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Growth performance of several promising local upland rice (*Oryza sativa* L.) genotypes of Southeast Sulawesi

T Wijayanto[1], Ramdayani[1], Arditya[1], Asniah[2], N W S Suliartini[1], N M Rahni[1] and L O Afa[1]

[1]Department of Agrotechnology, Faculty of Agriculture, University of Halu Oleo, Kendari, South East Sulawesi, 93132, Indonesia
[2]Department of Plant Protection, Faculty of Agriculture, University of Halu Oleo, Kendari, South East Sulawesi, 93132, Indonesia

E-mail: wijayanto_teguh@yahoo.com

Abstract. Southeast Sulawesi, which is located in the southeastern part of Sulawesi island, is one of the upland rice producers in Indonesia, although the cultivation in the area is still not optimal because the upland rice productivity is still considered low. Southeast Sulawesi has an extensive dry land area and local upland rice genotypes have good growth and yield potential. This study aimed to determine the differences in the growth of several local upland rice genotypes of Southeast Sulawesi which were cultivated in Kendari City. This paper is still focused on the vegetative growth of the genotypes tested. This research was carried out in Experiment Field 2, Faculty of Agriculture, Halu Oleo University, which is located in Kambu District, Kendari City, Southeast Sulawesi. The research was conducted using a randomized block design (RBD) consisting of 10 genotypes, namely Wagamba (V1), Wangkariri (V2), Momea (V3), Waburi-buri (V4), Konkep (V5), Bakala (V6), Wakawondu (V7), Tinangge (V8), Loiyo putih (V9) and Bombana (V10). Each treatment was repeated 3 times in order to obtain 30 experimental units. The results showed that potential genotypes that can be developed in Kendari City were Wakawondu genotype based on parameters of the number of tillers, plant height, and number of leaves, Wagamba genotype based on leaf width parameter, and Wangkariri genotype based on the flowering age and number of tiller parameter. Based on the overall performances, especially on the number of tillers (one of the most important parameters), in general Wakawondu is the most recommended genotype for further development.

1. Introduction

Rice (*Oryza sativa* L.) is the most important food crop commodity in Indonesia. Nearly 95% of Indonesia's population uses rice as a staple food. Indonesia's per capita rice consumption is among the highest in the world, including when compared to rice consuming countries in Asia, especially China, Japan and Malaysia [1, 2].

Lowland rice still receives primary attention to meet national food needs, due to the upland rice productivity is still relatively low. However, Indonesia actually has the potential for upland rice development because most areas of Indonesia have dry land. The development of upland rice in dry land which has not been optimally utilized can be a solution to the problem of food security [3].

Southeast Sulawesi has dry land potential that can be optimized to support efforts to increase national rice production through the development of upland rice [4, 2].

Upland rice productivity can be improved by using good varieties including better growth performance and high yielding varieties planted in a specific environment. Southeast Sulawesi has many potential local upland rice germplasms, which have been cultivated by local farmers for decades [5]. Potential cultivars originating from regions in Southeast Sulawesi can possibly be cultivated in certain areas including in the Kendari region. However, those upland rice genotypes had not been intensively recorded and evaluated. The main purpose of this research was to determine the differences in the growth of several local Southeast Sulawesi's upland rice genotypes which in the future the most recommended genotype can be cultivated in the Kendari area. In this paper, only vegetative growth data are discussed, since the yield parameters are still under evaluation.

2. Materials and methods

2.1. Research materials
The research was carried out in Experimental Field 2, Faculty of Agriculture, Halu Oleo University, Kendari, Southeast Sulawesi. The research materials used included seeds from 10 local upland rice genotypes, namely Wagamba, Wangkariri, Waburi-buri, Wakawondu (from North Buton area), Bakala, Tinangge, Momea, Loiyo putih (from South Konawe area), Konkep (from the region of Konawe Islands), and Bombana (from the Bombana area).

2.2. Research procedure
Soil analysis was carried out by taking soil samples (a-20 cm in depth) and analyzed in the Soil Science Laboratory of Agriculture Faculty, University of Halu Oleo. The analysis showed that soil pH was 4.36, the nitrogen content of 0.05%, and the P content of 5.02 ppm.

Land preparation began with clearing the land from weeds, wood and litter or plant debris. Subsequently, the soil was tilled 3 times and experimental plots were made. Plots were made with a size of 2 m x 3 m with a distance of 1.5 m between groups, the distance between the plots was 0.5 m. Liming was carried out after the first tillage by sprinkling lime over the cultivated land, and rotating it so that the lime is evenly distributed. Liming is carried out based on the pH of the soil analysis result (pH 4.36), with a dose of 1,280 kg ha^{-1} or 768 g per plot with the intended pH of 5.0, according to the method of [6].

