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Herbage Yield and Nutritive Value of Different Napier (*Pennisetum purpureum* Schumach) Grass Varieties

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Abstract

The experiment was conducted at National Jersey Breeding Centre, Samtse to assess the fresh herbage yield and nutritive value of four Napier grass varieties (CON, CO3, MO, and Pak-1) at different harvesting time intervals of 60, 90, and 120 days. Randomised Complete Block Design with three replications was used for the study. A significant difference ($p < .05$) in the herbage yield was observed among different Napier grass varieties. High fresh herbage yield of 23.70 t/ha was recorded in Pak-1 variety, and the highest dry matter yield of 151.52 g/kg was recorded in CO3 variety. There was no effect of different harvesting intervals on the herbage yield, while the number of tillers had significant effect ($p < .05$) on herbage yield. The shorter varieties were leafier and produced higher crude protein percent and dry matter compared to taller varieties. The CO3 variety gave the highest percentage of crude protein (12.62%) and ash (13.92%) as compared to other varieties. All four varieties of Napier grass had crude protein level above the critical limit (7%) required by ruminants for voluntary intake and rumen function.

Key words: herbage yield, nutritive value, Napier grass, crude protein

Introduction

Livestock is one of the important components in integrated and subsistence farming system in Bhutan. Availability of feed is economically the single most important determinant of animal production. Suitable animal feeding programme determines animal health, welfare, productivity, product safety and quality, and land use. In Bhutan, 70% of the total forage requirements are provided by forest grazing, permanent grassland and fallow land supplemented by fodder trees and crop residues (Roder *et al.,* 2001; Kinzang, 2006). However, availability of forage resources have been one of the bottlenecks in the major animal production regions in Bhutan (DOL, 2013). With recent dairy development initiatives in the country under One *Geog* Three Products (OGTP) approach, Department of Livestock continues to supply pasture seeds of both temperate and subtropical exotic fodder grasses to farmers. Selecting forage species for cultivation must take into consideration of the herbage yield, digestibility, and nutrient composition.

In the southern belt of the country, Napier (*Pennisetum purpureum* Schumach) is one of the popular exotic grasses cultivated by dairy farmers. It is the most promising and high yielding fodder with relatively higher dry matter (DM) content than most other tropical grasses which originated from central Africa and is extensively cultivated in Kenya to improve smallholder dairy production (Ansah *et al.,* 2010; ILRI, 2013). CON Napier grass is the main fodder grown by over 70% of smallholder dairy farmers in Kenya (Ansah *et al.,* 2010). In southeast Asian region, the major fodder grass species used are mainly the tall-growing types such as Napier, Guinea (*Panicum maximum* Schumach) and Guatemala grass (*Tripsacum laxum* Nash) (Halim, 1996).

In Bhutan, there are four varieties of Napier viz. Common Napier (CON), Mott Napier (MO), Coimbatore-3 Napier (CO3) and Pak Chong-1 Napier (Pak-1). Common Napier is probably the first exotic subtropical grass species introduced in Bhutan as it was

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found in Mongar since 1970s and is the main grass species used in National Jersey Breeding Centre (NJBC), Samtse (Wangchuk *et al.,* 2008). It is one of the most preferred fodder grasses by Bhutanese dairy farming community especially in southern belt of the country. Mott is also known as Dwarf elephant grass *(Pennisetum purpureum* cv. Mott). Napier grass is a tropical perennial bunchgrass usually managed by grazing or cut-and-carry system and is said to have developed in US (Moore and Willey, 2006). CO3 Napier was introduced in NJBC, Samtse in 2004 which was imported from Coimbatore in Tamil Nadu, India and cultivated in trial plots. This variety is a high yielding perennial fodder grass developed by the Tamil Nadu Agricultural University (TNAU), Coimbatore, India in 1997 and introduced in Sri Lanka in 1999 (Premaratne and Premalal, 2006). The latest Napier variety introduced in Bhutan is Pak-1, imported in 2011 from Thailand and currently this variety is cultivated in observation plot in NJBC, Samtse.

