Biodiversity of Kikuyu Grass (*Pennisetum clandestinum* Hochst. ex Chiov) in Indonesia as high protein forage based on morphology and nutrition compared

J I Royani¹, Rr N Utami¹, S Maulana¹, H Agustina¹, Herdis¹, R Herry², Sarmedi² and Mansyur³

¹Center for Agricultural Production Technology, Agency for the Assessment and Application of Technology (BPPT) LABTIAP Bld 610-614-Puspiptek Serpong, Tangerang Selatan, Banten, Indonesia
²PT Bio Farma Persero, Jalan Kolonel Masturi No. 1 Kabupaten Bandung Barat, Jawa Barat, Indonesia
³Faculty of Animal Husbandry University of Padjajaran, Jalan Raya Bandung-Sumedang Hegarmanah Jatinangor Kabupaten Sumedang, Jawa Barat, Indonesia

Corresponding author: juwartina.ida@bppt.go.id

**Abstract.** Kikuyu grass (*Pennisetum clandestinum* Hochst. ex Chiov) is tropical grass originates from Eastern Africa, that has been introduced in other tropical and subtropical areas including in Indonesia. Kikuyu used as forage with high protein content and palatable. In Indonesia, Kikuyu still rarely exists, and no data reported yet about Kikuyu growing in Indonesia except data about when it was introduced to Indonesia. The aims of this study were to know the biodiversity of Kikuyu in Indonesia and to compare its morphology and nutrition contents between accession. Exploring Kikuyu accessions was done around West of Java province area. The morphology of each accession was observed with parameters and nutrition content of each accession was analyzed using proximate analysis. The results showed 3 accessions of Kikuyu from Burangrang, Tangkuban Perahu and Bukit Tunggul location. Morphology of the 3 accessions shows not significant different in all parameters. Nutrition contents between accessions namely dry matter, water contents, and fat contents shows not significant different. Crude protein content of Kikuyu accessions was ranged between 18.18 to 21.48 % DM. In this study, Burangrang accession had higher crude protein (21.48%) than other accessions, for that it has potential to be developed as superior variety.

**1. Introduction**

Kikuyu grass (*Pennisetum clandestinum* Hochst.ex Chiov) is tropical grass from the Pennisetum family that originates from Eastern Africa [1]. In some country, this grass was invasive but, in another country, Kikuyu using as pasture. As pasture, Kikuyu grass is palatable, has high yield potential, excellent response to fertility and water, also resistance to trampling and persistence [2]. FAO [3] reported that Kikuyu grass mainly used for fodder as permanent dry-land irrigated pasture, hay, or silage.

Kumalo [4] divided 3 important functions of Kikuyu, i.e.: as agricultural importance, economic importance, and industrial importance. As agricultural importance, Kikuyu used as good candidate for planting because tolerant to drought, waterlogged environments and can be grown on agriculturally
marginal lands. As economic importance, Kikuyu with high lignocellulosic biomass from agro-food industries serves as an alternative for chemical and bio-fuel production [5]. For industrial importance, Kikuyu grass used for renewable energy production because rapid in growth and degradable biomass characteristics [5,6].

Kikuyu grasses have high nutritional content and dry matter production compared to other grass [7]. Reported by Murtagh [8], Kikuyu grass has crude protein content varies from 8.5 to 25.6 % DM and high annual dry matter production with 17 t DM/ha/year [9] to 28.2 t DM/ha/year [10]. Mears [11] said that generally production of dry matter of Kikuyu ranges between 9 to 30 t DM/ha depending on nitrogen (N) fertilization, climate, and soil type.

Even Kikuyu grass is endemic and originated from Eastern Africa, but it has been distributed in other tropical and subtropical areas including in Indonesia. Kikuyu grass still rarely exists and no data report yet about Kikuyu grass growing in Indonesia except data about the existence of Kikuyu grass introduced to Indonesia [12,13]. In West of Java, the grass that has characteristics such as Kikuyu grass is often referred to by the local name as Rumput Mentega. This is the first report about Kikuyu grass that found and grown in Indonesia. The aims of this research were to know the biodiversity of Kikuyu in Indonesia and comparing its morphology and nutrition contents from each accession.

