Grazing Characteristics in the Dwarf Elephantgrass (*Pennisetum purpureum* Schumach) Pasture by Breeding Beef Cows at the First and Second Years after Establishment

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ABSTRAK

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Untuk menentukan karakteristik penggembalaan pada lahan pastura *dwarf* rumput Gajah terhadap sistem rotasi penggembalaan, maka 5 are pastura dibuat dengan melakukan penanaman stek varitas *dwarf* (DL) dengan penggembalaan 3 ekor sapi potong selama dua tahun setelah pembentukan pada tahun 2003 dan 2004. Sistem rotasi dilakukan 4 kali penggembalaan selama 1 minggu pada tahun 2003 dan 5 kali penggembalaan selama 3 minggu pada tahun 2004 yang masing-masing selang masa istirahat penggembalaan 1 bulan. Jumlah tunas meningkat dari penggembalaan pertama sampai pada penggembalaan keempat atau kelima. Produksi hijauan mencapai puncak pada penggembalaan ke-4 masing-masing tahun 2003 dan 2004, sementara karakter lainnya seperti tinggi tanaman, rata-rata berat kering tunas dan persentase daun menurun pada setiap penggembalaan. Pada metode stratifikasi, persentase daun pada strata 1,2 dan 3 terkonsumsi sempurna dan mendekati sempurna pada strata 4 pada setiap tahun. Konsumsi hijauan meningkat dengan meningkatnya periode penggembalaan sampai pada penggembalaan ketiga dan keempat dan menurun pada akhir penggembalaan keempat pada tahun 2003 dan penggembalaan kelima pada tahun 2004 dikarenakan semakin sedikitnya hijauan yang tersedia. *Intake* hijauan rata-rata per ekor adalah 4,3-13,4 kg DM ekor^{-1} hari^{-1} pada tahun 2003 dan 6,7 – 11,4 kg DM ekor^{-1} hari^{-1} (15,5 – 28,6 g DM/kg berat hidup/hari) pada tahun 2004. Waktu merumput pada rumput DL adalah stabil pada 50 – 60% setiap hari penggembalaan pada penggembalaan pertama, namun pada akhir penggembalaan cenderung meningkat pada penggembalaan setiap tahun. Sehingga, berat hidup tiga ekor sapi potong tetap terpelihara selama penggembalaan dari pertama hingga keempat tanpa pemberian makanan konsentrat pada tahun 2004, pada saat konsumsi hijauan lebih dari 20 g DM kg berat hidup^{-1} hari^{-1}.

Key Words: Sapi Potong, *Dwarf* Rumput Gajah, Karakteristik Penggembalaan, Persentase Daun

ABSTRACT

MUKHTAR, M. 2007. Grazing characteristics in the dwarf Elephantgrass (*Pennisetum purpureum* Schumach) pasture by breeding beef cows at the first and second years after establishment. *JITV* 12(4): 274-285.

In order to determine grazing characteristics in the dwarf Elephantgrass pasture under the rotational grazing system, 5 a of pasture established by rooted tillers of dwarf variety of late-heading type (DL) was grazed by 3 head of breeding beef cows in the following 2 years after establishment in 2003 and 2004. Grazing system was conducted at 4 and 5 times for about 1-week grazing with 3-weeks and 1-month rest period in 2003 and 2004, respectively. Tiller number increased seasonally from the first through the fourth or fifth grazing, and herbage dry matter weight reached the peak at the fourth grazing both years, while some characters such as plant height, mean tiller dry matter weight and percentage of leaf blade tended to decrease with the grazing. From the stratified clipping method, percentage leaf blades in the top two, third and in the fourth strata were consumed perfectly and almost perfectly, respectively both years. Herbage consumption increased with the grazing up to the third and fourth grazing and dropped at the last grazing due to the poor regrowth under the decreasing air temperature both years. Dry matter intake per head averaged 4.3–13.4 kg DM head^{-1} day^{-1} in 2003 and 6.7-11.4 kg DM head^{-1} day^{-1} (15.5-28.6 g DM/kg LW^{-1} day^{-1}) in 2004. Grazing time on DL elephantgrass was stable at 50–60% in daytime at the first grazing day both years, while that at the last grazing day tended to increase with the grazing both years. Thus, live weights of 3 head of beef cows were maintained in the grazing from the second to the fourth time without concentrate feeding in 2004, when dry matter intake was above 20 g DM LW^{-1} day^{-1}.

Key Words: Dwarf-Elephantgrass, Grazing Characteristics, Beef Cows, Percentage Leaf of Blade

INTRODUCTION

Forage intake by grazing cattle is determined by several factors, such as availability and dry matter yields of forage mass (CUOMO *et al*., 1996; MIZUNO *et al*., 1998), chemical and physical compositions of the forage (MOSQUERA-LOSADO *et al*., 2000), and the nutritional requirements of the animal (WOODARD and PRINE, 1991). As palatability and adaptability for grazing by cattle were determined for 10 tropical grasses in Kumamoto prefecture in 1980s, carpet grass, silk sorghum and vaseygrass were considered to be promising grasses in this area. However, heading generally reduced the palatability in the examined tropical grasses under the grazing use (NADA, 1985). As dwarf Elephantgrass was a novel species in Japan and heading was restricted before autumn due to the sensitivity to the photoperiod (ISHII *et al*., 1998), it is necessary to determine the palatability of dwarf Elephantgrass under the grazing. In Thailand, under the cutting management of Leucaena mixed with Ruzigrass, dwarf and normal Elephantgrasses cut at 20-, 30- and 40-day intervals, dwarf Elephantgrass produced the highest in total and leaf dry matter yields among 3 grass species. In addition, dwarf Elephantgrass was reported higher quality (crude protein concentration) than other tropical grasses (TUDSRI *et al*., 2002). In examining the grazing system in dwarf Elephantgrass pasture, herbage mass per unit area, particularly leaf component, greatly influenced grazing behavior, and sward characteristics in the canopy were also associated with grazing behavior by cattle, and the quality and quantity of feed consumed by cattle (CHACON *et al*,. 1978; WILLIAMS and HANNA, 1995; MUIA *et al*., 1999; SOLLENBERGER and BURNS, 2001; GWAYUMBA *et al*., 2002).