Among four cultivars of Napier grass cultivated in Bhutan, CON Napier is widely used as fodder for cattle but little is known about its nutritive quality and herbage yield. The contribution of other cultivars as fodder resource to dairy production is not yet known at the farmers' level however, all the four Napier varieties are used as forage for dairy animals in NJBC. Frequency of harvest in Bhutanese dairy farming community is mostly once in a year except in few semi-commercial backyard farms. This practice is expected to continue unless appropriate cutting intervals and nutritive values are known in Bhutanese condition. The nutritive quality and herbage production are affected by several factors, one of which is the harvesting day after planting (Ansah *et al.,* 2010). Generally, herbage yield increases with age of the plant owing to rapid growth of tissues of plants (Minson, 1990). Therefore, this study was carried out to investigate the herbage yield and nutrient content of four different cultivars of Napier at different harvesting intervals of 60, 90, and 120 days after planting.

Materials and Methods

The study was conducted at NJBC, Samtse for a period of three months through 1 July, 2013 to 30 October, 2013. The study area falls under subtropical zone at an altitude of 500 metre above sea level (masl) with an annual average temperature of 23 ºC. The wet and dry seasons extend from May to August and November to January month respectively. Peak rainfall was recorded in the months of June and July with annual average rainfall of about 2,750 mm. The area has sandy and clayey soil, which occurs on flat topography.

Randomised Complete Block Design (RCBD) with three replications was used in the experiment. The experimental plots were ploughed and harrowed using tractor and the field was divided into 12 plots of 3 replications each for 4 varieties of Napier grasses. Parent Napier plants were cut with a minimum of three nodes per cutting, which were planted at 15-20 cm at an angle of about 45 degree in 12 plots each measuring 24 m^2. A plant-to-plant, intra, and inter row space of 0.5 m, 0.75 m, and 1 m respectively were maintained.

All cultivars root slips with three nodes were arranged from the NJBC farm. CON and MO Napier were abundantly available in the farm. CO3 Napier root slips were arranged from the propagation plot, and Pak-1 Napier was used from live harbarium of the farm kept for further transplantion and propagation. A total of 1,152 root slips were planted in 12 experimental plots each measuring 24 m^2. Weeding was carried out at 30 days after planting and thereafter weeding was done every 40 days considering the vigorous growth of weeds in subtropical areas especially during summer season. Fertilizer was not applied to the trial plots as the four cultivars were on their own supposed to serve as treatment since trial was aimed at varietal comparison of the nutritive value and herbage yield at different harvesting intervals. The plots were not irrigated as the experimental area falls under subtropical region and the soil remain humid till September.

The crops were harvested at 3 stages of 60, 90, and 120 days after planting (DAP). Samples were harvested from the middle rows leaving the border rows to avoid border effect (Carruthers *et al.,* 2000). Each sample was hand-harvested using sickle from 12 m^2 (2 × 6 m) leaving behind 15 cm high stumps for successive growth of crops. The samples were weighed using electronic weighing balance to determine fresh herbage yield per acre. Sub-samples of 1 kg were chopped into pieces of 2-5 cm length and then air-dried for 24 hours. The samples were then oven dried at 100 ºC and the DM content determined. Average plant heights were measured and tillering counts done at the time of harvesting by randomly selecting at least three plants from each plot.

Samples were powdered using Willy grinder to assess the dried biomass. Crude protein (CP) and ash content were analysed from the grounded samples of 15-25 g each. CP was determined using macro-Kjeldhal procedures and ash was determined by igniting 1-2 g of sample in a muffle furnace at 550 ± 20 ºC for 2 hours. Analysis of variance (ANOVA) was conducted to compare the means of herbage

yield and nutritive value of the four varieties of Napier using SPSS.

