

## **The effect of bio-slurry fertilization on growth, dry matter yield and quality of hybrid sudangrass and sorghum (*Sorghum bicolor*) Samurai-2 variety**

**Budiman Nohong\*, and Rohmiyatul Islamiyati**

*Department of Nutrition and Animal Feed, Faculty of Animal Science, Hasanuddin Univesity, Indonesia*

\*E-mail: budiman\_ek58@outlook.com

### **Abstract**

Nohong, B., & Islamiyati, R. (2018). The effect of bio-slurry fertilization on growth, dry matter yield and quality of hybrid sudangrass and sorghum (*Sorghum bicolor*) Samurai-2 variety. *Bulgarian Journal of Agricultural Science, 24*(4), 592–598

The objectives of this research were to evaluate the growth, production and quality characteristics of the hybrid sudangrass and sorghum Samurai-2 variety treated by different doses of liquid bio-slurry. This experiment was conducted using a complete randomized design with 2 factors in which the first factor was the type of plants (hybrid sudangrass and sorghum Samurai-2 variety) and the second factor included bio-slurry liquid fertilizer: P0 = no fertilizer (control), P1 = 5.750 kg bio-slurry/ha and P2 = 11.500 kg bio-slurry/ha. The data were analyzed using the variance analysis and DMRT test. There was no interaction between the types of plants and fertilization. Plant height, long of internode, number of leaves, dry matter production, crude protein content and dry matter digestibility of hybrid sudangrass ( $P < 0.05$ ) were significantly higher and the NDF, ADF and ADL content were significantly lower ( $P < 0.05$ ) than those of the sorghum Samurai-2 variety. On the other hand, the weights of panicles and seeds of the sorghum Samurai-2 variety ( $P < 0.05$ ) were higher than those of hybrid sudangrass. The fertilization with bio-slurry significantly increased ( $P < 0.05$ ) the weights of panicles, seeds and crude protein content, but also significantly decreased ( $P < 0.05$ ) the NDF content. It can be concluded that the hybrid sudangrass has the potential to be developed as a forage-producing crop because its production and quality are higher, while the sorghum Samurai-2 variety can be developed as a seed producer or forage.

*Keywords:* bio-slurry; dry matter yield; hybrid sudangrass; sorghum; nutritive value

### **Introduction**

Hybrid sudangrass or BMR sudangrass is an intermediate plant between sorghum and sudangrass. It was hybridized with sorghum, so the produced plant grows taller and have medium stem diameter (intermediate); moreover, its production and quality are higher than those of sudangrass (Kikindonov et al., 2016). A varieties that possess the brown midrib (BMR) trait have brown vascular tissue and show a low ADL content (Vendramini et al., 2010). Hybrid sudangrass has a high production potential if sufficient rainfall or irrigation is provided. During

the period of water shortage, hybrid sudangrass is capable of producing high forage mass (Slanev and Enchev, 2014). The TDN value exceeds 53%-60% and crude protein is as much as 9%-15%. Varieties with BMR traits are usually more suitable for grazing, and they can provide profits of 5%-8% higher compared to the non-BMR varieties (Vendramini et al., 2010).

Sorghum (*Sorghum bicolor* L.) has a high potential for cultivation because it has a large number of uses (Surya and Hoeman, 2009). Parts of the sorghum plant such as seeds, leaves and stems can be utilized. High carbohydrate sorghum seeds can be used as food that can replace rice and corn (Widowati,

2011), while leaves and stems can be made into silage (Imanda et al., 2016). Sorghum can be used as feed for the lactating dairy cows to increase the same amount of milk production as produced by the cows fed by corn silage (Bernard, 2016).

The increase of sorghum harvested area is caused by the development of plants which were previously grown to produce food into feed and industrial raw materials (Subagio and Suryawati, 2013), so sorghum as animal feed has significance especially in the tropics due to its adaptation to soil fertility (Pholsen and Suksri, 2007). Sorghum can grow and develop in less well-watered soil and slightly saline soil (Getachew et al., 2016). The intercropping of sorghum with indigofera produces dry matter of 3.31-4.21 tons/ha/ harvest, crude protein of 0.29-0.52 tons/ha/ harvest with a carrying capacity of 4.09-5.20 AU/ha (Teleng et al., 2016).

Breeding of sorghum with mutations induced by gamma irradiation has resulted in a number of mutants (Human et al., 2010). Sorghum mutant radiation (Samurai-2) produces two varieties, namely, Samurai-1 and Samurai-2, and both are superior and stable to the environment (Human et al., 2011). Samurai-1 is suitable for bioethanol production while Samurai-2 is suitable for food.

Soil fertility as the medium for growing plants is very important to improve and maintain the productivity and quality of sudangrass hybrid and sorghum Samurai-2 varieties feed. At harvest, most of the nutrients are exported out with the harvest. Sustainable crop production requires nutrients that must be replaced with fertilizer.