Previous study (MUKHTAR, 2006) indicated that dwarf Elephantgrass, particularly late-heading type (DL), was higher in tiller number, leaf area index and percentage of leaf blade than other dwarf and normal varieties, which suggested that DL was more suitable to the grazing system than other varieties. Comparing grazing suitability by dairy cows between dwarf and normal Elephantgrass varieties, DL was tolerant to the rotational grazing and maintained regrowth ability with one-month rest period during the hottest summer season. With the high productivity, overwintering and being consumed satisfactorily by dairy cows, DL can be fitted to the intensive grazing pressure in the small paddock as in the other tropical grasses.

Since beef calf breeding farmers has been decreasing very rapidly in the recent 10 years and this decrease was mainly derived from the small-sized holders in Southern Kyushu Island (MAFF, 2000), the target size for growing DL Elephantgrass pasture should be less than 5 head/holder for beef calf production. It is also necessary to determine when and how many times this DL Elephantgrass can be grazed by breeding beef cows during the growing season at the first and second years after establishment, and to estimate the dry matter intake by beef cows, and the size of carrying capacity with maintaining live weight of beef cows on DL Elephantgrass pasture.

Therefore, this study was aimed to determine the herbage dry matter production, percentage consumption of herbage by breeding beef cows and estimation of the dry matter intake of DL Elephantgrass pasture at the first and second years after establishment in 2003 and 2004.

MATERIALS AND METHODS

Pastures and management

The research was carried out at one paddock in Faculty of Agriculture, Miyazaki University from April 30 to November 1, 2003 and from March 26 to December 13, 2004. The examined variety of Elephantgrass (*Pennisetum purpureum* Schumach) was the dwarf-late (dwarf variety of late-heading type, DL), which was introduced from Thailand as a line of Dairy Promotion Organization, Thailand in 1996. Since the area of paddock was 20 m × 30 m (6 a), almost 5 a of this area was transplanted by DL and the rest of the area was used for the resting and watering of cows under the roof. The paddock field was established by transplanting rooted tiller of DL regrown from the overwintered stubble on April 30, 2003. Plant spacing and density were 1 m × 0.5 m and 2 plants/m^2, respectively. DL stubbles were cut at the ground level after overwintering on March 26 to activate the regrowth of tillers emerged from tiller bud on the underground stem, because large stubble hindered tiller buds from emerging after overwintering. The paddock was fertilized with 30 g N/m^2/year of chemical compound fertilizer by 6 times of split application before the start of grazing on May 16 and June 14 and after each grazing every month in 2003, and by 5 times before the start of grazing on May 8 and after each grazing almost every month in 2004. Weeding was conducted twice by hand before the start of grazing in 2003.

Grazing design and animal measurements

Three breeding beef cows per paddock were used in every grazing, except at the last grazing in 2004, when 2 cows were examined. Cow breeds were Japanese Black, except at the first, second and third trials in 2004 when 1 Japanese Brown cow was examined. Rotational grazing was conducted for 1-week grazing with 3-weeks rest period from mid-July to the end of October in 2003, except for the last prolonged rest period of 6

weeks due to the decline in air temperature. In 2004, grazings were conducted for about 1-week with 1-month rest period from early June to early December, except for the last prolonged rest period of 8 weeks. Grazing behavior and grazing time were monitored in daytime from about 7:00 or 8:00 am to 18:00 or 19:00 pm for 10 or 12 hrs, depending on the daylength of each grazing both years. In 2-3 days and 1-week before each grazing in 2003 and 2004, respectively, 3 beef cows were fed by the fresh Elephantgrass at 10 kg/head both in the morning and in the afternoon as an acclimation feeding. Live weight was determined at both pre-grazing and post-grazing on DL Elephantgrass pasture in 2004. No concentrates were fed to beef cows during the grazing.

Pasture measurements and samples

By the line transect method, 8 plants of DL Elephantgrass were selected and sampled by the stratified clipping method at 5 strata from 10 cm to above 90 cm in an interval of 20 cm at both pre-grazing and post-grazings. The five strata were I : ≥ 90 cm, II : 70 – 90 cm, III : 50 – 70 cm, IV : 30 – 50 cm and V : 10 – 30 cm above the ground. Sampling was applied to the herbage cut at 10 cm, stubble cut at the ground level and underground parts. Parameters measured were tiller number, plant height, fresh matter weight and dry matter weight of leaf blade, stem with leaf sheath and dead parts in the herbage, stubble and underground parts. Grazing and plant sampling started on July 13, 2 months and a half after transplanting in 2003 and on June 8, 2004. In addition, plant height was measured at the end of daytime during each grazing for all and half of plants in the paddock in 2003 and 2004, respectively. Because of weeding and the vigorous growth of DL Elephantgrass, growth of other species in the interrow space was negligible and sampling of other species was not conducted.

Calculation of consumption, dry matter intake and stocking rate

Herbage consumption was calculated by the difference between herbage dry matter weight at pre-grazing and that at post-grazing. Crop growth rate during the grazing period was estimated by the mean of herbage consumption in the consecutive 2 grazings, divided by the product of grazing cow number and grazing period (days). Average of live weights at pre-grazing was 452 kg/head among 5 grazings in 2004. Stocking rate was calculated by the product of cow density and grazing period, divided by the grazing and rest periods.

