The Effect of Cutting Age and Ratooning on Growth, Production, and Nutrient Content of *Brown Midrib Resistance* Sorghum

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**Abstract.** This research aimed to determine the effect of cutting age and ratooning on growth, production, and nutrient content of *Brown Midrib Resistance* (BMR) sorghum. This research used a split-plot design with the main plot was ratoon (ratoon 1 and 2), and the subplot was the cutting age (6 and 8 weeks). Each treatment was replicated three times. Sorghum was planted with planting space 75 x 25 cm. The variables observed were growth (plant height, plant length, and leaf width), production (dry matter and organic matter), nutrient content (dry matter content, organic matter, crude protein, extract ether, crude fiber, nitrogen-free extract, and calculation of the total digestible nutrient). The result showed that the ratooning treatment significantly affected \( P<0.05 \) the plant height, plant length, leaf width, dry matter production, organic matter production, and crude fiber content. Dry matter production from ratoon 1 was higher than ratoon 2. The cutting age significantly affected \( P<0.05 \) on plant height, plant length, leaf width, extract ether, crude fiber, crude protein, and total digestible nutrient. Crude protein content at the 6-week cutting age was higher \( P<0.05 \) than the 8-week cutting age. Based on the research, it can be concluded that the growth and production of sorghum will decrease during the second ratoon. The older the plants, the growth, and crude fiber content increased, but the crude protein and total digestible nutrient decreased.

1. **Introduction**

The provision of forage for ruminants is still experiencing some problems, including fluctuations of production throughout the year, where the availability of forage in the dry season is less than the rainy season [1]. More than 70% of the animal feed consists of forage. For this reason, efforts are needed to provide quality and sustainable feed, mainly forage [2].

Sorghum is a plant species that is very adaptable to drought when compared with other cereals. This plant is the potential to be developed and cultivated in Indonesia, especially to increase the productivity of marginal and dry land. *Brown midrib resistance* (BMR) is a species of sorghum that resulted from mutations in sorghum plants, which are specifically developed as feed plants. BMR sorghum has lower lignin content and higher digestibility than conventional sorghum, making it ideal as a forage feed [3].
Sorghum plants can be harvested two to three times, including primary plants and ratoons, as well as by utilizing high rooting power. Sorghum cultivation becomes more efficient because it can reduce labor costs and time for planting and tillage and the use of seeds and energy. Ratoon plantations tend to be more tolerant of drought stress than the initial plant [4].

The exact age of harvest will affect the production and nutrient content of plants. The older the cutting age, the higher the production but inversely proportional to its quality [5]. Therefore, it is necessary to research the effect of cutting and ratooning age on growth, production, and nutrient content of BMR sorghum.

2. Material and Method

2.1. Place and time
This research was conducted at the trial plot and Laboratory of Forage and Pasture, Department of Feed and Animal Nutrition, Faculty of Animal Science, Universitas Gadjah Mada for five months, from February to June 2018.

2.2. Materials
The research materials used were BMR sorghum seeds, urea fertilizer (46% N), manure, and materials for proximate analysis. The tools used were ruler, measuring tape, digital scales, analytical scales with 0.0001 g sensitivity, grinder Willey mill 1 mm diameter filter, oven, furnace, hand tractor, hoe, and equipment for proximate analysis.

2.3. Methods
This study used a split-plot design with ratooning as the main plot (ratoon 1 and 2) and cutting age (6 and 8 weeks) as the subplot. This treatment combination was repeated 3 times, so there were 6 plots. The plot was made with a size of 2 x 3 m² with planting space 75 x 25 cm. Before planting, the land was fertilized with 5 tons/ha of manure. Measurements of plant height, plant length, and leaf width were carried out once a week. Harvesting was done when the plants were 6 and 8 weeks old for each ratoon. The plants were cut 5 cm above the soil surface. The sample was dried in an oven at 55ºC and then ground using a Willey mill. Samples were then analyzed according to the AOAC method. Variables observed were growth (plant height, plant length, and leaf width), production (dry matter and organic matter production), nutrient content (dry matter, organic matter, crude protein, crude fiber, extract ether, nitrogen-free extract, and total digestible nutrient). If there were significant differences, it was further tested with Duncan's Multiple Range Test (DMRT).

3. Result and discussion

3.1. Vegetative growth
Analysis of variance of the plant’s height (Table 1) showed a significant difference (P <0.05) for the height of BMR sorghum from ratoon 1 and ratoon 2. Plant size at ratoon 1 was higher than ratoon 2. The height of BMR sorghum at ratoon 1 was 167.83 cm while in ratoon 2 was 81.83 cm. The height of the ratooned plant is 61 to 87% of the initial plant or the growth declining at 13 to 39% [6].