Because of the rising price of chemical fertilizers and their inefficient role in long-term sustainable production, it is necessary to search for another alternative, namely, the use of bio-slurry (cattle urine) to increase sustainable crop productivity (Raj et al., 2014). This organic material can be a source of nutrients for plants (Islam et al., 2010), because it contains nutrients in an available form (Bonten et al., 2014).

Hybrid sudangrass as a source of high quality forage and sorghum Samurai-2 varieties as a food producer and forage are still relatively new; therefore, the data on growth, production and quality of both types of plants are still very limited. The objectives of this study were to evaluate the characteristics of growth, production and quality of the hybrid sudangrass and sorghum Samurai-2 varieties that were treated by different dosages of the liquid bio-slurry fertilizer.

## Materials and Methods

### *Location and weather conditions*

This research was conducted at the Field Laboratory, Faculty of Animal Husbandry, Hasanuddin University, Makassar, Indonesia located at 10 km east of Makassar, Tamalanrea Jaya

Sub-district, Tamalanrea District and at 5°14'S, 119°49'E) with a height of 8 m above sea level. The experiments were conducted from September to December 2016. The average daily temperature, humidity and rainfall during the study were 27°C, 85%, and 390 mm respectively.

### *Material and plot design*

The material used in this research included the seeds of hybrid sudangrass plant (BMR sudangrass F<sub>1</sub> OG) from Johnny's Seeds imported directly from the United States. As a comparative material, radiation mutant sorghum (Samurai-2) which is superior and stable to the environment and suitable for food was used. The liquid fertilizer of bio-slurry containing N total of 0.87%, P<sub>2</sub>O<sub>5</sub> of 0.85% and K<sub>2</sub>O of 0.81% was also used. The plot size was 200 x 150 cm, and there were 18 plots, consisting of 2 types of plants and 3 levels of fertilizer. Each treatment was repeated or replicated for 3 times.

The sorghum seeds were planted in a plot with a planting space of 50 x 50 cm. Each plot consisted of two rows and each row was made into 3 cm deep holes. Each hole was filled with 5 seeds and then covered with soil. Uniformity was conducted when the plants were at the age of one week after planting. From each hole, one plant whose growth was relatively the same was chosen to stay in the plot, while the others were removed or pulled. The remaining plants were maintained until the end of the study. The bio-slurry fertilizer was given in the second week by spraying it around the plants.

### *Experimental design*

This experiment was performed using a complete randomized design with 2 factors. The first factor was the plant type (hybrid sudangrass and sorghum Samurai-2 variety). The second factor was the bio-slurry liquid fertilizer: P0 = no fertilizer (control), P1 = 5.750 kg of bio-slurry/ha equivalent to 50 kg N/ha, 49 kg P<sub>2</sub>O<sub>5</sub>/ha and 47 kg K<sub>2</sub>O/ha; P2 = 11.500 kg of bio-slurry/ha equivalent to 100 kg N/ha, 98 kg of P<sub>2</sub>O<sub>5</sub>/ha and 93 K<sub>2</sub>O/ha. The data was then analyzed statistically by using variance analysis (ANOVA) and MINITAB (Version 16). The Duncan Multiple Range Test (DMRT) was used to find out the differences among the treatments.

### *Observations*

Observations of growth included plant height and number of leaves starting from week 2 to week 15. Plant height (cm) for each plant was measured from the base of the plant to the tip. The number of branch leaves per plant was calculated from each selected plant, and the average number of leaves was calculated. The other parameters were calculated and observed after harvest at week 15 (105 days). The plants were harvested after the seeds were ripe or could be used as seeds. The stems,

leaves, panicles and seeds were separated and then weighed to determine the fresh weight. To obtain the dry material, the fresh samples were dried at 70°C for 48 hours and ground using a Willey mill with strain in 1 mm diameter.

### Methods applied

Kjeldahl method (AOAC, 2005) was used to determine the nutrient component for nitrogen (N). Crude protein was calculated, i.e.  $N \times 6.25$ . Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent (ADL) were determined according to Van Soest et al. (1991). The in vitro dry matter digestibility (IVDMD) was analyzed using Tilley and Terry method (1963).

## Results and Discussion

### Growth

The effects of bio-slurry fertilization on plant height, internode length, leaf number and stem ratio of hybrid sudangrass and sorghum variety Samurai-2 are presented in Table 1. Plant height, internode length and number of leaves ( $P < 0.05$ ) were significantly affected by different types of plants. Plant height and leaf number ( $P < 0.05$ ) were significantly affected by fertilization, while the internode length was not affected by fertilization. There was no interaction between the plant types and fertilizer for all growth parameters. Plant height, internode length and number of leaves on hybrid sudangrass were more significant ( $P < 0.05$ ) compared to sorghum Samurai-2 variety. The height of plants with P2 fertilizer application ( $P < 0.05$ ) was higher than that of P0 (control) and did not differ from the application of P1 fertilizer. The number of plant leaves treated with P1 and P2 was significantly higher ( $P < 0.05$ ) than that of the plants with no fertilizer (P0).

