Agronomic Characteristics of Gogo Rice Lines As a Result of Mass Selection

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Abstract—The study aims to determine the agronomic characteristics of local upland rice lines resulting from a mass selection. The study was conducted in Petimbe Village, Palolo District, Sigi Regency, Central Sulawesi Province, at an altitude of 500 above sea level, from February to June 2022. The study was arranged using a Randomized Block Design with twenty varieties/lines (one superior variety as a comparison) repeated three times so that there are 60 experimental plots. The results showed that the lines had higher plants than the comparison varieties. Pae dupa lines had a higher average number of tillers, although not different, while the number of productive tillers of comparison varieties was better. Untad II and Dongan lines flowered faster than high-yielding varieties and significantly differed. One line was harvested earlier than the comparison variety and was significantly different. Fifteen lines had more grain per panicle than the comparison varieties and were significantly different. Two lines had 1000-grain weights higher than the superior varieties and were significantly different. Eight lines had a higher average yield than the comparison varieties. Pae incense is a line with the highest production compared to the check variety. It is significantly different so that it can be further tested to determine the stability of the results

Key words— mass selection, upland rice lines, agronomic characters

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I. INTRODUCTION (*HEADING 1*)

This Around 60% of the world's population consumes rice as the primary food ingredient, especially in Asia [1]. Several countries, such as Asia, Latin America, and Africa, which have a semitropical climate with alternating rainy and dry seasons, grow rice as a commodity [2]. The rice crop commodity plays an essential role in providing food that supports the achievement of national food security. The need for rice as the primary food ingredient for the Indonesian population continues to increase in line with the increase in population every year, which reaches 1.33% per year [3]. In addition, the conversion of fertile land into various industrial and residential facilities continues to increase, so the expansion of rice planting areas is needed. The largest area for rice cultivation is on the island of Java, while the area outside Java is still relatively low. Thus, the extensification of land for rice cultivation needs to be carried out outside Java, where most of the land is dry. Dry land has great potential to support the national rice production increase program by increasing the planted area. In 2017 the total rice harvested area in Indonesia reached 15.71 million ha, 1.16 million ha of which was contributed by dry land [4]. So far, the contribution of upland rice to national rice production is still relatively small. This is because upland rice has a relatively lower yield than lowland rice productivity. In addition, the use of superior varieties has caused the loss of upland rice genetic resources as local varieties [5][6][7]. Efforts can be made to increase the productivity of upland rice through plant breeding. In the practice of plant breeding, genetic diversity is very desirable because the selection will be effective with a broad genetic diversity. *Mass selection* is a selection method that is often used in self-pollinated plants. Many phenotypically similar plants are seeded and mixed in mass selection to form new varieties [8]. The Faculty of Agriculture at Tadulako University 2017 has conducted a mass selection of upland rice from the primary population of local varieties. After five selection cycles, pure lines were obtained from a mass selection. This study aims to determine the agronomic characteristics of upland rice lines resulting from a mass selection.

2. MATERIALS AND METHODS

2.1. *Place and time*

This research was conducted on agricultural land in the village of Petimbe, at an altitude of 500 meters above sea level, with latitude 1° 07'03" and longitude 120° 02'29", Palolo District, Sigi Regency, from January to June. 2022.

2.2. *Upland rice lines*

Eighteen cultivars from exploration results in 2016 from Tojo Una-Una, Poso, and Sigi Regencies, were selected using the mass selection method from 2017 to 2020 in Tamarenja Village, Sindue Tobata District, Donggala Regency, Central Sulawesi Province. Then proceed with the selection of pathways in 2021 at the same place. In 2022, the nineteen lines were evaluated for their agronomic characters using one check varieties: superior varieties of Situbagendit.

2.3. *Tools and Materials*

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The tools used in this study were a hoe, machete, caliper, analytical scale, camera, meter, plastic, measuring cup, and stationery. The materials used include pearl NPK fertilizer, insecticides, and local upland rice cultivars.

