Morphology, Biomass Production, and Nutrient Analysis Four Napier Grass Cultivar (*Pennisetum purpureum* Schumach.) in Teak Tree Forest Area Megeri Village, Blora, Central Java

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Abstract. This study aims to determine the morphology, biomass production and nutrient analysis of four cultivars of napier grass (*Pennisetum purpureum* Schumach.) in teak tree forest area Megeri village, Blora Regency, Central Java. Four cultivars of napier grass namely Gama Umami, Biovitas, Pakchong, and Zanzibar being cultivated in teak tree forest area. The teak tree forest area was in Kawasan Hutan Dengan Tujuan Khusus (KHDTK) UGM. Previously there was no cultivation of new improved napier grass cultivars in KHDTK. Therefore, it is interestingly to investigate the introduction and growth ability in this area. Grasses were cultivated using stem cuttings approximately 15 cm and maintained for 4 months using a completely randomized design with 4 replications for each cultivar. During the cultivation period, morphological characteristics were observed including plant height, leaf length, leaf width, and tiller numbers. Plant was harvested after 4 month of cultivation and determine for biomass production and nutritional value of grass. The morphological characteristics and nutrient analysis among napier grass cultivars showed the similar trend. Gama Umami, Biovitas, and Pakchong had significantly higher biomass production than that Zanzibar cultivar.

1 Introduction

Napier grass (*Pennisetum purpureum* Schumach.) is popular warm season grass in Indonesia for being used as forage for livestock and dairy cattle. Currently in Indonesia has several improved cultivars that commonly used such as Gama Umami, Biovitas, Pakchong, and Zanizabar.

The cultivars of plants can have an impact on both the quality and quantity of the plant. A study on soybean plant found that different growth type had different on nutrient and quantity yield of soybean [1]. Another study on Brachiaria grass found that different species and cultivar lead to different nutrient and oxalate content [2]. Similarly, a study on Dwarf Napiergrass found that oxalate and silica content may varied among cultivars [3].

Different varieties of napier grass can have varying levels of nutrient content. The way that napier grass is planted can also affect its nutrient content. Intercropping pakchong with Indigofera and harvesting at 60 days produced the higher forage fresh weight and DM production, ADF contents and yields, CP yield, and the highest carrying capacity [4].

Teak tree plantations are an important part of the forestry industry in Indonesia. Teak is the most important commercial tree species in Indonesia, and there are 0.6 million hectares of production plantations based on seed from these plantations [5]. The area of teak plantation covers 1.081 million hectares, in which 0.837 million hectares are suitable for the clear-felling harvest system [6]. Blora Regency in Central Java has the largest teak Forest area in Java, Indonesia. The forest area is quite extensive and covers several catchments in Blora Regency [7].

Intercropping is a common practice in Teak plantation in Indonesia. In Gunungkidul, intercropping tuber crops with teak has been studied to diversify food crop products and make more effective use of land [8]. In addition, teak is sometimes planted with annual crops such as maize during the establishment period [9]. Intercropping can improve productivity and soil quality by increasing the amount of organic matter and improving soil structure. A study on arbuscular mycorrhizal inoculation in teak and napier grass agroforestry found that soil amendments like gypsum can improve soil structure, increase moisture content, and facilitate soil microbial functions [10]. Therefore, it’s important to investigate the morphology character, biomass production, and nutrient analysis in several cultivar of Napier grass cultivation in teak tree forest area Megeri Village, Blora Regency, Central Java to support agroforestry system in Indonesia and improve efficiency of land use in Indonesia.

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2 Methodology

2.1 Plant material

Four cultivars of napier grass namely *Pennisetum purpureum* cultivar Gama Umami, Biovitas, Pakchong, and Zanzibar were used in this study. Grasses were cultivated using stem cuttings approximately 15 cm.

2.2 Field experiment

The study was conducted in teak tree forest area Megeri village, Blora Regency, Central Jawa (7º21'40''S 111º26'36''E, elevation of 100 m above sea level). Most of the land in Blora Regency is dry land. The soil type characterized as sandly soil with relatively poor in organic matter. The climate of Blora Regency is tropical climate, relatively high temperatures in the dry season and sufficient rainfall in the rainy season. Plant cultivation maintained for 4 months using a completely randomized design with 4 replications for each cultivar.

