# Effect of cutting height and dry season closing date on yield and quality of five napier grass cultivars in Thailand

S. TUDSRI, S.T. JORGENSEN, P. RIDDACH AND A. POOKPAKDI
*Department of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand*

## Abstract

A field study was conducted under rainfed conditions to determine the effect of different cutting heights (0, 10, 20 and 30 cm) and dry season closing dates (November and January) on dry matter production and fodder quality of 5 different cultivars of napier grass (*Pennisetum purpureum*). The experiment was carried out at Suwanvajokkasikit Research Station, Pakchong, Nakornratchasima, Thailand between 1994–1996.

Dry matter yield of the 5 napier grass cultivars increased with higher stubble remaining, differences reaching significance in the second year. Delaying the closing date produced a negative effect on regrowth for the following season, especially when a low cutting height had been imposed. Nitrogen, phosphorus and potassium levels in leaf and stem were not affected by cutting height. NDF% was lower in herbage from 0 cm cutting height compared with 30 cm cutting. Cutting heights of 20 cm and 30 cm can be recommended through the growing season.

## Introduction

Most dairy cattle in Thailand are raised by smallholder farmers using the cut-and-carry system. Grass species which are commonly used on these farms are para (*Brachiaria mutica*), ruzi (*Brachiaria ruziziensis*), guinea (*Panicum maximum*) and napier grass (*Pennisetum purpureum*). Para and ruzi grass show poor persistence under prolonged dry conditions while guinea grass and napier are more tolerant of drought. Farmers usually do not consider such factors and tend to grow grasses according to the plant materials that are available. Even in the drier areas, they prefer to grow para grass because planting material is readily available. Thus, the yield of these species is low and persistence poor (1–3 years) because they are not well suited to these areas. Furthermore, the farmers have limited land for pasture growing, which accentuates feed shortage problems.

Tudsri *et al*. (1996) reported that dry matter yield of para grass was much lower than those of dwarf napier and purple guinea under infrequent cutting. Even with frequent cutting, the yield of para grass was only 50% of that for dwarf napier and purple guinea (Tudsri *et al*. 1996; Sukkagate *et al*. 1997). In later work at Pakchong, Tudsri *et al*. (1999) showed that napier grass produced higher dry matter yields than ruzi. The better performance of the genus *Pennisetum* over many other grasses lead to a number of *Pennisetum* selections being introduced from overseas including Merkeron, Taiwan A25, Mott dwarf and Tangashima. A preliminary study revealed that these cultivars showed similar dry matter yields under cutting management to common napier which had been cultivated in Thailand for several years (Riddach 1997). However, in order to optimise production, the cutting management for these introduced napier cultivars may differ from common practice. Most grassland farmers in Thailand tend to cut or graze their pasture at the end of the growing season and often continue through the drought period. This may lead to a reduction in pasture yield during subsequent regrowth in the following wet season. We examined the influence of 4 different cutting heights and 2 dry season closing dates on herbage yield and quality of 5 different cultivars of napier grass: common napier, dwarf napier, Merkeron, Taiwan A 25 and Tangashima.

## Materials and methods

The experiment was conducted at Suwanvajokkasikit Research Station, Pakchong, 150 km

Correspondence: S. Tudsri, Department of Agronomy, Kasetsart University, Bangkok, Thailand. E-mail: agrsat@nontri.ku.ac.th

north-east of Bangkok (101° 19′ E, 14° 38′ N). The soil is a sandy clay loam of moderate fertility with a pH of 6.5. The experimental design was a split-plot design with 3 replications. Main plots consisted of 5 napier grass cultivars, *i.e.* common napier, Merkeron, dwarf napier, Taiwan A25 and Tangashima and subplots consisted of 4 different cutting heights, *i.e.* 0, 10, 20 and 30 cm above ground level. The napier grasses were planted in rectangular plots of 3 m × 5 m on November 16, 1993 in rows 50 cm apart with 50 cm spacing within rows.

