Variation in the production and quality of bana grass over the growing season using hand-clipped samples

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The seasonal growth pattern and dry matter (DM) yield of bana grass (*Pennisetum purpureum* × *P. americanum*) was compared with that of kikuyu (*P. clandestinum*) under irrigation. In addition, the yield and chemical composition of bana grass at different stages of regrowth and during different periods of the growing season were studied, using clipped samples from exclosures. The DM yield of bana grass (23,2 t/ha) was not significantly higher than that of kikuyu (20,2 t/ha). For both pastures, highest DM production was realized during early autumn. Leaf: stem ratio was higher in bana grass during early summer than during late summer, but the rate of decline during regrowth was about the same for the two periods. The higher leaf: stem ratio was reflected in lower cell wall content, but the lower cell wall content did not coincide with higher digestibility. This suggests that minimal differences between the digestibility of the cell wall content of stems and leaves is a characteristic of bana grass at these growth stages. The DM yields after 40 days of regrowth were at least twice those realized when regrowth was less than 30 days. Since nutritive values were still satisfactory after six weeks but not after 12 weeks of regrowth, it is proposed that the optimum grazing stage of bana grass would be six weeks of regrowth or slightly more.

Die seisoenale groeipatroon en droëmateriaal(DM)-produksie van banagras (*Pennisetum purpureum* × *P. americanum*) is met dié van kikoejoe (*P. clandestinum*) onder besproeiing vergelyk. Hierbenewens is opbrengs en chemiese samestelling van bana op verskillende stadia van hergroei, en gedurende verskillende periodes oor die groeiseisoen met behulp van snymonsters in uitsluitingshokke bestudeer. Die DM-opbrengs van banagras (23,2 t/ha) was nie betekenisvol hoër as dié van kikoejoegras (20,2 t/ha) nie. Vir beide weidings is die hoogste DM-produksies gedurende die vroeë herfs verkry. Die blaar: stingelverhouding van banagras was hoër gedurende die vroeë somer in vergelyking met laat somer, maar die afname met hergroei was bykans dieselfde gedurende die twee periodes. Die hoër blaar: stingelverhouding is weerspieël in 'n laer selwandinhoud, maar die laer selwandinhoud het nie gepaard gegaan met 'n hoër verteerbaarheid nie. Dit het daarop gedui dat klein verskille tussen die verteerbaarheid van die selwande van blare en stingels van bana 'n kenmerk was in hierdie groeistadia. Die DM-opbrengs ná 40-dae-hergroei was ten minste twee keer so hoog as voor 30-dae-hergroei. Omdat voedingswaarde steeds bevredigend was na 6-weke-hergroei, maar nie na 12-weke-hergroei nie, word voorgestel dat die optimumstadium om banagras te bewei ná 6-weke-hergroei is, of ietwat later.

Keywords: Bana grass, kikuyu, nutritive value, season, yield.

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Introduction

Bana grass came into being in South Africa in the early fifties through hybridization between the annual babala (*Pennisetum americanum*) and the perennial Napier grass (*Pennisetum purpureum*). The aim was to produce a perennial grass with the yield potential of Napier, but which would be softer in texture and more palatable at a later growth stage, and which would possess better seed characteristics (Gildenhuys, 1950). The aims were largely met and the hybrid (bana: 'ba' for babala and 'na' for Napier) showed extremely high green fodder yields of some 110 t/ha. Unfortunately, the project was abandoned and it was only during the late seventies and early eighties that farmers became interested in the qualities of bana grass when promising reports were published in the popular press. Whilst establishment was satisfactory and information on quality and yield was promising, very little scientific information on this widely adapted crop, which could serve as a sound basis for recommendations, was available.

