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The Characteristics of the Morphological Genotypes of Local Sorghum [*Sorghum bicolor* (L.) Moench] from Buton Selatan

Agus Slamet[a*], Hisra[b], Rajab[c]

[a] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Buton, Indonesia
[b] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Buton, Indonesia
[c] Department of Agriculture of Buton Selatan Regency, Sulawesi Tenggara, Indonesia

[*]Corresponding author: Jl. Betoambari No. 36 Kota Baubau, Sulawesi Tenggara, 93726, Indonesia. E-mail addresses: aslametgus@gmail.com

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a b s t r a c t

Local sorghum (*Sorghum bicolor*) is a cereal crop that the people of Bahari Village, Buton Selatan Regency still cultivate as an interlude crop of corn. Local sorghum (*Sorghum bicolor*) functions as genetic material and a gene donor to improve the crop's characters in a plant breeding program. Therefore, it is necessary to take conservation steps to maintain the availability of sorghum germplasm collections. This study aims to characterize local sorghum (*Sorghum bicolor*) from Bahari Village, Buton Selatan Regency based on morphological characters (qualitative vegetative and generative parameters) and agronomic characters. This study was an explorative study that directly identified the genotypes of local *Sorghum bicolor* cultivated in the field. This study reveals six genotypes of local *Sorghum bicolor*; they are *Labanda, Lapandewa, Lagadi, Wapinauri, Mbae,* and *Madea.* The differences in sorghum genotypes can be more clearly identified in the generative phases, namely the symmetrical and pyramidal panicle shapes; the panicle density can be grouped into loose, slightly compact, and compact; husk colors vary from black, orange, grey, yellow, white, to red; the husk traits are categorized into short, slightly long, and very long; and the seeds are categorized round and round flat and white and brown. Meanwhile, the agronomic characters indicate that sorghum genotypes have long panicles; the weight of 100 seeds vary in categories from very low, low, to moderate; and one sorghum genotype (genotype *Lagadi*) has the fastest flowering and harvest ages than the other genotypes.

1. Introduction

Local sorghum (*Sorghum bicolor*) is a cereal crop that is potentially cultivated in Indonesia as foodstuffs (Irawan & Sutrisna, 2016), forage (Koten et al., 2012), or bioethanol (Dahlberg et al., 2011). Suarni and Subagio (2013) assert that sorghum crops are potentially cultivated as a functional food because it contains low gluten and glycemic index (GI) that are very suitable for diets and people with diabetes. Furthermore, sorghum crops contain anthocyanin compounds that function as antioxidants (Pasha et al., 2015) and phenolic compounds that function as anti-cancer (Arias & Bhatia, 2015).

Sorghum has the most features among other crops, such as 1) high level of adaptability in dryland (Borrell et al., 2014), 2) low water requirement (Susilowati & Saliem, 2013), 3) resilience to marginal land like acid land (Human et al., 2010), 4) ability to grow in slop lands and 5) resistance to pests and diseases (Rifa'i et al., 2015). Irawan and Sutrisna (2016) deploy that drylands can be potentially utilized to grow sorghum up to 23.9 million ha.

Sorghum crops developed in Indonesia are currently cultivated in drylands, such as in Sulawesi, Nusa Tenggara Timur, and Nusa Tenggara Barat. However, in Bahari Village, Buton Selatan Regency, and sorghum crops are only planted as an interlude crop of corn. To preserve the genetic diversity of sorghum, conservative steps, either-situ or ex-situ, are necessary. Furthermore, it is necessary to conduct a study on identifying and characterizing genotypes of local sorghum cultivated in Buton Island. The genetic diversity of local sorghum can be used as genetic material and a gene donor to improve the crop's characters in a plant breeding program. A plant breeding program is impossibly conducted without highly genetic materials, and thus, sorghum germplasm collections are necessarily inventoried.

