Morphological characterization of six Lombok upland rice cultivars

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Article Info

Abstract

Lombok upland rice is one of the cultivars that have the potential as a genetic source. However, Lombok upland rice is almost rarely found. Therefore, conservation was carried out through morphological characterization to provide genetic information. This study aimed to describe the characteristics of six Lombok upland rice cultivars, namely, Reket Putek Bulu, Reket Putek Buntung, Reket Bireng Bulu, Reket Bireng Buntung, Pare Beaq Sapit, and Beaq Ganggas. A completely randomized design was used, consisting of these six Lombok upland rice cultivars as treatments. Two superior cultivars were also used for comparison. The study revealed sufficient divergence for various qualitative and quantitative traits. Pare Beaq Sapit and Beaq Ganggas shared common morphological characters, and both were tall plants. The auricle and ligule colors of Reket Bireng Bulu were different from those of the other cultivars. Reket Putek Buntung had the latest flowering and harvesting age. Reket Putek Bulu and Reket Bireng Buntung had a high number of productive tillers. Six cultivars of Lombok upland rice were characterized to have morphological diversity, so that they are expected to be used as genetic material in rice plant breeding, thereby developed to avoid extinction.

INTRODUCTION

Rice is an important food crop for some of the world's population because of its benefits as a staple food. Indonesia is a country that has high level of rice consumption. The population of Indonesia is estimated to reach 311 million by 2050 (Trisia et al., 2016), and its consumption level may be exceeds its production level. Therefore, maintaining the availability of rice supply is needed to increase rice production.

Rice production can be increased through plant breeding programs by creating or developing new superior cultivars. Before starting a rice breeding program, a potential germplasm that can be used as a genetic material must be found first, one of which is derived from rice local cultivars. These cultivars are those that have long been cultivated by farmers and can adapt well to local environment. In addition, local cultivars still have high genetic diversity, indicating that they can be used as cross parents for rice plant breeding or as materials for improving the traits of rice plants.

Nusa Tenggara, including Lombok, has approximately 225 species of rice, from upland and paddy rice (Aryana, 2013). Lombok upland rice is now almost extinct because farmers rarely cultivate this plant due to its late harvesting age (approximately six to seven months) and low production. Interestingly, this rice is often used as food for important traditional events, especially brown rice. Lombok upland rice also tastes sweet and has large grains.

In line with the development of agricultural technology, the discovery of new rice cultivars is developing rapidly. Modern rice cultivars already have superior traits of rice, including high yield,

disease resistance, drought tolerance, and various other superiorities. Increasing productivity is one of the main goals in plant breeding programs, including rice. By using conventional technology and modern technology (biotechnology), plant breeders can produce short-grain rice varieties, new types of rice, and hybrid rice (Khan et al., 2015). Sajid et al. (2015) conducted a morphological characterization in some Pakistani rice accessions and figured out four accessions with positive characters, making them potential genetic materials for a plant breeding program.

Collection and conservation are attempts to protect Lombok upland rice from extinction or genetic erosion (Food and Agriculture Organization, 2014). Conservation can be performed in situ or ex situ. In addition, the preservation of germplasm accompanied by characterization is an effort to provide genes that are useful in repairing, creating, or developing superior cultivars. As a first step in the conservation and development of Lombok upland rice, morphological traits must be characterized, so that such traits can provide descriptive information on the important traits possessed. Accordingly, this study aimed to perform a morphological characterization in six Lombok upland rice cultivars, considering the contribution of germplasms in a plant breeding program, to confer a descriptive elucidation regarding the six rice cultivars.

MATERIALS AND METHODS

A completely randomized design was used, including six Lombok local upland rice cultivars, namely, Reket Putek Bulu, Reket Putek Buntung, Reket Bireng Bulu, Reket Bireng Buntung, Pare Beaq Sapit, and Beaq Ganggas. The cultivars were taken in East Lombok, West Nusa Tenggara. Two rice superior cultivars, Mentik Susu and Inpago-Unsoed 1, collected by the Faculty of Agriculture, Universitas Gadjah Mada, were used for comparison. Each treatment was replicated three times to obtain 24 experimental units.

