ORIGINAL ARTICLE

Effect of dates of closing cut on seed yield and seed quality of *Stylosanthes guianensis* CIAT 184

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Abstract

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The aim of this field research was to investigate the effect of dates of closing cut on seed yield and seed quality of *Stylosanthes guianensis* CIAT 184 at Khon Kaen Animal Nutrition Research and Development Center, during May 2003 to February 2004. A randomized complete block design with four replications was used. Experimental treatments consisted of five dates of closing cut spaced at about 14-day intervals (27 August, 10 September, 24 September, 8 October 2003 and uncut).

The results showed that date of closing cut had a significant effect on seed yields and pure germinable seed yields (PGSY) of *S. guianensis* CIAT 184. Plots closed on 10 September produced the highest seed yield and PGSY (P<0.05) of 564 and 553 kg/ha, followed by plots closed on 24 September and 27 August (422 and 406; 405 and 391 kg/ha). Uncut plots produced low yield and plots closed on 8 October produced the lowest seed yield and PGSY (401 and 388; 365 and 356 kg/ha). There were no significant differences in seed purity percentage, germination percentage and 1000-seed weight among treatments. Among the dates of closing

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cut studied, forage DM yield and CP yield were subsequently increased as date of closing cut was delayed. Based on this research, it was concluded that early-September was the optimum date of closing cut for *S. guianensis* CIAT 184 cultivation for seed production in Northeast Thailand.

Key words : *S. guianensis* CIAT 184, dates of closing cut, seed yield, seed quality

บทคัดย่อ

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ผลของระยะเวลาตัดปิดแปลงถั่วที่มีต่อผลผลิตและคุณภาพของเมล็ดพันธุ์ถั่วท่าพระสไตโล

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การศึกษาผลของระยะเวลาตัดปิดแปลงถั่วที่มีต่อผลผลิตและคุณภาพของเมล็ดพันธุ์ถั่วท่าพระสไตโล (*Stylosanthes guianensis* CIAT 184) ที่ศูนย์วิจัยและพัฒนาอาหารสัตว์ขอนแก่น อำเภอเมือง จังหวัดขอนแก่น ระหว่างเดือนพฤษภาคม 2546 ถึงเดือนกุมภาพันธ์ 2547 วางแผนการทดลองแบบ Randomized complete block จำนวน 4 ซ้ำ 5 ปัจจัยทดลอง โดยทำการตัดปิดแปลงถั่วห่างกันทุก ๆ 14 วัน คือ ตัดวันที่ 27 สิงหาคม, 10 กันยายน, 24 กันยายน, 8 ตุลาคม 2546 และไม่มีการตัดต้นถั่ว

ผลการทดลองพบว่า การตัดปิดแปลงถั่วท่าพระสไตโลวันที่วันที่ 10 กันยายน 2546 ได้ผลผลิตเมล็ดพันธุ์และเมล็ดพันธุ์บริสุทธิ์ที่งอกได้สูงสุด 90 และ 88 กก./ไร่ ตามลำดับ (P<0.05) ถั่วที่ตัดปิดแปลงวันที่ 24 กันยายน 2546 และวันที่ 27 สิงหาคม 2546 ได้ผลผลิตเมล็ดพันธุ์และเมล็ดพันธุ์บริสุทธิ์ที่งอกได้น้อยลงตามลำดับ (68 และ 65; 65 และ 63 กก./ไร่) สำหรับถั่วที่ไม่มีการตัดและถั่วที่ตัดปิดแปลงวันที่ 8 ตุลาคม 2546 ได้ผลผลิตเมล็ดพันธุ์และเมล็ดพันธุ์บริสุทธิ์ที่งอกได้ต่ำและต่ำสุด ตามลำดับ (64 และ 62; 58 และ 57 กก./ไร่) การไม่ตัดและตัดปิดแปลงถั่วไม่มีผลกระทบต่อความบริสุทธิ์ ความงอก และน้ำหนัก 1000 เมล็ด การตัดปิดแปลงถั่วท่าพระสไตโลล่าช้าจากวันที่ 27 สิงหาคม เป็นวันที่ 10 กันยายน, 24 กันยายน และ 8 ตุลาคม 2546 ทำให้น้ำหนักแห้งและโปรตีนของถั่วเพิ่มขึ้น จาก 116 และ 23 กก./ไร่ เป็น 270 และ 51; 459 และ 77; 682 และ 118 กก./ไร่ ตามลำดับ