The identification and characterization aim to investigate principle characters/traits that bring economic values or examine the characteristics of a certain variety. Kusumawati et al. (2013) assert that several characters of sorghum that are possibly investigated are morphological characters including leaf shapes, fruit shapes, seed coat colors, etc.; agronomic characters including harvest age, crop height, petiole length, number of tillers, etc.; and physiologic characters including allelopathic, phenolic, alkaloid compounds, etc. These characters are essential to produce gene sources and potential traits that are readily used in sorghum plant breeding programs.

This study aims to attain information on morphological and agronomic characters of local sorghum (*Sorghum bicolor*) genotypes cultivated in Bahari Village, Buton Selatan Regency. The information can be utilized to improve the effectiveness of selecting various principal characters in plant breeding programs.

2. Method

This study was conducted in Bahari Village, Sampolawa District, Buton Selatan Regency from May to August 2019. The village is located at an altitude of 20 - 50 m above sea level with latosol soil. Its air temperature is 25-32^0 C with rainfall ranging from 497-2644 mm/year. This study was an explorative study that employs an exploratory method to directly identify local sorghum genotypes cultivated by the society in the field. The materials utilized were local sorghum crops, and the tools utilized were stationary, scissors, plastic, name tags, meters, and digital cameras.

The morphological characters observed were qualitative parameters of the vegetative phases of leaves and stems including leaf surfaces, leaf tongues (presence or absence of ligules), and stem colors of sprouts; and qualitative parameters of the generative phase including seed colors, seed shapes, seed sizes, panicle shapes, panicle density, husk properties, and husk colors. Meanwhile, the agronomic characters observed included panicle length, seed weight, flowering age, and harvest age. Then, the data of this research were analyzed by employing a descriptive qualitative method.

3. Result and Discussion

Sorghum crop is one of the cereal crops cultivated by people in Bahari Village, Buton Selatan Regency as an altitude crop of corn. Recently, the information on morphological and agronomic genotypes of local sorghum bicolor of Buton Island has not been available. The determination of local sorghum genotypes encounters several obstacles, for example cultivating local sorghum in different areas. This study reveals six genotypes of local sorghum including G1 (*Labanda* genotype), G2 (*Lapandewa* genotype), G3 (*Lagadi* genotype), G4 (*Wapinauri* genotype), G5 (*Mbae* genotype), and G6 (*Madea* genotype).

The qualitative parameters of the vegetative phase of leaves and stems including leaf surfaces, leaf tongues (presence or absence of ligules), and stem colors of sprouts denote uniform appearance.

Table 1. The qualitative parameters of the vegetative phase

Genotype	Leaf surface	Leaf tongues	Stem colors of sprouts
G1	Slick	Exist	Green
G2	Slick	Exist	Green
G3	Slick	Exist	Red/Purplish black
G4	Slick	Exist	Green
G5	Slick	Exist	Green
G6	Slick	Exist	Green

Table 1 indicates that the qualitative parameter observed in vegetative age does not show significant differences among local sorghum genotypes: G1, G2, G3, G4, G5, and G6. This finding agrees with a study by Kusumawati et al. (2013) who report that five sorghum genotypes characterized in Sukarami, Solok Regency do not denote morphological differences. The only character that differentiates local sorghum genotypes in Bahari is the stem colors of sprouts. This study reveals that of the six local sorghum genotypes, G3 (*lagadi*) has red or purplish-black stem color of sprouts. Stem colors are influenced by anthocyanin levels in plants. Suliartini et al. (2011) deploy that anthocyanin pigments are phenolic compounds that result in red color for upland rice (*padi gogo*), and the blacker color indicates high anthocyanin levels.

The morphological characters of the generative phase observed are panicle characters (panicle shapes, panicle density), husk characters (husk characteristics and husk colors), and seed characters (seed colors, seed shapes, and seed sizes). This generative phase indicates differences in the six Bahari local sorghum genotypes. The generative characters are presented in Table 2.

