EFFECT OF SOIL QUALITY ON NUTRIENT COMPOSITION OF BRACHIARIA HYBRID MULATO II GRASS GROWN IN HIGHLANDS OF WEST JAVA INDONESIA

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Abstract

Mulato grass species have been introduced to the farmer in Indonesia due to their ability to provide feed for ruminant with high quality and biomass. However geographical, climatic, and soil quality (texture and properties) and management determined the quality of the grass or vice versa. Fertilizer and spacing were also affected the production of mulato.This study aimed to characterize and evaluate soil texture and properties and nutritive values of mulato grass grown in highlands Indonesia. This research was carried out in two different sites /location in Pangalengan, West Java, Indonesia. The sites that explored have different in the fertilizer and spacing of the grass (Pangalenga A and Pangalengan B). This research covered the characterization of geographical, climatic, and soil texture and characteristics/properties of those two sites, and tried to associate those characteristics into nutritive values of Mulato grass. Purposive sampling sample were used in this study and the data were descriptive interpreted. Results showed Pangalengan B site with high amount of fertilizer and shorter broadcast linear spacing had higher soil properties. However Pangalengan A site had better nutrient composition of mulato grass due to better this site received more solar radiation. In conclusion, beside soil properties and environment condition, soil texture and solar radiation will determine the nutritive composition of mulato grass.

Key words: *Soil quality, Mulato grass, Nutrient composition, Forage. Environment*

INTRODUCTION

One of the main problems in ruminant production in Indonesia is the quality and quantity of forages to be utilized by ruminants (Pengelly et al., 2003; Dahlanuddin et al., 2014; Rusdy, 2016). This low quality and quantity of forages is caused by low genetic potential of forage plant itself, as well as by the tropical climatic characteristics. Climatic characteristics in tropics consist of an irregular distribution of rainfall due to the existence of two distinct seasons of the year, rainy and dry, resulting in qualitative and quantitative variations in the availability of forages (Sampaio et al., 2010). The low quality of forage is caused mainly by their low availability level of crude protein (CP) and neutral detergent fibre (NDF) which is essential for ruminant metabolism and performance (Sampaio et al., 2010).

The impact of low quality and quantity of forages to the animal has been reported high in several aspects, such as low quantity and quality of milk production (Wang et al., 2014; Sun et al., 2020), low nutrients digestibility (Sampaio et al., 2010; Souza et al. 2010), and low health robustness caused by low immunity (Bertoni et al., 2009). These impacts lower the farmer's welfare as well as animal welfare, especially in developing tropical countries, such as Indonesia. Therefore, these impacts need to be minimized in order to support farmer's welfare as well as animal welfare.

To address these problems, researchers are keen to be engaged in the search of higher genetic potentials as well as more tropical climatic-adaptive of forage plants. One of them is Mulato (*Brachiaria hybrid cv. Mulato*). Mulato is reportedly adapted to infertile soils and known for its tolerance of prolonged drought and regrowth after sporadic frost (Inyang et al., 2010). Furthermore, Mulato has superior nutritive value when compared with

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other warm-season grasses, with crude protein (CP) concentrations fluctuating between 90 and 170 g kg^{-1} and in vitro digestibility from 550 to 620 g kg^{-1} (Lascano et al., 2006).

Mulato grass was developed and hybridized in 1989 by the Forage Project of The Centro Internacional de Agricultura Tropical (CIAT) in Colombia with the cultivar code of CIAT 36087 (Argel et al., 2007). Mulato grass is the product of hybridization between Brachiaria ruziziensis and Brachiaria decumbens cv. Basilisk. Mulato is reportedly grows well in the altitude of sea level to 1800 meter above sea level (masl) in either humid tropical environment or sub-humid region with 5 to 6 dry months with annual rainfall above 700 mm. Another reported beneficiary characteristic is that Mulato grows well in acid, well-drained soil.