2. Materials and methods
This research was performed at Master Seed Farm owned by PT Biofarma Persero and at Laboratorium of Plant Production of BPPT Puspiptek Serpong.

2.1. Materials
Materials in this study was the accessions of Kikuyu grass (Pennisetum clandestinum Hochst. Ex Chiov) resulted from exploration at some location in West of Java.

2.2. Methods

2.2.1. Exploration of Kikuyu grass. Exploration of Kikuyu grass was held at West of Java Indonesia with sampling methods. Location of sampling was based on the information from community about the existence of Kikuyu grass as Rumput Mentega. Tillers of Kikuyu grass from exploration were planting at Master Seed as seed collection in Cisarua Bandung Barat, West of Java with elevation 1.306-1.317 m. Master seed is farmland for collecting of many kinds of grass species owned by PT Biofarma Persero.

2.2.2. Observation of Kikuyu grass morphology. Morphology of 3 accessions of Kikuyu grass were observed one month after planting in same land and same condition at Master Seed. Parameters observed of each Kikuyu accessions including height of grass, length of roots, length and wide of leaves, distance between nodes and diameter of stem. Statistical data analysis was performed using a randomized complete design with 1 factor i.e: Kikuyu accessions. The data was analysis with IBM SPSS® software.

2.2.3. Analysis of nutrition contents of Kikuyu grass. Nutrition analysis was observed after harvesting Kikuyu grass 1 month after planting. Kikuyu grass were harvest 10-15 cm above the soil surface. Fresh weigh of biomass of Kikuyu grass was weighed after harvesting. Kikuyu grass was dried using oven with temperature used 55°C for 3 days to get the dries material. After dries material was weighed, then grounded and filtered using 1-2 mm sieve. For proximate analysis, we used methods from AOAC [14] to analysis dry matter, analysis of water content, ash, and crude fiber and analysis of fat and protein contents from 3 accessions of Kikuyu.
3. Results and discussions

3.1. Morphology of 3 accessions of Kikuyu
Exploration of Kikuyu grass found 3 accessions from 3 location, i.e: Bukit Tunggul, Burangrang, and Tangkuban perahu. Accession is referring to the plant materials collected from a particular area. After exploration all accessions were planted in Master seed of PT Biofarma Persero farmland.

Thirty of Kikuyu grass from each accession were observed in morphology characters then statistically analyze using IBM SPSS® software. Data showed that morphologically of those 3 accessions of Kikuyu were not significant different for all parameters. Earlier report [15,16], the phenotypic of variability of Kikuyu within populations is low thus making it difficult to distinguish the high level of plasticity. Gaviria [17] also reported the same pattern of similarities from morphological characters of Kikuyu grass that observed from 384 plants taken from 3 area of high tropic of Antioquia. Hence, we compared of 3 accessions with the mean of all parameters that we observed.

Table 1. Height of grass and length of root from 3 accessions of Kikuyu Grass

| Accessions   | Height of grass (cm) | Length of roots (cm) |
|--------------|----------------------|----------------------|
| Bukit Tunggul | 99.21 ± 33.36        | 14.40 ± 5.72         |
| Burangrang   | 74.30 ± 20.46        | 16.75 ± 4.76         |
| Tangkuban Perahu | 70.91 ± 25.09    | 13.04 ± 4.92         |

The data (Table 1) showed that height of grass from 3 accessions of Kikuyu was ranged between 70.91 ± 25.09 cm to 99.21 ± 33.36 cm. In term of height of grass, Bukit Tunggul accession was the highest compared other accessions. Our research of height of grass had result as reported by Moris [16] that Kikuyu grass had culms up to 90 cm or more high, usually less and not more than 60 cm. Information added by [18], that application of manganese to the soil can affected the plant height at the first and second cutting of Kikuyu with approximately 77 cm. Our research showed that with the application of manure Kikuyu grass had height until 99.21 ± 33.36 cm.