RESULTS

Change in plant characters

Herbage dry matter weight (HDMW), plant height and percentage of leaf blade both at pre-grazing and post-grazing are shown in Figure 1. Since all plants were regrown after the overwintering in May 2004, plant persistence in DL Elephantgrass is considered relative to other tropical grasses in Miyazaki, Japan. Pre-grazing HDMW tended to increase from July or June to October with some fluctuation at the third grazing both years, while it decreased at the last grazing of the early frosting season in 2004. The rapid drop in HDMW at the third grazing was closely related to the shortage in rainfall during the rest period. HDMW tended to be larger at the second year than at the first year in every grazing, even though the first grazing started earlier by one month at the second year. Post-grazing HDMW was almost correlated with pre-grazing HDMW, and the variation in HDMW among grazing times assessed by coefficient of variance, remained the same both years at 23-24% and 33-35% at pre-grazing and post-grazing, respectively. Both pre-grazing and post-grazing plant height tended to decrease slightly from the second to the last grazing both years. This is one of the typical characters in DL Elephantgrass that the change in HDMW was not closely correlated with that in plant height, compared with the positive correlation usually in normal Elephantgrass variety. Percentage of leaf blade decreased consistently from the first to the last grazing both at pre-grazing and post-grazing both years

Seasonal changes in tiller number and mean tiller dry matter weight both at pre-grazing and post-grazings are shown in Figure 2. Tiller number increased consistently from the first to the last grazing both at pre-grazing and post-grazing both years, while mean tiller weight both at pre-grazing and post-grazing decreased from the first to the second or third grazing to show stable weight in the later grazing both years, except at the fourth grazing in 2004 when it increased due to longer rest period. Tiller number was larger at the second year than at the first established year in each grazing, while the change in mean tiller weight showed a similar tendency with the grazing both years.

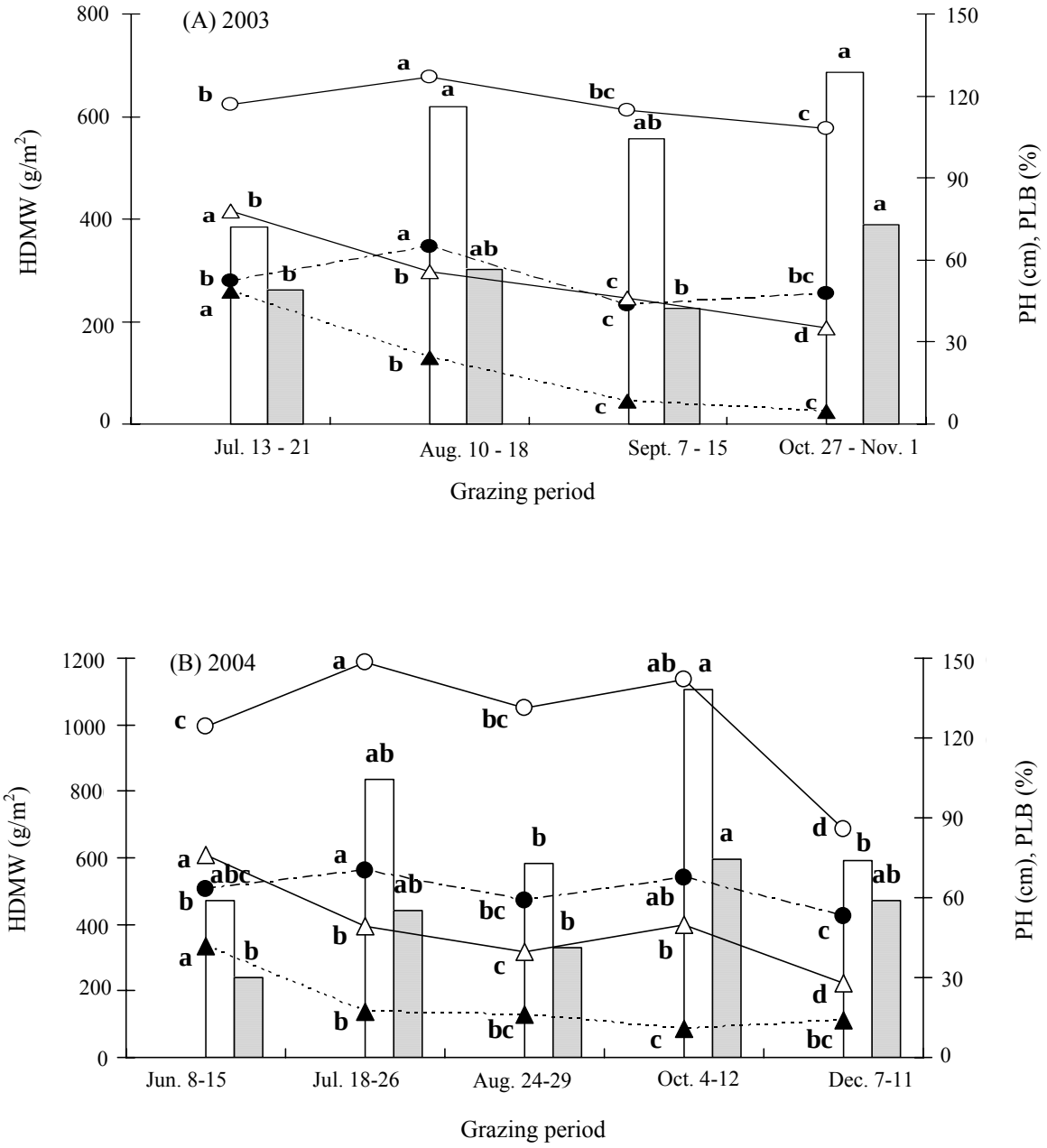

Figure 1. Change in herbage dry matter weight (HDMW), plant height (PH) and percentage of leaf blade (P LB) at pre-grazing and post-grazing in the dwarf-late elephantgrass pasture in 2003 (A) and 2004 (B).Plant were cut at 10 cm above the ground for measuring HDMW and PLB

Figures with different letters on the bar and besides the dot denote significant difference among grazing periods in HDMW, and PH and PLB, respectively, at 5% level