The cutting treatments commenced on March 30, 1994 and were carried out for 9 harvests at approximately 30-day intervals throughout 1994. The same cutting intervals were maintained in 1995 but the data were taken only in September, October and November due to shortage of labour and finance. After the last cutting on November 10, 1995, each subplot was divided into 2 parts and one part was cut again on January 15, 1996 creating two further subplots (dry season closing on November 10, 1995 and January 15, 1996). The sub-subplot size was 3 m × 2.5 m. Dry matter yields were taken from these plots on May 10, 1996.

For data collection, one quadrat, 1.0 × 1.0 m, was placed at random positions in each plot and cut with shears to the appropriate cutting height. The fresh material from these quadrats was separated into leaf and stem components. The material from each harvest was dried at 60°C for 3 days and dry matter yields estimated. The dried samples of each component for 3 replications were bulked together, except for 1995, and ground in preparation for nitrogen, phosphorus and potassium analyses by using an autoanalyser. After each harvest, all plots were cut to the appropriate height according to their treatment and material removed. Basal fertilisers (N:P:K) were applied at the rate of 300 kg/ha (15:15:15) before the start of the experiment and again in the early part of the growing season in 1996. Nitrogen was applied every 3 months at the rate of 60 kg/ha N.

For statistical analysis, to compare among cultivars and between cutting heights, a split-plot design was adopted. For the effect of the 2 dry season closing dates, a split-split-plot design was used. No statistical analysis was carried out for chemical composition in 1994 due to insufficient replications.

## Results

### *Rainfall*

In the first year (1994), rainfall was evenly distributed during the wet season (Table 1). Little rainfall was recorded during the dry and cooler period from October 1994–February 1995. Rain began to fall in March and continued for 2 months, after which dry conditions were again experienced during June and July. However, good rainfall was recorded in August–October 1995 before the commencement of the dry, cool period in November 1995 through to January 1996. Rainfall commenced in February 1996 and continued through to the end of the experiment in May 1996.

### *Dry matter production*

In 1994, there were significant differences between cultivars for stem yield and total yield but not for leaf yield (Table 2). Common napier, Merkeron and Tangashima were more productive ($P < 0.05$) in terms of total DM yield than the other two cultivars. Forage produced by dwarf napier had significantly ($P < 0.05$) higher leaf percentage than the other cultivars (Table 2).

Cutting height in 1994 had no significant effect on dry matter production (stem and leaf) though swards cut at 10, 20 and 30 cm above ground level were taller than those cut at ground level (visual observation).

In 1995, Tangashima produced higher dry matter yields at the end of the wet season (Sep–Nov) than all other cultivars but the difference reached significance only with Taiwan A25 (Table 2). Common napier and Tangashima had high stem yields and relatively lower leaf percentages than dwarf napier and Taiwan A25.

The mean dry matter yields of the 5 grass cultivars increased progressively with increasing cutting height.

The effect of closing date on pasture regrowth at the beginning of the wet season, as measured at the first cut on May 10, showed that closing earlier, on 10 November, encouraged better regrowth subsequently, particularly at the lower cutting height (Table 3).

**Table 1.** Actual and long-term mean rainfall and temperature at Suwanvajokkasikit Research Station, Packchong during the study.

| Month | Long- term mean rainfall[1] | 1994 | | | 1995 | | | 1996 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Rainfall | Temperature | | Rainfall | Temperature | | Rainfall | Temperature | |
| | | | Max | Min | | Max | Min | | Max | Min |
| | (mm) | (mm) | (°C) | | (mm) | (°C) | | (mm) | (°C) | |
| Jan | 11 | 8 | 30.3 | 15.9 | 2 | 30.2 | 14.9 | 0 | 29.6 | 15.3 |
| Feb | 18 | 15 | 32.0 | 20.5 | 15 | 31.2 | 15.4 | 55 | 29.2 | 18.8 |
| Mar | 64 | 68 | 32.0 | 19.4 | 68 | 33.6 | 19.3 | 38 | 33.5 | 18.2 |
| Apr | 85 | 80 | 33.3 | 21.1 | 149 | 34.3 | 21.8 | 127 | 32.9 | 21.1 |
| May | 150 | 180 | 31.6 | 21.2 | 259 | 31.7 | 21.5 | 175 | 31.1 | 21.2 |
| Jun | 99 | 171 | 30.0 | 21.9 | 19 | 31.8 | 22.0 | — | — | — |
| Jul | 105 | 100 | 29.0 | 22.3 | 65 | 31.7 | 22.1 | — | — | — |
| Aug | 144 | 202 | 29.0 | 20.2 | 167 | 30.0 | 21.8 | — | — | — |
| Sep | 215 | 152 | 28.8 | 20.8 | 375 | 29.3 | 21.0 | — | — | — |
| Oct | 165 | 46 | 28.7 | 18.6 | 186 | 29.0 | 19.9 | — | — | — |
| Nov | 29 | 10 | 29.2 | 18.7 | 9 | 27.8 | 17.6 | — | — | — |
| Dec | 6 | 0 | 29.7 | 17.6 | 0 | 26.8 | 15.3 | — | — | — |
| Total/mean | 1091 | 1032 | 30.3 | 19.9 | 1314 | 30.6 | 19.4 | | | |