2.4. Research design

This study was arranged using a Randomized Block Design (RAK) with 20 cultivars (18 lines from mass selection plus two check varieties) as treatments, namely: G1 = Pae Bohe, G2 = Menso, G3 = Maraki, G4 = Untad I, G5 = Untad II, G6=Untad III, G7=Untad IV, G8=Untad V, G9=Uva Buya, G10=Kalendeng, G11=Pulu Tau Leru, G12=Jahara, G13=Buncaili, G14=Pomegranate, G15=Pae Dupa, G16 = Puyutas, G17=Dongan, G18=Pulu Konta, G19=Local variety, G20=Situbagendit variety (G19 and G20 are check varieties) repeated three times to obtain60 experimental plots.

2.5. Research Implementation

Soil tillage is done by cleaning the soil from weed residue, hoeing, and leveling it. Maintenance includes weeding weeds and spraying the trademark insecticide dharmabas 500 ec with the active ingredient BPMC (butyl phenylmethyl carbamate) with a recommended four ml/1 liter of water. Then make 60 plots of beds with a size of 120 cm x 220 cm, a bed height of 25 cm, and a distance between beds of 60 cm. Planting was done using a table system (direct seed planting) separately, each planting hole filled with five seeds with a depth of 2 cm and a spacing of 20 cm x 20 cm. It is divided into two seedlings at the age of 21 days after planting. Pearl NPK fertilization with a 150 kg/ha dose was given twice. The first fertilization was carried out at 28 DAP and the second at 64 DAP at 50% each by adding 5 cm to the side of the plant. Harvesting was carried out according to criteria; 80–85% of the grains were straw-colored, the seeds at the bottom of the panicle were hard, not soft, and the grains were challenging but not easily broken when squeezed between the teeth.

2.6. Observation Variable

Observations were made on six sample plants. The observed variables included: plant height, number of tillers, number of productive tillers, number of grains per panicle, age of harvest, the weight of 1000 seeds, and yield.

2.7. Statistic analysis

The data were analyzed by analysis of diversity using SPSS version 25 software. If the results of the treatment F test have a significant or very significant effect, then it will be further tested with the Dunnet test of 5%.

3. RESULTS AND DISCUSSION

The analysis of diversity showed that the treatment significantly affected plant height, the maximum number of tillers, the number of productive tillers, the age of flowering, the age of harvest, the number of grains per panicle, the weight of 1000 seeds, and yield. The results of the Dunnet 5% test on plant height, the maximum number of tillers, the number of productive tillers, and flowering age are presented in table 1. In comparison, the results of Dunnet's 5% test on flowering age, number of grains per panicle, the weight of 1000 grains, and results are presented in table 2.

3.1. Plant height

The results of the analysis of diversity showed that the treatment had a very significant effect on plant height. This means that each line has different plant height characteristics. This difference is caused by the genetic composition contained by each strain is different. This study's results align with the results obtained by [9] and [10]. [11] obtained different results; namely, the plant height of the line was not significantly different from that of the check variety. According to [4], the desired plant height of upland rice varieties in Indonesia is 100-120 cm. The results showed that all tested lines had plant heights ranging from 134.06 cm to 171.72 cm, which was higher than the check variety (64 cm) (Table 1). Farmers prefer to keep the size of plants low because tall plants are more sensitive to falling, and falling will reduce grain yields [12]. It was further emphasized that plant height is highly correlated with the rate of fall and ease of harvesting, which is an essential factor in influencing the farmer's acceptance of new cultivars.

Table 1. The average value of plant height, the maximum number of tillers, the number of productive tillers, and 50% flowering age