Seeds were grown in 20 cm × 45 cm polybags containing a mixture of soil and manure with a ratio of 2 : 1. The seeds were then planted individually, four seeds within each polybag. Maintenance includes fertilizing, replanting, weeding, watering and pest and disease control. Fertilization was performed by giving TSP or SP-36 and KCl fertilizer at a dose of 60 kg.ha^{-1} (0.3 g per polybag) and 135 kg.ha^{-1} (0.7 g per

polybag), respectively. Such fertilization was applied at the beginning of planting by applying fertilizer in the holes made near the planting hole before being covered with soil. Meanwhile, urea fertilizer was applied at the age of 10, 35, and 55 days after planting (DAP) at a dose of 150 kg.ha^{-1} (0.8 g per polybag) and evenly distributed around the plants. Replanting was performed seven days after planting (DAP) by replacing dead plants, and one plant was maintained until harvest. Subsequently, weeding and pest and disease control were performed in accordance with field conditions. Harvesting was performed after the rice plants reached full maturity, in which 90 % of the panicles turned yellow.

Morphological characteristics observation was conducted during the vegetative and generative phases and after harvest time. Morphological characteristics were observed from each replication of one randomly selected genotype according to the Standard evaluation system (SES) for rice (International Rice Research Institute, 2013). The variables observed include leaf characteristics (leaf length, leaf width, leaf surface, flag leaf angle, leaf blade color, leaf sheath color, ligule color, ligule shape, collar color, and auricle color), culm characteristics (plant height, number of tillers, number of productive tillers, number of non-productive tillers, culm node color, culm internode color, and culm angle), panicle characteristics (panicle type, panicle axis, secondary panicle branch, and panicle length), and grain characteristics (flowering age, harvesting age, awn presence, and awn color, grain length, grain width, grain thickness, awn length, and 100 grain weight).

Qualitative data were descriptively analyzed, whereas quantitative data were analyzed using Analysis of Variance at α= 5 % significance level to determine differences between cultivars. If the differences were significant, then they were further tested using Least Significant Differences at α= 5 %, which was performed using R software version 3.6.1.

RESULTS AND DISCUSSION

The characterization result of the six Lombok upland rice cultivars indicated a morphological variance in the characteristics of leaf, stem, spikelet, and grain, which can be grouped on the basis of direct observation or calculation. Morphological

Table 1. CV of Lombok upland rice cultivars

Quantitative characteristics	CV (%)
Plant height	4.1
Leaf length	14.7
Leaf width	13.1
Ligula length	18.9
Basal culm internode diameter	19.1
Number of tillers	20.8
Number of productive tillers	22.5
Number of non-productive tillers	87.2
Flowering age	2.9
Harvesting age	4.3
Panicle length	6.8
Awn length	17.1
Rice length	6.3
Rice width	7.5
Grain stickness	19.9
100-grains weight	7.7

Remark: High CV = above 20 – 30 %.

characteristics can be divided into quantitative and qualitative characteristics. Quantitative characteristics are acquired by calculating the diversity coefficient. The coefficient of variation (CV) is used to indicate the variance value in a population. Values above 20 to 30 % indicates high variance (Couto et al., 2013).

Based on Table 1, the characteristics with high CV are the numbers of productive and non-productive tillers, showing a value of 22.5 % and 87.2 %, res-pectively. Meanwhile, the characteristic with lowest CV is flowering age, showing a value of 2.9 %. In plant breeding programs, CV can be useful, for example, to inform the quality of final and intermediary trials of the evaluated crops and indication of new cultivars (Couto et al., 2013). Diversity is the key to run a selection well. High diversity is a potential interference. According to Ovung et al. (2012), genetic diversity contributes to the potential effect of the derivative of a cross on desired recombinant heterosis and frequency in later generations.