2.3 Investigation on morphology

During the cultivation period, morphological characteristics were observed including plant height, leaf length, leaf width, and tiller numbers. Plant was harvested after 4 month of cultivation and determine for biomass production and nutritional value of grass.

2.4 Statistical analysis

Statistical analysis was conducted to compare the morphological characteristics, biomass production, and nutrient content among napier grass cultivars. Differences in means were evaluated by Tukey's test using R statistic program.

3 Result and Discussion

Table 1. Average of Morphology characteristics of 4 Napier grass cultivars

Cultivar	Average value of morphological characteristics			
	Plant height (cm)	Leaf length (cm)	Leaft width (cm)	Tiller numbers
Gama Umami	181.3^a	96.2	3.47	4
Biovitas	194.2^a	100.5^a	3.70	5
Pakchong	180.1^a	97.7	3.78	4
Zanzibar	169.9^b	93.3^b	3.13	3

Means in the same column followed by the different latter are significantly different at 0.001 probability level.

Based on the plant observation for 4 months after planted, plant growth data were obtained in Table 1. The morphological characteristics among the cultivars described the similar trend. However, Biovitas had significantly higher of plant height and leaf length than that of Zanzibar cultivar. Even though there was not significantly different between Gama Umami, Pakchong, and Biovitas cultivars. Plant growth is influenced by internal and external factors. The influence of internal factors in the form of genetics. Selection of varieties will affect the morphological value of the growth of the grass. This happens because it is genetic influences that cause differences in the speed of division, multiplication and enlargement of plant cells. while external factors can be influenced by soil and climate. Napier grass can grow optimally from the factor moist environment and soil conditions that have nutrients which is more, so that the high growth of elephant grass plants can seen for real. Napier grass will growth better in good and fertile land condition with sufficient nutrient. The moisture of soil was also affecting the plant growth. Napier grass had fibrous root system which considering deep rooting. In this research, Zanzibar had aggressive tiller number that spreads through rhizome under the ground. The morphological characteristics of napier grass cultivars, such as plant height, stem diameter, internode, leaf stem, ratio, fiber content, crude protein, and in vitro dry matter digestibility, can affect their productivity and quality [11].

Table 2. Biomass productino of 4 grass cultivars

Cultivar	Biomass production *(fresh weight)* First defoliation (Kg/m^2)
Gama Umami	6.15^a
Biovitas	7.25^a
Pakchong	6.57^a
Zanzibar	3.39^b

Means in the same column followed by the different latter are significantly different at 0.001 probability level.

The analysis result in Table 2 shows the production of biomass. The production of biomass among the cultivars described the similar trend. However, Biovitas had significantly higher of biomass production than that of Zanzibar cultivar. Even though there was not significantly different between Gama Umami, Pakchong, and Biovitas cultivars. The yield and chemical compostition related to biomass quality of elephant grass can be affected by the harvest time. A study found that different elephant grass genotypes showed a liner first-degree effect as a function of the harvest intervals, indicating that they did not reach their maximum production potential. Genotypes that had a linear second-degree effect had a higher yield [12].

Fresh production is influenced by nutrients that play a role production of biomass of a plant. Plant growth greatly affects the fresh biomass production of a plant. The fresh weight of the plant can reflect water and elements nutrients absorbed by plants. Water and nutrients absorbed by plant will affect plant growth, such as height plant, the number of leaves and leaf area which then affect the weight fresh a plant. The growth and production response of Pakchong elephant grass to different fertilizer doses and cutting ages were evaluated in another study. The study found that the optimal point for obtaining the best results in terms of plant height growth, number of leaves, number of tillers, production of fresh biomass, dry weight of stems, dry weight of leaves, and total dry weight of Pakchong elephant grass was a cutting edge of 60 days [13].