HDMW pre-grazing (□), HDMW post-grazing (△), PH pre-grazing (▤), PH post-grazing (▲), PLB pre-grazing (●) and PLB post-grazing (○)

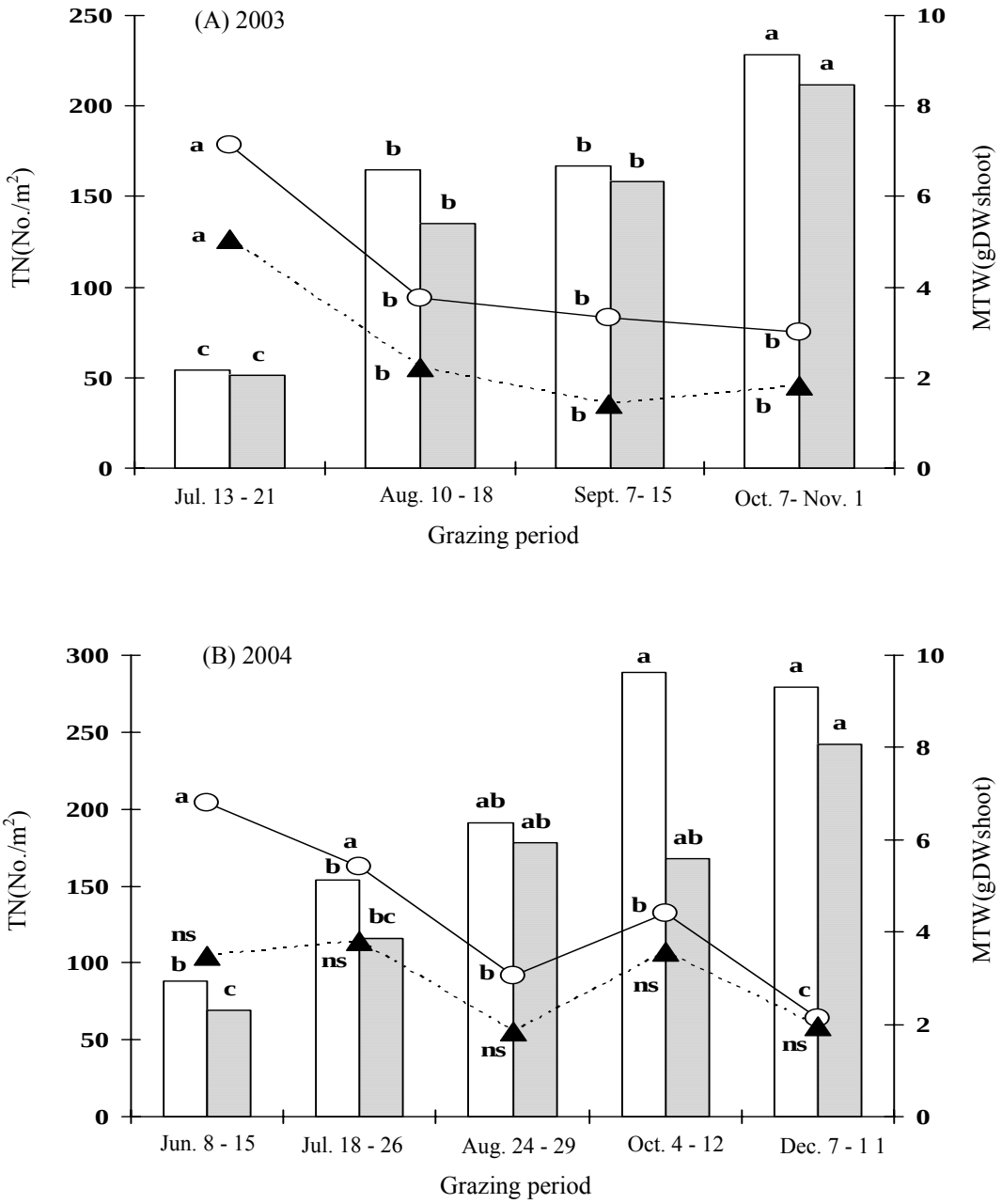

Figure 2. Change in tiller number (TN), and mean tiller dry weight (MTW) at pre-grazing and post-grazing in the dwarf-late elephantgrass pasture in 2003 (A) and 2004 (B). Plants for MTW were cut at 10 cm above the ground
Symbols with different letters denote significant difference among grazing periods at 5% level. ns: not significant
TN pre-grazing (▭), TN post-grazing (▭), MTW pre-grazing (○) and MTW pre-grazing (▲)

Canopy structure of the sward and consumed herbage by cows

Herbage dry matter weight (HDMW) and percentage leaf blade were determined at 5 strata from the stratified clipping method and the changes in percentage consumption and percentage leaf blade are shown in Figure 3. Pre-grazing percentage leaf blades were 100 % in the first and second strata both yearsand were nearly 95% and 80% in the third strata in 2003 and 2004, respectively. Post-grazing herbages at the top two and at the third strata were consumed by beef cows