Mulato grass also reported to responds well to fertilization, especially nitrogen. Hence, in regular fertilization rate, the forage yield of Mulato may range from 10 to 27 ton DM/ha/year, in which 20% of this yield might be produced in dry season (Argel et al., 2007). Other study reported that Mulato had a higher herbage accumulation compared to other strain of Brachiaria (Ipypora) which produced in Amazon biome (Paraiso et al., 2019). While in Southeastern Asian region, Thailand, Mulato produced 60% higher DM compared to ruzi grass, which made Mulato an interesting strain of grass to be utilized as main forage for dairy cows (Pizarro et al., 2013). In nutritional aspect, Mulato's crude protein (CP) content is ranging from 10% to 17%, influenced by harvest frequency, canopy height, soil nitrogen availability, and seasonal changes (Vendramini et al., 2014; Silva et al., 2017). The aim of this research is to characterize the production quality of Mulato biomass in different spots of production in tropical climatic highlands conditions in Indonesia.

MATERIAL AND METHODS

Mulato Grass Planting Site

The basis of Mulato production location selection is the dairy cow population, altitude, and climatic characteristics. The selection of production location then came up into one location in West Java Province, Indonesia which have the most populous dairy cow population, but having different altitude management in fertilizer and spacing and climatic characteristics. The sample of soil and mulato were collected in a dairy company in Pangalengan district, Bandung Regency, West Java, Indonesia.

Soil Analysis

Soil sampling was conducted using Auger Hand Drill with composite sampling method by diagonal system. Composite sampling is a technique of collecting soil samples from several individual sub-samples located on a homogeneous stretch of land. While diagonal sampling system of land is to determine one point as the center point, then determine the points around it as many as 3 pieces with the distance between each point ± 50 m measured from each point. Soil samples were taken at a depth of 60 cm in a moist condition, then mixed evenly in a plastic bucket, then soil samples were taken using the quarter method of about 1 kg to be analysed in the Laboratory of the Indonesian Vegetable Research Institute. Soil sample was then analysed with gravimetry methods (Sato et al., 2014) to determine the texture.

Nutrition evaluation with Proximate and Van Soest Analysis

Mulato sample was prepared and nutritionally analyzed using the techniques of Weende's proximate analysis, as described by Burns (2011) and Van Soest et al. (1991). The measured fractions were the moisture (water content), ash (minerals), crude protein (CP), ether extract (EE), crude fiber (CF), and nitrogen-free extract (NFE). The sample of Mulato biomass that used in the proximate analysis was obtained from two different production locations, using Quadrat (size 60 cm x 60 cm) as the grass sampling tool. In each production locations, 8-10 locations within fields were randomly selected for the sampling site. The sampling was done by placing quadrat in each selected sampling locations, then the biomass that captured by quadrat is harvested. The harvested biomass was then weighed and cut into approximately 2 cm size. One kg of biomass in each quadrat harvest was obtained and used as sample for proximate analysis procedure in the nutritional analysis laboratory.

RESULTS AND DISCUSSION

Geographical, climatic, and soil characteristics of Mulato production sites

Recently, mulato grass cultivation has been introduced and developed especially in highlands in West Java, Indonesia. High mulato production was found mostly at location with the highest rank of dairy cow population in West Java. One of the most population dairy cow is Pangalengan district (Bandung regency; West Java, Indonesia). Table 1 shows the geographical and climatic characteristics of Pangalengan sites.

Table 1. Geographical and climatic characteristics of Pangalengan site in this experiment

Site	Dairy cow population (head)[1]	Altitude (masl)[2]	Average ambient temperature (°C)[2]	Annual rainfall (mm)[2]	Average relative humidity (%)[2]
Pangalengan	32019	1410	24	2000	74,69

Sources:
[1]Jabar (Government of West Java) Open Data. 2018. Populasi Sapi Perah (https://data.jabarprov.go.id/dataset/populasi-sapi-perah)
[2]Indonesian Statistics Bureau. 2020. Kabupaten Bandung dalam Angka. (https://bandungkab.bps.go.id/publication/2020/04/27/8c8434f70a2533a283f20fb4/kabupaten-bandung-dalam-angka-2020-.html)

Pangalengan site is one of the highlands with in West Java with high population of dairy cows. The environmental climate in Pangalengan has an average temperature of 24°C with an average humidity of 70-80%. The ideal temperature or comfort zone for FH dairy cows is 6-18°C, but at a Temperature Humidity Index of <72 or equivalent to 23°C and humidity of 80% dairy cows can still live comfortably (Moran, 2019).

