Spring burning and splitting of nitrogen application may affect dry matter yield and flowering of *Digitaria eriantha* (Smuts finger grass)

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Abstract

The influence of split application of N fertiliser and spring burning on the DM yield and seed production potential of Smuts finger grass (*Digitaria eriantha*) was investigated over 3 years in South Africa. Burning was applied in August–September and 150 kg/ha/yr N was applied either as a single spring application, after the burn, or as split applications of 75–100 kg/ha N in spring and the rest after the first harvest in December. Burning dormant *D. eriantha* had no significant effect on DM yield or flowering; however, burning after the onset of spring growth reduced both DM yield and flowering ($P \leq 0.05$). Splitting the application of 150 kg/ha/yr N had no consistent influence on total DM yield, but transferred more of the DM production to late summer and early autumn. Split application of fertiliser N caused a significant ($P \leq 0.05$) reduction in density of inflorescences in December.

Introduction

The quantity of readily available nitrogen and plant-available soil water have the greatest influence on grass growth. Most of the world's planted pastures are, however, grown under dryland conditions. That makes nitrogen fertilisation the most important mechanism to increase DM yield. The question, "How much fertiliser should be applied and when?", now arises. Pieterse and Rethman (1995) concluded that the optimal amount of N to apply to pastures in the Transvaal middleveld was 150 kg/ha N. Published results of research on the optimal time to apply fertilisers are equivocal. In some trials, the highest yields on tropical pastures were obtained with a single application in spring (Rethman *et al.* 1989), while others obtained highest yields with split applications (Miles 1997). In other trials (Kaltofen *et al.* 1966; Wolton *et al.* 1971), split applications of N did not affect total DM yield for the season significantly, but did affect distribution of the DM production through the season.

Burning of palatable planted pastures is not a common practice among farmers in South Africa. However, unplanned burns do occur, and their effect on future production needs to be quantified. When a pasture is burned, up to 90% of the N in the organic matter can be volatilised. This can have a negative effect on the flow of N through the system that eventually will lead to a decline in DM yield from the pasture (Mannetje *et al.* 1983). In America, Burton (1944) found a significant drop in DM yield from an unfertilised *Paspalum notatum* pasture when it was burned in March or April, but not when the burn was carried out in February. The effect of the burn was accentuated with an increase in N fertilisation. On the other hand, burning resulted in an increase in the seed yield from both *Paspalum notatum* and *Cynodon dactylon,* but not from *Paspalum malacophyllum* (Ribbed paspalum). In South Africa, Rethman and Beukes (1988) found a significant drop in DM yield and an increase in seed yield with *E. curvula* after a spring burn. In some years, the DM yield on burned plots fertilised with 100 kg/ha N was equivalent to that from unburned plots that received only 50 kg/ha N. Cuomo *et al.* (1996) also found that spring burning of *Panicum virgatum, Andropogon gerardii* and *Sorghastrum nutans* pastures at the University of Nebraska resulted in a decrease in DM yield and the effects of burning were accentuated with a delay in the time of burning. Burning, however, had no significant influence on the DM yield of a *C. ciliaris* pasture in

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Queensland, Australia (Graham *et al*. 1985). This is a clear indication that species may react differently to a burning treatment and the reaction of a pasture to a burn depends on whether plants were dormant or not at the time of the burn.

We conducted a study to investigate the influence of split applications of nitrogen fertiliser and spring burning on the DM yield and flowering of *Digitaria eriantha.*

Materials and methods

In October 1994, a *D. eriantha* cv. Irene pasture was established in rows, 0.5 m apart, on a soil that is classified as belonging to the Suurbekom family; it is a mesotrophic, luvic soil of the Hutton form, and in this case, with a clay percentage of 25% (Soil Classification Working Group 1991). According to the USDA Soil Taxonomy System, the soil is a loamy, mixed, thermic Rhodic Kandiudalf (Soil Survey Staff 1990). At the onset of the trial in 1996, a soil analysis showed that the soil had a pH of 6.94, and P, Ca, Mg and K concentrations of 33, 510, 98 and 145 mg/kg, respectively. The trial consisted of 4 treatment combinations (burn and control × split and single applications of N) and was laid out on plots of 8 m × 3 m with 3 replications per treatment combination. The treatments and replications were randomly allocated to the plots. During the two years before the trial, the pasture received an annual application of 75 kg/ha N and the growth was mowed and removed as hay.

