An evaluation of Bana grass, Greengold and Pennaris. I. Intake by sheep and production characteristics

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Three *Pennisetum* selections, Bana, Greengold and Pennaris, were evaluated as forage for sheep. Dry matter yield, leaf:stem ratio and intake were determined at two regrowth heights, namely 300 mm and 800 mm. The trials were repeated in autumn, spring and summer. There were no significant differences ($p > 0.05$) between selections in chemical composition, yield or growth rate but Greengold produced more ($p < 0.01$) stem material. The 300-mm treatment was of better quality and leafier ($p < 0.01$), but had a lower yield than the 800-mm treatment ($p < 0.01$). There were, however, no differences ($p > 0.08$) in intake between the regrowth heights or selections. Intake in autumn was lower ($p < 0.01$) than in spring and summer, probably owing to the high moisture content of the material. Seasonal differences were more pronounced than selection differences. These selections were of a good quality and will sustain satisfactory levels of animal production, although the high moisture content and tall growth habit might limit intake by sheep.

Drie *Pennisetum* seleksies, Bana, Groengoud en Pennaris is as weigewasse vir skape geëvalueer. Droëmateriaalopbrengs, blaar:stam verhoudings en inname is op twee groeihoogtes bepaal, nl. 300 mm en 800 mm en oor drie seisoene herhaal, nl. herfs, lente en somer. Daar was geen verskille ($p > 0.05$) tussen seleksies in chemiese samestelling, opbrengs of groeitempo nie, maar Groengoud het deurgaans meer stammateriaal geproduseer ($p < 0.01$). Die 300 mm-behandeling was van 'n hoër ($p < 0.01$) kwaliteit en blaarinhoud maar laer groeitempo ($p < 0.01$) as die 800 mm-behandeling. Daar is egter geen verskille ($p > 0.08$) in inname tussen die groeihoogtes of seleksies gevind nie. Inname gedurende herfs was laer ($p < 0.01$) as tydens lente en somer, moontlik a.g.v. die hoë voginhoud van die materiaal. Seisoensverskille was meer betekenisvol as verskille tussen seleksies. Hierdie seleksies was van 'n goeie kwaliteit in die onvolwasse stadium en behoort aanvaarbare vlakke van diereproduksie te handhaaf, alhoewel die hoë voginhoud en groeiwyse, inname deur skape mag beperk.

Keywords: Grazing height, *Pennisetum* selections, seasonal effects, intake

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Introduction

Bana is a hybrid between the annual babala (*Pennisetum glaucum*) and the perennial Napier grass (*P. purpureum*). Little is known about the origins of Greengold (Groengoud or Harare) and Pennaris, but they could have originated from the same parent material since different environments and different parents have produced morphological variation (Muldoon *et al.*, 1979).

Since much selection among the former hybrids has taken place (Muldoon *et al.*, 1979), the term 'hybrids' can no longer be used, and therefore will be referred to as 'selections'.

In South Africa the popular agricultural press has published claims of excellent results obtained with Bana and Greengold by the farming community. A substantial amount of research has been directed at quantifying the yields of the parent material and selections although information on the nutritive value or limitations and animal performance to expect from the pastures, is limited.

Herbage intake of grazing animals is affected by nutritional factors like digestibility, but also by non-nutritional factors of the sward which affect grazing behaviour such as the amount and distribution of herbage, leaf:stem ratios, and grazing height (Hodgson, 1981). These factors were considered in this study when evaluating the three *Pennisetum* selections as forage for sheep. The objective was to quantify the intake and diet quality selected by sheep and measure yields at a younger physiological stage as compared to a more mature stage over three seasons (autumn, spring and summer).

Materials and methods

The study was conducted on the Hatfield Experimental Farm of the University of Pretoria, which is at an altitude of 1450 m. The farm receives a long-term average precipitation of 717 mm per annum of which 50% is recorded during the months of November to January. Paddocks were irrigated to supplement rainfall to ensure that moisture stress was not a limiting factor during the respective trial periods.

The pastures were established on 0.1 ha paddocks from rooted cuttings on a Hutton soil and, based on soil sample analyses, fertilised with 100 kg 2:3:4(30)/ha at establishment under dryland conditions. The rooted cuttings were planted 0,5 m apart in 1.5 m rows which resulted in a plant density of 12 000 plants/ha. As a result of practical limitations only two grazing heights could be monitored in this project, namely 300 mm and 800 mm. To obtain the different regrowth heights, the paddocks were mown with a drum mower to a height of approximately 5 cm at different times to allow them to reach the desired treatment heights at approximately the same time as indicated below:

800-mm regrowth: ± 6 weeks prior to commencement of grazing;

300-mm regrowth: ± 3 weeks prior to commencement with grazing.

