Agronomic Properties, Dry Matter Production and Nutritive Quality of Guinea Grass (*Megathrysus maximus)* Harvested at Different Cutting Intervals

Jusoh*, S. , A.R. Alimon and M.S. Kamiri
Department of Animal Science, Faculty of Agriculture,
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
*Corresponding author: shokri@upm.edu.my

Abstract

Response pattern of guinea grass to defoliation interval was assessed for about four months from July to October 2012 to investigate the morphological response, in terms of agronomic properties, dry matter production and nutritive value, of guinea grass (*Megathrysus maximus*) towards cutting interval. A newly planted guinea grass plot was divided into sub-plots and subjected to three cutting intervals, namely 3, 4 or 5-week-intervals. The experimental design was RCBD with 3 treatments (cutting intervals) with 4 replicates in each treatment and assessed for agronomic properties, DM production and nutritive quality of the harvested grass. There were significant differences ($p<0.05$) in DM yield where 5-week interval was the highest, crude protein was the highest at 3-week interval, and similar trends with neutral detergent fibre, acid detergent fibre and acid detergent lignin content of the grass. Guinea grass harvested at 5-week-interval appeared to have the highest DM yield with 1.32 of leaf to stem ratio.

Keywords: cutting interval, guinea grass, nutritive value, yield, crude protein

Introduction

The development of the livestock sub-sector in Malaysia and many tropical countries are hindered by many constraints, of which the unavailability of quality feed is a major factor. The main feed resources are low in quantity and quality for sustainable animal production, and it become the bottleneck to livestock production because it cannot satisfy minimum requirement of nutrients of animals due to harvesting at advanced stage of maturity (Kandel *et al.*, 2013). Maturity stage of pasture grass at harvesting or grazing is considered a crucial management practice as this determines nutritional quality of the grass. Tropical and sub-tropical grasslands are characterized by rapid growth during periods of heavy rainfall, leading to mature pasture plants containing high levels of cell wall constituents, low sugar and often very low in true protein (Sierra and Nygren, 2006). Herbage production is regulated by environmental variables, morphogenesis of plant species and characteristics of the sward or pasture, as plant tissues accumulate through leaf appearance and elongation, and are subjected to ageing and senescence (Lemaire et al., 2009).

Guinea grass (*Megathrysus maximus*) is among the most common introduced grass species used as a source of animal fodder in Malaysia. It is an ideal forage plant as it grows well on a wide variety of soils and even under light shade of trees and bushes and can survive long dry spells and quick-moving fires which does not harm the underground roots. It also responds quickly to fertilizer and watering. In term of pasture utilization of tropical pasture, there is a conflict between yield and nutritive quality of the forage, when harvesting the grass at an earlier stage results in low yield, but the nutritional quality of the grass drops than harvesting at a later stage. Stage of maturity at defoliation point can be considered as crucial management practice that determines DM production and nutritional quality of forage. McCosker and Teitzel (1975) indicated that crude protein declined with age and reported a range from 19% in 2- week regrowth with high nitrogen input to 9% or less at maturity. Therefore, the current study was conducted to investigate the morphological response, in terms of agronomic properties, production and nutritive value of guinea grass *(Megathrysus maximus)* harvested at 3-, 4- and 5-week cutting intervals.

Materials and Methods

Experimental site and design

The experiment was conducted at Field 2, Faculty of Agriculture, Universiti Putra Malaysia, Serdang (location 101^{o} 42'E, 2^{o} 12'N). The average annual rainfall of the area during the study period was 3000 cm and the average annual minimum and maximum air temperatures were 22^{o}C and 33^{o}C, respectively. The soil texture is clay loam with pH 5.2, nitrogen 0.04%, phosphorus 29 mg kg^{-1} and potassium 0.19 cmol^{+} kg^{-1}. The experimental design was Randomized Complete Block Design (RCBD) with three treatment of cutting interval and four replicates. The treatments are cutting interval where grass was harvested at 3 week, 4 week and 5 week intervals. The grass was planted on the area sized 180 m^{2} with land preparation following standard procedures, with initial disc ploughing, followed by disc harrowing and rotovating to form fine and friable seedbed. The plot was then applied with ground magnesium limestone at the rate of 4 t/ha and basal fertilizer of 60 kg N, 50 kg P and 40 kg K per hectare using urea (46% N), triple superphosphate, TSP (20% P) and muriate of potash, MOP (50% K), respectively.