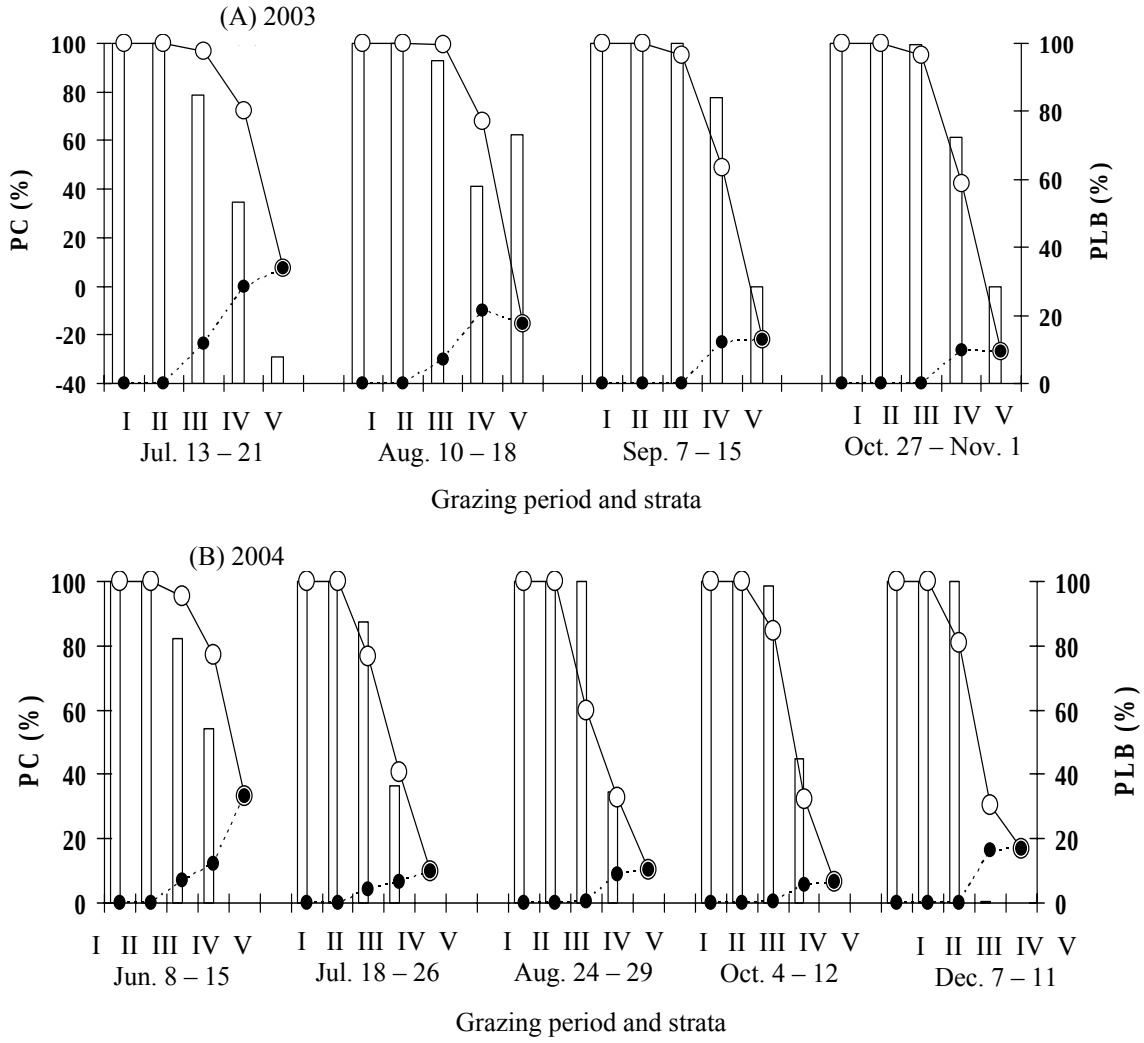

Figure 3. Change in percentage consumption (PC) percentage of leaf blade (PLB) at pre-grazing (O) and that at post-grazing (●) from the stratified clip method in the dwarf-late elephantgrass pasture in 2003 (A) and 2004 (B)
Strata : I : ≥ 90 cm, II : 70 – 90 cm, III : 50 – 70 cm, IV : 30 – 50 cm and V : 10 – 30 cm above the ground
PC = (pre-grazing HDMW – post-grazing HDMW)/pre-grazing HDMW x 100 (%)

perfectly and almost perfectly, respectively, from the first to the last grazing both years, based on percentage consumption, while this consumption decreased towards the bottom of strata.

Changes in herbage consumption, production during the grazing period and dry matter intake by beef cows are shown at each grazing both years in Table 1. Herbage consumption increased from the first to reach the peak at the third grazing and decreased at the fourth grazing in 2003. Seasonal change in herbage consumption was almost similar in 2004, when herbage consumption increased from the first to reach the peak at the fourth grazing with some fluctuation at the third grazing, and decreased rapidly at the fifth grazing. Herbage consumption decreased due to the decrease in HDMW at the third and fifth grazing in 2004, probably due to the lower precipitation and lower temperature in the previous rest period, respectively. Percentage consumption increased from the first to the third grazing and decreased at the fourth grazing due to the decline in percentage leaf blade in 2003. Contrarily in 2004, percentage consumption remained the same value at 44-49% from the first to the fifth grazing, and the great declines in percentage consumption at the last grazing both years were due to the decrease in leafage, compared with the higher dry matter accumulation in stem parts.

Dry matter intake by beef cows increased with the grazing to peak at the fourth grazing both years, and decreased at the fifth grazing in 2003 when temperature declined at the previous rest period, and averaged 4.3-13.4 kg DM/head/day both years.

Table 1. Herbage consumption (HC) and percentage consumption (PC) by breeding beef cows, dry matter production during the grazing period, dry matter intake (DMI), live weight (LW) of beef cows and stocking rate at about one-week grazing in 2003 and 2004