[1] Mean for period (1972–1995).

**Table 2.** Cumulative yield of herbage dry matter (t/ha) and leaf percentage in 1994 and 1995.

| | Components | | Total | % leaf |
|---|---|---|---|---|
| | Leaf | Stem | | |
| 1994 (9 cuts) Mar–Nov | | | | |
| Cultivar | | | | |
| Common napier | 19.2 | 12.1 a[1] | 31.3 a | 61 b |
| Merkeron | 18.2 | 9.8 ab | 28.0 a | 65 b |
| Dwarf napier | 19.8 | 6.3 c | 26.1 b | 76 a |
| Taiwan A25 | 17.2 | 8.9 b | 26.1 b | 66 b |
| Tangashima | 19.7 | 10.3 ab | 30.3 a | 66 b |
| Cutting height (cm) | | | | |
| 0 | 17.6 | 8.9 | 26.5 | 66 |
| 10 | 18.7 | 9.3 | 28.0 | 67 |
| 20 | 19.2 | 9.4 | 28.6 | 67 |
| 30 | 19.7 | 10.2 | 29.9 | 66 |
| 1995 (3 cuts) Sep–Nov | | | | |
| Cultivar | | | | |
| Common napier | 5.3 b | 4.0 a | 9.3 ab | 57 b |
| Merkeron | 6.1 ab | 2.8 b | 8.9 ab | 68 b |
| Dwarf napier | 6.8 a | 2.4 b | 9.2 ab | 74 a |
| Taiwan A25 | 6.0 ab | 2.3 b | 8.3 b | 72 a |
| Tangashima | 6.5 ab | 3.7 a | 10.2 a | 64 b |
| Cutting height (cm) | | | | |
| 0 | 5.1 c | 2.2 b | 7.3 c | 70 |
| 10 | 6.4 b | 2.6 ab | 9.0 b | 71 |
| 20 | 7.3 a | 2.6 ab | 9.9 ab | 71 |
| 30 | 7.3 a | 3.3 a | 10.6 a | 69 |

[1] Values in the same column for each main effect within years not followed by the same letter differ at $P < 0.05$.

*Chemical composition*

In both years, cutting height had relatively little effect on crude protein and phosphorus concentrations in the sward. However, herbage of plants cut to 30 cm height had consistently higher NDF and potassium (except in 1994 and Tangashima in 1995) concentrations than the herbage of plants cut to ground level (Table 4)

## Discussion

Although there was no effect of cutting height on total dry matter yield in the first year, severe cutting of napier grass cultivars reduced yields greatly at the end of the wet season in the second year. Even when cutting at 10 cm, the yields were still significantly reduced. The beneficial effects of lax cutting of pasture are related to the greater size and levels of residual plant variables following cutting, such as residual leaf area, the number of growing points and the amount of stubble reserves remaining (Ward and Blaser 1961; Harris 1978). The significant effect of higher stubble in 1995 on dry matter yield of all cultivars derived from increases in both stem and leaf yields. The different responses in the two years of the experiment were probably due to the pasture being repeatedly cut, which lead to the depletion of food reserves under a low cutting height (Harris 1978). A dry spell during June and July in 1995 may have further suppressed regrowth under the low cutting regimen.