Dates of application of treatments and harvest dates are shown in Table 1. Burning treatments were applied as head fires. In 1996 and 1998, burns were carried out when pastures were dormant, but in 1997, the burning was carried out after the grasses started to grow in spring. In single application treatments, 150 kg/ha N was applied on the first date. Where the split applications were applied, amounts applied were 75 + 75 kg/ha N (1996–97) and 100 + 50 kg/ha N (1997–98 and 1998–99). The nett plots were 6.6 × 1.2 m in size and harvesting was done with a self-propelled cutter-bar mower. All material from the nett plot was harvested and weighed fresh in the field, after which subsamples were taken for DM determination.

The number of inflorescences was counted on a 0.25 m^2 quadrat in each plot before the first harvest in 1996–97 and 1997–98.

Table 1. Time of application of fertiliser, burning and harvests.

Year	N application dates	Burning dates	Harvest dates
1996–97	Sep 13; Dec 11, 1996	Late Aug 96	Dec 11, 1996; Jan 31, 1997
1997–98	Oct 2; Dec 10, 1997	Late Sep 97	Dec 10, 1997; Mar 18, 1998
1998–99	Oct 5; Dec 21, 1998	Late Aug 98	Dec 21, 1998; Mar 31, 1999

Statistical analysis was done using the GLM procedure available in the SAS program on the main frame of the University of Pretoria.

Results

Rainfall

Rainfall received during the duration of the study plus the long-term mean rainfall for the area are shown in Figure 1.

Influence of split application of N

In 1996–97 and 1997–98, split and single applications of N produced similar total DM yields (P>0.05), but a single application produced more (P≤0.01) at the first harvest than a split application, with the reverse occurring (P≤0.01; 0.05) at the second harvest (Figure 2). In 1998–99, yield at the first harvest and total DM yield favoured a single application (P≤0.01).

Density of inflorescences was significantly (P≤0.01) higher following a single application of N in both 1996–97 (328 *vs* 188/m^2) and 1997–98 (272 *vs* 128/m^2).

Influence of burning

In 1996–97 and 1998–99, burning when the grass was still dormant had no significant (P>0.05) effect on DM yield at either harvest or total yield (Figure 3). However, in 1997–98, when burning was delayed until pasture was regrowing in spring, burning significantly reduced DM yield at the first (P≤0.01) and second (P≤0.05) harvests as well as total DM yield (P≤0.01).

Density of inflorescences on the pasture was not significantly affected (P>0.05) by burning in 1996–97 (278 *vs* 236/m^2) but was significantly (P≤0.01) reduced by the delayed burn in 1997–98 (272 *vs* 148/m^2).