Elsewhere, a number of other hybrids were obtained from an original crossing between babala and Napier grass. It has been confirmed that these *Pennisetum* hybrids are softer in texture, more leafy with a thinner stem, more succulent and, therefore, more palatable than Napier grass (Jodhpur, 1965; Gupta *et al.*, 1967). These authors further claimed that crude protein and soluble carbohydrate levels were higher in the hybrid than in Napier. Quality in terms of crude protein and phosphorus declines with age although satisfactory levels were achieved with a harvesting interval of 45 days (Nem-Urai, 1968). Higher DM production can be expected at 60-day cutting instead of 30- and 45-day cutting (Nem-Urai, 1968), but this is not to be recommended because of the decline in quality and palatability. A cutting interval of 45 days or about six weeks corresponds with a sward height of about 1 m. Under these conditions, a DM production of 11—18 t/ha could be expected under dryland conditions (Muldoon & Pearson, 1979). With irrigation, a DM yield of 20—25 t/ha could be expected.

The aim of this study was to characterize bana grass in terms of DM production and quality of regrowth following cutting at different times of the growing season. Kikuyu (*Pennisetum clandestinum*) was used to obtain a comparison of yield potential.

Pocedure

The study was conducted on the experimental farm of the University of Pretoria, at Hatfield, Pretoria. The average annual rainfall is *ca.* 700 mm, most of which is received in the period October—April. The farm is 1 370 m above sea-level.

Rooted cuttings of bana grass, obtained from Naboomspruit in the Northern Transvaal, were planted at 1 × 1 m spacings, while the kikuyu was already established. The fertilization programme was based on soil analyses, previous history and production potential. Nitrogen was applied at the rate of 280 and 230 kg N/ha to bana grass and kikuyu respectively, in 4—5 equal applications. In addition, bana grass was fertilized with 200 kg K/ha in two applications. Both pastures were treated once with 2.4 D herbicide to eliminate broad-leafed weeds. Pastures received supplementary irrigation to ensure that moisture was not limiting. This amounted to an average of 15 mm irrigation per week.

The kikuyu paddock was 0,36 ha in size and the bana paddock 0,4 ha. Dry matter yields were determined within five exclosures (1,2 × 1 m) placed at stratified random positions within each pasture for each growth cycle. Regrowth was measured when the bana grass had reached a height of 1 m and the kikuyu a height of 200 mm, by harvesting pasture to a height of 30—50 mm in the case of kikuyu and to stubble height in the case of bana grass. Four periods were evaluated: October to December, December to January, February to March and March to April.

The mass of material harvested within the exclosures was determined and a subsample was dried to constant mass at 100 °C to facilitate the calculation of DM content and yield. Exclosure yield was then converted to kg DM/ha:

$$\text{kg DM / ha} = \frac{\text{g DM / 1,2 m}^2 \times \dfrac{10\,000 \text{ m}^2}{1,2 \text{ m}^2}}{1\,000 \text{ g}}$$

The yield and chemical composition of bana grass at different stages of regrowth were studied in two additional trials conducted on an area adjoining the bana paddock. In the first trial, bana grass was harvested after 10, 20, 30 and 40 days of regrowth during the periods 1 November—10 December and 1 January—10 February. Yields were expressed as oven dry material per unit area, as calculated above. In the second trial, harvests were repeated at 42- and 84-day intervals throughout the growing season.

In both trials, samples were separated into leaf and stem for analyses. One per cent of sample mass was dried at 60 °C and analysed in duplicate for N and ash according to AOAC (1984), for NDF and ADF (Van Soest, 1966) and for IVDOM (Tilley & Terry, 1963, as modified by Engels & Van der Merwe, 1967).

A two-way analysis of variance with the GLM model [statistical analysis system (SAS), 1985] was used to determine the significance of differences in yield between pastures and periods. Least square means and standard errors of the mean were calculated. The level of significance was tested with Bonferroni.

Results and Discussion

The growth rate and the yield/ha are shown in Table 1. The pasture species did not differ significantly on average over the growing season, but did so within specific periods. Both bana grass and kikuyu had their highest growth rates in autumn, with kikuyu somewhat later than bana grass.