Time of grazing		Year	
		2003	2004
1st	HC[1] (g DM/m^2)	124.0	233.3
	PC[2] (%)	32.2	49.3
	Production (g DM/m^2)	88.2	66.8
	DMI (kg DM/head/day)	4.3	6.7
	DMI (g DM/kg LW/day)	----	15.5
	Stocking rate (head/ha)	17.1	12.7
2nd	HC[1] (g DM/m^2)	316.9	396.5
	PC[2] (%)	51.3	47.4
	Production (g DM/m^2)	129.3	90.0
	DMI (kg DM/head/day)	9.0	9.5
	DMI (g DM/kg LW/day)	----	21.8
	Stocking rate (head/ha)	17.1	15.5
3rd	HC[1] (g DM/m^2)	329.4	256.2
	PC[2] (%)	59.3	43.9
	Production (g DM/m^2)	59.7	53.3
	DMI (kg DM/head/day)	7.9	9.7
	DMI (g DM/kg LW/day)	----	20.9
	Stocking rate (head/ha)	15.5	9.2
4th	HC[1] (g DM/m^2)	297.6	511.3
	PC[2] (%)	43.4	46.2
	Production (g DM/m^2)	35.4	70.0
	DMI (kg DM/head/day)	13.5	28.6
	DMI (g DM/kg LW/day)	----	10.4
	Stocking rate (head/ha)	5.7	
5th	HC[1] (g DM/m^2)	----	119.0
	PC[2] (%)	----	20.1
	Production (g DM/m^2)	----	8.5
	DMI (kg DM/head/day)	----	7.5
	DMI (g DM/kg LW/day)	----	18.8
	Stocking rate (head/ha)	----	2.9
Annual total Annual mean	HC[1] (g DM/m^2)	1067.9	1516.3
	PC[2] (%)	46.6	41.4
	Production (g DM/m^2)	78.1	57.7
	DMI (kg DM/head/day)	8.7	9.0
	DMI (g DM/kg LW/day)	----	21,1
	Stocking rate (head/ha)	15.1	9.9
	Period	Jul 13 – Nov. 1	June 8 – Dec. 11

1) HC = Pre-grazing herbage dry matter weight (HDMW) – post-grazing HDMW
2) PC = HC/pre grazing HDMW x 100
------ = Not measured

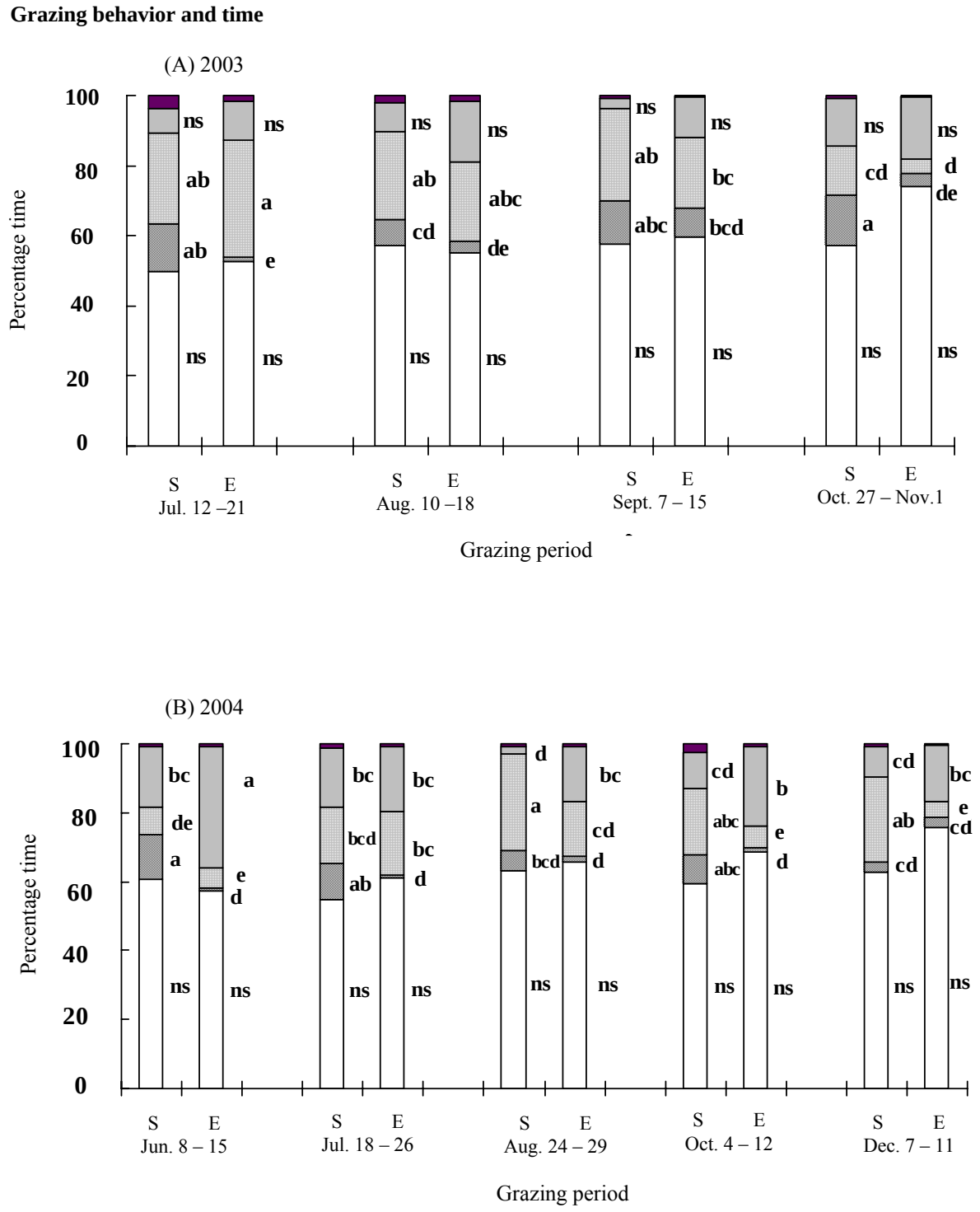

Figure 4. Percentage time at the start (S) and the end (E) of each grazing day in the dwarf-late elephantgrass pasture in 2003 (A) and 2004 (B)
Grazing on dwarf-late (▨), grazing on other plants (▥), standing without grazing (▨), lying without grazing (■), and drinking water (▭)
Symbols with different letters denote significant difference in each behavior among grazing periods at 5% level. ns : not significant.