The results of the BMR's height measurements with different cutting ages (Table 2) showed a significant difference (P <0.05) for both cutting at 8 weeks and at 6 weeks. The size of plants cut at 8 weeks was higher than at 6 weeks. The height of sorghum BMR at 8 weeks of cutting age was 137.17 cm, while that of 6 weeks was 112.5 cm. Cutting the forage at a more extended age can produce feed reserves for more growth [7].

Analysis of variance of the BMR sorghum’s length (Table 1) showed a significant difference (P <0.05) for the length of BMR sorghum from ratoon 1 and ratoon 2. Plant size at ratoon 1 was longer than ratoon 2. The length of BMR sorghum at ratoon 1 was 214 cm while at ratoon 2 was 107 cm. All vegetative characteristics of ratoon decrease in value when compared to the initial plant[8].

Analysis of variance of BMR sorghum with different cutting age (Table 2) showed a significant difference (P <0.05) for the length of BMR sorghum cut at 8 weeks and 6 weeks. BMR sorghum that
was cut at 8 weeks is longer than 6 weeks. The length of sorghum BMR at 8 weeks of cutting age was 175.5 cm, while that of 6 weeks was 145.5 cm.

### Table 1. Vegetative growth, biomass production, and nutrient content of BMR sorghum from different ratoon

| Variable                  | Ratoon 1                  | Ratoon 2                  |
|---------------------------|---------------------------|---------------------------|
|----------------------------|----------------------------|----------------------------|
| Vegetative growth (cm)    | 167.83±14.72              | 81.83±20.70               |
| Plant height*             | 214.00±19.84              | 107.00±15.47              |
| Leaf width*               | 4.68±0.51                 | 3.57±0.34                 |
| Biomass production (tons/ha) | 3.83±0.83                 | 0.52±0.64                 |
| Organic matter production* | 3.40±0.75                 | 0.46±0.57                 |
| Dry Matter                | 17.32±1.73                | 18.93±1.24                |
| Organic matter            | 88.90±1.15                | 87.51±0.93                |
| Crude protein             | 10.33±1.65                | 11.37±1.09                |
| Extract ether             | 3.78±0.52                 | 3.14±1.21                 |
| Crude fiber*              | 29.74±1.42                | 26.98±1.15                |
| Nitrogen-free extract     | 45.39±1.56                | 46.03±2.51                |
| Total digestible nutrient | 56.51±4.05                | 54.84±2.45                |

*significantly different

Analysis of variance of BMR sorghum’s leaf widths with different ratoon (Table 2) showed a significant difference (P <0.05) in the leaf width of BMR sorghum. The size of BMR sorghum leaves cut at 8 weeks was wider than at 6 weeks. The width of the BMR sorghum leaf at 8 weeks cutting age was 4.43 cm, while that of 6 weeks was 3.82 cm.

Analysis of variance in leaf width of BMR sorghum with different cutting ages (Table 1) showed a significant difference (P <0.05). The leaf width in ratoon 1 was fuller than ratoon 2. The leaf width of Sorghum BMR in ratoon 1 was 4.68 cm while in ratoon 2 was 3.57 cm. The forages produced by ratooning had fewer leaves with smaller sizes[9].

#### 3.2. Biomass production

Analysis of variance in dry matter production of BMR sorghum with different ratoon showed a significant difference (P <0.05). Dry matter production from ratoon 1 was higher than ratoon 2. Production of BK sorghum BMR ratoon 1 was 3.83 tons/ha while in ratoon 2 was 0.52 tons/ha. The ratoon system has a weakness as the production will decrease because its growth has decreased[10].

Analysis of variance in dry matter production of BMR sorghum with different cutting age (Table 2) showed that there was no significant difference (P > 0.05) with the cutting age treatment of 6 weeks and 8 weeks. Forage production with a 40-day cutting interval is not much different from a 50-day cutting.

Analysis of variance showed a significant difference (P <0.05) in the organic matter production of BMR sorghum (Table 1) from ratoon 1 and ratoon 2. Organic matter production of BMR sorghum from ratoon 1 was 3.40 tons/ha while in ratoon 2 was 0.46 tons/ha. Ratoon plants experience a shorter vegetative phase so that it affects the low yield of production[9].