Leaf morphological characteristics

The variances in leaf characteristics by measurement are presented in Table 2. The leaf length of Reket Putek Bulu cultivar was not significantly different from that of Reket Bireng Bulu by observation, but significantly different from those of the six other cultivars. The leaf length of the six Lombok upland rice cultivars ranged between 46.3 cm to 63.7 cm, while the high-yielding cultivars were relatively short, ranging between 39.3 cm to 46.3 cm. Moreover, the leaf area of Pare Beaq Sapit cultivar was not significantly different from that of Reket Putek Bulu cultivar, but significantly different from those of the six other cultivars. The leaf area of the six Lombok upland rice cultivars ranged between 1.3 cm to 2.1 cm, which was different from that of the two high-yielding cultivars, which was 1.7 cm on average. Leaf size has a direct significant impact on leaf area (Weraduwage et al., 2015). Leaf area is important in the photosynthesis. Moreover, the light absorption can make the best performance when the leaf size is optimal. When a leaf is too wide, it might inhibit the light absorption of the leaves below it.

In addition to leaf size, the qualitative character-istics of the leaf were observed (Table 2). A variance was found in the leaf blade surface and ligule in the six Lombok upland rice cultivars and two high-yielding cultivars. The first cultivar group comprised interme-diate type of leaves, while the second one comprised those with hair presence on the leaf blade surface. The first group also had acuminate ligules, whereas the others had split ligules (Figure 1). A study by

Table 2. Leaf characteristics of Lombok upland rice and two superior cultivars

Characteristics	Reket Putek Buntung	Reket Putek Bulu	Reket Bireng Bulu	Reket Bireng Buntung	Pare Beaq Sapit	Beaq Ganggas	Mentik Susu	Inpago-Unsoed 1
Leaf length (cm)	47.0 bcd	63.7 a	60.3 abc	55.7 bcd	49 bcd	46.3 cd	46.3 cd	39.3 d
Leaf width (cm)	1.7 bc	2.0 ab	1.3 d	1.6 cd	2.1 a	1.5 cd	1.7 bcd	1.7 bcd
Ligule length (cm)	2.4 a	2.0 ab	1.3 cd	1.6 bcd	1.8 bc	1.1 bc	1.7 bc	1.3 cd
Leaf blade surface	2	2	2	2	2	2	1	1
Leaf blade color	2	2	2	2	2	2	2	2
Collar color	1	1	1	1	1	1	1	1
Auricle color	1	1	2	1	1	1	1	1
Leaf angle	1	1	1	1	1	1	1	1
Leaf node color	1	1	1	1	1	1	1	1
Leaf sheath color	1	1	1	1	1	1	1	1
Ligule color	1	1	2	1	1	1	1	1
Ligule shape	1	1	1	1	1	1	2	2

Remarks: Leaf blade surface: 1 = no hairs, 2 = intermediate; Leaf blade color: 2 = green; Collar color: 1 = green; Auricle color: 1 = white, 2 = purple line; Culm angle: 1 = erect; Leaf node color: 1 = green; Leaf sheath color: 1 = green; Ligule color: 1 = white, 2 = purple line; Ligule shape: 1 = acuminate, 2 = Split. (The number subsequently followed by the same alphabet in the same line was significantly the same based on the Least Significant Different test at α= 5 %).

Figure 1. Acuminate shapes of Pare Beaq Sapit (A) and Reket Putek Bulu (B) and two-cleft shape in Mentik Susu (C)
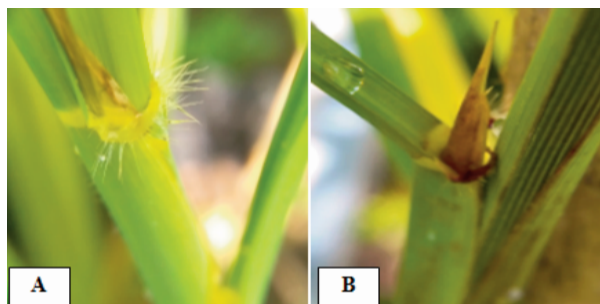

Figure 2. Green auricle in Reket Putek Bulu (A) and purple auricle in Reket Bireng Bulu (B)

Rawte et al. (2017) had also reported 95 % of landraces with split shape of ligule.