Immediately afterwards 300 kg limestone ammonium nitrate (LAN-28%N)/ha (84 kg N/ha) fertiliser was applied.

To estimate intake, faecal samples were collected daily from five intact merino-type wethers and oesophageal samples were obtained from five oesophageally fistulated animals per treatment as described by Du Preez (1993). Intake was determined as faecal output divided by indigestibility (Langlands, 1975).

The pasture variables (available DM, leaf:stem ratios and pasture growth rates) were measured prior to grazing at the beginning of each season's sampling. This was done by harvesting three randomly selected plants at stubble height in each paddock and determining the DM content. The number of plants per paddock was then counted and the available pasture/paddock calculated as DM/ha. Leaf:stem ratios were determined by separating subsamples of each plant into leaf and stem using a sheep shear. Each component was then weighed and the DM content of each determined. Rate of growth was calculated as available pasture divided by the number of days required for the pastures to reach the desired height. The observations were repeated over three seasons, namely autumn (April 1991), spring (October 1991) and summer (February 1992).

Analytical procedures

Oesophageal fistula samples were freeze-dried while all faecal, feed and pasture samples were dried at 60°C in a convection oven and then milled through a 1-mm screen. Dry matter, organic matter (OM) and nitrogen (N) content of samples was determined according to A.O.A.C. (1990), NDF according to Van Soest *et al.* (1967), and *in vitro* digestible OM (IVDOM) as described by Tilley *et al.* (1963), and modified by Engels *et al.* (1967). *In vitro* values were converted to *in vivo* values as proposed by Engels *et al.* (1981).

Data were analysed for season, selection and regrowth height and their interactions using a two-way analysis of variance procedure. Results are presented as means across seasons, selections and regrowth heights, all with their respective standard errors. Values with common letters on the same horizontal line do not differ significantly at the 5% significance level. Owing to limited space and because of practical considerations, no replications were possible. Adding one replicate alone would have required, in addition, six paddocks and 30 sheep. Even though it is not the most desirable experimental design it was the only practical way of comparing pastures and regrowth heights within the same experiment.

Results and discussion

Pasture parameters as influenced by season, regrowth height and selection are presented in Table 1.

In summer the pastures had much ($p < 0.01$; $n = 54$) higher growth rates and produced more ($p \leq 0.02$; $n = 54$) DM than in autumn and spring, similar to the findings of Köster (1991). This could be expected since these selections are tropical plants and adapted to high environmental temperatures (Muldoon *et al.*, 1979). In order of sequence, however, the summer trial was the last of the three seasons. Ferraris *et al.*, (1980) reported an increased yield for *P. purpureum* as the plant matured and increased in tiller density, as well as higher average daily temperatures. In this study, all three factors were present to a greater extent in summer than during the other seasons. Age of pasture and a concomitant increase in tiller density were, therefore, confounding factors when estimating yield and growth rate.

The highest proportion of leaf was produced in spring. The 300 mm regrowth height had a lower

Table 1 Pasture parameters as influenced by season, regrowth height and selection.

	Autumn	Spring	Summer
Growth rate (kg/ha/d)	46.8 ± 3.74^a	30.3 ± 2.41^a	94.4 ± 9.42^b
Available DM (kg/ha)	1920 ± 298.3^a	1967 ± 295.6^a	3374 ± 560.1^b
%Leaf %Stem	$62{:}38 \pm 1.9^a$	$80{:}20 \pm 3.5^b$	$65{:}35 \pm 3.9^a$
	300mm	800mm	
Growth rate (kg/ha/d)	41.5 ± 5.30^a	72.83 ± 7.56^b	
Available DM (kg/ha)	954 ± 74.2^a	3887 ± 278.7^b	
%Leaf %Stem	$78{:}22 \pm 2.5^b$	$60{:}40 \pm 2.4^a$	
	Bana	Greengold	Pennaris
Growth rate (kg/ha/d)	61.4 ± 7.53	60.3 ± 11.28	49.8 ± 7.07
Available DM (kg/ha)	2236 ± 300.3	2676 ± 554.7	2349 ± 407.9
%Leaf %Stem	$74{:}26 \pm 2.4^b$	$59{:}41 \pm 4.2^a$	$73{:}27 \pm 3.3^b$

[abc] Values in rows bearing different superscript letters are significantly different ($p < 0.05$)

growth rate ($p < 0.01$; $n = 54$) than the 800-mm treatment and produced significantly less available DM ($p < 0.01$; $n = 54$). Growth rates in this study were, however, lower than other findings (180–270 kg DM/ha/day) under subtropical conditions (Woodard *et al.*, 1993).

