CHAPTER 6

THE GROWTH AND PRODUCTIVITY OF FIVE PERENNIAL SUB-TROPICAL GRASS SPECIES UNDER IRRIGATION IN PRETORIA, SOUTH AFRICA.

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Abstract

Five subtropical grass species, *Cenchrus ciliaris,* a *Cynodon* hybrid*, Digitaria eriantha subsp. eriantha, Panicum maximum* and *Pennisetum clandestinum,* were cultivated in 15 m^2 plots with non-limiting water and nutrients. The growth patterns and productivity of the five grasses were studied to facilitate management and utilization recommendations.

With adequate water and nutrients, all five grass species were able to produce green material throughout the summer growing season. Under the conditions on the Hatfield Experimental Farm of the University of Pretoria, *C. ciliaris*, *D. eriantha* and *P. maximum* produced the highest growth rate and production during the 1997/98 growing season. During the first part of each growing cycle, the growth rate and production of *P. clandestinum* and the *Cynodon* hybrid were similar. Towards the

end of the cycles, however, this changed with the growth of the *Cynodon* hybrid surpassing that of *P. clandestinum*. *P. clandestinum*, despite a low growth rate, had a reliable leaf production throughout the growing season. This was different from the other four grasses, which started to flower at the end of each growth cycle, resulting in an increase in the amount and proportion of stem material.

It should also be kept in mind that these grasses were subjected to a light to medium defoliation, resulting in a high growth rate during the second growth cycle. This might not have been the case if heavy grazing, which could reduce the photosynthetic leaf area, had been applied.

Due to the lower yields of *P. clandestinum* it is , however, necessary to adjust animal numbers and period of stay in each paddock very carefully. *P. clandestinum* is also prone to lodging if left to grow too tall, causing the lower leaves to senesce and thus reduce the productivity. The periods of absence should not, therefore, be too long.

The *Cynodon* hybrid, *C. ciliaris*, *D. eriantha* and *P. maximum* tended to reach full bloom within one to two weeks of each other. The utilization of these species, for grazing, hay or foggage, and the impact of such flowering on quality (because of the increase in the proportion of stem/fibre) will, therefore, influence harvest/management decisions.

Keywords

Cenchrus ciliaris, Cynodon hybrid*, Digitaria eriantha* subsp. *eriantha, Panicum*

maximum, Pennisetum clandestinum**,** growth rate, leaf area

6.1 Introduction

The growth patterns of a grass can provide information on the availability of that species at a given time of the year. This can help with fodder flow planning (Smith *et al.*, 1986; Pieterse *et al.*, 1988) and identifying grass species for specific purposes in a specific area. This information can also play an important role in making management decisions that will ensure optimum utilization of the grass species without impacting upon growth in the subsequent season.

In this study the growth patterns of the five grasses under non-limiting growth conditions were determined. The hypothesis being that there will be differences in growth patterns leading to different management and utilization strategies.

6.2 Materials and Methods

Five subtropical perennial grasses were established in 15 m^2 plots on the Hatfield Experimental Farm, Pretoria, (25˚45'S, 28˚16'E), South Africa, during October 1996. The trial ended in June 1998. The five grasses were *Cenchrus ciliaris* cv. Molopo (Blue buffel-grass)*,* a *Cynodon* hybrid cv. K11 (Coach-grass)*, Digitaria eriantha subsp. eriantha* cv. Irene (Smuts finger-grass)*, Panicum maximum* cv. Gatton (Guinea grass) and *Pennisetum clandestinum* cv. Whittet (Kikuyu grass)*.*A fully randomized design with three replications was used.

The grasses were established using seedlings produced during the winter of 1996 and transplanted after the last cold snap in October of that year. Seedlings were produced for all the grasses except the *Cynodon* hybrid, which was established from vegetative sprigs collected on the experimental farm. The creeping grasses (the *Cynodon* hybrid and *P. clandestinum*) were established at a rate of 160 000 plants ha^{-1} while the tufted grasses (*C. ciliaris*, *D. eriantha* and *P. maximum*) were planted at a rate of 300 000 plants ha^{-1}. After establishment in 1996, the grasses were irrigated on a weekly basis. An overhead irrigation system was used and individual plots were not differentially irrigated. In the first week of September 1997 all the plots received 50 mm irrigation. The irrigation/rainfall information for the period September 1997 - April 1998 is set out in table 6.1.

Table 6.1 Irrigation applied and rainfall recorded on the experimental farm during September 1997 till April 1998.