The characteristics of the leaf blade surface were potentially related to the tenacity against the bacterial leaf blight disease. The leaf blade surface, especially cuticle thickness, either structurally or chemically, was related to the pathogenic and non-pathogenic microorganism activities cloning the surface (Wheeler, 1975). In this research, the six Lombok upland rice cultivars had an intermediate type leaf surface, whereas the two high-yielding cultivars had a slippery leaf blade surface with no hair presence. Based on this finding, Lombok upland rice can be considered a crossbreed or in rice development, and it may have tenacity against the bacterial leaf blight disease.

Meanwhile, all characterized cultivars had green leaf blade, leaf sheath, and leaf node. The leaf blade color had a significant impact on farmers' preference for a new high-yielding cultivar. That 70 % of farmers prefer the harvesting time to the leaf blade color (Mokuwa et al., 2014). Green is the most preferred leaf color when compared to dark green or light green. The six Lombok upland rice cultivars had green leaves, making them possible options when selecting parents in crossbreeding.

Meanwhile, the leaf ligule and auricle could distinguish rice from grass at the seedling stage. Reket Bireng Bulu cultivar had a purple auricle, whereas another cultivar had a white one (Figure 2). Similarly, Reket Bireng Bulu cultivar had a purple-lined ligule, whereas another cultivar had a white-

lined ligule (Figure 1). The leaf ligule protect the axilla from debris, preventing a decay (Dresvyannikova et al., 2019).

Culm morphological characteristics

Table 3 indicates that plant height varied between cultivars. In terms of height, Reket Putek Bulu cultivar was not significantly different from Pare Beaq Sapit and Beaq Ganggas cultivars, yet significantly different from the five others. The six Lombok upland rice cultivars were categorized as tall plant types in the rice group (Figure 3). This categorization is in line with Nurhasanah et al. (2016), confirming the non-existence of local rice shorter than 100 cm. Meanwhile, the two other cultivars were shorter due to mutation or breeding.

Observation of the number of tillers and productive tillers indicated a varied number in all cultivars, especially in the six Lombok upland rice cultivars, which had fewer tillers and productive tillers than the two high-yielding cultivars. Mentik Susu cultivar was significantly different from other cultivars. It had the highest number of tillers and productive tillers. The number of tillers was indeed different based on the genotype. In addition to the genetic factors, space, soil fertility level, and environment supporting plant growth were the factors affecting tiller production. Moreover, in terms of the number of non-productive tillers, Mentik Susu cultivar was significantly different from Reket Putek Bulu, Pare Beaq Sapit, and Beaq Ganggas cultivars. It had the highest number of non-productive tillers. Variation in the number of productive tillers and number of non-productive tillers are related to the genetic factors and the environment including soil nutrient, water, or light required for photosynthesis. Furthermore, branches can be overlapped due to space limitation, thereby disturbing the plant growth (Chomicki et al., 2017).

In terms of bottom culm diameter, no significant difference was found in all characterized cultivar.

Table 3. Culm characteristics of Lombok upland rice and two superior cultivars

Characteristics	Reket Putek Buntung	Reket Putek Bulu	Reket Bireng Bulu	Reket Bireng Buntung	Pare Beaq Sapit	Beaq Ganggas	Mentik Susu	Inpago-Unsoed 1
Plant height (cm)	126.7 b	137.0 a	124.7 b	128.0 b	146.7 a	148.0 a	95.7 c	83.7 d
Number of tillers (cm)	4.3 cd	6.0 cde	7.3 cd	11.3 b	7.7 c	3.3 e	22.7 a	8.3 bc
Number of productive tillers	3.7 d	3.0 d	3.7 d	9.3 b	7.0 bc	2.7 d	17.7 a	6.3 c
Number of non-productive tillers	2.3 ab	1.3 b	3.7 ab	2.0 ab	0.7 b	0.7 b	5.0 a	2.0 ab
Basal culm internode diameter	0.6 a	0.5 a	0.6 a	0.6 a	0.6 a	0.6 a	0.5 a	0.5 a
Internode culm color	2	2	2	2	2	2	1	1
Culm angle	1	1	1	1	1	1	1	1