### Yield components

The effects of bio-slurry fertilization on dry matter yield, weight of the panicles and seeds of the Hybrid Sudangrass and Sorghum Samurai-2 variety are presented in Table 1.

The dry matter yield was significantly influenced by the types of plants ( $P < 0.01$ ). The panicle weight ( $P < 0.01$ ) was greatly affected by fertilization, while the seed weight was not affected by fertilization. There is no interaction between the types of plants and the application of fertilizer. The panicle weight of sorghum Samurai-2 was greater ( $P < 0.05$ ) than that of hybrid sudangrass. The weight of panicles with fertilizer application of P2 dose was significantly higher ( $P < 0.05$ ) than that of P1 and without fertilizer (P0) while the treatment of fertilization P1 was not different ( $P > 0.05$ ) from the control (P1). The seeds of sorghum Samurai-2 are heavier ( $P < 0.05$ ) than those of hybrid sudangrass while the plant seed weight was not affected ( $P > 0.05$ ) by fertilizer application, and there was no interaction between plant species and fertilizer application.

### Crude protein content (CP)

The effect of bio-slurry on the crude protein content of hybrid sudangrass and sorghum Samurai-2 variety is presented in Table 2. The crude protein content was greatly influenced ( $P < 0.01$ ) by forage and fertilization. There was no interaction between plant species and fertilization. The crude protein content of hybrid sudangrass was higher ( $P < 0.05$ ) than that of sorghum Samurai-2 variety whereas the crude protein contents of the fertilized plants with the P1 and P2 doses were higher ( $P < 0.05$ ) than those of the non-fertilized plants (P0).

### NDF, ADF and ADL contents

The effects of bio-slurry fertilization on NDF, ADF and ADL contents of hybrid sudangrass and sorghum Samurai-2 variety are presented in Table 2. The NDF, ADF and ADL contents were significantly ( $P < 0.01$ ) influenced by the plant type differences. The NDF content was significantly ( $P < 0.01$ ) influenced by fertilization, but it had no effects on ADF and ADL contents. There was no interaction between the types of plants and the application of fertilizer. The NDF, ADF and ADL contents of hybrid sudangrass ( $P < 0.05$ ) were lower than those of the sor-

**Table 1**  
Characteristics of growth, production of hybrid sudangrass and sorghum Samurai-2 variety

Parameters	Type of plants		Level of bio-slurry		
	Hybrid sudangrass	Sorghum Samurai-2	P0	P1	P2
Plant height (cm)	196.39±31.62 <sup>a</sup>	153.47±8.25 <sup>b</sup>	157.79±27.47 <sup>a</sup>	177.62±34.13 <sup>ab</sup>	189.38±28.91 <sup>b</sup>
Internode (cm)	20.15±2.49 <sup>a</sup>	10.18±3.43 <sup>b</sup>	13.84±4.23 <sup>a</sup>	14.60±7.93 <sup>a</sup>	17.07±5.52 <sup>a</sup>
Number of leaves/plant	6.16±0.65 <sup>a</sup>	4.55±0.35 <sup>b</sup>	5.08±0.73 <sup>b</sup>	5.20±1.41 <sup>a</sup>	5.78±1.61 <sup>a</sup>
Panicles (g/plant)	32.44±6.32 <sup>b</sup>	57.67±7.95 <sup>a</sup>	40.58±17.24 <sup>b</sup>	4492±14.69 <sup>b</sup>	49.67±13.23 <sup>a</sup>
Seeds (g/100 seeds)	3.31±0.20 <sup>b</sup>	3.94±0.26 <sup>a</sup>	3.48±0.42 <sup>a</sup>	3.65±0.43 <sup>a</sup>	3.75±0.37 <sup>a</sup>
Dry matter forage (t/ha)	13.74±1.10 <sup>a</sup>	12.99±1.30 <sup>b</sup>	11.88±0.63 <sup>b</sup>	13.76±0.64 <sup>a</sup>	14.45±1.23 <sup>a</sup>

Means with different superscripts in the same treatment and line are significantly different

**Table 2****Crude protein, NDF, ADF, ADL content, *in vitro* dry matter and organic matter digestibility of hybrid sudangrass and sorghum Samurai-2 variety**