These selections appear to have an exponential growth curve with rapid growth taking place after the plants had reached 300 mm, since the 800 mm regrowth treatment had higher growth rates than the 300-mm treatment. Therefore, the shorter material must have been harvested before the rapid growth phase had been reached. This may suggest that these selections should not be harvested too soon after regrowth commences as optimal growth may only be achieved at a later stage.

The 300-mm treatment also had a higher leaf:stem ratio ($p < 0.01$; $n = 54$). There were no differences ($p > 0.05$) observed with growth rates or available DM between selections. Greengold, however, had significantly less leaf material compared to Bana and Pennaris ($p < 0.01$; $n = 54$). The leaf:stem ratio is very important to the grazing animal since they select for leaf under most conditions (Hodgson, 1981). Köster (1991), working with Bana, reported that cattle also selected leaf instead of stem. Stobbs (1973) attributed the lower intake of tropical pastures compared to temperate forages to the lower leaf:stem ratio of the former. The leaf fraction has a shorter rumen retention time compared to stem, even at the same digestibility (Minson, 1981), which may permit more feed to be consumed. In the young plant the two fractions are both highly digestible and Köster (1991) found that in immature Bana grass there were no differences ($p > 0.05$) in digestibility between the two fractions.

Highly significant interactions ($p < 0.01$) for all three pasture parameters were found for Selection x Season, Selection x Regrowth height and Season x Regrowth height. No conclusions could therefore be drawn about the main treatment effects and no clear, consistent trends emerged from the pasture trials. The effects of season and regrowth height, however, had a greater influence on the results than did differences between the selections.

In Table 2 the chemical composition of hand-clipped leaf and stem fractions is presented.

Table 2 A comparison of the chemical composition of stem and leaf fractions

	Stem	Leaf
% N	1.9 ± 0.14^a	2.9 ± 0.18^b
% NDF	66.6 ± 0.98^b	61.6 ± 0.91^a
IVDOM (%)	63.0 ± 1.09^a	68.1 ± 0.79^b

^{abc} Values in rows bearing different superscript letters are significantly different ($p < 0.05$)

The leaf material contained higher N and lower NDF ($p < 0.01$; $n = 36$) and was more digestible than stem material across season, selection and regrowth height, which was similar to the findings of Laredo *et. al.* (1973).

In Table 3 the quality of material selected by oesophageally fistulated sheep is presented. Since the DM content of oesophageally selected material could not be determined owing to saliva contamination, only the DM content of the harvested tufts is presented.

There were no differences ($p > 0.05$) in the quality of the diet selected between seasons. However, the animals grazing shorter material selected a much higher nitrogen and lower cell wall content as well as material of higher digestibility compared to that of the 800-mm treatment ($p < 0.01$; $n = 18$). The dry matter content of the 300-mm treatment was also lower ($p < 0.01$; $n = 18$) than the taller material. No differences ($p > 0.05$) were observed in the quality of the diet selected by sheep between selections.

In Table 4 the estimated intake of sheep as influenced by season, regrowth height and selection is presented.

The intake of sheep in autumn was lower ($p < 0.01$; $n = 90$) than in spring or summer. During spring sheep consumed the highest digestible organic matter intake (DOMI) per metabolic livemass

Table 3 The chemical composition of oesophageal extrusa and DM content of harvested tufts as influenced by season, regrowth height and selection

	Autumn	Spring	Summer
N (%)	3.1 ± 0.24	2.8 ± 0.13	2.7 ± 0.23
NDF (%)	57.7 ± 2.04	54.8 ± 1.08	57.4 ± 1.56
IVDOM (%)	70.3 ± 1.64	70.8 ± 0.95	69.1 ± 1.84
DM (%)	15.1 ± 2.56	19.3 ± 0.91	21.8 ± 2.87
	300mm	800mm	
N (%)	3.2 ± 0.13^{b}	2.5 ± 0.11^{a}	
NDF (%)	54.2 ± 0.74^{a}	59.0 ± 1.28^{b}	
IVDOM (%)	72.5 ± 0.51^{b}	67.6 ± 1.15^{a}	
DM (%)	15.3 ± 1.40^{a}	22.2 ± 1.87^{b}	
	Bana	Greengold	Pennaris
N (%)	3.0 ± 0.21	2.8 ± 0.25	2.8 ± 0.18
NDF (%)	55.9 ± 1.11	57.4 ± 2.11	56.5 ± 1.70
IVDOM (%)	70.0 ± 1.56	69.3 ± 1.71	70.8 ± 1.30
DM (%)	18.0 ± 2.98	18.9 ± 1.96	19.4 ± 2.70