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Stylosanthes guianensis CIAT 184 is a tropical perennial forage crop that originated in Central and South America. It is high forage yield potential which can thrive in a wide range of soil types, well adapted to sandy-loam soil with low organic matter and rather high acidity, and drought tolerance. *S. guianensis* CIAT 184 was evaluated for its forage production potential, persistence including flowering and seed setting in Thailand since 2000. It adapted in the region and exhibited high forage yield potential, high seed production particularly in Northeast Thailand (Satjipanon *et al.*, 1995). Its wide use is due to its easily being established from seed which is an important key for Thai farmers to plant forage for their livestock, since it is easier and cheaper than vegetative propagation.

Cutting the tip of legume at the appropriate time before flowering causes a multiplying of the branches that leads to increases in inflorescence number and seed yield could be increase as well; meanwhile farmers could also obtain forage for animals. However, inappropriate cutting time may decrease seed yield and seed quality of the legume. Hare and Waranyuwat (1960) suggested that cutting or grazing legume should not be done after August, as it would affect the productivity of flowering. Time of final closing cut or defoliation had a significant effect on seed yields of *Paspalum atratum*. Plots closed in mid-June produced the highest seed yield, followed by plots closed in mid-May and mid-April. Plots closed in mid-July produced low yield and plots closed in mid-August produced no seed (Phaikaew, 2004). With any new forage crop, an understanding of optimal date of closing cut is essential for maximizing seed yield and seed quality. The objectives of this research were to (i) identify the optimum date of closing cut for Northeast Thailand involved in *S. guianensis* CIAT 184 seed production; (ii) compare forage yield and herbage nutritive value of *S. guianensis* CIAT 184 closing cut at different dates.

Materials and methods

Location and climate of the experimental site

The experiment was conducted under rainfed conditions during May 2003 to February 2004 at Khon Kaen Animal Nutrition Research and Development Center, Khon Kaen Province, Northeast Thailand (16º00' N, 102º30' E; elevation 166 m). The field was cropped with *S. guianensis* CIAT 184 in the season before application of the treatments. The soil at the experimental site is sandy loam (fine-loamy, siliceous, isohyperthermic oxygenic Kandiustults). Temperature and precipitation data were obtained from the Thapra Meteorological Station, located about 1 km north of the experiment site. The climatic data of weekly mean rainfall, maximum and minimum air temperatures throughout the growing season of this study are shown in Figure 1.

Experimental design and treatments

A randomized complete block design with four replications was used. Experimental treatments consisted of five dates of closing cut spaced at about 14-day intervals (27 August, 10 September, 24 September, 8 October 2003 and uncut). The experimental treatment had been imposed using general practices of farmers for seed production of S. guianensis CIAT 184 involved in closing cut, which generally has been done at around late-August till early-October.

Seedling preparation

Scarification of seeds was done by soaking in hot water at 80ºC for 5 min to reduce hard-seededness, then sown in a plastic drainable seedling tray on 23 May 2003 in the nursery. Plants were watered every day as necessary to avoid drought. Seedlings stayed 28 d in the nursery and were then transplanted to the plots.