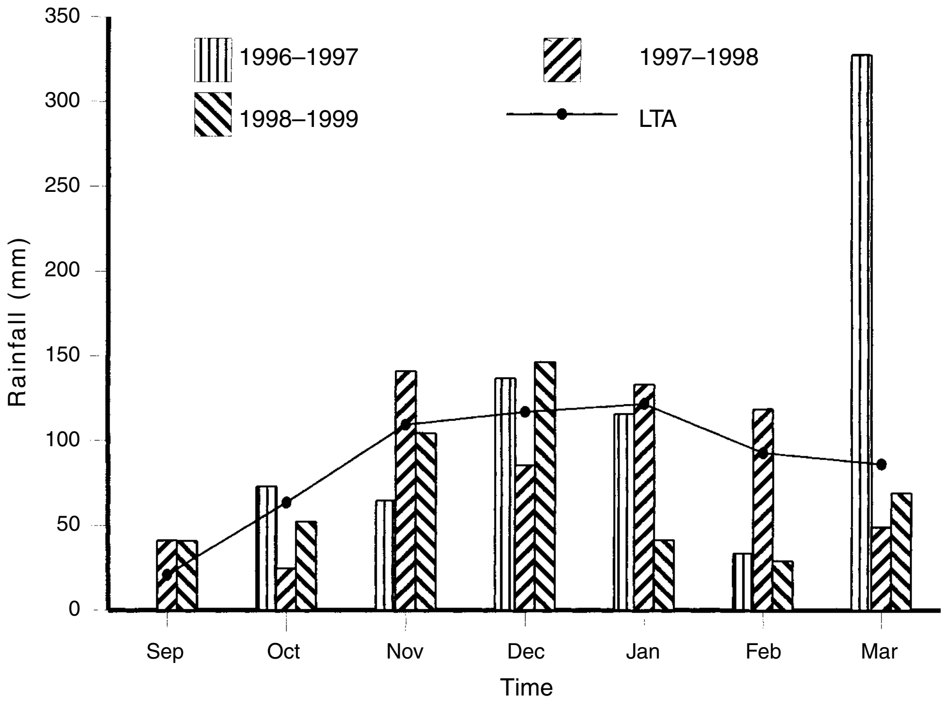

Figure 1. Monthly rainfall during the trial period as well as the 50-year monthly average (LTA) measured during the growing season on the Hatfield Experimental Farm of the University of Pretoria.

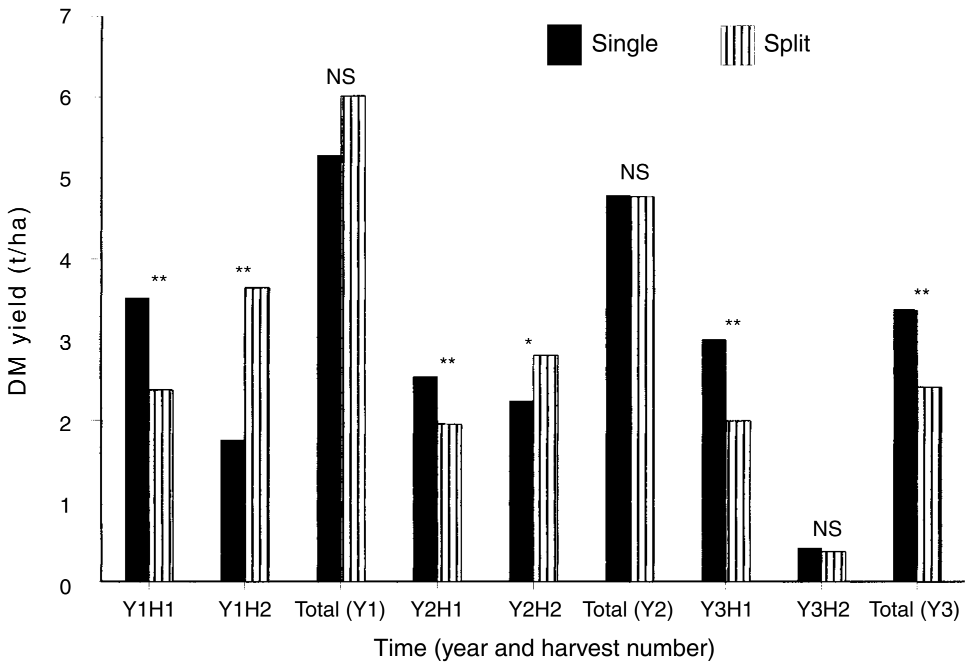

Figure 2. The influence of single versus split applications of N fertiliser on the DM yield of a *Digitaria eriantha* (Smuts finger grass) pasture. Y1, Y2 and Y3 represent 1996–97, 1997–98 and 1998–99, respectively, while H1 and H2 represent harvests in December and January/March.

