Potential Development of Sorghum Plants (*Sorghum bicolor* L. Moench) as Alternative Animal Feed in South Konawe Regency

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ABSTRACT
Sorghum *(Sorghum bicolor* L. Moench*)* is a cereal crop that has potential to be cultivated and can be relied upon as a source of ruminant animal feed, especially in marginal and dry areas in Indonesia. This study aims to find out the potential of sorghum plants as alternative feed ruminant cattle in South Konawe district. This study used 13 strains of Sorghum namely SAAR/2/*WAXWING, O/HP-82-A-15-1-4, O/HP-12-A1-1-9, O/HP-78-A22-3-7, O/HP-6-A8-2-10, O/HP-22-A27-1-10, O/HP-92-A1-1-3, O/HP-12-A5-4-5, O/HP-78-A2-5-2, O/HP-82-A15-2-3, GURI 3, GURI 5 and GURI 7. The research began with the manufacture of a bed measuring 2.5 m x 5 m with a distance between the beds of 50 cm while the distance between repeats of 1 m planting distance was 70 cm x 25 cm. Plant maintenance activities included watering, fertilization, looting, embroidery, and pest and disease control. Harvesting was done by cutting the base of the stalk or malai until the neck shaft malai at the age of 70 days. The study used a Complete Randomized Design (CRD) consisting of 13 treatments and 3 repetitions. Each repetition consists of 3 plants. The observed variables included plant height, stem diameter, leaf length and leaf width. The data obtained were analysed using multiple fingerprint analysis. The results showed that there were significant differences between the plant strains tested. Strain 12 (GURI 5) showed the best growth response and yield compared to other strains. Plant height, stem diameter, leaf length and leaf width of sorghum Strain 12 (GURI 5) were 765; 11.3; 534 and 41.0 cm. In conclusion, strain 12 (GURI 5) has the opportunity to be developed as an alternative forage for livestock in South Konawe.

Keywords: *South Konawe, sorghum, animal feed.*

1. INTRODUCTION

The main obstacles in the provision of forage feed are the quantity, quality and continuity affected by the seasons and low productivity of the land. In the rainy season, forage production is high while in the dry season there is often a shortage of forage.

South Konawe Regency is located in Southeast Sulawesi Province with a land area of 451,420 ha or 11.83 per cent of the land area of Southeast Sulawesi. The land level in South Konawe is generally mountainous and hilly flanked by lowland which is very potential for development in the agricultural sector. The land surface in this regency is generally a very potential plain for agricultural development. The soil type is mostly grumusol type, followed by podzolic, alluvial, mediteran and latosol soil type [1]

Sorghum *(Sorghum bicolor* L. Moench*)* is a cereal crop that has the potential to be cultivated and can be

relied upon as a source of ruminant animal feed, especially in marginal and dry areas in Indonesia. According to [2], sorghum is a forage feed producing plant of about 3 tons / ha and at optimum conditions can reach 30-45 tons/ha per year in the form of fresh materials even in marginal land.

Sorghum is a cereal plant that is not from Indonesia, but it is from Ethiopia and Sudan in Africa [3]. Although this plant comes from outside Indonesia, the development prospects are still very potential due to agro ecological conditions and the availability of supportive land.

Sorghum plants have been known and cultivated for a long time in several regions in Indonesia such as Central Java, Yogyakarta, East Java, parts of NTB and NTT [2]. In South Konawe itself, sorghum plants have not been cultivated much, even though there have been many studies that prove that sorghum can be used as food, animal feed and ethanol producers [4]. Fresh sorghum plants in the form of stems and leaves can be used as ruminant fodder [5]. In Australia, sorghum stems and leaves have been developed into *forage* sorghum and *sweet* sorghum for feed because it has a sweet and crunchy taste [6]. Sorghum has also been processed into silage making it easier to digest [7]. The nutritional quality of sorghum is better than elephant grass, namely water content 10.1%, coarse protein 9.28%, fat 1.9%, coarse fiber 2.1% and TDN and 46.38% [8].

