Effect of date of closing cut on seed yield and its components of *Andropogon gayanus* cv. Kent

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Abstract

The effect of date of closing cut on seed production of *Andropogon gayanus* cv. Kent was studied in NE Thailand. Cutting in August, September or October produced progressively lower pure seed and pure live seed yields than the uncut control (433.9 *vs* 285.2, 159.3 and 62.1 kg/ha; and 302.6 *vs* 206.7, 99.2 and 38.6 kg/ha, respectively). Delayed peak flowering in association with increasing moisture stress, and a reduced leaf area at flowering may have led to decreased yields. Thousand-seed weight was unaffected by cutting date. Tiller density increased with later cuts, but as inflorescence density remained similar, tiller fertility decreased. Seed purity was unaffected by cutting date. Closing cuts had a large, negative effect on inflorescence size, indicated by dramatic reductions in pure seed yield per inflorescence with successive cuts. Seed germination percentage decreased following cutting in September or October, resulting in lower pure live seed yield. Closing cut dates between May and August should be investigated.

Introduction

Gamba grass (*Andropogon gayanus*) is an ideal addition to pasture production in north-east Thailand. Its drought-resisting qualities (Bowden 1964; Jones 1979; Skerman and Riveros 1990)

are suitable for adaptation to the 6-month annual dry season characteristic of the area, providing dry season forage where none is currently available. Seed production of gamba in Thailand has not been researched, as its release was relatively recent.

Gamba is a short-day flowering plant and, in Thailand, flowers in the first week of November with seed being harvested in early December. Seed development of the crop must be timed so that photosynthetic products are channelled into seed production when flowering occurs. If regrowth starts before the optimum time, the seed crop will not flower earlier, but will instead grow taller, produce more dry matter and be prone to lodging (Hill and Loch 1993). In Chiang Yeun, north-east Thailand, gamba will grow up to 4 metres tall if unchecked through the wet season. Observations, in 1994, were that gamba still grew to 3 metres in height when cut in August.

At a similar latitude in the southern hemisphere, Andrade and Thomas (1984) studied cutting management and determined optimal closing dates for *Andropogon gayanus* cv. Planaltina in Brazil. They found that material produced in the first half of the season should be removed. Otherwise, if uncut, plants became too tall and seed yield was not maximised. When cut too late in the season, swards still flowered abundantly but the lack of leaf area led to small inflorescences and greatly reduced seed yields.

The typical rainfall pattern in north-east Thailand is one of a gradual start to the wet season which climaxes in the months of June, August and September. To establish the most appropriate closing cut date for gamba in NE Thailand, an experiment was designed to measure the effects of timing of closing cut on seed yield and its associated components. Improved knowledge on seed production will ultimately determine the extent to which it is adopted.

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Materials and methods

Research was conducted over one year at the Department of Livestock Development's Chiang Yeun Animal Nutrition Station, Mahasarakham, in north-east Thailand (16.5° N, 103° E). Average rainfall is 1075 mm per annum. The soil is classified into the Khorat soil series and is characterised by a sandy loam over a clay loam. Organic matter concentration is 0.57%, available P 9 ppm and available K 35 ppm, with a pH range from 4.6–5.8.

The experiment was conducted on a sward which was established in 1993 using a randomised complete block design (RCBD) with 4 defoliation treatments and 4 replications (Table 1). Plot size was 4 × 4.5 m. The experimental period was from May 1995 until April 1996. Details of fertiliser applications are given in Table 1. One seed crop was harvested.

Table 1. Management details.

Activity	Timing and Fertiliser levels
Sowing of pasture	Wet season **1993**
First cleaning cut/Burn	All treatments cut and then burnt, **May 17, 1995**
Basal fertiliser applied	Wet season **1993** Wet season **1994** 90 kg/ha N 10 kg/ha P 50 kg/ha K 20 kg/ha S **May 29, 1995**
Treatment closing cut applied	Treatment 1: Not cut (Control) Treatment 2: Cut **Aug 15, 1995** (C_{Aug}) Treatment 3: Cut **Sep 15, 1995** (C_{Sep}) Treatment 4: Cut **Oct 16, 1995** (C_{Oct})
Fertiliser applied at treatment closing cut	90 kg/ha N 10 kg/ha P 50 kg/ha K Applied to Control on **Aug 15, 1995**
Seed harvested	Control **: Dec 7, 1995** C_{Aug} **: Dec 11, 1995** C_{Sep} **: Dec 22, 1995** C_{Oct} **: Jan 8, 1996**
Seed quality testing	**Apr 1996**