Analysis of organic matter production of BMR sorghum with different cutting age (Table 2) showed that there was no significant difference (P > 0.05) with the cutting age treatment of 6 weeks and 8 weeks. Organic matter production always follows the production of dry matter[11].

#### 3.3. Nutrient content

Analysis variance of the dry matter content of BMR sorghum (Table 1 and 2) showed that there was no significant difference (P > 0.05) in the treatment of different cutting and ratooning age. Analysis of variance of organic matter content from BMR sorghum (Table 1 and 2) shows that there was no significant difference (P > 0.05).
Table 2. Vegetative growth, biomass production, and nutrient content of BMR sorghum from different cutting age

| Variable                  | 6 weeks     | 8 weeks     |
|---------------------------|-------------|-------------|
|----------------------------|-------------|-------------|
| Vegetative growth (cm)    |             |             |
| Plant height*             | 112.5±50.57 | 137.17±46.48|
| Plant length*             | 145.50±56.45| 175.50±61.45|
| Leaf width*               | 3.82±0.53   | 4.43±0.78   |
| Biomass production (tons/ha)|           |             |
| Dry matter production     | 2.11±1.85   | 2.24±2.06   |
| Organic matter production | 1.86±1.63   | 2.01±1.85   |
| Nutrient content (%)      |             |             |
| Dry Matter                | 18.31±1.85  | 17.94±1.61  |
| Organic matter            | 88.02±0.69  | 88.39±1.67  |
| Crude protein*            | 11.77±0.89  | 9.93±1.33   |
| Extract ether*            | 2.80±0.77   | 4.12±0.58   |
| Crude fiber*              | 27.50±1.57  | 29.22±1.92  |
| Nitrogen-free extract     | 46.26±1.94  | 45.16±2.12  |
| Total digestible nutrient*| 58.11±2.39  | 53.24±2.03  |

*significantly different

Analysis variance of crude protein content from BMR sorghum with different ratoon (Table 1) showed that there was no significant difference. Different cutting age (Table 2) indicated that there were significant differences (P <0.05).

Analysis of variance showed that ratooning (Table 1) did not show significant results (P > 0.05) on the crude protein content of BMR sorghum. The crude protein content in sorghum (Table 2) with a 6-week cutting age was higher than an 8-week cutting age (P<0.05). Sorghum BMR with a cutting age of 6 weeks, had a crude protein content of 11.77% while that of 8 weeks was 9.93%. As plant age increases, crude protein levels decrease.

The results show that the extract ether content of BMR sorghum with different ratoon (Table 1) did not show a significant difference (P >0.05). Different cutting age on BMR sorghum (Table 2) showed significant difference (P <0.05). The extract ether with a 6-week cutting age was lower than 8-week cutting age. Sorghum BMR with a 6-weeks cutting age has extract ether content of 2.8% while 8 weeks was 4.12%. The longer the cutting age, the plants will get enough light so that the higher chlorophyll can increase crude fat content.

Analysis of variance showed that ratoon (Table 1) showed significant different (P> 0.05) on crude fiber. Ratoon 1 had higher crude fiber content than Ratoon 2. The crude fiber content in ratoon 1 was 29.74%, while in ratoon 2 was 26.98%. The time of the emergence of sorghum plants was longer than rice. Rat shoots in rice appear on the second to fourth day after harvest, while sorghum is 8.8 days after harvest, so that plant growth is slower.

Analysis of variance of crude fiber in BMR sorghum with different cutting age (Table 2) showed that there was a significant difference (P <0.05). Sorghum BMR with 8 weeks of cutting age had crude fiber content of 29.22% while that of 6 weeks was 27.5%. A longer harvesting age has more opportunities for plant cells to arrange their cell wall fibers, resulting in higher levels of crude fiber.

Analysis variance of nitrogen-free extract (NFE) sorghum BMR with different ratoon and cutting age did not show a significant difference (P> 0.05). Analysis of total digestible nutrient (TDN) BMR sorghum with different cutting age (Table 2) showed that there were significant differences (P <0.05). Sorghum BMR with a cutting age of 6 weeks, has a TDN of 58.11% while that of 8 weeks was 53.24%. The longer the harvest, the lower the TDN value. Analysis of variance showed that the ratooning did not show significant different (P> 0.05) on TDN sorghum BMR content.
4. Conclusion
BMR sorghum in ratoon 1 had higher growth and production than ratoon 2. Cutting age 8 weeks can increase plant growth, crude fiber content, and extract ether, but there is a decrease in crude protein content and total digestible nutrients (TDN).

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