Table 3. Nutrient content of 4 grass cultivars

Lines	Average of nutrient content (%)				
	Dry matter	Organic matter	Crude fiber	Crude protein	Crude fat
Gama Umami	16.85	82.80	29.82	14.89	2.57
Biovitas	16.13	82.79	33.40	16.97	2.12
Pakchong	15.63	81.66	31.02	17.92	1.96
Zanzibar	14.73	80.13	33.28	16.95	2.18

Means in the same column followed by the different latter are significantly different at 0.001 probability level.

The analysis result in Table 3 shows that the nutrient content of 4 grass cultivars. The nutrient content of dry matter among the cultivars described the similar trend. However, Gama Umami had significantly higher dry matter content than that Zanzibar. Even though there was not significantly different between Gama Umami, Pakchong, and Biovitas cultivars. Dry matter is the total feed substances other than water in a material feed. Dry matter is an accumulation of food reserves such as protein, carbohydrates and fat, as well as photosynthate is found in the stems and leaves of plants. Plant dry matter production is influenced by several factors, one of which is water content (KA) in the plant itself. The DM content in plants is greatly influenced by the rate photosynthesis and the products of photosynthesis. Then it is related with nutrients in the soil, water and light intensity.

Gama Umami has a much lower crude fiber content compared to other cultivars. Differences in crude fiber content in plants are influenced by genetics plants, harvest age, nutrients in the soil and light intensity. The number of stems and leaves increased as the growth stage increased. The crude fiber content of plants is also influenced by place altitude. Differences in cultivars can also cause differences in fiber content rough because the nutrient content of plants is greatly influenced by genetic potential. The genetic characteristics of the varieties of napier grass may influence their ability to produce energy, due to their different levels of fiber and lignin. A study found that different elephant grass varieties had different levels of fiber in neutral detergent, acid detergent fiber, lignin, moisture, dry matter content, and higher heating value [14]. The number of leaves and stem was also affect the nutrient value produced from plant [15].

Pakchong has a much higher crude protein content compared to other cultivars. The low value of the nutritional content of a plant is influenced by several factors, one of which is harvest age. The crude protein content of grass decreased as increasing the harvest age. In addition, the effect of mutation induction in the elephant grass mutants that cause genetic variation is also a factor that determine the value of nutrient content in plants. Besides that, the nitrogen content available in the soil also has an effect in plant crude protein content. The main source of variation in crude protein content in elephant grass is genotype, age of harvest and environment. Proper nitrogen will enhance plant growth then cause an increase in metabolism, so it will accelerating the conversion of carbohydrates into protein inside plant. Sufficient nitrogen will increase vegetative growth and expand the size of the leaves to catch more light, nitrate, and phosphate which are necessary for the preparation of protein and chlorophyll. Defoliation time will also affect nutrient value, where the crude protein content decreased from the first to second defoliation [16].

The organic matter among the cultivars described the similar trend. Organic matter is one of the constituent components of the material dry. The organic matter content is affected by the dry matter content and ash in plants. Organic matter is related to protein content crude oil, crude fat and crude fiber in plants. The organic material content in grass can influenced by the condition of nutrients in the soil. Lack of nutrients in the soil causes a decrease organic matter content in plants. Light intensity and water availability can also affect the plant organic matter content.

The nutrient content of crude fat among the cultivars described the similar trend. However, Gama Umami had significantly higher dry matter content than that Pakchong. Crude fat content in plants is very high influenced by the level of N absorbed by plants. It's related by the process of fat formation by plants. The crude fat of plant also affect by the age of plant, increasing age of plant will increasing the crude fat of plant [17]. Crude fat content in plants is also influenced by the addition of NPK fertilizer, the addition of fertilizer will increasing N levels in the soil so that it can increase formation of crude fat and vegetative growth of plants. The increase in vegetative cells can increase the crude fat content, because fat is part of the protoplast.

In conclusion, napier grass cultivar Biovitas, Gama Umami, and Pakchong could adapt with high morphology characteristics, high biomass production, and high nutrient value. The research data could be used for plant breeder to develop new cultivar of napier grass which can adapt in teak tree shade area. Cultivation of napier grass in teak tree forest area or KHDTK UGM is recommended and could support the agroforestry system in Indonesia. Further research about teak tree shade for napier grass ability in teak tree forest, planting space area, intercropping with another plant and fertilizer management are needed.

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