**Table 3.** Effect of closing date on regrowth of pasture at the beginning of the following wet season (May 10, 1996) as affected by cutting height.

| Closing date | Cutting height (cm) | | | | Mean |
|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | |
| | (t/ha) | | | | |
| Nov 10,1995 | 3.83 a[2] | 4.01 a | 4.31 a | 4.17 a | 4.08 A[1] |
| Jan 15, 1996 | 3.18 b | 3.27 b | 3.42 b | 4.40 a | 3.56 B |

[1] Values in the same column not followed by the same upper case letter differ at P = 0.05.
[2] Values in the same row not followed by the same lower case letter differ at P = 0.05.

**Table 4.** Average chemical composition analysed from dried plant material from 1994 and 1995.

| Cultivars | Plant part | Cutting height (cm) | N | P | K | NDF |
|---|---|---|---|---|---|---|
| | | | | (%) | | |
| 1994 | Leaf | 0 | 2.28 | 0.31 | 2.60 | na[1] |
| Common napier | | 30 | 1.71 | 0.28 | 2.27 | na |
| | Stem | 0 | 1.40 | 0.31 | 2.57 | na |
| | | 30 | 1.18 | 0.28 | 2.43 | na |
| | Leaf | 0 | 2.11 | 0.34 | 2.27 | na |
| Merkeron | | 30 | 1.97 | 0.33 | 2.03 | na |
| | Stem | 0 | 1.31 | 0.36 | 3.17 | na |
| | | 30 | 1.30 | 0.37 | 2.60 | na |
| | Leaf | 0 | 2.18 | 0.30 | 1.80 | na |
| Dwarf napier | | 30 | 2.30 | 0.30 | 1.90 | na |
| | Stem | 0 | 1.05 | 0.35 | 2.50 | na |
| | | 30 | 1.69 | 0.28 | 2.47 | na |
| | Leaf | 0 | 2.21 | 0.33 | 1.47 | na |
| Taiwan A25 | | 30 | 2.14 | 0.32 | 1.90 | na |
| | Stem | 0 | 1.20 | 0.37 | 2.13 | na |
| | | 30 | 1.19 | 0.40 | 2.60 | na |
| | Leaf | 0 | 2.11 | 0.33 | 1.60 | na |
| Tangashima | | 30 | 1.91 | 0.28 | 2.03 | na |
| | Stem | 0 | 1.40 | 0.40 | 3.00 | na |
| | | 30 | 1.35 | 0.36 | 2.73 | na |
| 1995 | Leaf | 0 | 1.87 | 0.42 | 1.54 | 65.9 |
| Common napier | | 30 | 1.81 | 0.38 | 1.70 | 67.4 |
| | Stem | 0 | 0.90 | 0.40 | 1.66 | 70.9 |
| | | 30 | 1.01 | 0.40 | 1.75 | 72.7 |
| | Leaf | 0 | 2.29 | 0.38 | 1.60 b[2] | 66.1 |
| Merkeron | | 30 | 2.25 | 0.29 | 2.24 a | 67.0 |
| | Stem | 0 | 1.43 | 0.37 | 1.75 b | 67.6 |
| | | 30 | 1.55 | 0.34 | 2.47 a | 71.0 |
| | Leaf | 0 | 2.25 | 0.35 | 1.59 b | 64.9 |
| Dwarf napier | | 30 | 2.01 | 0.34 | 1.87 a | 65.0 |
| | Stem | 0 | 1.32 | 0.43 | 2.11 | 68.7 |
| | | 30 | 1.08 | 0.42 | 2.30 | 68.0 |
| | Leaf | 0 | 2.04 | 0.35 | 1.79 b | 66.0 |
| Taiwan A25 | | 30 | 1.90 | 0.33 | 2.11 a | 65.8 |
| | Stem | 0 | 1.15 | 0.47 | 2.33 | 66.7 |
| | | 30 | 1.17 | 0.38 | 2.53 | 68.8 |
| | Leaf | 0 | 2.08 | 0.38 | 1.76 | 66.5 |
| Tangashima | | 30 | 1.88 | 0.36 | 1.58 | 67.9 |
| | Stem | 0 | 1.14 | 0.51 | 2.34 | 69.4 |
| | | 30 | 1.15 | 0.46 | 2.04 | 69.7 |

[1] na = not available.
[2] Values within columns for each element in 1995 not followed by the same letter differ at P<0.05.