Lines	Plant height (cm)	Maximum number of tillers	number of productive tillers	50% flowering age
G1 (Pae bohe)	142.11 *	6.44 *	3.78 *	120.33 *
G2 (Meso)	162.17 *	5.33 *	4.44 *	108.33 *
G3 (Maraki)	148.83 *	8.33 ns	5.78 *	122.00 *
G4 (Untad I)	157.60 *	5.22 *	4.44 *	93.00 ns
G5 (Untad II)	141.63 *	4.67 *	3.56 *	85.67 ns
G6 (Untad III)	143.33 *	8.78 ns	5.33 *	97.00 ns
G7 (Untad IV)	171.72 *	5.44 *	3.56 *	99.33 *
G8 (Untad V)	147.56 *	5.78 *	5.67 *	121.00 *
G9 (Uva buya)	139.78 *	5.44 *	4.00 *	97.33 ns
G10 (Kalendeng)	138.37 *	5.20 *	4.53 *	88.33 ns
G11 (Pulu tau leru)	134.06 *	5.89 *	4.11 *	106.00 *
G12 (Jahara)	150.67 *	4.78 *	4.11 *	97.33 ns
G13 Buncaili)	143.28 *	6.33 *	4.89 *	122.67 *
G14 (Delima)	136.21 *	5.73 *	4.51 *	100.67 *
G15 Pae dupa)	140.44 *	10.89 ns	7.44 ns	110.33 *
G16 (Puyutas)	154.94 *	5.89 *	4.00 *	113.67 *
G17 (Dongan)	158.00 *	4.22 *	3.22 *	83.00 ns
G18 (Pulu konta)	148.72 *	5.56 *	4.00 *	129.33 *
G19 (Tako)	162.72 *	4.56 *	4.11 *	95.00 ns
G20 (Situbagendit)	64.00	10.56	8.56	88.67
Dunnet 5%	22.91	2.90	2.49	9.19

Description: ns = non significant; * = significant

3.2. Maximum number of tillers and number of productive tillers

The results of the analysis of diversity showed that the treatment had a significant effect on the number of maximum and productive tillers. The maximum number of tillers of the tested lines was lower than that of the check variety except for line 15 (Pae dupa). Meanwhile, the number of productive tillers of the mass selection lines were, at most, the number of productive tillers of the check variety (Table 1). The results of [12] showed that the number of tillers obtained was more than in this study. [13] reported that the uneven distribution of active photosynthetic radiation (PAR) was a source of heterogeneity in individual tiller yields. Early-emerging superior tillers preceded the topmost light source and overshadowed late-emerging tillers under light-limited conditions.

[14] showed that each clump had 8-18 tillers of selected upland rice varieties. In addition, the number of productive tillers ranged from 7-14 panicles. The number of tillers is determined by genetic characteristics during the vegetative growth phase and is also influenced by environmental factors such as solar radiation. The number of tillers is not only determined by genetics but also influenced by environmental factors such as light. [15] stated that

the number of tillers and adaptability were different from each variety because the differences in each variety were determined by the interaction between the genotype and a favorable environment or under thegrowth and development of rice.

Table 2. Average harvest age, number of grains per panicle, the weight of 1000 seeds, and yield

Lines	Harvest age(days)	number of grainsper panicle	the weight of1000 seeds	Yield (t.ha^{-1})
G1 (Pae bohe)	161.00 *	100.17 tn	23.11 tn	2.15 tn
G2 (Meso)	137.00 *	119.50 tn	22.94 tn	3.13 tn
G3 (Maraki)	160.00 *	92.72 tn	19.33 tn	2.58 tn
G4 (Untad I)	118.00 tn	144.11 *	31.06 *	4.95 tn
G5 (Untad II)	115.00 *	127.33 *	23.67 tn	2.71 tn
G6 (Untad III)	127.00 tn	115.78 tn	25.33 tn	3.89 tn
G7 (Untad IV)	128.00 tn	209.56 *	24.22 tn	4.50 tn
G8 (Untad V)	148.00 *	205.33 *	22.89 tn	6.61 tn
G9 (Uva buya)	120.33 tn	159.67 *	24.33 tn	3.89 tn
G10 (Kalendeng)	116.00 tn	138.67 *	25.27 tn	3.99 tn
G11 (Pulu tauleru)	134.33 tn	133.56 *	24.72 tn	3.39 tn
G12 (Jahara)	126.33 tn	152.56 *	23.83 tn	3.82 tn
G13 Buncaili)	168.00 *	134.39 *	20.61 tn	3.36 tn
G14 (Delima)	129.33 tn	149.44 *	26.33 tn	4.45 tn
G15 (Pae dupa)	141.00 *	148.22 *	26.22 tn	7.08 *
G16 (Puyutas)	142.33 *	164.89 *	26.11 tn	4.39 tn
G17 (Dongan)	112.00 *	130.83 *	24.67 tn	2.71 tn
G18 (Pulu konta)	165.67 *	111.78 tn	28.67 *	3.20 tn
G19 (Tako)	122.67 tn	226.06 *	24.50 tn	5.77 tn
G20 (Situbagendit)	125.00	79.22	22.39 tn	2.15 tn
Dunnet 5%	9.54	44.29	5.89	3.77