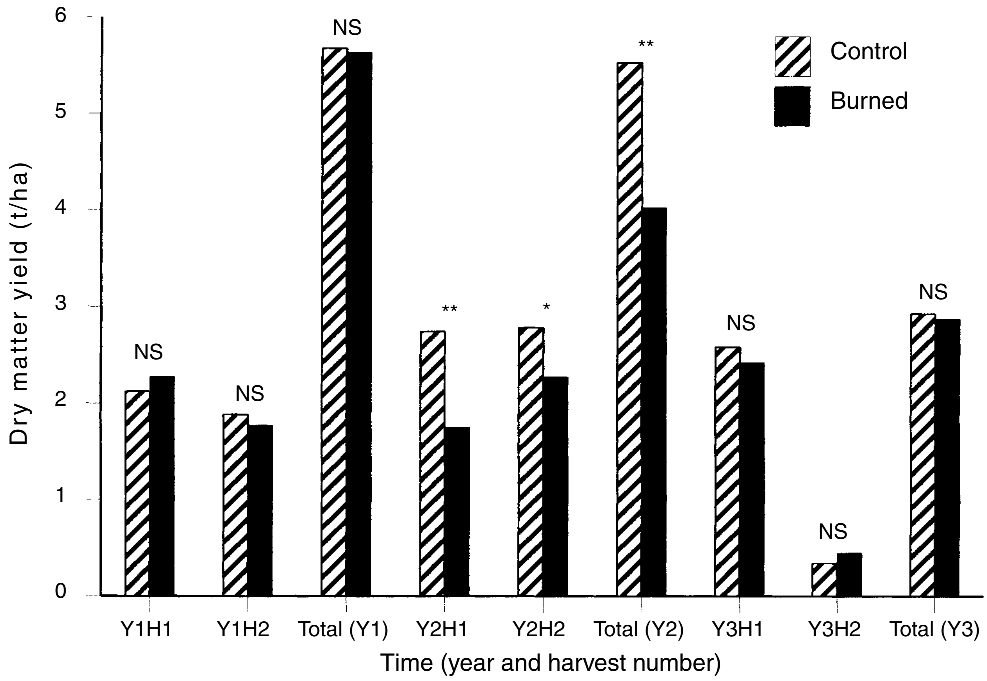

Figure 3. The influence of spring burning on the DM yield of a *Digitaria eriantha* (Smuts finger grass) pasture. Y1, Y2 and Y3 represent 1996–97, 1997–98 and 1998–99, respectively, while H1 and H2 represent harvests in December and January/March.

Discussion

The results obtained with single *vs* split applications during 1996–97 and 1997–98 support the findings of Kaltofen *et al.* (1966) who also found no differences in total DM yield between single and split applications. These authors found a more even distribution between the first and second harvests. The fact that the single application yielded significantly higher than the split application during 1998–99 can be attributed to average rainfall between September and December and well below average falls in the January–March period, with the result that there was almost no growth after the first harvest. The increase in flowering and therefore expected seed yield obtained with an increase in N fertilisation corresponds with results obtained by Burton (1944) with *Paspalum notatum*, Grof (1969) with *Brachiaria mutica* and Ramírez and Hacker (1996) with a *Digitaria eriantha* pasture. The increase in flowering stems can be directly ascribed to an increase in vigour, because of the higher availability of N early in the growing season.

The absence of any significant effect of spring burning on DM yield during the 1996–97 and 1998–99 growing seasons can be attributed to the time of the burn as illustrated by Burton (1944). According to N.F.G. Rethman (personal communication), burning in the trial by Rethman and Beukes (1988) was carried out in September, at which time the grass had already started to grow. The reduction in DM yield in this trial during the 1997–98 growing season following a burn after spring growth had commenced was therefore similar to that obtained by Rethman and Beukes (1988). The reaction of the pasture in terms of flowering was very different from that obtained with *Eragrostis curvula* (Rethman and Beukes 1988), but was similar to that obtained by Burton (1944) with *Paspalum malacophyllum* (Ribbed paspalum).

Conclusion

Split application of N fertiliser, when applied at the optimum rate for a single application in spring (Pieterse and Rethman 1995), will not have a significant effect on the DM yield of *D. eriantha*. The distribution of the DM production will, however, be altered, with a greater percentage produced during the second half of the season. Although it was not one of the parameters of this trial, it can be expected that the N concentration in the DM from the second harvest will also be higher than that of the single application. There is, however, a need to determine whether the optimum level for a single application in spring (150 kg/ha N) will still be optimum when split applications are applied. This study has also indicated that a spring application of 150 kg/ha/yr N will increase flowering in *Digitaria eriantha* during the main seed production period in December.

Burning in spring when the grass is dormant will not reduce DM yield or flowering in *D. eriantha*; however, when the burning is delayed until after the onset of spring growth, DM yield and flowering will be reduced.

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