The results of this study agree with the findings of McLeod (1972) that guinea grass (*Panicum maximum*), with its erect growth habit, gave maximum yields when cut at a height of 40 cm above ground level. However, in terms of palatability, McLeod (1972) recommended that guinea grass be cut at 30 cm above ground level. Tinakorn *et al*. (1987) also suggested that grasses with an erect growth habit should be cut at higher levels to obtain maximum yield. This is in contrast to grasses with a creeping growth habit such as paragrass (*Brachiaria mutica*) (Tunjanpong 1964; Kaewichian 1969), ruzi (*Brachiaria ruziziensis*) (Tinakorn *et al*. 1987) and pangola (*Digitaria decumbens*) (Tudsri *et al*. 1998) which produced maximum yields from low cutting heights (5–10 cm).

Of the two dry season closing dates, November 10, 1995 gave the best regrowth at the beginning of the following wet season when cut to 0, 10 and 20 cm above ground level, while closing date had no effect on regrowth after the long dry period (Table 3) when cut at 30 cm. These results demonstrate that lax cutting of the pasture at the end of the rainy season is of major importance in achieving subsequent high forage production at the beginning of the wet season especially if the pasture is cut in the middle of the dry season (January). Plants with a lot of high stubble can use the reserves in the stem bases for quicker regrowth when rains occur. These results support the finding of Tudsri and Kangsanao (1994) who found that cutting shortly after the onset of drought stress caused a significant depression in subsequent plant dry weight and leaf area. Under conditions of severe water stress, even lax cutting can lead to plant death within 6 weeks from cutting. It is suggested, therefore, that hard grazing or cutting during the middle of the dry season (January) should be avoided and preference given to merely "taking the top off" the grass and thereby ensuring the retention of adequate stubble.

In terms of the recommendations relating to cutting management of napier grasses early in the dry season (November), it appears that farmers may be able to cut these stands to a lower level (*e.g.* down to 10 cm rather than 30 cm) as even small additions of quality feed may be highly significant. Such a practice does not appear to affect recovery growth with the subsequent onset of rains.

Although there were no significant differences in yield between the napier cultivars, Tangashima and common napier tended to produce the highest dry matter yield compared with Merkeron, dwarf napier and Taiwan A25 which were similar in yield (Table 2). However, the highest leaf percentage was obtained from dwarf napier, followed by Taiwan A25. Sukkagate *et al.* (1997) also found that dwarf napier produced a higher leaf: stem ratio than ruzi, purple guinea and paragrass over a wide range of maturities. The ratio declines slowly with age. Leaf fraction is the major determinant of pasture quality (Davison *et al.* 1981) and the performance of animals is closely related to the amount of leaf in the diet. This highlights the importance of using dwarf napier instead of the current species, ruzi grass, for dairy production in the central plain area of Thailand.

Cutting intensity had little effect on nitrogen and phosphorus concentrations in the leaf and the stem but more important was the relatively low NDF and potassium concentrations when the sward was cut to 0 cm compared with 30 cm (Table 4). These results support the finding of Middleton (1982) who found that cutting height had little effect on chemical composition of the sward. The NDF levels tended to increase at high cutting heights compared with low cutting heights.

Most Thai dairy farmers tend to cut their pasture at very low levels (0–10 cm). They believe that such low cutting height can prevent expansion of the grass stool, which may cause poor persistence of the pasture as earlier reported by Tudsri and Sawadipanich (1993). Our results from this experiment suggest that the optimum cutting height for all napier cultivars should not be lower than 20 cm in order to achieve good quick regrowth compared with cutting to ground level or to 10 cm above ground level which is common practice in Thailand. An early closing date (November) is more desirable than a late dry season closing date (January). If the farmers want to delay the closing date in order to get dry season grazing, at a time when even small additions of quality feed may be highly significant, a higher stubble of 30 cm must be maintained.