Data collection and seed harvesting

At treatment closing cuts, plots were cut back to 25 cm and all trash removed. All recordings were taken from the inner 3 × 3.5 m of each plot. Initial flowering (first anthesis) date was recorded for each plot. Ripening seedheads were tied together into manageable bunches and, when seed was almost ripe, nylon gauze bags were tied over the bunches and remained for the duration of harvest. Bags facilitate the collection of all seed produced. Inflorescence density/m^2 was calculated from the total number of inflorescences in the 10.5 m^2 harvest area. At seed harvest, two 1 m^2 quadrats were sampled for tiller numbers. Tiller fertility is expressed as the percentage of inflorescences over the total number of tillers. First harvest date and succeeding retrieval dates were recorded (Table 1). Plots were harvested individually. Harvest took place after seed started to drop, and when seed was easily displaced from the racemes by light brushing. Seed was allowed to collect in the gauze bags until most ripened seed had fallen. Remaining ripe seed was threshed off inflorescences by lightly tapping the gauze bag. At retrieval, seed heads were cut, heaped in the shade, and allowed to sweat for 5 days, after which any remaining seed was collected. Seed was air-dried, in the shade, over several days.
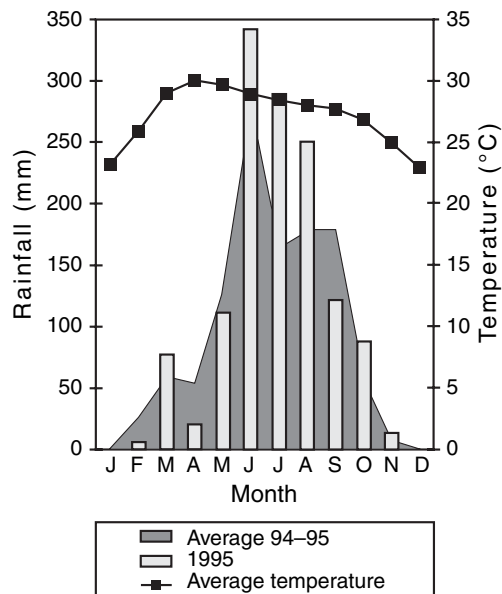
Plant height was recorded before first seed retrieval. Total seed, cleaned seed, and thousand-seed weight (TSW) were recorded (adjusted to 10% moisture concentration). "Pure seed" was defined as any fertile spikelet or floret, irrespective of the presence of a caryopsis. Germination tests (over 14 days) were conducted on the gamba seed at 4 months post harvest. Dormancy was broken with KNO_3. Pure germinating seed % (PGS) was calculated by multiplying the germination percentage with percentage purity of seed. PGS was then used to calculate total pure live seed yield (PLSY). The number of pure seeds per inflorescence was calculated using inflorescence density, thousand-seed weights and pure seed yield.

Statistical analysis

Response variables for each experiment were analysed by analysis of variance and LSD tests. All data was analysed using the Minitab Statistical Programme.

Results

Rainfall and temperature

Figure 1. Monthly rainfall during experimental period and mean long-term monthly temperatures (using average of daily maximum and minimum temperatures at Khon Kaen).

Rainfall in 1995 was above average with 1303 mm being recorded (Figure 1). Temperatures were not recorded at the site but average monthly temperatures for Khon Kaen (25 km east) are provided.

Lodging

Lodging greatly influenced the control treatment density, causing death of many tillers, but did not affect other treatments. Lodging made harvesting difficult as many stems were lying horizontal.

Seed yield

Successively later closing times produced significantly different and progressively lower pure seed yields (PSY) (Table 2). Maximum yield was attained from the control treatment, 7 times that of the minimum yield from the October defoliation (434 *vs* 62 kg/ha). Seed yields from undefoliated plants were also 3 times those of plants defoliated in September and 52% higher than from plants cut in August.

Differences in thousand-seed weights of treatments (TSW) were not significant.

Pure seeds per inflorescence

All closing cut treatments resulted in less pure seeds per inflorescence than the control treatment and the decline was progressive with later closing cuts (Table 2).