Table 1 DM yield of bana grass and kikuyu during different periods of the growing season

Pasture	Season	Growth rate (kg DM/ha/d)	Yield (kg DM/ha)
Bana	1 Oct.— 6 Jan.	$93{,}1^{a}$	9125
	7 Jan.—10 Feb.	$97{,}3^{a}$	3407
	11 Feb.—10 Mar.	180^{b}_{1}	5041
	11 Mar.—25 Apr.	125^{ab}	5642
		Average 113	Tot. 23 215
Kikuyu	1 Oct.— 4 Dec.	92,4	6007
	5 Dec.—29 Jan.	115	6420
	30 Jan.— 9 Mar.	130_{2}	5075
	10 Mar.— 1 Apr.	128	2698
		Average 112	Tot. 20 200

[a,b] Values in the same column (for bana grass) with different superscripts differ significantly ($P \leqslant 0{,}05$).

[1,2] Values in the same column (for both pastures) with different subscripts differ significantly ($P \leqslant 0{,}05$).

Standard error of the mean for production rate = 13,1 kg.

The increase in yield of bana grass from spring to autumn is not only a seasonal effect but may be partially ascribed to an increase in plant density. Bana grass was planted at the start of the season from rooted cuttings and as the season advanced, tufts increased in size. Nevertheless, the growth rate from February to March was distinctly more rapid than during the previous periods, while kikuyu showed a more even increase towards the autumn period (Table 1). To some extent the growth rate would be a function of N and the way in which it was applied. Environmental condition × N application interaction has previously been reported (Muldoon & Pearson, 1979). However, Cross (1979) found a similar growth pattern for kikuyu as shown in Table 1, although he used a different N application regime under different environmental conditions.

Dry matter yields previously reported for kikuyu (Cross, 1979) appear to be generally lower than those achieved in this trial. Fair (1989), however, estimated that yields of 20—22 t DM/ha should be possible with moisture and N levels equivalent to those applied in this study. Dry matter yields for other *Pennisetum* species such as Napier (Crespo & Guzman, 1973) and hybrid *Pennisetum* species similar to bana grass (Chheda *et al.*, 1973) correspond with the DM yield of 23 t/ha found for bana grass. The growth of bana grass was measured at a height of 1 m at approximately 40-day intervals.

Higher yields could be expected with longer intervals (Nern-Urai, 1968; Rethman, N.F.G. & Pieterse, P.A., unpublished results, 1989), but this is not to be recommended because of a decline in quality (Table 3).

The change in yield and in chemical composition of bana grass during two periods after 10, 20, 30 and 40 days of regrowth is shown in Table 2.

Yields in both periods were much higher after 40 days of regrowth than during the first 30 days of regrowth. Regrowth after 40 days corresponds to a sward height of about 1 m as mentioned before. Yields obtained in both periods are in accordance with yields obtained by Chin & Hong (1975) with *Pennisetum purpureum*, and by Natarajan *et al.* (1981) with a hybrid *Pennisetum* at about the same stages of regrowth. The 40-days regrowth results may be used as a further measure to estimate total DM yield during the active growing season. Based on the assumption that four to five growing periods of 40 days could be achieved and that the yield in each would average 5500 to 6000 kg DM/ha (see Table 1), a total DM yield for the growing season of 24—26 t DM/ha for bana grass would not be unrealistic.

Leaf:stem ratio was higher during the November—December period than during the January—February period (Table 2), but the rate of decline during regrowth was about the same. The higher leaf:stem ratio is reflected in a lower cell wall content (ADF and NDF) which is in accordance to observations that leaves contain less cell wall than stems at comparable physiological stages (Laredo & Minson, 1973;

Table 2 Change in yield and chemical composition of bana grass during two periods and after different periods of regrowth