Parameters	Type of plants		Level of bio-slurry		
	Hybrid sudangrass	Sorghum Samurai-2	P0	P1	P2
CP (%)	6.97±0.38 <sup>a</sup>	6.37±0.61 <sup>b</sup>	6.25±0.57 <sup>b</sup>	6.68±0.39 <sup>a</sup>	7.08±0.51 <sup>a</sup>
NDF (%)	69.46±1.08 <sup>a</sup>	71.08±1.29 <sup>b</sup>	71.35±1.23 <sup>b</sup>	70.16±1.22 <sup>b</sup>	69.29±1.27 <sup>a</sup>
ADF (%)	38.72±0.43 <sup>a</sup>	40.43±0.29 <sup>b</sup>	38.44±0.19 <sup>a</sup>	38.58±0.79 <sup>a</sup>	38.72±0.99 <sup>a</sup>
ADL (%)	5.56±0.22 <sup>a</sup>	6.02±0.18 <sup>b</sup>	5.73±0.33 <sup>a</sup>	5.80±0.32 <sup>a</sup>	5.79±0.31 <sup>a</sup>
IVDMD (%)	56.08±0.14 <sup>a</sup>	54.74±0.09 <sup>b</sup>	55.75±0.21 <sup>a</sup>	55.40±0.26 <sup>a</sup>	55.30±0.26 <sup>a</sup>
IVOMD (%)	56.27±0.75 <sup>a</sup>	54.91±0.43 <sup>b</sup>	55.36±1.08 <sup>a</sup>	55.46±0.98 <sup>a</sup>	55.97±0.91 <sup>a</sup>

Means with different superscripts in the same treatment and line are significantly different

ghum Samurai-2. The NDF contents of the fertilized plants with the doses of P1 and P2 ( $P < 0.05$ ) were lower than those of the plants without fertilizer (P0).

#### *In vitro* dry matter digestibility (IVDMD)

The effects of bio-slurry fertilization on dry matter digestibility of hybrid sudangrass and sorghum Samurai-2 variety are presented in Table 2. Dry matter digestibility was affected ( $P < 0.01$ ) by forage species. There was no effect of fertilization on dry matter digestibility and no interaction between plant species and fertilization. The dry matter digestibility of the hybrid sudangrass was higher ( $P < 0.05$ ) than that of sorghum Samurai-2.

#### Organic matter digestibility (OMD)

The effect of bio-slurry fertilization on organic matter digestibility of hybrid sudangrass and sorghum of Samurai-2 variety is presented in Table 2. Organic matter digestibility was affected ( $P < 0.01$ ) by forage species. There was no effect of fertilization on organic matter digestibility and no interaction between plant species and fertilization. The organic material digestibility of the hybrid sudangrass plant was higher ( $P < 0.05$ ) than that of Samurai-2 sorghum variety.

#### Plant height

Plant height is a measure that is used as a growth indicator and as a parameter used to measure the effects of treatment applied. Plant height ranged from 153.47 cm to 196.39 cm between types of plants. The results of this study showed that the range of plant height of hybrid sudangrass as reported by Mohammed (2010) was between 177 cm–214 cm and for the sweet Sorghum, (Surya and Hoeman, 2009) it could reach the height up to 154.50 cm. The plants that were not fertilized (P0) were lower (157.79 cm) than those given by P1 and P2 fertilizers with the heights of 177.62 cm and 189.38 cm respectively. The effects of bio-slurry fertilizer on the growth of potato plants were reported by Amara and Mourad (2013).

#### Yield components

The number of leaves has a strong impact on the forage quality. The average number of leaves per plant that survived until harvest at the age of 15 weeks (105 days) for the hybrid sudangrass and sorghum Samurai-2 variety reached 6.16 leaves and 4.55 leaves, respectively. Our results were lower than those reported by Tahir et al. (2005) in which the number of leaves of sorghum x hybrid sudangrass varies between 10.87–12.2. Meanwhile Ayub et al. (2010) reported that the average number of leaves from the eight varieties of sorghum varied from 9.13 to 10.83 leaves per plant. The low number of planting leaves in the two plant species used in this study is due to the age factor, as the two plants were harvested when the beans were already ripe/dry. The number of leaves of the hybrid sudangrass was greater because most plants could form new shoots that produced leaves, whereas in sorghum there was no shoot formation. Application of bio-slurry fertilizer gave a significant effect ( $P < 0.05$ ) on increasing the number of leaves. The increase in the number of leaves was due to the application of bio-slurry in cabbage leaves (Shahbaz et al., 2014), whose number increased from 7.3 leaves without treatment to 12.6 leaves with the bio-slurry treatment with the dose of 600 kg bio-slurry/ha.

The weights of panicles ranged from 32.44 g/plant to 57.67 g/plant and the weight of seeds ranged from 3.31 g/100 seeds to 3.39 g/100 seeds among crop types. The sorghum Samurai-2 variety was superior in panicles and seed weights. This is in accordance with the purpose of the development, i.e. to make this plant hybrid produce seeds as a source of food. According to Ahmad et al. (2014), the weight of panicles in sorghum is a selection criterion in obtaining a superior variety because of its great effect on the production of dry beans. The weight of panicles and seeds produced by the sorghum Samurai-2 variety are similar to those of various mutant sorghum strains varying from 53.43 to 93.36 grams per plant, and the weight of seeds ranges from 2.67 to 3.21 grams per plant as reported by Sihono (2009). Unlike the hybrid sudangrass, although its panicles look big, they are lighter because only a few seeds are formed with

smaller sizes, and most of the panicles are hollow. The hybrid sudangrass plant belongs to a hybrid plant group, resulting in lower quality of seeds. This is in accordance with the opinion of McPherson et al. (2011) stating that plants belonging to hybrid crop groups produce poor seeds. Fertilization of bio-slurry increased the weight of panicles at the dose of P2. The effects of fertilizer application on the panicle weight of Kawali sorghum variety had been reported by Tacoh et al. (2017).