Sorghum plants are also tolerant to drought and puddles, can produce marginal land, and are relatively resistant to pest or disease disorders [2]. Sorghum plants consist of forage feed and grain that has the potential to be used as ruminant animal feed based on silage. This sorghum is very palatable especially young and flowering plants [6]. Seeing the huge potential of sorghum, the Ministry of Agriculture has made sorghum as one of the crops that continue to be researched and developed both technology and the creation of new superior varieties. This research aims to find out the potential development of sorghum plants *(Sorghum bicolor* L. Moench*)* as alternative animal feed in South Konawe.

2. MATERIALS AND METHODS

This research was conducted at the Onembute Experiment Garden (area ± 500 m^2) belonging to BPTP Southeast Sulawesi located in South Konawe Regency, Southeast Sulawesi province. Some of the strains studied included: SAAR/2/ WAXWING, O/HP-82-A-15-1-4, O/HP-12-A1-1-9, O/HP-78-A22-3-7, O/HP-6-A8-2-10, O/HP-22-A27-1-10, O/HP-92-A1-1-3, O/HP-12-A5-4-5, O/HP-78-A2-5-2, O/HP-82-A15-2-3, GURI 3, GURI 5, GURI 7 obtained from BALIT-CEREAL Maros. Fertilizer used was cow manure as basic fertilizer, Urea, TSP and KCl.

2.1. Soil Preparation

The land used in the research was processed manually then added fertilizer, fertilized and given bio char to improve the quality of the soil. The research plot was made with a size of 1.5 m x 5 m. Land processing was carried out one month before planting.

2.2. Planting

Fourteen days after soil processing, sorghum seeds were planted by tugal means. Planting distance was between rows 25 cm. Then, channel blocks with a distance of 50 cm were made between the plots to facilitate irrigation, weeding and observation. Each planting hole (depth of 5 cm) was sown 3-4 sorghum seeds. After the seeds germinated and grew normally, looting was done by missing two plants per planting hole.

2.3. Maintenance

Before planting sorghum seeds, the land was watered first to accelerate the growth of sorghum sprouts. Furthermore, the land will be watered once a week.

2.4. Fertilization

The provision of fertilizer was done twice during the growing season. The first fertilizer was given at the age of 7-10 days after planting (HST). The types of fertilizers given were 150 kg of urea, 200 kg of SP36 and 100 kg of KCL/ ha, 112.5 g of Urea, 150 g of SP36, 75 g KCl/plot and 18.75 g of Urea, 25 g of SP36, and 12.5 g of KCl/line. The second fertilizer was given at the age of 30 HST to encourage flowering. The fertilizers given were 150 kg urea/ha, 112.5 g urea/plot and 18.75 urea/row.

2.5. Plant selection

Selection of plants was done when the plant was 10 days old by leaving 2 of the best plants in each planting hole. Watering the plant was done every day until it reached an airy capacity. Plant weeding was done if there were weeds. Pests were handled by spraying dursban brand insecticides. Cutting the plant was done 100 days after planting (DAT). The method of cutting the plant was by cutting the plant 5 cm above the base of the stem.

The study used a non-factorial Complete Randomized Design (CRD) consisting of 13 strains with 3 repetitions. The observed variables included: plant height, stem diameter, leaf length and leaf width. Plant

height was measured from the surface of the soil to the end of the highest plant in the sample plant using a ruler/meter. The diameter of the stem was obtained by measuring from the stem of the plant contained at the boundary of the surface of the soil. The length of the leaves was measured from the base to the tip of the leaf. The width of the leaves was measured from the right and left sides of the leaves.

The data obtained were analysed using analysis of variance and the treatments that showed significant differences were further tested using the Duncan's multiple distance test [9].

3. RESULTS AND DISCUSSION

The results show that the sorghum strain has a significant effect ($P<0.05$) on plant height, stem diameter, leaf length and leaf width (Table 1).