The texture of soil is determined using gravimetry method. Based on Table 2, the soil texture characteristics in Pangalengan site A and B is different. In Pangalengan B, ash content is the most component of the soil (45%), which is higher compared with Pangalengan A (40%). Meanwhile sand in Pangalengan B had lower sand component compared with Pangalengan A (33 vs 44%). Pangalengan B had higher clay component of the soil (22%) compared with Pangalengan A (16%). Pangalengan B had higher pH compared with Pangalengan A. It seems the high amount of fertilizer influenced soil textute and pH.

Table 2. Soil Quality in Various Planting Systems/site at Pangalengan A = Linear Broadcast) and P2 (Pangalengan B = Linear Broadcast, More Fertilizer in Pangalengan, Bandung Regency

Parameter	Pangalengan A	Pangalengan B
Soil Quality		
N (%)	0.50	0.69
Ca (%)	30.88	32.62
Sand Texture	44.00	33.00
Dust Texture	40.00	45.00
Clay Textures	16.00	22.00
pH H2O	7.40	7.60
pH HCL	6.90	7.10
C_org Kurmies	4.13	7.50
C/N	8.00	11.00
P2O5 (Bray)	-	-
P2O5 (Olsen)	27.50	149.50
Mg (%)	2.79	4.57
K (%)	5.58	5.49
On (%)	0.57	3.16
CEC (cmol(+)/kg)	36.56	39.31
AS (%)	109.00	117.00

Note: Pangalengan A = Linear Broadcast and Pangalengan B = Linear Broadcast with more Fertilizer in Pangalengan, Bandung Wesr Java; C-organic, Cation Exchange Capacity (CEC), Alkaline Saturation (AS); (*) = Gravimetry; (**)= FM Spectro; ()= AAS

In Pangalengan sites, it is found that the land use is pasture (or can be classified as moor). The land is found in plain (plain) landform, which is located in the highlands, with various slopes, from 3 - 8% to 15 - 25%. This land is formed from lava flows that settle on the highlands. Soil formed comes from basalt, andesite, and breccia source rock. The resulting soils are dark soils, with soil type associations of Tropoudlts, Tropoudalfs, and Tropohumults. The fertility potential of these lands is moderate to high. This is coupled with the addition of high manure in the experimental garden.

Based on soil properties, Pangalengan B had higher N, Ca, C organic, C/N, P205, Mg, Cation Exchange Capacity (CEC), Alkaline Saturation (AS) compared with Pangalengan A. Meanwhile, Pangalengan A only had a bit higher in % K compared with Pangalengan B (Table 3). It seems Pangalengan B had better soil properties because this site received more fertilizer compared to Pangalengan A. However the soil texture were not affected by fertilizer.

Mulato grass nutrient content

Mulato grass planted on Pangalengan A has higher levels of Ash, CP, CF, and Ca, but CF content is lower than mulato grown at Pangalengan B. Although, nutrition composition of mulato in Pangalengan B is fertilized more, the time of cutting grass in Pangalengan B is longer. The planting density of mulato grass in Pangalengan B is also higher, which allows the grass not to receive solar irradiation evenly.

Table 3 shows the nutrient content of Mulato grass determined using proximate and fiber fraction analyses. Based on proximate analysis results, no difference found in the nutrient content of mulato grass in Pangalengan A compared to Pangalengan B, except in dry matter (DM), ash content, crude protein content, and crude fat content. Higher DM and crude fat content were found in Pangalengan B compared to Pangalengan A, with the value of 179.55 vs 152.57, 21.90 vs 17.83, respectively. On the contrary, higher ash content, crude protein content, and ether extract content were found in Pangalengan A compared to Pangalengan B, with the value of 12.58 vs 11.32%, 23.19 vs 21.13%, and 2.70 vs 2.45%, respectively. In addition, mineral calcium (C) content approximately twice higher in Pangalengan A compared to Pangalengan B, with the value of 0.69 vs 0.34%.