Before sowing the seeds were soaked in water for 24 hours. Media for nurseries in trays containing rice husk and sand in the ratio of 1:1. The nursery was held for 2 weeks until ready for transplanting. Planting was carried out when the seedlings were 18-20 days after sowing which begins with making planting holes with a spacing of 25 cm x 20 cm each. Each planting hole was planted with 1 seed to obtain 25 plants per plot.

Fertilization was carried out using organic and inorganic fertilizers. Organic fertilizer in the form of cow dung, with the dose of 450 kg ha^{-1}, was spread out on the plots as a base fertilizer, two weeks before seedlings sowing, to allow a good decomposition of the fertilizer. The inorganic fertilizers used were Urea (N), SP36 (P) and KCL (K). Fertilization doses were urea (N) 150 kg ha^{-1} (90 g per plot), SP36 (P) 100 kg ha^{-1} (60 g per plot) and KCl (K) 100 kg ha^{-1} (60 g per plot).

2.3. Research design
This research was carried out using a randomized block design (RBD) consisting of 10 genotypes, namely: Wagamba (V1), Wangkariri (V2), Momea (V3), Waburi-buri (V4), Konkep (V5), Bakala (V6), Wakawondu (V7), Tinangge (V8), Loiyo putih (V9) and Bombana (V10). Each treatment was repeated 3 times in order to obtain 30 experimental units.

The observed variables consisted of growth parameters, namely: plant height (cm), number of leaves (strands), leaf length (cm), leaf width (cm), number of tillers (plants), flowering age (DAP).

The data from the observations were analyzed using variance based on a randomized block design (RBD), followed by Duncan's Multiple Range Test (DMRT). Once the yield parameter data become available, further analysis such as Path Analysis by Singh and Chaudhary (1979) might be used to identify causal relationships (direct or indirect) between variables, especially between vegetative variables to yield variables.

3. Results and discussion

3.1. Results

The research result findings on some growth parameters of the ten upland rice genotypes tested are presented in table 1. The growth performances of the ten genotypes are varied. In most cases, three upland rice genotypes namely Wakawondu, Wangkariri, and Wagamba generally show better growth performances as compared to the other genotypes.

Tabel 1. Averages of plant height (cm), leaf length (cm), leaf width (cm), number of leaves (strands), number of tillers (plants) at the age of 77 days after sowing (DAS), and flowering age of several genotypes of local upland rice from Southeast Sulawesi planted in Kendari region.

Treatments	Plant height (cm) 77 DAS	Leaf length (cm) 77 DAS	Leaf width (cm) 77 DAS	Leaves number (strands) 77 DAS	Tiller number (plant) 77 DAS	Flowering ages (day)
V1 (Wagamba)	107.43[a]	69.57[ab]	1.73[a]	72.27[b]	16.90[bc]	135[ab]
V2 (Wangkariri)	101.20[a]	62.40[bc]	1.60[a]	50.47[b]	31.20[ab]	118.2[c]
V3 (Momea)	109.97[a]	69.97[ab]	1.53[a]	54.60[b]	12.90[c]	159.1[a]
V4 (Waburi-buri)	101.60[a]	69.10[ab]	1.67[a]	69.83[b]	19.23[bc]	143.7[ab]
V5 (Konkep)	113.43[a]	70.70[a]	1.60[a]	81.70[b]	18.57[bc]	133.5[ab]
V6 (Bakala)	82.20[b]	53.03[d]	1.23[b]	87.77[b]	26.87[bc]	153.5[a]
V7 (Wakawondu)	80.33[b]	56.57[cd]	1.23[b]	151.40[a]	45.13[a]	141.5[ab]
V8 (Tinangge)	103.30[a]	68.87[ab]	1.50[a]	80.67[b]	21.60[bc]	135.3[ab]
V9 (Loiyo Putih)	104.23[a]	69.20[ab]	1.63[a]	77.30[b]	17.80[bc]	136.5[ab]
V10 (Bombana)	105.03[a]	69.90[ab]	1.60[a]	52.10[b]	16.93[bc]	124.7[bc]

Note: The numbers followed by different letters in the same column are significantly different based on the DMRT with a 95% confidence level.