Common guinea grass were planted using vegetative clump split with 5 tiller/point in rows with five rows per plot spaced at 1 m between rows and 0.5 m between points in each row, giving a density of 20,000 plants/ha and they were allowed to establish for a period of 2 months before the first cut was taken followed by cutting interval treatment, sampled for four, five and seven consecutive harvests for 5, 4 and 3 weeks interval, respectively.

Morphology Development Measurement

Morphological development measurements include botanical composition, tiller count/plant and leaf to stem ratio. The botanical composition refers to the percentage of weed species and sown grass established in the same area, where all vegetation within one meter^{2} was cut and separated. The number of tiller per plant was measured from the five clumps. Measurements taken before each harvest included plant height and density of tillers. Plant height was based on five culms taken randomly in each plot, measured using a steel tape from the ground level to the highest leaf. The grass was harvested at 15 cm above the ground level, and after each harvest the total dry matter yield was estimated based on samples from 1 x 0.5 m quadrats after drying the cut samples in forced-air oven at 65^{o}C over 4 days. Leaves were separated from stems and the leaf-to-stem ratio (LSR) was estimated based on the dry weight of each component for each sample. The dried samples were then ground to pass a 1-mm sieve and the ground samples were used for laboratory analyses. The proximate analysis was carried out to determine crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and ash (AOAC, 1984). Differences among varieties were tested using analysis of variance and where differences were significant, means separation using Duncan's Multiple Range Test was carried out using SAS 9.2 (SAS Institute Inc., 2011).

Result and Discussion

Morphology Development Measurement

Botanical composition of three different cutting interval show that the percentage of grass was increased with the increase of cutting interval with 50% at three week cutting interval, 65% at four week and 82% at 5 week cutting interval (Table 1), indicating the mature grass sward depressed the growth of weedy species through competition for space, nutrients and sunlight. Leaf to stem ratio was decreased with longer cutting interval as shown in Table 1. The ratio of leaf to stem of the grass was 5.1 at 3 week cutting interval, but reduced to 2.5 at 4 week cutting interval and 1.3 of leaf to stem ratio at 5 week cutting interval. The reduction in leaf to stem ratio indicate the reduction in quality in certain parts of the grass as it advanced in maturity. The tiller number per plant was increased with grass maturity as the number of tiller develops. The average DM yield production of guinea grass at different cutting interval found that the yield per harvest of guinea grass was the highest at 5 week cutting interval (1527.7 kg /ha), followed by 4 week cutting interval (923.7 kg/ha) and 3 week cutting interval (738.4 kg/ha), (Figure 1). The total DM production over the study period was 5168.8kg for 3 weeks interval, 4618.5kg for 4 weeks interval and 6110.8kg for 5 weeks interval. The nutritive value indicating the quality of feed offered to the animal, the average crude protein of the guinea grass was the highest at 3 week old (15.3%), followed by 4 week interval (12.8%) and 5 week interval (11.1%). (Table 1).

However, in this study similar results were obtained in that the longer the vegetative growth of the plant, the greater the number of leaves produced from the newly emerging tillers. This may be due to the longer physiological growth phases of the plants in the lower cutting frequency the CP content guinea grass leaves used in the study by Tona (2011) of Nigeria were adequate as compared with the 7-8% CP recommended as the least value required by ruminants for efficient performance.

The result showed that the highest yield were generally obtained with the longest cutting interval and this was in line with Rengsirikul et al., (2011) who showed that the peak in biomass yield of napier grass occurred in all cultivars with 3-month inter-cutting interval, with a mean of 50.2 t dry matter (DM) ha^{-1} $year^{-1}$ averaged across cultivars, while a 6-month interval produced 46.2 t DM $ha^{(-1)}$ $year^{(-1)}$, and by considering plant requirements the forage is maintained in an active growing and tillering phase longer, allowing forage production continues.

The nutritive value of the guinea grass harvested at 3, 4 and 5 weeks cutting interval depends primarily on the physiological and morphological development of grasses. A significant amount of published data generally show that there is a progressive decline in digestibility as plants change from a leafy vegetative to a morphological stemmy growth as plants grow to maturity.