## Acknowledgements

We thank the staff of Suwanvajokkasikit Research Station for their assistance, and Dr M.D. Hare and Professor B.R. Watkin for suggestions and criticism of the manuscript. This experiment was supported by National Research Council of Thailand and Kasetsart University Research and Development Institute.

## References

DAVISON, T.M., COWAN, R.T. and O'ROURKE, P.K. (1981) Management practices for tropical grasses and their effects on pasture and milk production. *Australian Journal of Experimental Agriculture*, **21**, 515–532.

HARRIS, W. (1978) Defoliation as a determinant of growth, persistence and composition of pasture. In: Wilson, J.R. (ed.) *Plant Relations in Pasture.* (CSIRO: Melbourne).

KAEWICHIAN, G. (1969) *Effect of cutting height on yield and quality of para grass* (Panicum purpurascens). B.Sc. (Agriculture) Thesis. Kasetsart University, Bangkok, Thailand.

MCLEOD, C.C. (1972) *Field Investigation Report May 1970–October 1972.* Borabue Pasture and Range Development Centre, Department of Land and Development, Thailand.

MIDDLETON, C.H. (1982) Dry matter and nitrogen changes in five tropical grasses as influenced by cutting height and frequency. *Tropical Grasslands*, **16**. 112–117.

RIDDACH, V. (1997) *Yield and quality of some napier grass species.* M.Sc. (Agriculture) Thesis. Kasetsart University, Bangkok, Thailand.

SUKKAGATE, S., TUDSRI, S. and POOKPAKDI, A. (1997). Effect of close cutting on the yield and quality of four tropical grass pastures. *Paper presented at the 32nd Kasetsart University Annual Conference, 3–5 February 1997, Bangkok, Thailand.* pp. 104–112.

TINAKORN, S., WILAIPON, B., SURIYAJANTRATHONG, V. and MANIDOOL, C. (1987) Studies on yield and chemical compositions of eight tropical grass species at Packchong. *Annual Report 1987. Packchong Feed Research Centre, Nutrition Division, Department of Livestock Development, Ministry of Agriculture and Cooperative, Thailand.*

TUDSRI, S. and SAWADIPANICH, S. (1993) Managerial approach to pasture production in Thailand. In: Chen, C.P. and Satjipanon, C. (eds) *Strategies for suitable forage-based livestock production in southeast asia. Proceedings of the 3rd meeting of RWG on Grazing and Feed Resources of Southeast Asia, 31 January–6 February 1993, Khoan Kaen, Thailand.* pp. 111–125.

TUDSRI, S. and KANGSANAO, M. (1994) Effect of water stress and cutting height on Dwarf napier (*Pennisetum purpureum* cv. Mott). *Paper presented at the 32nd Kasetsart University Conference, 3–5 February 1994, Bangkok, Thailand.*

TUDSRI, S., SUKKAGATE, S. and POOKPAKDI, A. (1996) Dry matter production and qualtiy of some tropical grasses. *The Kasetsart Journal*, **30**, 293–302.

TUDSRI, S., PACHANAWAN, N., SAWADIPANICH, S., BUMRUNG, N. and JENGNAY, Y. (1998) Productivity and quality of CP-pangola (*Digitaria decumbens* cv. CP-1) under different management conditions. I. Effect of frequency and height of cutting. *The Kasetsart Journal*, **32**, 265–274.

TUDSRI, S., SAWADIPANICH, S., PRASANPANICH, S., JARIPAKORN, P. and ISWILANONS, S. (1999) Development of Suitable Pasture Production System for Small Dairy Farms in Central Plain Areas. *Report submitted to National Research Council of Thailand, Ministry of Science and Technology.*

TUNJANPONG, S. (1964) *Effect of cutting height on yield and quality of para grass* (Panicum maximum) *in the second year.* B.Sc. (Agriculture) Thesis. Kasetsart University, Bangkok, Thailand.

WARD, C.Y. and BLASER, R.E. (1961) Carbohydrate food reserves and leaf area in regrowth of orchardgrass. *Crop Science*, **1**, 366–369.

*(Received for publication June 27, 2001; accepted October 2, 2002)*