Crop cultivation

The experimental site was moldboard-plowed to a depth of about 20 cm and then roller-harrowed in late-April 2003. Soil samples were

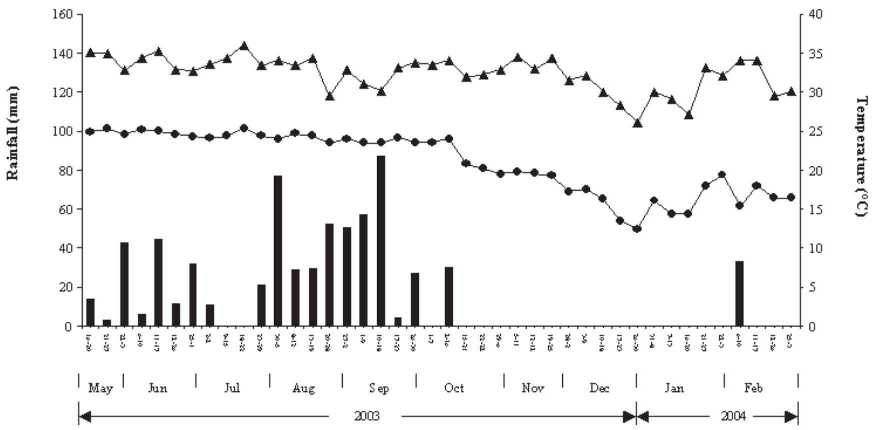

Figure 1. Weekly weather data during the experimental period: rainfall in shown by the columns; minimum temperature ●-●; maximum temperature ▲-▲.
Source: Thapra Meteorological Station, Khon Kaen (2004).

taken from depths of 0 to 15 cm as composites of four samples from four random locations within each plot. The samples were shade dried, crushed and sieved through a 2 mm mesh before being analyzed for major nutrients. Plot size was 4x5 m with four rows per plots. On 20 June 2003, the plots were hand-transplanted in 100-cm wide rows with 50-cm spacing within rows at a rate of 1 seedling/hill, which resulted in 2 plants/m^2. Two days prior to planting, each plot was top dressed 25 kg N/ha as urea, 150 kg P/ha as triple super-phosphate, 25 kg K/ha as potassium choride and 62.5 kg S/ha as gypsum. The entire plot area was kept weed-free with hand hoeing at 20 and 75 d after planting and whenever necessary.

Data collections, plant closing cut and seed harvesting

In order to minimize the effect of border row, all samples were taken from the 3x4 m strip perpendicular to the row direction of each plot. Plants were clipped to a 20-cm stubble height from the central two rows of each plot using a sickle according to their respective treatments. Fresh weight was recorded, and a subsample of approximately 500 g was collected from each plot and dried in a forced-air oven (60ºC) for 48 h to determine forage DM, which was used to calculate DM yield. Subsamples were prepared for quality analysis by grinding with a Wiley mill to pass through a 1-mm screen. Ten plants were selected randomly from the central two rows and the following growth variables were recorded for each plot; date of start flowering, days to first flowering, days to seed maturity and plant height at seed maturity. Ripening seedheads were tied together into manageable bunches and when the seed was almost ripe nylon gauze bags were tied over the bunches and remained there for duration of the harvest. Bags facilitate the collection of all seed produced. Plots were harvested individually in the last week of January 2004. Harvest took place after mature seeds were observed; seedheads with nylon gauze bags were cut. Seed was allowed to collect in the gauze bags until such time weather permitted the collection of dry seed. Ripe seed was threshed off the inflorescences by heavily threshing the gauze bag using a mallet.

Chemical analyses, seed processing, seed quality measurement and calculation of secondary attributes

Plant samples were investigated potential forage quality differences between dates of closing cut. Dry matter (DM), ash and nitrogen (Kjeldahl-N) were determined using the methods described by AOAC (1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin (ADL) were determined by the methods of Goering and Van Soest (1970). Seed from all treatments was air-dried at ambient temperature for 3 d in a seed shed until seed moisture content dropped below 10%, before cleaning through hand screens and a Dakota seed blower. Cleaned seed was weighed for each plot. Seed moisture content (MC), 1000-seed weight (TSW), seed purity (SP), and seed germination (SG) were determined using the seed test methods of the International Seed Testing Association for *S. guianensis*. TSW was determined from pure-seed spikelet weight. Germination test was done in February 2004. Four replications of a 100-seed sample were treated with concentrated H_2SO_4 then tested for germination on blotters in clear plastic petri dishes at alternating temperatures of 20ºC for 16 h and 30ºC for 8 h in a daylight/fluorescent-lighted germinator (AOSA, 1988). Seedlings were counted and removed from petri dishes every second day during a 10-d test period. Germination percentage was determined. Seed yield and TSW were corrected to 9 % MC. Further parameters were calculated as follows: the content of crude protein (CP) = Nx6.25; dry matter yield (DMY) = fresh forage yield x %DM; pure seed yield (PSY) = SYxSP/100; and PGSY = PSYxSG/100.