Total ash, CP, hemicellulose and IVDMD contents decreased with decreasing frequency of defoliation, whereas DM, ADF, ADL and cellulose contents showed an increasing trend with a decrease in defoliation frequency (Tessema, Mihret, & Solomon, 2010). The CP percentage of all the treatments ranged from 11.1 to 15.3 %, which was above the minimum CP level required for rumen function (7·5%) and the NDF percentages recorded in this experiment ranged from 54·4 to 91 %, which is below and above the average value for tropical grasses (66·2%) and within the threshold level of NDF beyond which DM intake of cattle is negatively affected (60·0%).

The shorter cutting interval had lower botanical composition of guinea grass sward in this experiment show that there was less weed infestation in plots with low defoliation frequency because of shaded condition created by grass canopy. However, longer cutting interval decreased in leafy fraction of the grass plant, indicates lower in quality of forage. The number of tiller number per plant and DM production of guinea grass were higher in longer cutting interval plants, however the quality of grass was lower in longer cutting interval. Farmers can choose longer cutting interval to obtain higher quantity of forage but the balance between quality and quantity are the most important criteria to be considered in managing defoliation of guinea grass to achieve maximum benefit for animal production needs.

Table 1: Main affect means of harvests (± SE) of chemical analysis and morphological parameters of Guinea grass at different cutting intervals

Parameter	Cutting interval (weeks)		
	3	4	5
Crude Protein (%)	15.27^{a}(± 0.07)	12.73^{b} (±0.21)	11.10^{c} (±0.14)
Ash (%)	0.36^{a} (± 0.02)	0.29^{a} (± 0.02)	0.31^{a} (± 0.03)
Dry Matter Basis (%)	91.34^{c} (± 0.25)	92.10^{b} (±0.17)	92.95^{a} (±0.12)
NDF (%)	85.38^{0} (± 0.72)	87.97^{b} (± 0.46)	90.91^{a} (± 0.37)
ADF (%)	39.13^{C} (± 0.45)	43.46^{b} (± 0.74)	47.59^{a} (± 0.58)
ADL (%)	2.27^{a} (± 0.22)	3.03^{b} (±0.41)	2.71^{a} (±0.17)
Leaf to Stem ratio	5.20^{a} (± 0.11)	3.03^{b} (± 0.28)	1.32^{c} (± 0.04)
Botanical composition (%)			
a. weed	63.33^{a} (±1.79)	63.33^{a} (± 0.67)	68.75 (± 1 -43)
b. grass	36.68^{b} (±1.79)	36.68^{b} (± 0.67)	31.25^{a} (± 1.43)
Tiller count per plant	4.00^{c} (±0.19)	4.67^{b} (± 0.24)	5.50^{a} (±0.17)
Tiller and root weight (g)			
a. Tiller	1.00^{a} (± 0)	4.00 (± 0)	7.25^{c} (± 0.25)
b. Root	17.50^{a} (± 0.29)	29.00^{b} (± 0.41)	87.50^{c} (± 0.96)

*Mean with different superscripts are significantly different according to DMRT test (P<0.05) following a significant ANOVA.