Remarks: Culm angle: 1 = erect; Internode culm color: 1= green, 2= yellow gold. (Means followed by the same letters in the same line are not significantly different based on the Least Significant Different test at α= 5%).
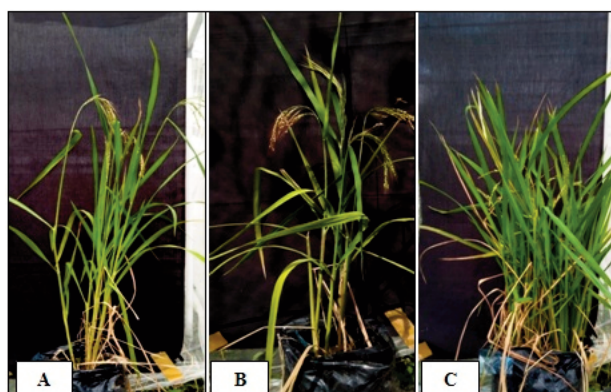

Figure 3. Height difference between Pare Beaq Sapit cultivar (A), Reket Putek Bulu cultivar (B), and superior Mentik Susu cultivar (C).

The six Lombok upland rice cultivars had golden-yellow culms, whereas the two high-yielding cultivars had green culms. All characterized cultivars had straight angle culms. Angle culms are useful in determining accurate density. A straight angle culm enables high density, whereas an open angle culm requires a low density for overlapping leaves because the high density limits the ability to photosynthesize.

Panicle Morphological Characteristics

The six Lombok upland rice cultivars and the two high-yielding cultivars indicated varied values in panicle morphological characteristics (Table 4). Beaq Ganggas cultivar had the longest panicle, suggesting a significant difference from other cultivars. Juhriah et al. (2013) and Kartina et al. (2020) categorized panicle length into short (< 20 cm), medium (20 cm to 30 cm), and long (> 30 cm). In this categorization, Reket Putek Buntung, Reket Putek Bulu, and Beaq Ganggas belong to the long panicle group, whereas the other cultivars, including two high-yielding cultivars, belong to the medium panicle group. Variation was affected by the genetic factors of cultivar. Liu et al. (2011) and Yao et al. (2015) explained that panicle length is affected by the genetic factors of rice cultivars. The longer the panicle, the more the grains. If farmers cannot maintain the same environment and field, then the panicle length of the cultivars is the same.

The number of secondary panicles in each cultivar varied, whereas that of branches affected yield of rice plants. Each panicle can contain 100 – 120 rice florets (Zhang et al., 2017). Reket Putek Bulu and Reket Putek Buntung cultivars had medium panicle, whereas other cultivars had compact panicles. Flag leaf senescence was early in all Lombok upland cultivar, whereas that in the two superior cultivars was late (Figure 4). All characterized cultivars had a straight panicle axis, whereas Mentik Susu cultivar had a droopy panicle.

Grain morphological characteristics

The grain morphological characteristics of the six Lombok upland rice cultivars and two high-yielding cultivars are presented in Figure 5. Table 5 indicates that all grain characteristics came with varied values

Table 4. Panicle characteristics of Lombok upland rice and two superior cultivars

Characteristics	Reket Putek Buntung	Reket Putek Bulu	Reket Bireng Bulu	Reket Bireng Buntung	Pare Beaq Sapit	Beaq Ganggas	Mentik Susu	Inpago-Unsoed 1
Panicle length (cm)	33.6 bc	30.4 c	21.4 e	26.3 d	34.1 b	39.2 a	26.1 d	20.6 d
Panicle type	1	5	5	1	1	1	1	1
Secondary panicle branch	2	2	2	2	2	2	2	2
Flag leaf senescence	1	1	1	1	1	1	5	5
Panicle axis	1	1	1	1	1	1	2	1

Remarks: Hair presence: 0 = glabrous, 5 = short, 9 = long; Hair color: 3 = brown, 4 = red; Grain shape: 1 = slender, 2 = thick; Grain tip color: 2 = pale yellow, 4 = red; Panicle type: 1 = compact, 5 = intermediate; Secondary panicle branch: 2 = heavy; Flag leaf senescence: 1 = early, 5 = late; Panicle axis: 1 = straight, 2 = droopy.
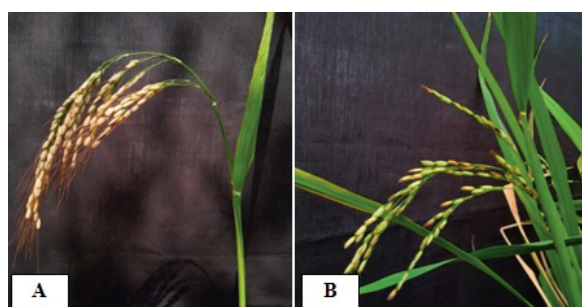