3.1. Plant Height

The results of analysis of variance on 13 sorghum strains significantly affect plant height ($P<0.01$). Strain 11 is not significantly different from strain 1, 3, 4, 6, 7, 8, 10 but significantly different from strain 2, 5, 9 and 13. Strain 12 (GURI 5) shows the best plant height i.e. 765 cm, while the lowest is shown by strain 11 (GURI 3) i.e. 317 cm. The average plant height of the sorghum strain in this study is 317-765 cm, higher than [10] i.e. 205 – 221 cm. This is due to differences in harvest age. The harvest age of this study is 10 DAP while in the study of [10], sorghum is harvested at the age of 60 DAP. The results of this study are in line with the statement of [11], the height of sorghum plants is influenced by harvest time. The height of sorghum plants increases with the increase in plant maturity (maturity stage) [12], [13], [14]. This is due to the transfer of energy from the vegetative phase to the sorghum phase generative before the entry of the flowering period so that plants no longer grow vertically but rather on flower development and distribution of sorghum seeds. Plant height is an important indicator for the biomass produced, especially for the development of multi-functional varieties or potential as bioenergy [15].

The height of the sorghum plant is affected by the number and size of the stem segment. The sorghum plant has a height of about 3.5-6.5 meters. China has developed sorghum as animal feed and sugar producers with an average height at harvest time of 6 meters. The height of the sorghum plant has a correlation with the age and number of leaves. According to [16] the height of sorghum plants depends on the variety, number and size of stem segments.

The high growth of plants is related to the increase in the number of leaves, the number of books, the lengthening of stems and flowers. This growth is influenced by genetic and environmental factors so the

Table 1. Average Plant Height, Stem Diameter, Leaf Length and Leaf Width of some Sorghum

Treatment (Strain)	Observation Variables			
	Plant Height (cm)	Stem Diameter (mm)	Leaf Length (cm)	Leaf Width (cm)
1	621^{abc}	9.7^{ab}	434^{abc}	34.5^{abc}
2	662^{bc}	12.0^{b}	471^{bc}	35.8^{bc}
3	467^{abc}	8.3^{ab}	356^{abc}	28.1^{abc}
4	563^{abc}	8.7^{ab}	422^{abc}	28.9^{abc}
5	663^{bc}	11.0^{ab}	481^{bc}	35.9^{bc}
6	507^{abc}	9.0^{ab}	422^{abc}	27.7^{abc}
7	406^{ab}	6.0^{a}	323^{ab}	20.9^{ab}
8	605^{abc}	9.7^{ab}	439^{abc}	33.8^{abc}
9	642^{bc}	11.7^{b}	443^{abc}	36.7^{bc}
10	468^{abc}	10.7^{ab}	392^{abc}	32.7^{abc}
11	317^{a}	6.0^{a}	274^{a}	16.7^{a}
12	765^{c}	11.3^{b}	534^{c}	41.0^{c}
13	646^{bc}	12.0^{b}	468^{bc}	38.5^{bc}

Note:

*Strain 1: SAAR/2/*WAXWING, Strain 2: O/HP-82-A-15-1-4, Strain 3: O/HP-12-A1-1-9, Strain 4: O/HP-78-A22-3-7, Galur 5: O/HP-6-A8-2-10, Strain 6: O/HP-22-A27-1-10, Ggalur 7: O/HP-92-A1-1-3, Strain 8: O/HP-12-A5-4-5, Strain 9: O/HP-78-A2-5-2, Strain 10: O/HP-82-A15-2-3, Galur 11: GURI 3, Galur 12: GURI 5, Galur 13: GURI 7

* Different superscripts show significantly differences ($P<0.01$)

minimum and maximum size varies depending on the type of plant and the surrounding environment [17].