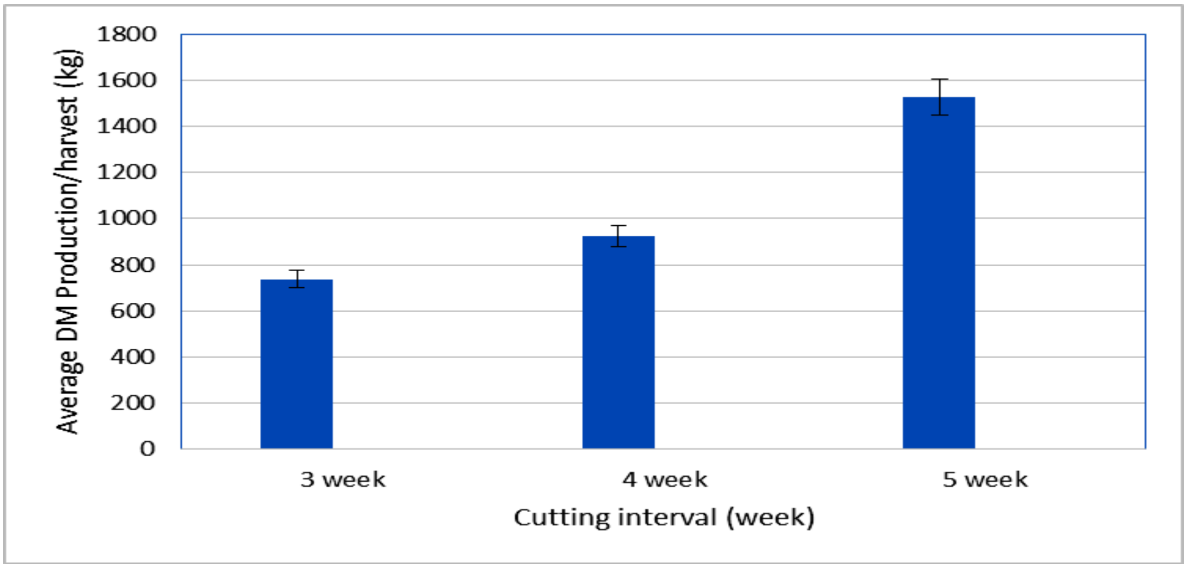

Figure 1: The average DM Production of guinea grass harvested at 3, 4 and 5 week cutting interval during the study period.

Conclusion

While cutting interval (harvesting age) had a marked effect on forage composition of guinea grass, there was limited effect of cutting interval (rate of cutting). Cutting at 5-weekly interval seem to provide maximum yield of material with acceptable leaf to stem ratio (1.32) and nutritional quality (CP: 11.10%, NDF: 90.91%, ADL: 47.59%, ADL: 2.71%). The production of animals depends on production and quality of the grass that are offered to them. Good management of cutting or grazing system would be the main factor to produce optimal production in animal industry. Therefore, feeding and digestion studies are needed to confirm whether animal production was also optimal under this regime.

References

Aganga, A.A. and Tshwenyane, S. 2004. Potentials of Guinea Grass *(Panicum maximum)* as Forage Crop in Livestock Production. Pakistan Journal of Nutrition 3 (1): 1 - 4

AOAC. 1984. AOAC Official Methods of Analysis (14th Edition., pp. 129 – 130). Washington DC: Association of Official Analytical Chemists.

Kandel, T. P., Sutaryo, S., Møller, H. B., Jørgensen, U., and Lærke, P. E. 2013. Chemical composition and methane yield of Reed Canary grass as influenced by harvesting time and harvest frequency. Bioresource Technology, 130: 659–666. doi:10.1016/j.biortech.2012.11.138

Lemaire, G., Da Silva, S. C., Agnusdei, M., Wade, M., and Hodgson, J. (2009). Interactions between leaf lifespan and defoliation frequency in temperate and tropical pastures: A review. Grass and Forage Science, 64, 341–353. doi:10.1111/j.1365-2494.2009.00707.x

McCosker, T.H. and Teitzel,J.K. 1975. A review of Guinea grass (*Panicum maximum*) for the wet tropics of Australia. Tropical Grasslands, 9: 177-190.

Rengsirikul, K., Ishii, Y., Kangvansaichol, K., Pripanapong, P., Sripichitt, P., Punsuvon, V., and Tudsri, S. 2011. Effects of inter-cutting interval on biomass yield, growth components and chemical composition of Napier grass (*Pennisetum purpureum* Schumach) cultivars as bioenergy crops in Thailand. Grassland Science, 57: 135–141. doi:10.1111/j.1744-697X.2011.00220.x

SAS Institute Inc. 2011. The PHREG Procedure. In SAS/STAT 9.3 User's Guide (pp. 4517–4721).

Sierra, J., and Nygren, P. (2006). Transfer of N fixed by a legume tree to the associated grass in a tropical silvopastoral system. Soil Biology and Biochemistry, 38: 1893–1903. doi:10.1016/j.soilbio.2005.12.012

Tessema, Z. K., Mihret, J., and Solomon, M. 2010. Effect of defoliation frequency and cutting height on growth, dry-matter yield and nutritive value of Napier grass (*Pennisetum purpureum* (L.) Schumach). Grass and Forage Science, 65: 421–430. doi:10.1111/j.1365-2494.2010.00761.x

Tona, G. 2011. Chemical composition and nutrient digestibility of *Panicum maximum* and *Piliostigma thonningii* leaves fed to West African Dwarf rams as dry season feed . Ozean J. Applied Sciences, 4(3:), 189 – 194.