Figure 4. Early flag leaf senescence in Reket Putek Bulu cultivar (A) and late flag leaf senescence in superior Mentik Susu cultivar (B)

Table 5. Grain characteristics of Lombok upland rice and two superior cultivars

Characteristics	Reket Putek Buntung	Reket Putek Bulu	Reket Bireng Bulu	Reket Bireng Buntung	Pare Beaq Sapit	Beaq Ganggas	Mentik Susu	Inpago-Unsoed 1
Flowering age (DAP)	142 a	96 e	95 e	108 c	102 d	107 cd	121 b	92 e
Harvesting age (DAP)	200 a	152 b	138 c	164 b	154 b	193 a	137 c	137 c
Awn presence	0	9	5	0	9	5	0	0
Awn color	-	4	3	-	3	3	-	-
Awn length (cm)	0	4.3 a	1.8 c	0	3.4 b	3.0 b	0	0
Rice length (mm)	7.0 c	8.0 ab	8.0 ab	8.0 ab	7.9 bc	9.0 a	7.9 bc	7.0 c
Rice width (mm)	1.9 a	1.8 a	1.9 a	1.7 a	1.9 a	1.9 a	1.4 b	1.7 a
Rice thickness (mm)	1.3 a	1.2 ab	0.9 b	1.2 ab	1.3 a	1.2 ab	0.5 c	0.3 c
Grain 100 weight (g)	3.5 b	3.3 b	2.3 c	2.7 c	4.2 a	4.3 a	1.9 d	1.5 e
Grain shape	2	2	1	1	2	2	1	1
Grain tip color	2	4	2	2	2	2	2	2

Remarks: DAP = days after planting; Awn presence: 0= no awn, 5= short, 9= long; Awn color: 3= brown, 4= red; Grain shape: 1=slender, 2=thick; Grain tip color: 2=pale yellow, 4= red. (Means followed by the same letters in the same line are not significantly different based on the Least Significant Different test at α= 5 %)

Figure 5. Grain characteristics of Reket Bireng Bulu (a), Reket Bireng Buntung (b), Reket Putek Buntung (c), Reket Putek Bulu (d), Beaq Ganggas (e), Pare Beaq Sapit (f), Mentik Susu (g), and Inpago-Unsoed 1 (h)

in all characterized cultivars. Reket Putek Buntung had the earliest flowering period, which was 142 DAP, indicating a significant difference from the other cultivars. Moreover, Reket Putek Buntung had the latest harvesting age, which ranged 193 – 200 DAP, suggesting a non-significant difference from Beaq Ganggas. Variation in the flowering and harvesting age was due to genetic and environmental factors. Zhao et al. (2011) and Huang et al. (2012) mentioned that the flowering age of rice cultivar is affected by the genetic traits of cultivars. The period is also affected by sun radiation intensity, temperature, or height.

Furthermore, Reket Putek Bulu, Reket Bireng Bulu, Pare Beaq Sapit, and Beaq Ganggas cultivars

had awn, whereas the other cultivars did not. The awn length of Reket Putek Bulu cultivar was significantly different from those of Reket Bireng Bulu, Pare Beaq Sapit, and Beaq Ganggas cultivars. Reket Putek Bulu had the longest awn in the red color, whereas the three others had brown awn.

Beaq Ganggas cultivar had the longest grain, measuring 9.0 mm, which was significantly different from those of Reket Putek Buntung, Pare Beaq Sapit, and two high-yielding cultivars. The grain width of Mentik Susu cultivar, as the high-yielding cultivar, was significantly different from that of the other cultivars. Its width was the smallest, which was 1.4 mm. The six Lombok upland rice cultivars

had thicker grains than those of the two high yielding cultivars. Moreover, the grains of Beaq Ganggas and Pare Beaq Sapit cultivars were the heaviest, followed by those of Reket Putek Buntung, Reket Putek Bulu, Reket Bireng Buntung, and Reket Bireng Bulu.