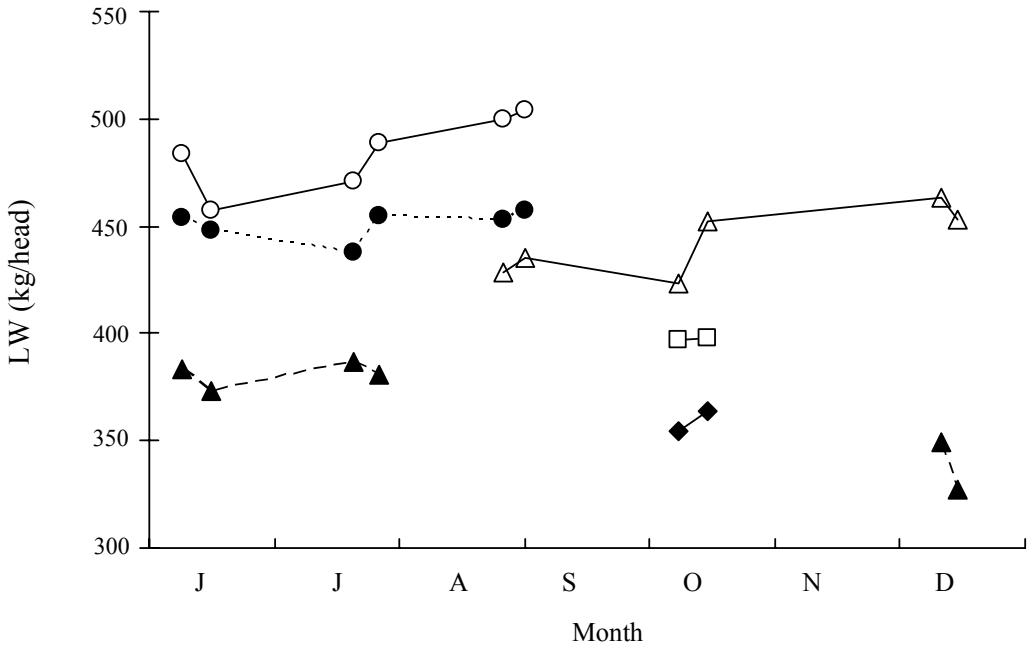

Figure 5. Live weight (LW) change of breeding beef cows during each grazing in the dwarf-late elephantgrass pasture in 2004.and indicate the start and the end of grazing, respectively

Percentage time of grazing behavior at both the start and the end of each grazing is shown in Figure 4. Grazing time on DL Elephantgrass at the start of grazing tended to be stable among 4-5 grazing times at about 50% and 60% in 2003 and 2004, respectively. However, at the end of each grazing both years, grazing time on DL Elephantgrass tended to increase with grazing to reach 70% at the last grazing both years. In a previous study with dairy cows (MUKHTAR, 2006), grazing time at the sunny or hot day was shorter than at the cloudy or cold day. In the present study, grazing time on DL elephantgrass at the cloudy day on August 24, 2004 or at the cold day on October 27, 2003 and December 7, 2004 also tended to be larger in percentage time than at the sunny and hot day on the other dates. Irrespective of seasons, beef cows grazed DL Elephantgrass at 50–60% and 60–70 % of daytime in 2003 and 2004, respectively.

Cow live weight change

Changes in live weight of breeding beef cows at each grazing on DL elephantgrass pasture in 2004 are shown in Figure 5.

Three beef cows grazed DL Elephantgrass pasture at 5 grazing times except at the fifth grazing when two beef cows did. It is somewhat difficult to compare live weight change among grazing times, because testers were different at every grazing except at the first and second grazing. However, live weight was maintained at least from the second to the fourth grazing during the hot summer season under this grazing system without concentrate feeding, except at the early and latest growing seasons. Dry matter intake was positively correlated with daily gain ($r = 0.577$, $P>0.10$) in 2004.

DISCUSSION

Characteristics of plant characters in DL elephantgrass pasture under the rotational grazing system

Pre-grazing herbage dry matter weight (HDMW) of DL Elephantgrass averaged 561 g/m^2 and 719 g/m^2 for 4 and 5 grazing times in 2003 and 2004, respectively. The increase in HDMW was correlated with that in tiller number, but not that in plant height from the first to the last grazing both years. The positive correlation of tiller number with HDMW indicated the vigorous regrowing ability of the tiller production in DL Elephantgrass during the grazing use. Tiller number and HDMW showed the highest at the fourth grazing with extended rest period for about 6-weeks and 5-weeks in 2003 and 2004, respectively. Contrarily, percentage of leaf blade and mean tiller weight

decreased constantly with the grazing. This decrease in percentage of leaf blade was associated with the increasing stem capacity for dry matter accumulation.

The increase in HDMW with the grazing suggested that DL Elephantgrass pasture expanded the capacity to graze and supply enough herbage for feeding beef cows for a week per month during the warm growing season from June or July to September and for several days at the last grazing before winter season even in early December.

Uniform regrowth in tiller number among plants between two subsequent grazings

Tiller number affected HDMW as well as leaf mass in the normal and dwarf elephantgrasses (ISHII *et al*., 1998), and as reported in the previous study, DL Elephantgrass had more tiller number than other varieties under the grazing use in the following two years after establishment (MUKHTAR, 2006). Pre-grazing tiller number increased uniformly among the consecutive 2 grazing times both years, while tiller number tended to be vary among rows with the grazing. These two results suggested the high tillering ability after defoliation of mother tillers. In a bahiagrass sward, spatial heterogeneity in herbage mass and the stability of the spatial pattern were well quantified by an estimation of electronic capacitance probe, and the pattern of spatial heterogeneity observed early in the growing season remained quite stable for 5 months until the late grazing season (HIRATA, 2000). Under the cutting management (MUKHTAR, 2006), tiller number increased with the increase in cutting frequency in the following 2 years after establishment, which was the same tendency as in the present study under the grazing management. Tiller number in the DL Elephantgrass pasture was maintained well by the grazing of breeding beef cows for 3-weeks and 1-month rest period to produce enough HDMW for almost 1-week grazing in the first and second years after establishment.