3.2. Stem Diameter

The results of the analysis of 13 sorghum strains show significantly different on the stem diameter (P<0.01). Strain 11 is not different from strains 1, 3, 4, 6, 8, 10 but significantly different from strains 2, 9, 12 and 13. Strains 2 (O/HP-82-A-15-1-4), 9 (O/HP-78-A2-5-2), 12 (GURI 5) and 13 (GURI 7) shows the highest stem diameter of 12.0 mm, while the lowest is shown by strains 7 (O/HP-22-A27-1-10) and 11 (GURI 3) i.e. 6.0 mm. The average diameter of the sorghum strain stems in this study ranges from 6.0 to 12.0 mm, lower than [14] i.e. 16.6 – 17.4 mm. This is due to the initial phase of sorghum growth in this study which takes place in the dry season with low rainfall, so it is suspected that plants experience water stress that affects the characteristics of growth, among others, the diameter of the stem. According to [18], in the early period of growth, water stress negatively affects the diameter of the stems in sugarcane plants.

The rate of growth continues to decrease in the direction of plant growth and development in the direction of generative. This is in accordance with [19] which states that after flowering, the resulting assimilate will be limited in use for the growth of leaves, stems and roots of the plant. The transfer of energy from the vegetative phase to the generative phase results in the development of good generative factors such as malai length, wet malai weight, seed weight per plot and weight of 100 seeds per plant.

3.3. Leaf Length

The results of analysis of variance on 13 sorghum strains has a significant effect on leaf width (P<0.01). Strain 11 is not significantly different from strain 1, 3, 4, 6, 7, 8, 9 and 10 but significantly different from strain 2, 5 and 13. Strain 12 (GURI 5) shows the highest leaf length i.e. 534 cm, while the lowest shown by strain 11 (GURI 3) i.e. 274 cm. This indicates that strain 12 is easier to take up the nutrients needed in the photosynthesis process for cell elongation and differentiation compared to other strains. Leaves are important organs for plants because the photosynthesis process occurs in the leaves and the resulting photosynthetic is used as a building material for plant biomass [20]. [21] states that the availability of sufficient nutrients during growth causes plant metabolic activity to be more active so that the process of cell elongation and differentiation will be better.

The average leaf length of the sorghum strain in this study (274 – 534 cm) is higher than [11] (83-199 cm). This is due to differences in harvest time, where the harvest age in this study is 100 DAP, while the [11] study is 70 DAP. According to [22] the length of the leaves of the sorghum strain varies based on the length of time it is harvested. Sorghum begins to enter a generative phase which is marked by the appearance of flowers. The average leaf lengths of sorghum ranges from 83-199 cm at 70 DAP.

3.4. Leaf Width

The results of analysis of variance on 13 sorghum strains has a significant effect on leaf width (P<0.01). Strain 11 is not significantly different from strain 1, 3, 4, 6, 8 and 10 but significantly different from strain 2, 5, 9 and 13. Strain 12 (GURI 5) shows the highest leaf width i.e. 41 cm, while the lowest is shown by line 11 (GURI 3) i.e. 16 cm. The average leaf width of the sorghum strain in this study varies from 16 to 41 cm, higher than [14] which is 6-12 cm. The difference is caused by the different harvest ages. The sorghum strain in this study is harvested at 100 DAP while in the [14] study it is harvested at 60 DAP.

Bullard and York [23] stated that the number of sorghum plants correlated with a long vegetative period, as evidenced by each addition of one leaf which took 3-4 days. Hasan *et al.* [24] stated that sorghum also has flag leaves that appear last, along with panicle initiation plants.

4. CONCLUSION

Strain 12 shows the best growth response and yield with a plant height of 765 cm, a stem diameter of 11.3 cm, a leaf length of 534 cm and a leaf width of 41.0 cm. Strain 12 has the opportunity to be studied and developed in South Konawe.

AUTHORS' CONTRIBUTIONS

Fanny Yulia Irawan, was responsible for the whole research including the proposal and research activity. Wa Ode Al Jumiati and Caturina Pasau help to collect data. Nur Santy Asminaya and Nurlaha was helping with data analysis and writing report as well article for publication.

ACKNOWLEDGMENTS

We express our deepest gratitude for the financial support from the Center for Research and Development of Cereal Crops and the researchers and extension workers of the Cereal Crops Research Institute for their assistance in the research.

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