Statistical analyses

The various data were subjected to the analyses of variance (ANOVA) procedure for randomized complete block design experiments using the general linear models (GLM) of the SAS System for Windows (SAS 6.12, TS level 020, SAS

Institute, 1989). Probabilities less than 0.05 were considered significant. Treatment means were compared using Duncan's New Multiple Range test (Steel and Torries, 1980).

Results

Climatic conditions and soil characteristics

Climatic conditions in the Northeast Thailand were generally considered to be good for *S. guianensis* CIAT 184 growth and seed yielding. During experimental period, rainfall was rather low as well as poorly distributed. Rainfall was evenly distributed in the wet season (May to September 2003), which was the timing of the growing stage of *S. guianensis* CIAT 184. The precipitation was highest in early-September 2003. Early-season precipitation was abundant for establishment of plants. Less rain was received with an abnormal suspended period in mid-July 2003. Extremely low amount of rainfall was received after mid-October 2003, with no measurable precipitation occurring in November 2003 to January 2004, which was the timing of the flowering and seed setting stage of *S. guianensis* CIAT 184. Total precipitation during the experimental period (May 2003 to February 2004) was 663.7 mm. Weekly mean maximum and minimum air temperatures ranged from 29.2 to 36.3 and 15.7 to 25.2ºC, respectively. Analysis of a composite

Table 1. Effect of dates of closing cut on some agronomic characters of *S. guianensis* CIAT 184.

Dates of closing cut	Start flowering	Days to first flowering (d)	Days to maturity (d)	Plant height (cm)
27 August	31 Oct 2003	164.0^{d}	193.0^{d}	100.0^{b}
10 September	4 Nov 2003	172.0^{c}	199.0^{c}	83.0^{c}
24 September	12 Nov 2003	177.0^{b}	202.0^{b}	62.0^{d}
8 October	17 Nov 2003	181.0^{a}	208.0^{a}	49.0^{e}
Uncut	24 Oct 2003	154.0^{e}	193.0^{e}	135.0^{a}
Significance	-	*	*	*
CV (%)	-	0.48	0.58	1.20

[a,b,c,d,e] Means with different superscripts in the same row are significantly different (p<0.05).
*** = P<0.05, CV = coefficient of variation.**

Table 2. Effect of dates of closing cut on seed yield and seed quality of *S. guianensis* CIAT 184.

Dates of closing cut	Seed yield (kg/ha)	Seed quality			Pure germinable seed yield (kg/ha)
		Purity (%)	1000-seed weight (g)	Germination (%)	
27 August	405^{b}	97	3.910	99.5	391^{b}
10 September	564^{a}	98	3.777	99.8	553^{a}
24 September	422^{b}	98	3.869	98.5	406^{b}
8 October	365^{b}	98	4.022	99.3	356^{b}
Uncut	401^{b}	98	3.829	99.3	388^{b}
Significance	*	NS	NS	NS	*
CV (%)	18.8	1.4	3.8	0.78	18.9

[a,b] Means with different superscripts in the same row are significantly different (p<0.05).
*** = P<0.05, NS: Values are not significantly different (P>0.05), CV = coefficient of variation.**

sample collected from the experimental site revealed that pH (water) was 5.18, total-N was 0.06 %, available P was 26.98 ppm, available K was 35.92 ppm, Ca was 168.20 ppm, Mg was 9.60 ppm, S was 0.00 ppm and organic matter was 1.17%.