Month	Irrigation (mm)	Rainfall (mm)	Total (mm)
September 1997	85	42	127
October	125	23.4	148.4
November	50	127.6	177.6
December	60	98.6	158.6
January 1998	25	135.2	160.2
February	50	120.5	170.5
March	70	69.4	139.4
Till 20 April 1998	30	1.5	31.5
Total (mm)	505	618.2	1 113.2

The soil at the site is a Shorrock series of the Hutton form (MacVicar *et al.*, 1991) with 30% clay in the top soil. The A-horizon of the soil is uniform to a depth of 1.2 m, before reaching the B-horizon that contains coarse gravel. According to soil analyses, the pH(H_2O) of the experimental soil was on average 6.02. The phosphorus (Bray II) and potassium (Ammonium acetate extractable cations) status in the top (0 - 30 cm) soil (24 mg kg^{-1} P; 76 mg kg^{-1} K) was much higher than that of the sub (30 - 60 cm) soil (1 mg kg-1 P; 19 mg kg-1 K). To achieve a non-limiting soil phosphorus and potassium status of 40 mg kg-1 P and 150 mg kg-1 K, which would ensure that these nutrients were not limiting, annual applications of these nutrients were necessary. As the plots were not grazed, but removed as hay, N, P and K were lost from the soil and the fertilizer regime was designed to replace these losses. At planting (October 1996), the plots received 50 kg N ha^{-1}, 40 kg P ha^{-1} and 25 kg K ha^{-1}. After planting each plot received 75 kg N ha^{-1} and 200 kg K ha^{-1} during January 1997 and March 1997 as top dressing. During the autumn and winter of 1997 the plots received neither irrigation nor fertilizers. At the beginning of October 1997 every plot received a top dressing of 75 kg N ha^{-1} and 200 kg K ha^{-1}. The grasses were cut back during January 1998, after which each plot received another top dressing of 75 kg N ha^{-1} and 200 kg K ha^{-1}. The fertilizers used were limestone ammonium nitrate (LAN) (28.0% N), superphosphate (8.3% P) and potassium chloride (KCl) (50.0% K).

In June 1997, the grasses on all the plots were cut back to a height of 5 cm for the creeping grasses, while the tufted grasses were cut back to a height of 10 cm. During the winter neither water nor fertilizer were applied and the growth was negligible till late in September 1997. Starting from the second week in October 1997 in 20 day intervals, sample plots of 1 m^2 in each main plot were harvested. The grasses in a sample plot were cut back to a height of 5 (creeping grasses) or 10 cm (tufted grasses), while the rest of the main plot were left undisturbed. At the end of December 1997, *C. ciliaris*, the *Cynodon* hybrid, *D. eriantha* and *P. maximum* reached full bloom and all the main plots were cut back to the relevant heights. For *P. clandestinum* the main plots were cut back as soon as the grasses reached a height of 40 cm. The materials of the sequential harvests were divided into leaf and stem material after which the leaf area were measured before all the material was dried for 48 h at 65˚C. The dry matter yields were determined subsequently.

6.3 Results

6.3.1 Growth rate and cumulative dry matter production

In the study area, September is characterised by relative cool nights, resulting in new growth being delayed until the end of September / beginning of October. During the 20 days of the first growth cycle (20 October 1997), there were very little differences in the growth rate of the five species (Figure 6.1). During the following three weeks, slight differences in growth rates could be discerned. At the beginning of December 1997, some differences in the growth rates of the five grasses are evident, with these becoming stronger in mid December. At this stage, *C. ciliaris* and *D. eriantha* had higher growth rates followed by *P. maximum,* with the *Cynodon* hybrid and *P. clandestinum* having almost the same growth rate (Figure 6.1). At the end of the first growth cycle (8 January 1998), the *Cynodon* hybrid exhibited a higher growth rate than that of *P. clandestinum*, but this was still not as high as that of the other three grass species.

In the first growth cycle, there were no differences in growth rate between *D. eriantha* and *C. ciliaris,* which had the highest yields (Figure 6.2), before they were cut back for the second growth cycle. The two creeping grasses, especially *P. clandestinum,* produced the lowest yields over the same growth period (Figure 6.2), with the growth rate and yield of *P. maximum* being lower than those of the other two tufted grasses, but higher than those of the two creeping grasses for the first growth cycle (Figure 6.1 and 6.2).

The yields in the second growth cycle were much higher than in the first growth cycle for all the grass species (Figure 6.2). The three tufted grass species again produced higher yields than the two creeping grasses. The yields of the three tufted species, at the end of the season did not differ much, but the yield of the *Cynodon* hybrid was much better than that of *P. clandestinum*.

As with the growth rate during the first growth cycle, the growth rate of the *Cynodon* hybrid was initially slow but during March and April (1998) it surpassed the growth of *P. clandestinum* (Figure 6.1). The growth rates of the three tufted grass species were essentially similar up until the end of March (1998), when the growth rate of *C. ciliaris* increased slightly and remained as such until the end of the trial (20 April 1998). The growth rate of *D. eriantha* and *P. maximum* only began to separate at the end of the trial (20 April 1998) with *D. eriantha* exhibiting a slightly higher growth rate than *P. maximum* (Figure 6.1).