Description: ns = non significant; * = significant

3.3. *Flowering and harvesting age*

Flowering age and harvest age are two variables that have a relationship in a crop. The flowering age in upland rice is considered better because water availability is critical for flower formation. Harvest age is an indication of plant maturity. Upland rice harvesting age can be divided into three, namely long (125-150 days), medium (115-125 days), and early (100-115 days) [16]. The results showed that the harvesting age of upland rice lines ranged from 112 to 168 days, meaning that it was classified as early to deep. The check variety has an average harvest age (of 125 days). Ten lines had a harvest age that was not different from the check variety, while the other nine lines were significantly different. Line 17 (Dongan) was the line that had the fastest harvest age compared to other lines and checks varieties (Table 2). The research results by [17] showed that the cultivars tested had early to moderate harvest ages. The results of [18] research that evaluated 17 upland rice genotypes showed that only one genotype had a faster harvesting age than the check variety. The results of research by [19] showed that the check variety had the fastest harvest age compared to the evaluated genotypes.

3.4. *Number of grains per panicle*

The number of grains per panicle is a yield component affecting rice productivity. The resultsshowed that the number of grains per panicle ranged from 79.22 to 209.66. Of the nineteen lines evaluated, five lines did not differ from the check variety, while the other lines did not differ fromthe check variety (Table 2). G7 (Untad IV) and G8 (Untad V) lined with the highest number of grains per panicle compared to other lines and check varieties. The amount of grain contained is different in each variety because each variety has different adaptability in responding to a lack of light for filling seeds [20]. Each rice variety is adaptable to environmental biophysical conditions. The results of the research by [21] showed that the number of productive tillers of mutant lines was more than the check variety. The number of panicle grains of the mutant line was higher than that of the check one variety, while the second check variety was more. The yield of four mutant lines had higher yields than the comparison varieties.

3.5. *Weight 1000 grains*

The weight of 1000 seeds is the yield component determined by the grain size of each variety. Each variety has a specific appearance of grain as a marker of variety, and this appearance includes the weight of 1000 seeds. The analysis of diversity showed that the treatment affected the weight of 1000 grains. This means that each strain has a different weight of 1000 seeds. The results showed that the weight of 1000 seeds ranged from 19.33 to 33.06 grams. The G4 (United 1) and G18 (Pulu Konta) lines were the lines that had the heaviest 1000-grain weight compared to the check variety and were significantly different (Table 2). The weight of the other lines did not differ from the comparison varieties.

3.6. *Grain yield*

The outcome is a very complex trait whose expression is controlled by many genes. The results showed that the treatment significantly affected the yield of upland rice. This means that each strain has a different result. Table 2 shows that all the lines had no different production compared to the check variety except for G15 (Pae dupa), which was different. According to [21], this difference is caused by genetic background, environment, and interaction, but environmental influences dominate over genetics. Plant production is the accumulated, stored carbohydrates produced through photosynthesis during the vegetative and generative phases. In rice plants, most stored carbohydrates result from photosynthesis after the generative phase. Thus production has been described from yield components such as the number of productive tillers, panicle length, number of spikes per panicle, and weight of 1000 grains. [22] stated that rice production depends on at least three components: the number of tillers, the number of panicles, and the weight of 1000 grains. The results of the research by [19], which evaluated several genotypes of upland rice, showedthat the grain yields reached 4.08 to 9.35 tons.ha^{-1} and the check variety used had lower yields than the evaluated cultivars. [23] evaluated four mutant lines and obtained higher yields than the comparison varieties. The results of [18] research that evaluated 17 upland rice genotypes showed that only five genotypes had grain yields exceeding the check variety with a range of 3.43 to 4.44tons.ha^{-1}.

4. Conclusion

Each strain has a different genetic makeup, so the observed traits differ. Vegetative growth, such as plant height and the maximum number of tillers of check varieties, were better than the evaluated lines. Several lines show better trait performance than the situbagendit varieties. Pae incense (G15) is a line with good yields so that it can be tested as a potential line to be developed into superior varieties and used as a parent in other crosses.

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