^{abc} Values in rows bearing different superscript letters are significantly different ($p < 0.05$)

Table 4 Intake of sheep as influenced by season, regrowth height and selection

	Autumn	Spring	Summer
OMI (g/d)	609 ± 28.1^{a}	1022 ± 34.5^{b}	1054 ± 25.5^{b}
DOMI(g/kg $W^{0.75}$/d)	23.6 ± 1.13^{a}	40.9 ± 0.73^{c}	35.5 ± 1.10^{b}
	300mm	800mm	
OMI (g/d)	891 ± 32.0	899 ± 44.7	
DOMI (g/kg $W^{0.75}$/d)	35.0 ± 1.51	31.7 ± 1.13	
	Bana	Greengold	Pennaris
OMI (g/d)	836 ± 37.6	884 ± 43.2	965 ± 57.6
DOMI(g/kg $W^{0.75}$/d)	31.4 ± 1.31	33.0 ± 1.54	35.6 ± 2.01

^{abc} Values in rows bearing different superscript letters are significantly different ($p < 0.05$)

and in autumn the lowest, with the summer period being intermediate and differing significantly from both the other periods ($p < 0.01$; $n = 90$). The lower intake in autumn could have been attributed to the high moisture content of the pasture during that season (Table 3), although differences were not found to be significant ($p > 0.05$). Meissner, *et al.* (1992) reported that intake of *Lolium multiflorum* was depressed when the DM content dropped below 18%. The lower intake in autumn obtained with sheep in this study is in contrast to Muldoon *et al.* (1979) and Köster (1991) who found that the intake of steers was higher in autumn (50.4 g DOMI/kg $W^{0.75}$ /d) than during spring or summer (41.8 and 42.9 g DOMI/kg $W^{0.75}$/d respectively). In spring the material on offer consisted mainly of leaf (Table 1) and tended to have a lower NDF content than during the other two seasons (Table 3). This could have contributed to the higher intake levels observed for the spring material in this study since Egan *et al.* (1985) noted that the rate and extent of digestion of NDF appeared to be important in the regulation of feed intake.

The intake estimates compared favourably with values quoted by Minson (1981), who found the average intake of several tropical pastures to be 56 g DM/kg $W^{0.75}$/d. In autumn intake would not have been sufficient to maintain mature animals (Engels, 1972), whereas animal production could take place with intake levels achieved in spring and summer (Table 4).

There were no differences ($p = 0.08$; $n = 90$) in intake between the two grazing heights, although the 300 mm regrowth height appeared to have produced higher estimates relative to body mass. This was surprising since there were significant differences ($p < 0.01$; $n = 54$) in pasture availability (Table 1) and quality of the diet selected (Table 3). It is postulated here that even though the 800-mm treatment may have had a lower digestibility and N content than the 300-mm treatment, it was still of sufficient quality to meet the maintenance requirements of mature sheep, but that the grazing height limited intake. In the 300-mm treatment the high moisture content (Table 3) was probably responsible for limiting intake in that treatment (Meissner, *et al.,* 1992). The two treatments were perhaps too close to one another for treatment differences to be evident.

There were no differences between the three selections in intake ($p = 0.15$; $n = 90$). Sheep grazing Pennaris, however, tended to have the highest intake and sheep grazing Bana the lowest. This could be expected since there were no differences between selections in the quality of material selected (Table 3).

Significant interactions ($p < 0.05$) for intake estimates were found for Selection x Season and Regrowth height x Season. No generalisations could therefore be made about the intake parameters between selections across seasons. The Selection x Regrowth height interaction was not significant ($p > 0.05$).

Conclusions

Differences for all parameters were more pronounced between regrowth heights and seasons than between selections.

From an animal production point of view, the optimal grazing stage would be physiologically younger material, with the highest potential intake to be achieved in spring, since more leaf material is produced. Greengold may, as a result of the higher stem content, probably not be as suitable for grazing by sheep as the other two selections.

As a result of the high moisture content and lower DM production of the 300-mm regrowth, it might be advisable to delay grazing of these pastures to a later stage, although quality of the material will be reduced. The 800 mm regrowth material appeared, however, to be of high enough digestibility and should sustain animal production, with the additional benefit of a higher DM production. When sheep are grazing the pastures a compromise between the two grazing heights would perhaps be the best recommendation, since the taller material could limit intake. A compromise between quantity (pasture production) and quality (chemical composition and digestibility) would have to be sought depending upon the production system and the livestock requirements.