Plant growth

The effects of dates of closing cut on some agronomic characters of *S. guianensis* CIAT 184 are presented in Table 1. Both days to first flowering and days to seed maturity were significantly greatest (P<0.05) for 8 October treatment and significantly lowest (P<0.05) for uncut treatment. Plant height at seed maturity was significantly greatest (P<0.05) for uncut treatment and significantly lowest (P<0.05) for 8 October treatment.

Seed yield and seed quality

The results of the effects of dates of closing cut on seed yield and seed quality of *S. guianensis* CIAT 184 are presented in Table 2. Seed yield and PGSY were significantly greatest (P<0.05) for 10 September treatment, whereas 27 August; 24 September; 8 October and uncut treatments were not significantly different from each other. There were no significant differences in seed purity percentage, germination percentage and 1000-seed weight among treatments.

Forage yield

Effects of dates of closing cut on DM yield and CP yield of *S. guianensis* CIAT 184 are reported in Tables 3. Among the dates of closing cut studied, both DM yield and CP yield were significantly greatest (P<0.05) for 8 October treatment and significantly lowest (P<0.05) for 27 August treatment.

Forage quality

Chemical composition of *S. guianensis* CIAT 184 closing cut at different dates is shown in Table 4. CP concentrations were significantly greatest (P<0.05) in 27 August relative to 10 September, 24 September and 8 October treatments. NDF, ADF, ADL and ash concentrations were significantly lowest (P<0.05) in 27 August relative to 10 September, 24 September and 8 October treatments.

Discussion

The result indicated that delaying closing cut resulted in a decrease in plant height at seed maturity. This was mainly due to the decreased growing period. The flowering of *S. guianensis* CIAT 184 closing cut at 27 August, 10 September, 24 September, 8 October 2003 and uncut commenced on 31 October, 4 November, 12 November, 17 November and 24 October 2003,

Table 3. Effect of dates of closing cut on DM and CP yield of *S. guianensis* CIAT 184.

Dates of closing cut	DM[1/] yield (kg/ha)	CP yield (kg/ha)
27 August (96 DAP)	725[d]	146[d]
10 September (110 DAP)	1,690[c]	317[c]
24 September (124 DAP)	2,870[b]	479[b]
8 October (138 DAP)	4,261[a]	739[a]
Significance	*	*
CV (%)	18.9	21.9

[a,b,c,d] Means with different superscripts in the same row are significantly different (p<0.05).
*** = P<0.05; CV= coefficient of variation; [1/] DM = dry matter, CP = crude protein, DAP = days after planting.**

respectively. A similar finding was reported by Kiyothong *et al.* (2002), who reported that flowering of *S. guianensis* CIAT 184 grown at Khon Kaen Animal Nutrition Research and Development Center in 2001 commenced in mid-October continued until late-December. *S. guianensis* CIAT 184 is a short-day plant; it requires a day length of less than 12 h for flowering, with best results at 10 h (Mannetje and Jones, 1992). Generally, late October to November in Northest Thailand a day length less than 12 h therefore it is the optimum period for flowering.

The results in this study showed that date of closing cut had a significant effect on seed yields and PGSY of *S. guianensis* CIAT 184. Plots closed on 10 September produced the highest (P<0.05) seed yield and PGSY of 564 and 553 kg/ha, followed by plots closed on 24 September and 27 August (422 and 406; 405 and 391 kg/ha). Plots uncut produced low yield and plots closed on 8 October produced the lowest seed yield and PGSY (401 and 388; 365 and 356 kg/ha). This was mainly due to the 10 September closing cut being a suitable time for receiving high amount of precipitation (Figure 1). In addition, it had a sufficient growing period after cutting. This also might be due to plant height of 10 September closing cut probably being optimum. From the observation in field plots, it can also be noted that plant could be grown in optimum condition. These contributed to more branching and flowering subsequent to seed setting and eventually resulted in high seed yield. From the observation in field plots, it can also be noted that stem and leaves of 27 August and uncut plots grew abundantly as compared to 10 September, 24 September and 8 October plots. In addition, lodging and pile up itself has been obviously observed. This led to competition for light and nutrients, ultimately resulting in lower seed yield. The 24 September and 8 October plots were closed on the time of encountering abnormal suspension and poor rainfall distribution during early-October and mid-October 2003. In addition, it had an insufficient growing period after closing. This resulted in less branching and flowering subsequent to less seed setting and eventually resulted in lower seed yield. This result was in agreement with Phaikaew (2004), who reported that time of final closing cut or defoliation had a significant effect on seed yields of *P. atratum*. Plots closed in mid-June produced the highest seed yield, followed by plots closed in mid-May and mid-April. Plots closed in mid July produced low yield and plots closed in mid-August produced no seed.