Morphological Classification

In disclosing similarities and dissimilarities of a plant, genetic classification is crucial. Cluster analysis is deployed to analyze diversity and group plants based on morphological observations or group several populations of certain species by the degree of morphological commonness (Smith and Smith, 1989). Additionally, it allows us to examine inter-species commonness correlation presented in the form dendrograms. Here, we exerted two morpho-logical characteristics, which are quantitative and qualitative, in dendrogram analysis presented in Figure 6 and Figure 7.

The cluster analysis using qualitative characteristics (Figure 6) revealed that Pare Beaq Sapit and Beaq Ganggas cultivars shared a high coefficient of simi-
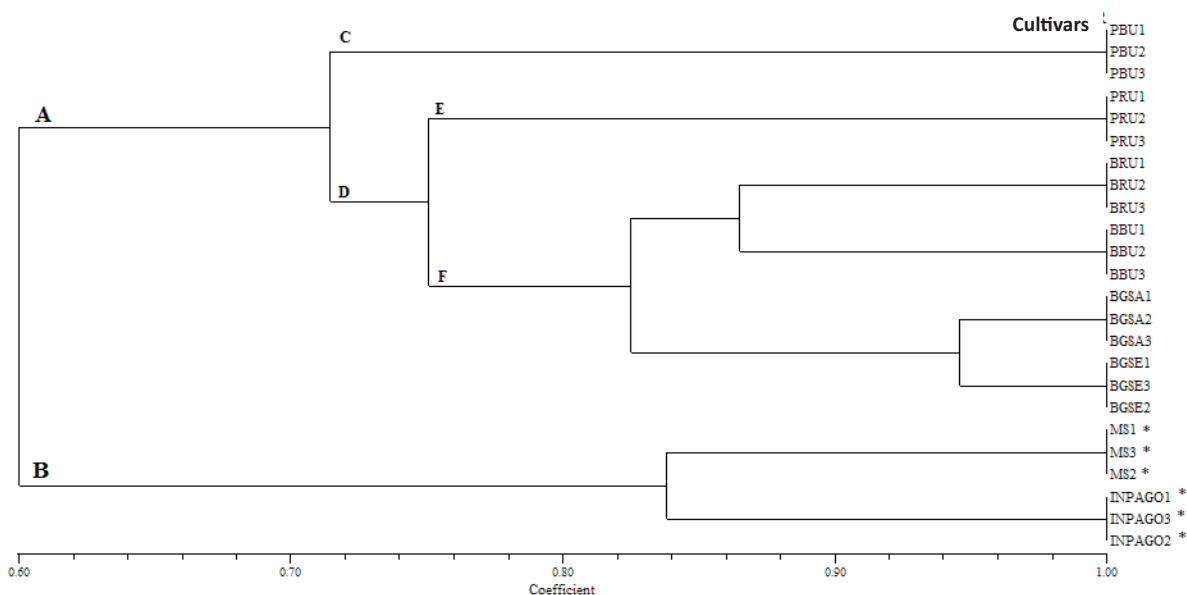

Figure 6. Dendograms of Lombok upland rice based on individual data of qualitative characters (Remarks: *Superior cultivars; PBU: Reket Putek Buntung; PRU: Reket Putek Bulu; BRU: Reket Bireng Bulu; BBU: Reket Bireng Buntung; BGS: Pare Beaq Sapit; BGSE: Beaq Ganggas; MS: Mentik Susu; INP: Inpago Unsoed 1).
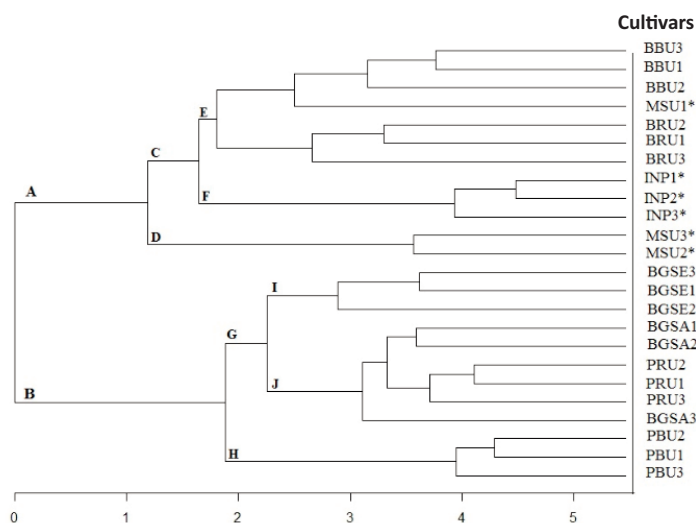