The average dry matter yield ranged from 13.74 t/ha to 12.99 t/ha among types of plants. The high production of dry matter in hybrid sudangrass was due to the differences in its genetic property. Reddy et al. (2003) stated that the characteristics of crop production are determined among others by their genetic property. The dry matter production obtained in this study was lower than that reported by Venuto and Kindiger (2008) stating that dry matter productions from hybrid sudangrass cultivar Sweeter 'N Honey BMR and Honey Graze BMR were 18.0 t/ha and 20.2 t/ha, respectively. The same result was reported by Kikindinov et al. (2015) stating that the production of dry matter varied from 20.77 t/ha for hybrid sudangrass and 27.37 t/ha for sudangrass. The low production of dry matter of hybrid sudangrass in this study was probably caused by the differences in soil fertility of the area where the research was conducted. The production of the forage dry matter of the sorghum obtained in this study was similar to that reported by Ayub et al. (2012) who stated that the production of forage dry matter of sorghum varied between 12.61 and 22.53 t/ha. The production of dry matter with bio-slurry fertilizer is higher than that without fertilization (control). Similar result had been reported by Nasir et al. (2012) stating that the application of bio-slurry may increase the production of dry matter of cabbage plant.

Crude protein content varied from 6.37% to 6.97% among plant species. This is consistent with the statement of Fales and Fritz (2007), that the genetic differences among and within forage crop species have a major effect on forage quality. The effects of varietal differences on crude protein content have been reported by a number of researchers. Shambas-2 variety and Omdoum variety contain 8.2% and 9.3 % crude protein respectively, according to Idris and Mohammed (2012). Pacific BMR variety and Bettagraze variety contain 16.8% and 16.1% crude protein respectively, according to Millner et al. (2011).

Significant differences in the crude protein content of various genotypes have also been reported by Mohammed (2010) that the average crude protein of some of the sudangrass genotypes grown in Khartoum State, Sudan, varies between 5.25% and 7.88%. In addition, differences among cultivars may also cause differences in crude protein content (Uzun et al., 2009; Mahmood and Honermeier, 2012). Fertilizations of P1 and P2 bio-slurry increased the crude protein content by 6.68-7.08% if compared with the plants without fertilization (P0). The effects

of bio-slurry on increasing the crude protein content of sorghum from 6.11% to 7.7% has been reported by Nohong et al. (2016). Similar results were found in the *Pueraria javanica* plant, suggesting that the administration of bio-slurry increased the crude protein (Mudhita et al., 2016). Similarly, nitrogen fertilization at a dose of 40-80 kg N/ha increased the crude protein content from 9.08% to 10.90% (Hazary et al., 2015).

The contents of NDF, ADF and ADL are important factors affecting the quality of feed plants. The clear distinction between the hybrid sudangrass and the sorghum Samurai-2 variety on NDF, ADF and ADL contents in this study supports the findings of other researchers who investigated the effects of genotypic differences on fiber components (Mahmood and Honermeier, 2012; Nawaz et al., 2016). The low contents of NDF, ADF and ADL of hybrid sudangrass are due to its possession of BMR. According to Bean et al. (2013), plants that possess BMR properties consistently have low NDF, ADF and ADL contents. In this study the contents were in the range reported by Beck et al. (2007) according to which the contents of NDF and ADF of sorghum-hybrid sudangrass were 72.2% and 43.2% respectively for plants without BMR and 66.1% and 39.0% for those with BMR. The same result is also reported by Millner et al. (2011) according to which the hybrid sudangrass (Pacific BMR) contains lower NDF and ADF than those of sorghum. Astigaraga et al. (2014) stated that sorghum that has BMR properties contains lower ADL than that without BMR.

There was a decrease in NDF content due to fertilization. The same results were reported by Nirmal et al. (2016) that the increase of N fertilizer on the three cultivars of sorghum results in the decrease of NDF content. The high contents of NDF, ADF and ADL of sorghum Samurai-2 variety showed that the quality of this variety was lower than that of hybrid sudangrass. According to Schroeder (2012), if the percentage of NDF increases, the intake of dry matter is generally reduced, while the ADF content is related to the ability of livestock to digest forage.