Inflorescence emergence and density

Inflorescence emergence dates were significantly affected by closing date. Gamba flowering is strongly day-sensitive, so the later the closing cut the shorter the time to flowering.

Differences in inflorescence densities were not significant but densities tended to increase with closing cuts in August or September.

Tiller density and fertility

Tiller densities for the undefoliated and August-closed plants were significantly (P < 0.001) lower than those of the later closing cut treatments. Likewise, tiller fertility differences were highly significant (P < 0.005). Tillers of undefoliated plants or plants defoliated in August, were at least twice as fertile as those of plants from the September and October closing cut treatments.

Table 2. The effect of closing cut date on seed yield and its components. Data within rows followed by the same letter do not differ (P>0.05).

Cutting date	Uncut	15 Aug	15 Sep	16 Oct	LSD (P=0.05)
Plant height (cm)	363.5 a	274.3 b	201.0 c	138.5 d	23.6
Tiller density (no/m^2)	95.8 b	115.3 b	230.5 a	193.0 a	39.5
Fertile tillers (%)	42.3 a	45.3 a	19.5 b	18.5 b	15.4
Inflorescence density (no/m^2)	38.8	52	45	36	NS[1]
Time to flowering (days after closing cut)	150.3 a	82.5 b	50.5 c	31.3 d	2.7
Purity (%)	93.0	93.8	88.6	92.5	NS
Germination (%)	75.8 a	76.5 a	67.5 b	67.2 b	6.0
Pure seeds per inflorescence	364	176	117	55	NA[2]
TSW (g) (thousand-seed weight)	3.07	3.11	3.03	3.14	NS
PSY (kg/ha) (pure seed yield)	433.9 a	285.2 b	159.3 c	62.1 d	103.5
PLSY (kg/ha) (pure live seed yield)	302.6 a	206.7 b	99.2 c	38.6 c	65.9

[1]Not significant.
[2]Not analysed.

Height

Height before seed harvest was affected by cutting treatment. The later the closing cut, the shorter the plant heights, with treatments differing significantly.

Seed quality.

Seed purity was similar in all treatments (88.6–93.8%). Seed germination from the September and October closing cut treatments was significantly reduced. Germination percentages for the undefoliated and August closing cut treatments were similar, as were the September and October-closed treatments.

PGS% from the 2 late-cut treatments was significantly lower than those from the control and August treatments. PLSY decreased significantly ($P < 0.001$) with successive closing cuts, except for the October treatment which produced a lower PLSY but did not differ significantly from the September-cut treatment.

Discussion

This study has shown that cutting at any of the times tested (August–October) significantly reduced the yield of pure germinating seed. This was despite the fact that lodging greatly affected the control treatment. Tiller density in the undefoliated control tended to be lower than that in August closing cut treatments, and was significantly lower than in the September and October treatment plots. This was possibly due to tissue death as a result of high moisture levels under the canopy (leading also to secondary disease infection) and stem breakage.

Cutting later in the season significantly increased tiller densities but without significant changes in inflorescence density. Although tiller densities in the two late cut treatments were significantly higher than in the control, a closing cut in August produced a similar tiller density to the undefoliated treatment. Yet seed yield from plants defoliated in August was significantly lower than that of the control. Andrade and Thomas (1981; 1984) also failed to demonstrate significant tiller density and tiller fertility differences.

The reduction in seed yield could not be attributed to changes in inflorescence density or tiller fertility, although several sources have described a relationship between these two components and seed yield (Haggar 1966; Cameron and Humphreys 1976; Loch 1980; Humphreys

and Riveros 1986; Ramirez and Hacker 1994), in several species. Andrade and Thomas (1984) also failed to demonstrate any relationship, though they cited Mishra and Chatterjee (1968) who described a decline in tiller fertility (with later cuts) which was highly correlated with lower seed yields.

As gamba is a short-day plant it was natural to expect that, with later closing cuts, the length of time to emergence of the first inflorescence would decrease. However, harvesting dates were progressively later with later closing cuts, showing a delay in the peak flowering of each treatment.