Results and Discussion

The total herbage yield, DM, height and number of tillers of four varieties of Napier grasses are provided in Table 1. There was significant differences ($p < .05$) in the fresh herbage yield amongst the Napier varieties. Pak-1 variety produced higher total herbage yield of 23.70 t/ha as compared to other Napier varieties in this study. There were no differences in the fresh herbage yield amongst the CON, CO3 and MO. The higher fresh yield of Pak-1 might be attributed to its height, which was recorded tallest (62.41 cm) among all the four varieties in this study. Ayub *et al.* (2009) and Aganga *et al.* (2005) reported that the higher herbage yield was mainly due to greater plant height, stem diameter, and higher number of leaves. However, there was no significant effect ($p > .05$) in the number of tillers among different varieties of Napier, which is in agreement with the report of Ansah *et al.* (2010).

A higher DM production was recorded for the shorter Napier varieties (CO3 and MO) in this study. Likewise, it was also observed that the shorter varieties had denser tillering as compared to the tall varieties. Similar observation was made by Halim *et al.* (2013) and Rengsirikul *et al.* (2013). Denser tillerings suggest that in shorter varieties partitioning of photosynthates was more towards tillering at the expense of stem elongation (Halim *et al.,* 2013).

Table 1. Mean herbage yield, dry matter, height, and number tillers of the four varieties

Variety	Herbage yield (t/ha)	Dry Matter (g/kg FM)	Height (cm)	Tillers(Nos.)
CON	(16.16±5.36)^{a}	(132.28±15.55)^{a}	(50.18±20.73)^{a}	(10.04±4.11)^{a}
CO3	(12.22±2.99)^{a}	(151.52±11.38)^{a}	(35.85±12.65)^{a}	(18.04±10.56)^{a}
MO	(12.70±4.66)^{a}	(149.90±16.53)^{a}	(34.03±17.11)^{a}	(20.31±11.21)^{a}
Pak-1	(23.70±7.00)^{b}	(140.20±19.76)^{a}	(62.41±17.40)^{b}	(13.22±8.40)^{a}

Means with different superscripts within same columns are significantly different; $N = 12$, ($p < .05$)

Effect of harvesting intervals on the herbage yield of Napier grass

There was no effect of harvesting intervals on the herbage yield and DM content in all four varieties of Napier grasses ($p > .05$). Grasses harvested at 60 DAP had the highest herbage yield and DM content (Table 3), which contradicts with the reports of Wadi *et al.* (2004) who recorded highest herbage yield and DM content at 90 DAP. The highest herbage yield and DM in this study may be due to repeated cuttings at short intervals contributing to lower yield in successive harvests. However, harvesting intervals had effect on the height of grasses and number of tillers. An increasing number of tillers were observed with increase in harvesting days, which was similar to the findings of Ansah *et al.* (2010) and Wadi *et al.* (2004).

Table 2. Mean herbage yield, DM, height and tillers in different harvesting days

Harvest interval	Herbage yield (t/ha)	DM (g/kg FM)	Height (cm)	Tillers (Nos.)
60 days	(16.97±10.71)^{a}	(150.27±18.62)^{a}	(49.69±26.74)^{a}	(5.21±0.38)^{a}
90 days	(16.75±4.95)^{a}	(135.43±10.18)^{a}	(31.61±8.26)^{b}	(17.71±1.43)^{b}
120 days	(14.87±3.71)^{a}	(144.72±19.43)^{a}	(55.55±13.49)^{a,c}	(23.28±2.51)^{b}

Means with different superscripts within same columns are significantly different; $N = 12$, $p < .05$

Effect of variety on the nutritive value of different Napier grasses

The minimum level of CP content required in the grasses necessary for voluntary feed intake in ruminants is 7% (Van, 1994; Nori *et al.,* 2009). All four varieties recorded CP level higher than the critical minimum level required for voluntary feed intake. The CP content ranged from 9.52% to 12.62% (Table 5) which was within the levels reported by Kariuki *et al.* (1998), Hussain and Khan (2000), Aregheore (2005), Orodho (2006), and Manaye *et al.* (2009). The study recorded leafier growth with

Table 3. Mean crude protein and ash content of the four varieties of Napier grass