Dry matter digestibility of the hybrid sudangrass was higher than that of sorghum Samurai-2 variety, and this is related to low contents of ADF and ADL, compared to those of sorghum Samurai-2 variety (Table 2). High NDF and ADF contents exhibit lower digestibility due to the higher lignification (Van Soest, 1985). ADL is a major component of plant cell walls, long known for its negative impact on forage quality (Li et al., 2008; Ledgerwood et al., 2009). The effects of genotype on dry matter digestibility had been reported by various researchers. Sriagtula et al. (2017) reported that there were differences in dry matter digestibility between sorghum mutant lines Patir 3.1, Patir 3.2, and Patir 3.7 reaching 60.10%, 65.88% and 63.45% respectively. The BMR properties possessed by hybrid sudangrass produce low ADL content (Table 2) resulting in higher digestibility (Table 2). Similar results were reported by Puteri

et al. (2015) that sorghum Samurai-1 variety containing BMR properties of Patir 3.5, Patir 3.5 and Patir 3.6 had higher digestibility than non-BMR sorghum.

In this research, *in vitro* organic matter digestibility of hybrid sudangrass was 56.27% and that of sorghum Samurai-2 variety was 54.91%. The value *in vitro* organic matter digestibility of hybrid sudangrass in this study are lower compared with that reported by Erisek and Kilik (2017) which states that the organic matter digestibility of sorghum-sudan grass hybrid was 67.99%. While the value of organic matter digestibility of sorghum Samurai-2 variety in this study are higher compared to the sorghum Samurai-1, reported by Puteri et al. (2015), which is 39.60%, but it was lower than the organic matter digestibility of sorghum mutant line, i.e. 63.38% (Sriagtula et al., 2017).

## Conclusion

The hybrid sudangrass has the potential to be developed as a forage-producing plant due to its higher production and quality, while the sorghum Samurai-2 variety can be developed as a food or forage producer.

## Acknowledgement

We would like to express our gratitude to Ronald Sang and Djoko Soetrisno for their services in providing seeds of hybrid sudangrass or BMR sudangrass to be studied.

## References

- Ahmad, M. S. L., Wigena, A. H., & Human, S. (2014). Identifikasi Pengaruh Beberapa Karakter Agronomi Terhadap Daya Hasil Sorghum (*Sorghum bicolor* L. Moench) Dengan Analisis Lintas. *Jurnal Ilmiah Aplikasi Isotop dan Radiasi*, 10(2), 127-135.
- Amara, D. G., & Mourad, S. M. (2013). Influence of organic manure on the vegetative growth and tuber production of potato (*Solanum tuberosum* L. varspunta) in a Sahara desert region. *International Journal of Agriculture and Crop Sciences*, 5(22), 2724-2731.
- Astigarraga, L., Bianco, A., Mello, R., & Montedónico, D. (2014). Comparison of brown midrib sorghum with conventional sorghum forage for grazing dairy cows. *American Journal of Plant Sciences*, 5(07), 955-962
- Ayub, M., Khalid, M., Tariq, M., Elahi, M., & Nadeem, M. A. (2012). Comparison of sorghum genotypes for forage production and quality. *Journal of Animal and Plant Sciences*, 22(3), 733-737.
- Bean, B. W., Baumhardt, R. L., McCollum Iii, F. T., & McCuisition, K. C. (2013). Comparison of sorghum classes for grain and forage yield and forage nutritive value. *Field Crops Research*, 142, 20-26.
- Beck, P. A., Hutchison, S., Gunter, S. A., Losi, T. C., Stewart, C. B., Capps, P. K., & Phillips, J. M. (2007). Chemical composition and *in situ* dry matter and fiber disappearance of sorghum × Sudangrass hybrids. *Journal of Animal Science*, 85(2), 545-555.
- Bernard, J. K. (2016). *Forage sorghum for dairy cattle*. USDA, National Institute of Food and Agriculture, USA.
- Bonten, L. T. C., Zwart, K. B., Rietra, R. P. J. J., Postma, R., De Haas, M. J. G., & Nysingh, S. L. (2014). *Bio-slurry as fertilizer: is bio-slurry from household digesters a better fertilizer than manure? A literature review* (No. 2519). Alterra, Wageningen-UR.
- Erisek, A., & Kilic, U. (2017). Determination of *in vitro* gas production and forage qualities of alfalfa and sorghum-sudangrass forages. *Sch. J. Agric. Vet. Sci.*, 4(7), 273-281.
- Fales, S. L., & Fritz, J. O. (2007). Factors affecting forage quality. *Forages*, 2, 569-580.
- Getachew, G., Putnam, D. H., De Ben, C. M., & De Peters, E. J. (2016). Potential of sorghum as an alternative to corn forage. *American Journal of Plant Sciences*, 7(07), 1106-1121.
- Hazary, M. E. H., Bilkis, T., Khandaker, Z. H., Akbar, M. A., & Khaleduzzaman, A. B. M. (2015). Effect of nitrogen and phosphorus fertilizer on yield and nutritional quality of Jumbo Grass (Sorghum Grass × Sudan Grass). *Adv. Anim. Vet. Sci*, 3(8), 444-450.
- Human, S., Andreani, S., Sihono, S., & Indriatama, W. M. (2011). Stability test for sorghum mutant lines derived from induced mutations with gamma-ray irradiation. *Atom Indonesia*, 37(3), 102-106.
- Human, S., Trikoesoemaningtyas, T., Sihono, S., & Sungkono, S. (2010). Development of Sorghum Tolerant to Acid Soil Using Induced Mutation with Gamma Irradiation. *Atom Indonesia*, 36(1), 11-15.
- Idris, A. E., & Mohammed, H. I. (2012). Screening and Evaluation of Forage Sorghum Cultivars for Forage production using multicriterion decision analysis. *Advances in Environmental Biology*, 6(3), 1141-1151.
- Imanda, S., Effendi, Y., Sihono, S., & Sugoro, I. (2016). Evaluasi *in vitro* silase sinambung sorghum varietas Samurai-2 yang mengandung probiotik BIOS K2 dalam cairan rumen kerbau / *In vitro* evaluation of continuous silage of sorghum variety Samurairai-2 containing probiotic BIOS K2 in rumen fluid. *Jurnal Ilmiah Aplikasi Isotop dan Radiasi*, 12(1), 1-12.
- Islam, M. R., Rahman, S. M. E., Rahman, M. M., Oh, D. H., & Ra, C. S. (2010). The effects of biogas slurry on the production and quality of maize fodder. *Turkish Journal of Agriculture and Forestry*, 34(1), 91-99.
- Kikindonov, T., Slanev, K., Enchev, S., & Kikindonov, G. (2015). Results of breeding sudangrass, sorghum-sudangrass hybrids and sweet sorghum for green mass productivity. *Agrarni Nauki*, 7(18), 17-23.
- Kikindonov, T., Slanev, K., Kikindonov, G., & Enchev, S. (2016). Assessment of the effectiveness of biomass accumulation in sudangrass, sorghum x sudangrass hybrids and sweet sorghum forms. *International Journal of Current Research*, 8(5), 31002-31006.
- Ledgerwood, D. N., DePeters, E. J., Robinson, P. H., Taylor, S. J., & Heguy, J. M. (2009). Assessment of a brown midrib (BMR) mutant gene on the nutritive value of sudangrass using *in vitro* and *in vivo* techniques. *Animal Feed Science and Technology*, 150(3-4), 207-222.
- Li, X., Jing-Ke, W., & Chapple, C. (2008). Improvement of bio-