As purity and TSW were similar for all treatments, it is surmised that reduced leaf area during development of the heads in the later cuts, led to smaller inflorescences with reduced seed yields (Humphreys and Riveros 1986). Indeed, our results, tabled as pure seeds per inflorescence, show that the biggest variation due to treatments was in the size of the inflorescences. The delay in peak flowering, leading into the dry season, may have contributed to reductions in seed yield (Andrade and Thomas 1981, 1984; Humphreys and Riveros 1986), by subjecting the plants to more moisture stress during flowering and maturation.

Pure seed yield from this experiment was much higher than reported by Andrade and Thomas (1981; 1984) and others (Mishra and Chatterjee 1968; Harrison 1987; Skerman and Riveros 1990; Schultze-Kraft 1992). This is despite much lower relative inflorescence and tiller densities in our study. Possible reasons for this are the total amount of seed retrieved and its high purity, achieved through the use of the nylon gauze bags for seed collection.

Seed quality decreased significantly as closing cut was made after August. Quality, measured through germination percentage and pure germinating seed percentage, suffered when closing cuts were later than August, again possibly due to moisture stress.

Andrade and Thomas (1981; 1984) produced improved seed yields when applying a closing cut to gamba seed crops at some stage of the wet season. Our trial aimed to remove a lot of the vegetative bulk grown in the first half of the wet season. As our seed yields in this trial progressively decreased with successive closing cuts, the dates we chose may be too late in the season. Future research on seed yield should focus on

closing dates earlier than our current treatment dates, perhaps between May and August (the first half of the wet season).

Acknowledgements

References

ANDRADE, R.P. DE and THOMAS, D. (1981) Pesquisas em avaliacao de pastagens e producao de semestes de forrageiras no centro de pesquisa agropecuaria dos cerrados. In: Medeiros, R.B., Nabinger, C. and Saibro, J.C.D. (eds) *Producao e. Technologia de sementes de forrageiras Tropicais e. Subtropicas*. Promocao CONTRIJUI/ UFRGS/ FAO. Porte Alegre e. IJUI/ RS/ Brasil, 82.

ANDRADE, R.P. DE AND THOMAS, D. (1984) Effects of cutting or grazing in the wet season on seed production in *Andropogon gayanus* var. bisquamulatus (Hoscht.) Stapf. *Journal of Applied Seed Production*, **2**, 29–31.

BOWDEN, B.N. (1964) Studies on *Andropogon gayanus* Kunth III. An outline of its biology. *Journal of Ecology*, **52**, 255–271.

CAMERON, A.G. and HUMPHREYS, L.R. (1976) Nitrogen supply, CCC, and harvest time effects on *Paspalum plicatulum* seed production. *Tropical Grasslands*, **10**, 205–211.

HAGGAR, R.J. (1966) The production of seed from *Andropogon gayanus*. *Proceedings of the International Seed Testing Association*, **31**, 251–259.

HARRISON, P.G. (1987) Gamba grass — Management for seed production. *Agnote No. 256, December 1987. Department of Industries and Development, Northern Territory of Australia*.

HILL, M.J. and LOCH, D.S. (1993) Achieving potential herbage yields in tropical regions. *Proceedings of the XVII International Grassland Congress, Rockhampton, 1993*. pp. 1629–1635.

HUMPHREYS, L.R. and RIVEROS, F. (1986) Tropical pasture seed production. *Plant Production and Protection Paper 8, FAO, Rome*.

JONES, C.A. (1979) The potential of *Andropogon gayanus* Kunth in the oxisol and ultisol savannas of tropical America. *Herbage Abstracts*, **49**, 1–6.

LOCH, D.S. (1980) Selection of environment and cropping systems for tropical grass seed production. *Tropical Grasslands*, **14**, 159–168.

MISHRA, M.L. and CHATTERJEE, B.N. (1968) Seed production in the forage grasses *Pennisetum polystachyon* and *Andropogon gayanus* in the Indian tropics. *Tropical Grasslands*, **2**, 51–56.

RAMIREZ, L. and HACKER, J.B. (1994) Effect of nitrogen supply and time of harvest on seed yield components of *Digitaria eriantha* cv. Premier. *Journal of Applied Seed Production*, **12**, 66–76.

SCHULTZE-KRAFT, R. (1992) *Andropogon gayanus* Kunth. In: Mannetje, L.'t and Jones, R.M. (eds) *PROSEA — Plant Resources of South-East Asia. 4. Forages*. pp. 44–46. (Pudoc: Wageningen).