The value of these pastures as grazing for sheep will only be realised with sound management such as preventing the pastures from maturing and becoming too tall, and supplementation for producing animals. They do, however, remain more suited for grazing by cattle.

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References

A.O.A.C., 1990. Official methods of analysis. 15th ed. Arlington, Virginia, U.S.A.

DU PREEZ, M.M., 1993. Factors influencing the intake and utilisation of Italian Ryegrass (*Lolium multiflorum*) with some emphasis on dry matter content and soluble protein. M.Sc. (Agric) Thesis, University of Pretoria.

EGAN, J.K. & DOYLE, P.J., 1985. Effect of intraruminal infusion of urea on the response in voluntary food intake in sheep. *Aust. J. Agric. Res.* 36, 483.

ENGELS, E.A.N., 1972. A study of the nutritive value of natural and sown pastures in the central Orange Free State with special reference to the energy requirements of sheep. Ph.D. thesis, University of Stellenbosch.

ENGELS, E.A.N. & VAN DER MERWE, F.J., 1967. Application of an *in vitro* technique to South African forages with special reference to the effect of certain factors on the results. *S. Afr. J. Anim. Sci.* 10, 983.

ENGELS, E.A.N., DE WAAL, H.O., BIEL, L.C. & MALAN, A., 1981. Practical implications of the effect of drying and treatment on nitrogen content and *in vitro* digestibility of samples collected by oesophageally fistulated animals. *S. Afr. J. Anim. Sci.* 11, 247.

FERRARIS, R. & SINCLAIR, D.F., 1980. Factors affecting the growth of *Pennisetum purpureum* in the wet tropics. Short-term growth and regrowth. *Aust. J. Agric. Res.* 31, 899.

HODGSON, J., 1981. Influence of sward characteristics on diet selection and herbage intake by the grazing animal. In: Nutritional limits to animal production from pastures (Part 4). Proceedings of an International Symposium held at St. Lucia, Queensland, Australia, August 24-28, 1981. Edited by: J.B. Hacker, Commonwealth Agricultural Bureaux.

KÖSTER, H.H., 1991. 'n Vergelyking van Bana met Kikoejoe en Voersorghum ten opsigte van voedingswaarde en opbrengs deur middel van beeste. M.Sc. (Agric) verhandeling, Universiteit van Pretoria.

LANGLANDS, J.P., 1975. Techniques for estimating nutrient intake and its utilisation by the grazing ruminant. In: Digestion and metabolism in the ruminant. (Eds) McDonald, I.W. and Warner, A.C.I. University of New England Publishing Unit, Armidale.

LAREDO, M.A. & MINSON, D.J., 1973. The voluntary intake, digestibility and retention time by sheep of leaf and stem fractions of five grasses. *Aust. J. Agric. Res.* 24, 875.

MEISSNER, H.H., DU PREEZ, M.M., ENSLIN, A.D. & SPREETH, E.B., 1992. Utilisation of *Lolium multiflorum* by sheep. 1: Influence of dry matter content and correlated factors on voluntary intake. *J. Grassl. Soc. South Afr.* 9, 11.

MINSON, D.J., 1981. The effects of the chemical and physical composition of herbage eaten upon intake. In: Nutritional limits to animal production from pastures (Part 4). Proceedings of an International Symposium held at St. Lucia, Queensland, Australia, August 24-28, 1981. (Ed.) J.B. Hacker. Commonwealth Agricultural Bureaux.

MULDOON, D.K. & PEARSON, C.J., 1979. The Hybrid between *Pennisetum americanum* and *Pennisetum purpureum*. *Herbage abstr.* 49, 189.

STOBBS, T.H., 1973. The effect of plant structure on the intake of tropical pastures. Variation in the bite size of grazing cattle. *Aust. J. Agric. Res.* 24, 809.

TILLEY, J.M.A. & Terry, R.A., 1963. A two-stage technique for *in vitro* digestion of forage crops. *J. Brit. Grassl. Soc.* 18, 104.

VAN SOEST, P.J. & WINE, R.H., 1967. Use of detergents in the analysis of fibrous feeds. IV. Determination of plant cell wall components. *J. Assoc. Off. Anal. Chem.* 50, 50.

WOODARD, K.R. & PRINE, G.M., 1993. Dry matter accumulation of elephantgrass, energycane and elephantmillet in a subtropical climate. *Crop Sci.* 33, 818.