Data of root of 3 accessions of Kikuyu showed that the length of roots ranges between 13.04 ± 4.92 cm to 16.75 ± 4.76 cm and Burangrang accession was the longer root than another with 16.75 ± 4.76 cm (Table 1). Our result for roots system of Kikuyu showed that roots from 3 accessions of Kikuyu maybe still develop to grown because roots system of Kikuyu had the dense rooting and can be reach until more than 2 m [19] or down to 3 m [20]. The roots system of Kikuyu grasses well known as roots with strengths root and well-developed root system so Kikuyu grass can be an exceptional species used for erosion control [21,22] especially on desert edges and salinized soils [23].
Table 2. Length and wide of leaves from 3 accession of Kikuyu Grass

| Accessions       | Part of grass | Length of leaves (cm) | Wide of leaves (cm) |
|------------------|---------------|-----------------------|---------------------|
| Bukit Tunggul    | Top           | 24.08 ± 10.28         | 0.82 ± 0.17         |
|                  | Middle        | 25.89 ± 6.34          | 1.01 ± 1.12         |
|                  | Bottom        | 16.09 ± 6.34          | 0.59 ± 0.12         |
| Burangrang       | Top           | 17.20 ± 7.62          | 0.82 ± 0.13         |
|                  | Middle        | 15.32 ± 3.97          | 0.65 ± 0.19         |
|                  | Bottom        | 14.02 ± 3.58          | 0.52 ± 0.11         |
| Tangkuban Perahu | Top           | 21.67 ± 8.42          | 0.87 ± 0.13         |
|                  | Middle        | 20.36 ± 5.65          | 0.69 ± 0.13         |
|                  | Bottom        | 14.42 ± 5.00          | 0.52 ± 0.16         |

Figure 3. The length of leaves of Kikuyu Grass

Figure 4. The distance between nodes of Kikuyu Grass

For parameters of length and wide of leaves, we compared 3 parts of height of grass, i.e: at top, middle and bottom of grass for identification of leaves. Data showed no significant different from 3 accessions of Kikuyu that observed from length and wide of leaves. We compared 3 accessions of Kikuyu leaves with the mean of data. The data showed that length of leaves from 3 accession of Kikuyu from top, middle, and bottom of grass no significant different. The length of leaves between 3 accessions of Kikuyu were 14.02 ± 3.58 cm to 25.89 ± 6.34 cm. The part of grass that has length of leaves shorter than another part was bottom of grass for all accessions (Table 2).

Kikuyu grass had leaves with usually narrow and long up to 25 cm and wide of leaves was 2.5 mm [24]. Our result showed that 3 accession of Kikuyu grass had the same size from length but no for wide of leaves. The wide of leaves from 3 accessions had short than previous report [17]. The wide leave has no significant different from 3 accessions of Kikuyu. The data showed that wide of leaves of 3 part of grass from 0.52 ± 0.16 cm to 1.01 ± 1.12. Reported by Mears [11] leaves of Kikuyu had blade-shaped with 15 cm long x 5 mm broad, tightly folded when young and flattened when older.

For distance between nodes, we also compared 3 parts of distance between nodes: at top, middle and bottom part of grass. Statistically, data for distance between nodes of 3 accessions of Kikuyu showed no different significantly. Distance between nodes of 3 accessions of Kikuyu ranges between 2.84 ± 0.57 cm to 5.72 ± 0.71 cm. The middle part of grass had distance nodes more length than in top and bottom part of grass (Table 3) with 4.99 ±0.81 cm to 5.72 ± 0.71 cm.
Table 3. The distance between nodes and diameter of stem from 3 accession of Kikuyu Grass

| Accessions   | Part of grass | Distance between nodes (cm) | Diameter of stem (cm) |
|--------------|---------------|-----------------------------|-----------------------|
| Bukit Tunggul| Top           | 3.30 ± 1.00                 | 2.96 ± 0.65           |
|              | Middle        | 5.72 ± 0.71                 | 3.93 ± 0.78           |
|              | Bottom        | 4.87 ± 1.38                 | 3.48 ± 0.92           |
| Burangrang   | Top           | 2.96 ± 0.94                 | 2.93 ± 0.59           |
|              | Middle        | 4.99 ± 0.81                 | 3.79 ± 0.53           |
|              | Bottom        | 3.81 ± 1.33                 | 3.44 ± 0.56           |
| Tangkuban Perahu | Top     | 2.84 ± 0.57                 | 2.74 ± 0.52           |
|              | Middle        | 5.09 ± 1.04                 | 3.49 ± 0.64           |
|              | Bottom        | 3.10 ± 0.81                 | 3.42 ± 0.65           |