Figure 6. Dendograms of Lombok upland rice based on individual data of quantitative characteristics (Remarks: *Superior cultivars; PBU: Reket Putek Buntung; PRU: Reket Putek Bulu; BRU: Reket Bireng Bulu; BBU: Reket Bireng Buntung; BGS: Pare Beaq Sapit; BGSE: Beaq Ganggas; MS: Mentik Susu; INP: Inpago Unsoed 1).

larities, namely 0.9, indicating that they had the closest genetic distance and shared the highest number of common characteristics. Meanwhile, Reket Putek Buntung cultivar manifested the furthest genetic distance at a coefficient of 0.71. Such a genetic distance was because Reket Putek Bulu cultivars had the least similarities to other cultivars tested. However, it was later found that Reket Putek Bulu was incredibly similar to Reket Putek Buntung by characteristics, except for hair presence.

Moreover, the cluster analysis using quantitative characteristics (Figure 7) pointed out Pare Beaq Sapit and Mentik Susu cultivars were individually segregated with peer groups and other cultivar groups. This differentiation is likely bred by mutation or the result of crosses, which came from other species. Also, it shows a potential contribution of geographical location or environment to the phenomenon. In the genetic concept, a variation of phenotypes is the product of an expression between the variation of genotypes and the environment, making the first variation largely affected by the environment (Frankham et al., 2002). However, genetic classification using morphological characteristics calls for a further validation by deploying more other accurate characters, specifically molecular. This is because genotypes derived from the same area did not necessarily belong to the same cluster. As such, geographical location is not always related to the genetic variation (Daradjat et al., 2009). Hartati et al. (2010) argued that population classification was not invariably connected to geographical location although geographically adjacent populations were inclined to form particular sub-clusters.

The cluster analysis exerting qualitative and quantitative characteristics shows differences in a kinship seen from the degree of similarities between cultivars investigated. In plant breeding, kinship between individuals or populations is often used as reference in assembling superior cultivars with certain desired characters (Sunarto, 1997). Conceptually, individuals or populations with distant genetic kinship are more commonly used as parent in the activity. It is because a cross between individuals or populations with distant kinship generally produces offspring with a high genetic variation (Sunarto, 1997). This study found out that Beaq Ganggas, Pare Beaq Sapit, and Reket Putek Buntung, observed using qualitative characteristics, and Reket Putek Buntung and Reket Bireng Bulu, observed using quantitative ones, were five cultivars of Lombok upland rice with the furthest kinship. Hence, they were potential superior parents for the future rice breeding programs, decided by considering the result of characterization made.

Meanwhile, crosses between parents from close kinship are avoided for they might narrow down the genetic variation of offspring (Sunarto, 1997). As contended by this study, Beaq Ganggas, Pare Beaq Sapit, and Reket Putek Buntung, based on qualitative characters, and Reket Putek Buntung and Reket Bireng Bulu, based on quantitative ones, shared a high degree of commonness. Therefore, a high genetic variation and few genetic similarities of germplasm constitute a remarkably useful capital in the future rice breeding programs (Mangoendidjojo, 2003).

CONCLUSIONS

The present study revealed sufficient divergence for various qualitative and quantitative traits. Pare Beaq Sapit and Beaq Ganggas shared common morphological characters, and both were tall plants. The auricle and ligule colors of Reket Bireng Bulu were different from those of the other cultivars. Reket Putek Buntung had the latest flowering and harvesting age. Reket Putek Bulu and Reket Bireng Buntung had a high number of productive tillers.

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