Period	Regrowth (d)	Yield (kg DM/ha)	L:S* (%)	DM (%)	IVDOM (%)	N (%)	ADF (%)	NDF (%)
1 Nov.—10 Dec.	10	229	100:0	9,29	67,3	3,85	27,4	46,7
	20	1670	100:0	12,8	66,9	3,38	31,5	50,3
	30	2728	76:24	17,2	64,8	2,44	34,8	65,7
	40	6789	68:32	21,9	60,5	2,21	37,8	66,7
	Average	2854	86:14	15,3	64,9	2,97	30,9	57,4
1 Jan.—10 Feb.	10	1828	78:22	13,0	72,9	2,97	29,9	55,0
	20	2790	76:24	15,7	69,5	1,91	35,4	62,3
	30	4562	57:43	17,3	68,3	1,83	36,4	65,2
	40	6356	57:43	20,4	64,0	1,65	38,0	67,5
	Average	3884	67:33	16,6	68,7	2,09	34,9	62,5

* Leaf : stem ratio.

Table 3 Differences in quality of leaves and stems of bana grass after 6 and 12 weeks of regrowth

	Regrowth				
	6 weeks		12 weeks		
Parameter	Leaves	Stems	Leaves	Stems	SE_m *
ADF in DM (%)	$37,2^{a}$	$48,5^{bc}$	$43,0^{ab}$	$54,9^{c}$	2,09
NDF in DM (%)	$63,8^{a}$	$71,7^{b}$	$72,8^{b}$	$79,7^{c}$	1,90
IVDOM (%)	$59,9^{b}$	$57,2^{ab}$	$49,6^{a}$	$49,4^{a}$	2,57

Average for age

	6 weeks	12 weeks	PR > F
ADF in DM (%)	42,9	49,0	0,001
NDF in DM (%)	67,8	76,3	0,001
IVDOM (%)	58,6	49,5	0,003

Average for component

	Leaf	Stem	PR > F
ADF in DM (%)	40,1	51,7	0,001
NDF in DM (%)	68,3	75,7	0,001
IVDOM (%)	54,7	53,3	0,602

$^{a-c}$ Values in the same line with different superscripts differ significantly ($P \leq 0,05$).

* Standard error of the mean.

Norton, 1982). What is of interest is that the lower cell wall content did not coincide with a higher digestibility, which suggests that cell walls of stem material must have been at least as digestible or even more digestible than cell walls of leaf material. If these results are considered in association with those in Table 3 where the chemical composition and digestibility of 6 and 12 week regrowth material is displayed, it is evident that while the stem is young (< 40 days regrowth), digestibility remains high but will decline substantially towards 12 weeks of regrowth. Mowat *et al.* (1965) and Hacker (1971) found, with both temperate and tropical grasses, that at a young stage of growth leaf may be less digestible than stem. According to the present data, this possibly results because the cell wall of leaves at this stage is less digestible than the cell wall of stems. A feature of bana grass though, is that even after 12 weeks of regrowth, stems and leaves were still equally digestible (Table 3).

The N content declined during regrowth and bana grass contained more N during November—December than during January—February (Table 2). Whilst the stage at which N fertilizer was applied may have had an influence, the major influence was probably leaf:stem variations between the different periods. It is known that the N content of leaf is usually higher than that of stem (Laredo & Minson, 1973). Nitrogen content declined from 3,85% after 10 days regrowth to 2,21% after 40 days regrowth and from 2,97% to 1,65% for the two periods respectively (Table 2). Singh *et al.* (1965) reported declines from 3,52% after two weeks of regrowth to 1,44% after 16 weeks of regrowth, which is of the same order. Köster *et al.* (1992), in a study with oesophageally fistulated cattle, found the N content of fistula samples to remain above 2,1% throughout the active growing season, which suggests that in general, the N content of bana grass should not limit digestibility and intake.

In conclusion it is suggested that the optimum stage at which bana should be grazed is about six weeks of regrowth or slightly more. Dry matter yield should be adequate and palatability and nutritive value satisfactory. Higher yields may be obtained up to 12 weeks of regrowth (Rethman, N.F.G & Pieterse, P.A., unpublished results, 1989) but quality may then be lower, which could reduce nutritive value.

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