Table 2. The morphological characters of the generative phase of Bahari local sorghum genotypes

Generative parameter		**Local sorghum genotypes**					
		G1	**G2**	**G3**	**G4**	**G5**	**G6**
Panicle	Panicle shapes	Pyramidal	Symmetrical	Pyramidal	Symmetrical	Pyramidal	Pyramidal
	Panicle density	Loose	Compact	Loose	Compact	Slightly compact	Compact
Husk	Husk characteristics	Moderate	Moderate	Moderate	Long	Moderate	Long
	Husk colors	Black	Orange	Grey	Yellow	White	Red
Seed	Seed colors	Brown	White	Brown	White	White	White
	Seed shapes	Flat round	Round	Round	Flat round	Round	Flat round
	Seed sizes	Very small	Very small	Very small	Very small	Very small	Very small

The panicle characters of six Bahari local sorghum genotypes vary as presented in Figure 1.

Figure 1. The morphological panicle characters of Bahari local sorghum genotypes G1: *Labanda* sorghum; G2: *Lapandewa* sorghum; G3: *Lagadi* sorghum; G4: *Wapinauri* sorghum*;* G5: *Mbae* sorghum; and G6: *Madea* sorghum.

The morphological panicle characters of Bahari local sorghum genotypes have various shapes. Trikoesoemaningtyas et al. (2018) argue that the pinnacle shapes become the most primarily different characters of sorghum genotypes. There are nine panicle shapes of sorghum; they are inverted pyramid (width at the top), namely inverted-pyramidal (width at the top), symmetrical, wide at the bottom, pyramidal, oval, cylindrical, and elliptical (resembling a flute and a cone) (UPOV, 2015). The results of identification reveal that Bahari local sorghum has two panicle shapes: symmetrical (found in G2, G4, and G6 sorghum) and pyramidal (found in G1, G3, and G5 sorghum). This result agrees with the research result by Mukkun et al. (2018) who characterize 53 local sorghum species in Nusa Tenggara Timur and find two panicle shapes: symmetrical and pyramidal.

Besides the panicle shapes of sorghum, panicle density becomes another obvious character to compare the differences of genotypes. The results of observation reveal three types of panicle density; they are loose (on G1 and G2), slightly compact (on G5), and compact (on G2, G4, and G6). Moreover, the same results are reported by Kusumawati et al. (2013) who investigate local sorghum in Sukarami, Solok Regency, and find three types of panicle density; they are loose, slightly loose, and compact. Meanwhile, a study assessing local sorghum in East Java reveals two kinds of panicle density; they are loose and compact. The cultivated sorghum is aimed at possessing compact panicles because the density positively correlates to high yields (Brown et al., 2006).

Different from the morphological parameters of the vegetative phase, the morphological characters of the generative phase, denote highly wide varieties of the six Bahari local sorghum genotypes, particularly on panicles and seeds. These varieties are presented in Figure 2.

Figure 2. The morphology of panicles and seeds of Bahari local sorghum; G1: *Labanda* sorghum; G2: *Lapandewa* sorghum; G3: *Lagadi* sorghum; G4: *Wapinauri* sorghum*;* G5: *Mbae* sorghum; and G6: *Madea* sorghum

Bahari local sorghum genotypes have various panicle colors: black, orange, grey, yellow, white, and red. Red and black sorghums contain tannins and anthocyanins that are ten times as many as white sorghum (Dykes & Rooney, 2006). Kondombo et al. (2016) assert that sorghum is a self-pollinating crop with a high pollination rate because its panicles are very light and open. The results of the cross-breeding of the oldest sorghum grains result in various colors. This indicates that the cross-breeding in sorghum crops produces a new genotype that increases the variety of sorghum germplasms.

Furthermore, the panicle characteristics of Bahari local sorghum genotypes have different characters. Kusumawati et al. (2013) argue that the panicle characteristics are classified into four types: very short (covering 25% of a seed), short (covering 50% of a seed), slightly long (covering 75% of a seed), and very long (covering 100% of a seed). This study reveals that G1 and G2 have similar panicle shapes that are covering 100% of the seed; G2 and G4 have panicles that almost cover the whole seeds; and G3 and G5 have panicles that are classified as short.