- mass through ADL modification. *The Plant Journal*, 54, 569-581.
- Mudhita, I. K., Umami, N., Budhi, S. P. S., Baliarti, E., Noviandi, C. T., Budisatria, I. G. S., & Wattimena, J.** (2016). Effect of bali cattle urine on legume cover crop puero (*Pueraria javanica*) productivity on an east Borneo oil palm plantation. *Pakistan Journal of Nutrition*, 15(5), 406-411.
- Mahmood, A., & Honermeier, B.** (2012). Effect of row spacing and cultivar on biomass yield and quality of *Sorghum bicolor* L. Moench. *Journal fur Kulturpflanzen-Journal of Cultivated Plants*, 64(7), 250-257.
- McPherson, J. M., Kotzé, W., & Van den Berg, D.** (2011). *Hybrid or open pollinated variety seed – weigh up the options*. Afrikaans, Tswana, Sesotho, Sesotho sa Leboa, Zulu dan Xhosa.
- Millner, J. P., Silungwe, D., & McGill, C. R.** (2011). Forage quality of sorghum, sudan-grass sorghum $\times$  sudan-grass and pearl millet cultivars in Manawatu. *Agronomy New Zealand*, 41, 13-22.
- Mohammed, M. I.** (2010). New sudangrass forage cultivars selected from the original population (*Sorghum bicolor* 'Garawi', syn. S. sudanense). *African Journal of Range & Forage Science*, 27(1), 51-55.
- Nasir, A., Khalid, M. U., Anwar, S., Arslan, C., Akhtar, M. J., & Sultan, M.** (2012). Evaluation of bio-fertilizer application to ameliorate the environment and crop production. *Pak. J. Agri. Sci.*, 49(4), 527-531.
- Nawaz, H., Ashfaq, U., Ali, M., & Rehman, M. S.** (2016). In situ rumen degradation kinetics of four sorghum varieties in Nili Ravi buffaloes. *JAPS: Journal of Animal & Plant Sciences*, 26(2).
- Nirmal, S. S., Solanke, A. V., Dudhade, D. D., Shinde, M. S., Gadakh, S. R., Durgude, A. G., & Damame, S. V.** (2016). Response of forage sorghum [*Sorghum bicolor* (L.) Moench] cultivars to nitrogen levels. *International Journal of Science, Environment and Technology*, 5(4), 2605-2609.
- Nohong, B., Rasyidand, T., & Yusuf, M.** (2016). The effects of bio-slurry fertilizer on Sorghum bicolor and Centrosema pubescens planted with inter-cropping. *Transylvanian Review*, 24(10), 2552-2560.
- Pholsen, S., & Suksri, A.** (2007). Effects of phosphorus and potassium on growth, yield and fodder quality of IS 23585 forage sorghum cultivar (*Sorghum bicolor* L. Moench). *Pakistan Journal of Biological Sciences: PJBS*, 10(10), 1604-1610.
- Puteri, R. E., Karti, P. D. M. H., & Abdullah, L.** (2015). Productivity and nutrient quality of some sorghum mutant lines at different cutting ages. *Media Peternakan*, 38(2), 132-137.
- Raj, A., Jhariya, M. K., & Toppo, P.** (2014). Cow dung for eco-friendly and sustainable productive farming. *Environ. Sci.*, 3(10), 201-202.
- Reddy, B. V. S., Reddy, P. S., Bidinger, F., & Blümmel, M.** (2003). Crop management factors influencing yield and quality of crop residues. *Field Crops Research*, 84(1-2), 57-77.
- Schroeder, J.** (2012). *Interpreting forage analysis*. North Dakota State University Extension Service, Fargo, ND.
- Shahbaz, M., Akhtar, M. J., Ahmed, W., & Wakeel, A.** (2014). Integrated effect of different N-fertilizer rates and bioslurry application on growth and N-use efficiency of okra (*Hibiscus esculentus* L.). *Turkish Journal of Agriculture and Forestry*, 38(3), 311-319.