Canopy structure of DL Elephantgrass pasture and its grazing suitability, in relation to the change in plant height following the start of grazing

Data of stratified clipping method revealed that beef cows grazed to consume the leafage of DL Elephantgrass better with the time of grazing passed. Leafage at the top two and third strata were grazed perfectly and almost perfectly, respectively, based on the percentage consumption at each strata. At the fourth and fifth strata, the capacity in stem with leaf sheath was higher than in leaf blade, while the herbage at the fourth strata can be consumed better than that at the fifth strata by the beef cows, because leaf blade at the fifth strata attached near to the bottom of the ground surface. Compared to temperate system, assessments of canopy characteristics and associated grazing behavior were seldom examined because of the large number of forage species, diversity of their morphology and limited resources. The important relationships between grazing behavior and these canopy characteristics, and grazing behavior for long-term intake and animal performance were reviewed and concluded that the largest differences in canopy characteristics between tropical and temperate swards were those of the upper canopy strata including leaf production and bulk density. Tropical swards have large vertical heterogeneity in density, plant-part proportion, nutritive value, leaf percentage, leaf mass, and green herbage at the upper strata of the canopy (SOLLENBERGER and BURNS, 2001). It is suggested that the high consumption rate at the upper strata in DL Elephantgrass was derived from the uniform and erect leaf arrangement without heading tillers in Japan (MUKHTAR, 2006).

In order to maintain better regrowth after each grazing, post-grazing plant height in DL is should be kept at about 50–60 cm above the ground. Before the start of the third grazing both years, HDMW as well as stem capacity dropped from the previous grazing, and the rest period was necessary to extend for getting better regrowth after the third grazing, which was strongly related to the shortage in precipitation during the former rest period in 2004 (Table 1). At the last grazing both years, grazing periods were confined to 5 and 4 days in 2003 and 2004, respectively, because the decline in percentage leaf blade was drastic from the previous grazing and keeping plant height at a certain height of 50–60 cm above the ground was essential for the next spring regrowth after overwintering, based on previous observation.

Herbage consumption and dry matter intake per head in relation to live weight change

Based on herbage consumption by beef cows in the DL Elephantgrass pasture, the dry matter intake per head in each grazing was calculated in the range of 4.3-13.4 and 6.7-11.4 kg DM head^{-1} day^{-1} in 2003 and 2004, respectively. The increase in dry matter intake per head at the corresponding period in the second year from that in the first year was correlated with the increase in herbage consumption.

Although there was no standard for dry matter intake by grazing beef cows on DL Elephantgrass pasture, dry matter intake obtained in this experiment averaged 7.9–13.4 kg DM head^{-1} day^{-1} in the hot summer season from June or July to September or October. Under 3 stocking rates (7.5, 10 and 15 beasts/ha) under the average of live weight at 230–250 kg/head) on 3 varieties of stargrass swards in Florida, USA, forage intake was calculated at 7.6, 9.3 and 10.2

kg DM/animal/day for high, medium and low stocking rate, respectively (ADJEI *et al*., 1980). This rate was almost corresponded with the present data in the grazing on DL Elephantgrass pasture. In Kyushu, rotational grazing of tall fescue, dallisgrass and bahiagrass pasture was conducted from late-March to mid-November, and calculated for the carrying capacity at 3.36, 3.87 and 3.29 beasts/ha (average of body weight at 650 kg/head by Japanese-Brown cattle) for tall fescue, dallisgrass and bahiagrass, respectively (NADA and SAWAMURA, 1985). considering beef cow performance in live weight, 5 a of DL Elephantgrass pasture may supply enough herbage to maintain the live weight for 3 head of beef cows without concentrate feeding, for one week at the second year after the establishment. Seasonal dry matter utilization of stargrass at 75–90% by cattle was directly related to stocking rate, and cattle average daily gain over seasons ranged from 0.18 to 0.56 kg/day for stargrass, and was inversely related to stocking rate (ADJEI *et al*., 1980). Thus, DL pasture can be managed as a grazing pasture with one-month rest period under the stocking rate of 9.8 beasts/ha (average of live weight at 426 kg) for beef calf production in 2004, if other 4 DL Elephantgrass paddocks can be used for grazing, because rest periods were about 1 month in 2004.

Grazing behavior of beef cows in the DL Elephantgrass pasture

Length of grazing day on DL Elephantgrass increased both during grazing day from the first to the last grazing period both years, *i.e.* from 50–60% to reach 70% on the last period in both years. Length of grazing DL Elephantgrass was reduced by several factors, such as large amount of leafage, which was related with bite size (CHACON *et al*., 1978) and hot climate. Interestingly, length of grazing on DL Elephantgrass tended to decline when herbage consumption was the highest at the third and fourth grazing in 2003 and 2004, respectively. On the last day in every grazing in DL pasture, length of grazing day time increased up to 70% of the day, which was the same tendency to the low-yielding swards in Setaria and pangola grass, where cattle prolonged the grazing time to compensate for the small bites prehended (up to 707 min in 24 hr), as reported by CHACON *et al*. (1978).

CONCLUSIONS

With the increase in tiller number, herbage dry matter weight increased, while plant height tended to decrease from mid-July to early November and from mid-June to early December in 2003 and 2004, respectively. Percentage of leaf blade decreased constantly with the grazing. Stratified clipping method revealed that the herbages at strata above 50 cm from the ground surface were grazed almost perfectly by the beef cows in the dwarf-late Elephantgrass pasture.

Dry matter intake per head increased with grazing up to the fourth time, reaching average of 7.9-13.4 kg $head^{-1}$ day^{-1} from the second to the fourth time. Thus, cow live weight tended to be at least maintained at the stocking rate of 9.9 head/ha from July to October in the second year, if other 4 paddocks of 5 a can be used for grazing because rest periods were about 1 month in 2004.

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