Diameter of stem also observed from 3 part of grass: at top, middle and bottom part of grass. The data showed that no significant different between 3 accessions of Kikuyu for diameter of stem. Diameter of stem ranges between 2.74 ± 0.52 cm to 3.93 ± 0.78 cm.

The parameters of morphology of the 3 Kikuyu accessions were generally not many different. This is probably because locations of Kikuyu accessions found located around West of Java with almost same environment. So that, possibility of genetic variation in the accessions found was still low or almost no difference.

3.2. Nutrition contents of 3 accessions of Kikuyu

Nutrition contents from forage is the important factor to know the quality of forage. There are several factors that affect the nutritional content of forages, i.e: genotype of plants, maturity, season, management, and anti-quality factor [25].

Table 4. Nutrition values from 3 accession of Kikuyu Grass (% DM)

| Accessions            | Dry matter | Water content | Ash contents | Crude fiber content | Fat content | Protein contents |
|-----------------------|------------|---------------|--------------|--------------------|-------------|-----------------|
| Bukit Tunggul         | 15.54      | 84.46         | 14.10        | 20.51              | 2.51        | 18.16           |
| Burangrang            | 16.70      | 83.30         | 11.50        | 20.58              | 1.50        | 21.48           |
| Tangkuban Perahu      | 15.54      | 84.46         | 12.60        | 20.85              | 1.78        | 19.78           |

The nutrition contents of 3 accession of Kikuyu were based on proximate analysis showed that no significant different nutrition contents from dry matters, water contents, and fat contents. But for ash contents, Bukit Tunggul accession has ash content higher than other accessions with 14.10% and for protein content Burangrang accession has higher than another with 21.48%. As seen from Table 4. Burangrang accessions has high protein content but low ash content.

If we compared the result of crude protein from literature, crude protein of Kikuyu ranges between 8.5 to 25.6% DM [7]. Our result showed that crude protein ranges between 18.18 to 21.48 % DM that means our accessions had high crude protein contents and potential to develop as superior variety. Research by [26] reported crude protein of Kikuyu cv Hosaka at different stages of growth for 4, 8, and 12 weeks after planting with crude protein from 14.1 ± 0.8, 19.1 ± 1.0, and 24.0 ± 1.7 %.

As reported that age of plant affects the resulting of crude protein and tend to be increased percentage of crude protein. Our research using biomass of Kikuyu at 1 month after planting or 30 days or 4 weeks resulted higher of crude protein if we compared with research from Fukumoto and Lee [26] at the same
time. Research also reported by [7] that crude protein from Kikuyu was 15.2% when analysis at 28 days and by Botha et al. [27] that crude protein from Kikuyu had higher of crude protein 23.1-23-7% even harvest at 28 days with add by fertilizer 600 kg N/ha/annum. Most of nutritional contents of Kikuyu from 3 accessions showed results that are close to the nutrition table on Feedipedia [20] for Kikuyu grass.

Our result is preliminary activities research that the data, location of accessions, morphology, and the nutrient contents of Kikuyu grass in Indonesia, can be used for estimating the prospect of Kikuyu grass in Indonesia. The authentication of species, the probability found accessions at another places or location in Indonesia, genetic variability, the optimal cultivation for biomass productivity connecting with nutrients content, the digestibility of feed from Kikuyu grass to livestock become continuity research that we had been design to development and improvement research of Kikuyu grass in Indonesia.

4. Conclusions
There was no significant different in all morphological parameters and nutrition content observed of 3 accessions of Kikuyu in this study. Crude protein content of Burangrang accession is the highest than other accessions. The crude protein ranges between 18.18 to 21.48% DM that means our accessions had high crude protein content and potential to be developed as superior variety in Indonesia.

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