Data from observation and the Duncan's multiple range test (table 1) shows that the lowest average plant height is found in the Wakawondu (V7) and Bakala (V6) genotypes. The longest average leaf length was obtained in the Konkep genotype (V5), but it was not significantly different from the genotypes of Wagamba (V1), Momea (V3), Waburi-buri (V4), Tinangge (V8), Loiyo Putih (V9), Bombana (V10). The lowest average leaf length was found in the Bakala genotype (V6). The highest average leaf width was found in Wagamba (V1), but it was not significantly different from other genotypes, except for the Bakala (V6) and Wakawondu (V7) genotypes, which were the genotypes with the lowest leaf width. While the highest average number of leaves of upland rice was found in the Wakawondu genotype (V7), which was significantly different from the other genotypes, and the highest number of tillers was found in the Wakawondu genotype (V7), but it was not significantly different from the Wangkariri genotype (V2). The lowest average number of tillers was found in Momea (V3).

For flowering age, data from observations and the Duncan's test in Table 1 shows that the longest average flowering age is found in Momea (V3) and Bakala (V6), while the fastest average of age of flowering is in genotypes Wangkariri (V2) and Bombana (V10), with the average values of 118.2 DAS and 124.7 DAS, respectively.

Figure 1. Plant growth condition in the vegetative phase (left) and towards the generative phase (flowering) (right).

3.2. Discussion

Each local upland rice genotype has an average plant height that varies according to its genetic characteristics. Various plant heights can be classified into high, low, and medium groups. Based on the IRRI Standard Evaluation System for rice [7], the plant height classes are short (<90 cm), medium (91-125 cm) and tall (> 126 cm). In this study, the genotypes of upland rice with the medium plant height category (91-125 cm) were the Konkep, Momea, Waburi-Buri, Wangkariri, Wagamba, Tinangge, Loiyo Putih and Bombana genotypes, while the genotypes with low plant height category (<90 cm) were the Bakala and Wakawondu genotypes. Leaf length characters also vary, which was not much different from the plant height. Generally, the higher the upland rice plant, the longer the leaves will be because the length of the upland rice leaves follows the height of the stem.

The number of tillers is a product of the vegetative phase of the plant which determines the yield of rice crops. According to [8], rice tillers are an indicator of the growth of healthy or sick rice plants. Although in character, the number of tillers is also influenced by plant genetics, the role of N is also very important in the process of producing the number of tillers. The results showed that the highest average number of tillers at the age of 77 DAS was found in the Wakawondu genotype, namely 45.1 tillers (table 1). For the flowering age variable, the genotypes with the fast-flowering time were Wangkariri genotype with an average of 118 DAS and Bombana with an average of 124 DAS. While the genotypes with a long flowering time were the genotypes of Momea and Bakala with averages flowering age of about 159 DAS and 153 DAS, respectively.

The new type of rice is characterized by the character of fewer tillers (8-10 tillers), all productive tillers, thick-skinned (200-250 grains per panicle), pithy, medium plant height (90-100 cm), and sturdy trunk, upright leaves, thick, and dark green, deep and deep roots, medium age (110-130 days), and resistant to pests and diseases [9]. These characteristics are intended to increase the yield potential by 20-25% [10]. [11] reported that local upland rice grown on marginal soils in North Buton, including the Wakawondu genotype, had an average panicle length of 37.32 cm, an average number of grains of 149.37 grains, an average wet weight of 53.80 g, an average dry weight of 44.88 g, Wangkariri genotype had an average panicle length of 35.57 cm, an average number of grains 101.35, an average wet weight of 34.20 g and a dry weight of 25.65 g. While the Waburi-buri genotype had an average panicle length of 31.69 cm, an average number of grains 119.90 and an average wet weight of 34.68 g and a dry weight of 28.74 g.

Based on the criteria for new types of rice, in this study, those with medium plant height were Wakawondu and Bakala genotypes. However, based on previous research [12], the Bakala and Wakawondu cultivars had a higher average plant height compared to Wangkariri cultivars [13, 14]. From the results of this study, the genotypes which had the characteristics of ideal type of rice based on the New Type Rice based on the parameters of the number of tillers, plant height and number of leaves was the Wakawondu genotype, based on flowering age and the number of tillers was in the Wangkariri genotype, and based on leaf width parameter there was on the Wagamba genotype. The character appearance shown is not only influenced by genetic factors [15, 16], it is also greatly influenced by environmental factors on the growth of these plants [17, 18].

4. Conclusion

Based on the results of research and discussion, it can be concluded that there are differences in the characters of the vegetative growth of the local upland rice genotypes planted in Kendari City, especially based on parameters of plant height, leaf length, leaf area, number of leaves, number of tillers and flowering age. In this research, based on the overall performances, especially on the number of tillers (one of the most important parameters), Wakawondu genotype seemed to perform better, in terms of growth parameters, as compared to other genotypes tested. This genotype is potential, and might later be recommended for further evaluation and development. The findings, however, are still yet conclusive until the yield data are analyzed and evaluated.

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