12.17^{a}

The difference in shade level has significantly effected the parameters of dry grain production. The higher the shade level, the greater the rate of decline in production, in the form of dry grain weight (Figure 1). Each cultivar has different levels tolerant to low light intensity so that there are differences in the level of decline in production due to the shade of each cultivar.

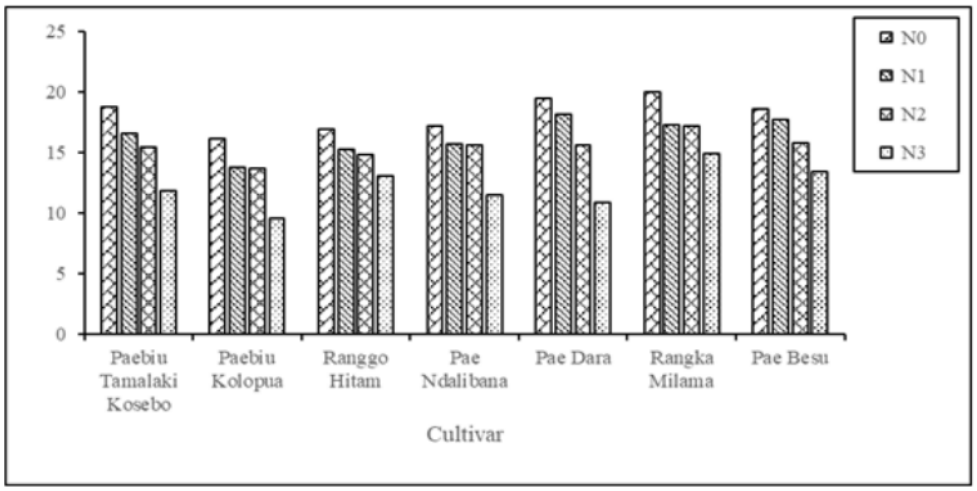

***Figure 1.** Effect of shading level on the yield of various rice cultivars*

3.1.2. Anthocyanin Content

The results showed that shade treatment could increase the content of anthocyanin. Increased of anthocyanin as a result of shading treatment occurred in all the cultivars tested (Table 2)

***Table 2.** The effect of shading level on anthocyanin content*

Cultivar	Anthocyanin Content (mg/100g)		
	Without Shading (N_0)	Shading Level 50% (N_2)	Increasing Anthocyanin Content (fold)
Paebiu Tamalaki Kosebo	5.98	50.79	8.49
Paebiu Kolopua	0.29	2.33	8.03
Ranggo Hitam	3.32	29.60	8.92
Pae Ndalibana	14.60	20.49	1.40
Pae Dara	3.20	15.50	4.84
Rangka Milama	4.21	11.70	2.78
Pae Besu	3.72	5.63	1.51

The highest increase in anthocyanin content due to the shade level occurred in *Ranggo Hitam* cultivars (8.92 fold). It was followed by *Paebiu Tamalaki Kosebo* (8.49 fold), *Paebiu Kolopua* (8.03 fold), *Pae Dara* (4.84 fold), *Rangka Milama* (2.78 fold), *Pae Besu* (1.51 fold) and *Pae Ndalibana* (1.40 fold).

3.2. Discussion

Based on the character production, it appears that the shade level has a significant effect on the yield of upland red rice. The higher the shade level, the lower the yield. The results of this study are in line with the influence of shade on the capacity of plants to fill seeds [8], which is indicated by the large percentage of filled grain or empty grain.The results also showed that shade treatment could increase levels of anthocyanin. Increased levels of anthocyanin can reach 8-fold as occurs in *Ranggo Hitam* cultivars, and *Paebiu Tamalaki Kosebo* cultivar and *Paebiu Kolopua*. The shade has a significant effect on the anthocyanin content of upland red rice. Anthocyanins have found in epidermal cell vacuoles [22],[23].

Under shaded conditions, anthocyanins are also found in leaf mesophyll cells [24] so that the concentration increases under shaded conditions [25],[26]. Red rice does not only source of carbohydrates but also functions as a source of healthy food [27] because it contains anthocyanins [28],[29], which are antioxidants. Increasing and improving the quality of red rice is, therefore, very dependent on the amount of anthocyanin content.

4 CONCLUSION

It concluded that the shade level would determine the decreasing percentage of full grain. Shade level also will determine rice quality in terms of anthocyanin content. The shade level increases the level of anthocyanin content on *Ranggo Hitam* cultivar, and follow by the *Paebiu Tamalaki Kosebo* cultivar and *Paebiu Kolopua* cultivar.

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