The results indicated that TSW and germination percentage were unaffected by date of closing cut, ranging from 3.777 to 4.022 g and 98.5 to 99.8%, respectively. Seed purity percentage was also unaffected by date of closing cut, ranging from 97 to 98. The reason could possibly be the inflorescences were covered with nylon gauze bags since early seed setting stage, it was unlikely those seeds directly fell down to the soil and there was a lower chance of seeds being contaminated; consequently seed purity was not different. A similar finding was reported by Kiyothong *et al.* (2002), who reported that seed purity percentage of *S. guianensis* CIAT 184, which its inflorescences covered with nylon gauze bags since early seed setting stage was not different. The method of covering inflorescences with nylon gauze bag is currently used by the Department of Livestock Development to harvest seed of Panicum maximum TD58, which obtain high purity seed.

Forage DM yield and CP yield of all date of closing cut treatments were subsequently increased as date of closing cut was delayed. Generally, more biomass of the plant is produced as day after plant (DAP) increases. Forage DM yield and CP yields increased from 725 to 1,690 2,870 and 4,261; 146 to 317 479 and 739 kg/ha as closing cut was delayed from 27 August to 10 September, 24 September, and 8 October, respectively (Table 3). Forage DM yield and CP yields were greatest for 8 October treatments and lowest for 27 August treatments. This was mainly due to the 8 October treatment having the longest period of time (138 DAP) for growing and storing nutrient in stem which resulted in greatest forage DM yield and CP yield, whereas the 27 August treatment had the shortest period of time (96 DAP) for growing and storing nutrient in stem which resulted in lowest forage DM yield and CP yield. Although 8 October treatment produces the highest forage DM yield and CP yields, it was not realized as the optimum date of closing cut. In this study, the highest seed yield and good seed quality would be realized rather than forage yield and forage quality.

The CP, NDF, ADF, ADL and ash concentrations of *S. guianensis* CIAT 184 ranged from 16.6 to 20.1, 52.8 to 66.1, 33.3 to 42.6, 7.6 to 9.9 and 7.7 to 9.9%, respectively (Table 4). The CP, NDF and ADF concentrations of *S. guianensis* CIAT 184 were found to be similar to those reported by Kiyothong and Wanapat (2004), who reported that CP, NDF and ADF concentrations of *S. guianensis* CIAT 184 grown at Khon Kaen Animal Nutrition Research and Development Center were in the range of 16.30 to 19.10, 48.00 to 61.50 and 33.50 to 47.30%, respectively. The result in this study showed that CP concentrations of *S. guianensis* CIAT 184 decreased as closing cut was delayed. There was a notable difference in CP concentrations and forage DM yields. Forage DM yields of *S. guianensis* CIAT 184 increased, wherease CP concentrations decreased as closing cut was delayed.

Conclusion and recommendations

Based on this research, it was concluded that early-September was the optimum date of closing cut for *S. guianensis* CIAT 184 cultivation for seed production, which would achieve high seed yield and good quality seed as well as forage yield for animals. However, the experiments in second- and third-year crops still need to be clearly defined in order to provide practical recommendations to farmers especially those in the Northeast of Thailand.

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