- Siyono, S.** (2009). Penampilan sifat agronomi galur mutan sorgum (*Sorghum bicolor* L. Moench.) di kabupaten Bogor. *Jurnal Ilmiah Aplikasi Isotop Dan Radiasi*, 5(1), 31-42.
- Slanev, K., & Enchev, S.** (2014). Influence of variety and density on crop productivity of sorghum x sudan grass hybrids in flowering stage. *Bulgarian Journal of Agricultural Science*, 20(1), 182-185.
- Sriagtula, R., Karti, P. D. M. H., Abdullah, L., Supriyanto, S., & Astuti, D. A.** (2017). Nutrient changes and *in vitro* digestibility in generative stage of M10-BMR sorghum mutant lines. *Media Peternakan*, 40(2), 111-117.
- Subagio, H. & Suryawati** (2013). Wilayah penghasil dan ragam penggunaan sorgum di Indonesia. In: *Sorghum, Inovasi Teknologi dan Pengembangan*. Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian.
- Surya, M. I., & Hoeman, D. S.** (2009). Evaluasi keragaman genetik sorgum manis pada mutan generasi Ke-2 hasil iradiasi gamma. *Agrovita*, 31(2), 142-148.
- Tacoh, E., Rumambi, A., & Kaunang, W. B.** (2016). Pengaruh pemanfaatan pupuk bokasi feses sapi terhadap produksi sorgum varietas Kawali. *Zootec*, 37(1), 88-95.
- Tahir, M. H. N., Sadaqat, H. A., & Khan, I. A.** (2005). Genetic potential of high forage yielding sorghum  $\times$  sudangrass hybrids for resistance to stem borer (*Chilo partellus*) and shoot fly (A. soccata). *Pak. Entomol*, 27(1), 57-62.
- Telleng, M., Wiryawan, K. G., Karti, P. D. M. H., Permana, I. G., & Abdullah, L.** (2016). Forage production and nutrient composition of different sorghum varieties cultivated with indigofera in intercropping system. *Media Peternakan*, 39(3), 203-209.
- Tilley, J. M. A., & Terry, R. A.** (1963). A two-stage technique for the *in vitro* digestion of forage crops. *Grass and Forage Science*, 18(2), 104-111.
- Uzun, F., Ugur, S., & Sulak, M.** (2009). Yield, nutritional and chemical properties of some sorghum x sudan grass hybrids (*Sorghum bicolor* (L.) Moench x *Sorghum sudanense* Stapf.). *Journal of Animal and Veterinary Advances*, 8(8), 1602-1608.
- Van Soest, P. J.** (1985). Composition, fiber quality, and nutritive value of forages. In: *Forages, the science of grassland agriculture*, Iowa State Univ. Press Ames, Iowa, USA, pp. 413-421.
- Van Soest, P. V., Robertson, J. B., & Lewis, B. A.** (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74(10), 3583-3597.
- Vendramini, J., Newman, Y., Erickson, J., Vermerris, W., & Wright, D.** (2010). *Forage Sorghum*. IFAS Ekstension Service, University of Florida.
- Venuto, B., & Kindiger, B.** (2008). Forage and biomass feedstock production from hybrid forage sorghum and sorghum-sudangrass hybrids. *Grassland Science*, 54(4), 189-196.
- Widowati, S.** (2011). *Sorghum: Penanganan dan Pengolahan Berbagai Produk Pangan*. Bogor (ID), Badan Penelitian dan Pengembangan Pertanian, Kementrian Pertanian
- AOAC (2005). Official Methods of Analysis. Association of Official Analytical Chemists. Editor: Horwitz, W and G.W. Latimer, Jr. Published by AOAC International. 18th Edition. USA.