In terms of fiber fraction, higher NDF and lignin content found in Mulato grass planted in Pangalengan A compared to Pangalengan B, with the value of 68.21 vs 65.60%, and 5.41 vs 4.98%, respectively. Based on this data, it seems that lignin content contributes higher in the fiber content in Mulato grass planted in Pangalengan A compared to Pangalengan B.

Table 3 Quality of Mulato Grass (proximate and fiber fraction analyses) planted in different planting systems (Pangalengan A = Linear Broadcast) and (Pangalengan B = Linear Broadcast, More Fertilizer in Pangalengan Kab. Bandung

Parameter	Pangalengan A	Pangalengan B
Proximate Analysis (%, otherwise stated different)		
DM*	152.57	179.55
Ash	12.58	11.32
CP	23.19	21.13
CF	17.83	21.90
EE	2.70	2.45
NFE	43.70	43.21
P**	0.26	0.30
N	3.71	3.38
C***	0.69	0.34
Fiber fraction analysis (%)		
ADF	32.93	32.95
NDF	68.21	65.60
Lignin	5.41	4.98
Hemicellulose	35.28	32.65
Cellulose	27.52	27.97

Description: Pangalengan A = Linear Broadcast; Pangalengan B = Linear Broadcast. More Fertilizer; DM (Dry Matter [g/kg]), CP (Crude Protein), CF (Crude Fiber), NFE (Nitrogen-Free Extract), Ca (Calcium), P (Phosphorus), N (Nitrogen), NDF=Neutral Detergent Fiber; ADF = Acid Detergent Fiber; (*) = Gravimetry; (**)= FM Spectro; (***)= AAS

Based on table 3, it seems that higher fertilizer was not affecting the nutritional value of Mulato grass. For example, the CP content was not found higher in Pangalengan B, suggesting that the effect of fertilizer amount is negligible. Despite this, higher amount of fertilizer resulting higher DM content of Mulato grass, which expanding its nutritional value. It is interesting to note, however, the difference of planting site is also in the aspect of soil characteristics between two sites. The soil of Pangalengan A planting site has higher sand content compared to Pangalengan B. In contrast, the soil of Pangalengan B has higher clay content compared to Pangalengan A. This soil charactersitics seems also influenced the nutritional value of Mulato grass. In earlier study, Hendarto and Setyaningrum (2022) also found no significant differences in King grass crude protein content planted in different types of fertilizer. In contrast with fertilizer effects, Mokgakane et al. (2021) found significant effects of soil types to nutritional value of several grass species planted in South African Highvelds. The results of current study seem in line with those mentioned earlier studies, in which effects of soil types were more prominent compared to effects of fertilizer amount.

In the current study, the CP content of Mulato grass exceeding the recommendation of CP level to ensure good maintenance of rumen function (21), suggesting that this grass has a good nutritional value. In terms of beneficial fiber content (ADF and NDF), the grass in this study was in the reported range by Evitayani et al. (2004). However, lignin content in this grass is a noticeable limiting factor as higher lignin content might reduce the either palatability or digestibility of the grass (23).

CONCLUSION

In conclusion, the nutritional value of Mulato grass is promising, indicated by high DM and CP content along with beneficial fiber (ADF and NDF) contents. The amount of fertilizer seems increasing Mulato grass' nutritional value by increasing its dry matter content and lower its lignin content. Other factors as soil characteristics and climatic condition seems also determining the effects on Mulato grass nutritional value. It is therefore recommended for further study to also consider difference in soil characteristics, climatic condition, seasonal variation, fertilizer amount, and planting space that might causing different effects to Mulato grass production in longer period of time.

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