Variety	Crude Protein (%)	Ash (%)
CON	10.27 ± 7.01	(12.55 ± 1.51)^{a}
CO3	(12.62 ± 4.63)^{a}	(13.92 ± 2.28)^{a}
MO	(12.18 ± 8.32)^{a}	(12.46 ± 1.98)^{a}
Pak-1	(9.52 ± 5.11)^{a}	(12.56 ± 2.89)^{a}

Mean with different superscripts within same columns are significantly different; n = 12, $p < .05$

higher CP content in shorter varieties as compared to the taller varieties which agrees with findings of Halim *et al.* (2013). The CP content of CON (11%) and MO (12%) varieties in this study was found similar to the findings of Fleischer *et al.* (1996) and Jusoh (2005).

There was no significant difference ($p > .05$) in ash percent among the varieties, which ranged from 12.46–13.92%. CO3 had the highest ash percent (13.92%) as compared to other three varieties. Comparative study among 8 Napier varieties in central Thailand by Rengsirikul *et al.* (2013) recorded ash percent ranging between 10.9–15.9%, and Adjolohoun *et al.* (2008) reported ash content of 12.43% in Napier grasses.

Effect of different harvesting days on the Nutritive value of Napier grasses

Table 6 shows the CP and ash content of Napier grasses harvested at different time intervals of 60, 90, and 120 days. A significant difference ($p <.05$) in CP and ash content was observed for different harvesting intervals. The CP content recorded was highest (14.88%) at 90 DAP and lowest at 60 DAP (3.86%). Ayub *et al.* (2009) found CP content lower than critical level (7%) at 60 DAP. The low CP content at 60 DAP in current study could be attributed to climatic factors and harvesting time where the grasses were tender and efficiency of nutrients uptake by the grass from the soil was below optimum level. The climatic factors, such as temperature, evaporation, and light intensity can strongly influence the nutritional characteristics of forages, implying that the lower values was often observed in the tropics (Astuti *et al.* 2009). Palacios-Diaz *et al.* (2013) and Goncalves and Coast (1991) reported that the low CP is usually observed in poor nitrogen soil, and immatured grasses. Nevertheless, prolonged days of cutting tended to decrease CP content which is in line with the findings of Watyu and Singh (1996).

There was a significant difference *($p <.05$)* in ash content for different harvesting intervals. The ash content increased with increase in harvesting intervals which was contradictory to the findings (Ayub *et al.,* 2009; Bukhari, 2009). Accumulation of ash in the grass is largely explained by soil type and in particular its texture, which is a very important factor in deposition of inorganic constituents especially Silica (Si) in biomass where grass grown on sandy soil consistently showed lower ash content compared to clayey soils (Bakker and Elbersen, 2005). Higher ash content in the present study may be attributed to higher soluble Si level in clay soil and water uptake ability as water uptake is directly related to uptake of Si as reported by Rao *et al.* (2007) leading to higher concentration of ash in the grass.

Table 4. CP and ash content of Napier grasses at different harvesting days

Harvesting Intervals	Crude Protein (%)	Ash (%)
60 days	$(3.87 \pm 3.67)^{a}$	11.52 ± 1.12
90 days	$(14.88 \pm 4.38)^{b}$	$(11.85 \pm 0.95)^{a}$
120 days	$(14.70 \pm 2.58)^{b}$	$(15.85 \pm 1.98)^{b}$

Means with different superscripts within same columns are significantly different; N = 12, $p < .05$

Conclusions

Taller varieties of Napier grasses had higher herbage yield as compared to shorter varieties due to greater plant height, stem diameter, and higher number of leaves. However, the shorter varieties yielded higher DM content than the taller varieties suggesting that the shorter varieties have less moisture content. All four varieties of Napier grass had CP level above the critical limit required by ruminants for voluntary intake. But the shorter varieties were leafier with higher CP content compared to the taller varieties suggesting that shorter varieties can be better choice for farmers engaged in animal production. High quality and sufficient DM of Napier grass are determined by cutting heights at first harvest, therefore, assessment of nutritive value and herbage yield at different cutting heights of Napier grass may give further decision on appropriate cutting heights.

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