The seed color character of Bahari local sorghum genotypes only consists of two colors: brown and white. The varieties of sorghum seed colors are caused by colors and pericarp thickness (Trikoesoemaningtiyas et al., 2018), endosperm color (Andriani & Isnaini, 2013), and the existence of a layer of tannins and genes that control the strength of colors (Porter, 2011). Sutrisna et al. (2013) state that the genotype of white seeds is potentially utilized as foodstuff. Meanwhile, high tannin of red and brown (dark) sorghums can inhibit the crop body's ability to absorb protein and other nutrition. However, sorghum with dark seeds (red and brown) is more resistant to fungus because it has higher phenols than sorghum with light colors (Saniaty et al., 2017).

The characters of seed shapes and seed sizes of the six Bahari local sorghum are uniforms. (Berenji et al., 2011) state that there are three types of seed shapes: narrowly elliptical, elliptical, and flat round. The observation reveals that the seed shapes and seed sizes of all local sorghum genotypes are not different. Furthermore, this study reveals that Bahari local sorghum genotypes have a round shape and very small seeds ($\pm$ 0.2 mm). This finding is similar to that by (Rifa'i et al., 2015) who report that sorghum seeds observed are round with conical tips.

Some of Bahari local sorghum genotypes observed indicate different agronomic characters that include parameters of panicle length, number of panicles, the weight of 100 seeds, flowering age, and harvest age. The agronomic characters are presented in Table 3.

Table 3. Agronomic parameters of Bahari local sorghum genotypes

Parameters	Local sorghum genotypes					
	G1	**G2**	**G3**	**G4**	**G5**	**G6**
Panicle length (cm)	34.5	35.1	35.4	35.2	37.1	31.5
Weight of 100 seeds (gr)	2.10	2.15	2.50	2.6	1.50	2.69
Flowering age (dap)	50-70	50-70	40-50	50-70	50-70	50-70
Harvest age (dap)	90-100	90-100	80-90	90-100	90-100	90-100

G1: *Labanda*; G2: *Lapandewa*; G3: *Lagadi*; G4: *Wapinauri*; G5: *Mbae*; G6: *Modea* dap: days after planting

Table 3 shows that all sorghum genotypes measured have uniform panicle lengths (classified as long). Saniaty et al. (2017) deploy that the character of panicle lengths varies from 31–40 cm and is considered long. Meanwhile, the weight character of 100 grains are classified into five categories: very low (< 1.6 g), low (1.6–2.5 g), moderate (2.6–3.5 g), high (3.6–4.5 g), and very high (> 4.5 g) (Berenji et al., 2011). The majority of sorghum genotypes observed are categorized as very low (G5), low (G1, G2, and G3), and moderate (G4 and G6). Meanwhile, the observation result reveals that the flowering age and harvest age of the G3 sorghum genotype is the fastest among the other local sorghum genotypes. This condition is influenced by factors of nutrition and the environment. The factors of nutrition and environment are highly required during growth. The appropriate environment for growth will stimulate plants to flower and harvest age faster (Sulistyowati et al., 2016; Motlhaodi et al., 2018)

4. Conclusion

This study successfully identified six Bahari local sorghum genotypes: G1 (*Labanda* sorghum), G2 (*Lapandewa* sorghum), G3 (*Lagadi* sorghum), G4 (*Wapinauri* sorghum), G5 (*Mbae* sorghum), and G6 (*Modea* sorghum). The differences in sorghums can be more obviously observed in the generative phase. These differences include symmetrical and pyramidal panicle shapes; panicle density ranging from loose, slightly compact, to compact; panicle colors varying from black, orange, grey, yellow, white, to red; the panicle characters ranging from short, slightly long, and very long; and seeds ranging from round and round flat as well as white and brown. Meanwhile, the agronomic characters of sorghum genotypes reveal that the panicles are considered long; the weight of 100 seeds varies from very low, low, and moderate; one sorghum genotype (*Lagadi* sorghum) has the fastest flowering age and harvest age among the other genotypes.

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