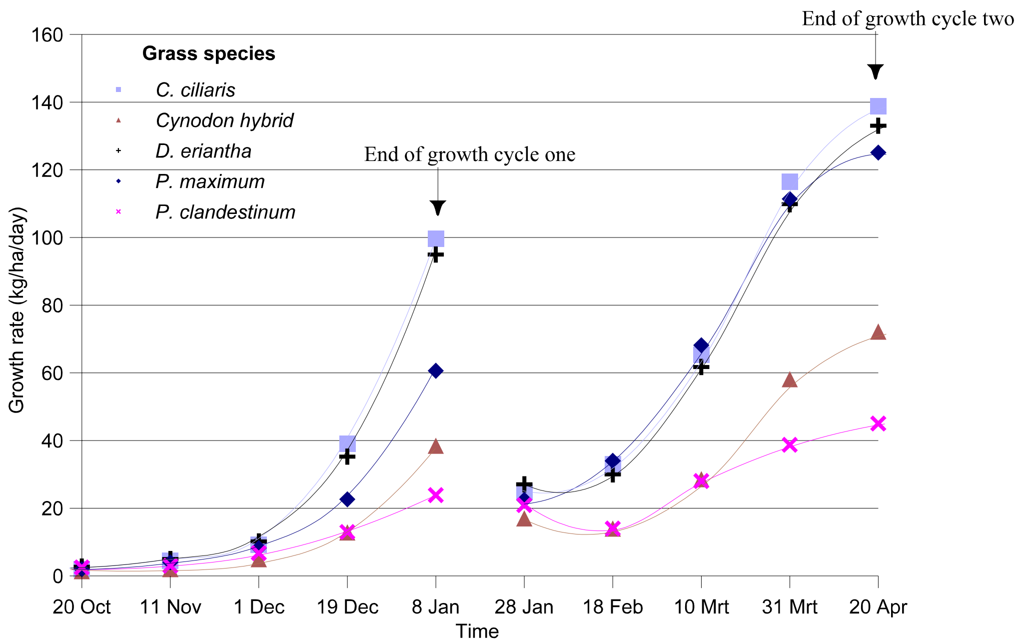

Figure 6.1 Relative growth rates of sub-tropical grasses over two growth cycles under irrigation.

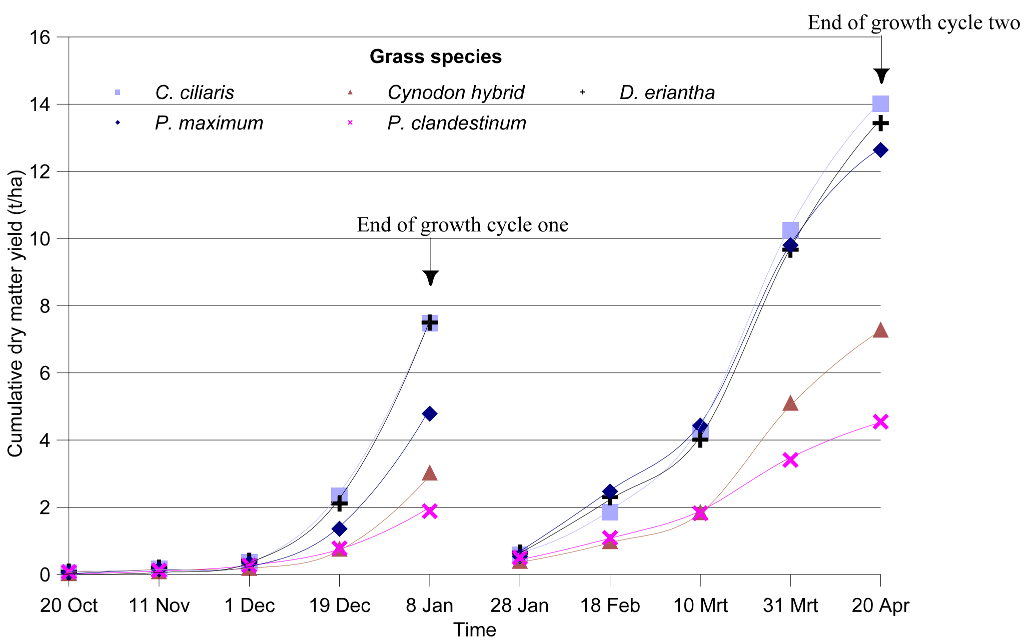

Figure 6.2 Cumulative dry matter yields of five grass species over two growth cycles, under irrigation.

6.3.2 *Cumulative leaf area*

The cumulative leaf area per sample plot (1 m^2) (Figure 6.3) of all five grass species followed the same trend as the growth rate (Figure 6.1) and dry matter yield (Figure 6.2). There was, however, a clearer distinction between the species with *D. eriantha* maintaining the highest leaf area and *P. clandestinum* the lowest (Figure 6.3) during the first growth cycle.

In the second growth cycle the leaf area of the *Cynodon* hybrid was almost equal to that of *P. maximum*, but the leaf areas of all these grasses were lower than that of *C. ciliaris* and *D. eriantha* (Figure 6.3). The leaf area of *P. clandestinum* was once again the lowest of all the grass species.

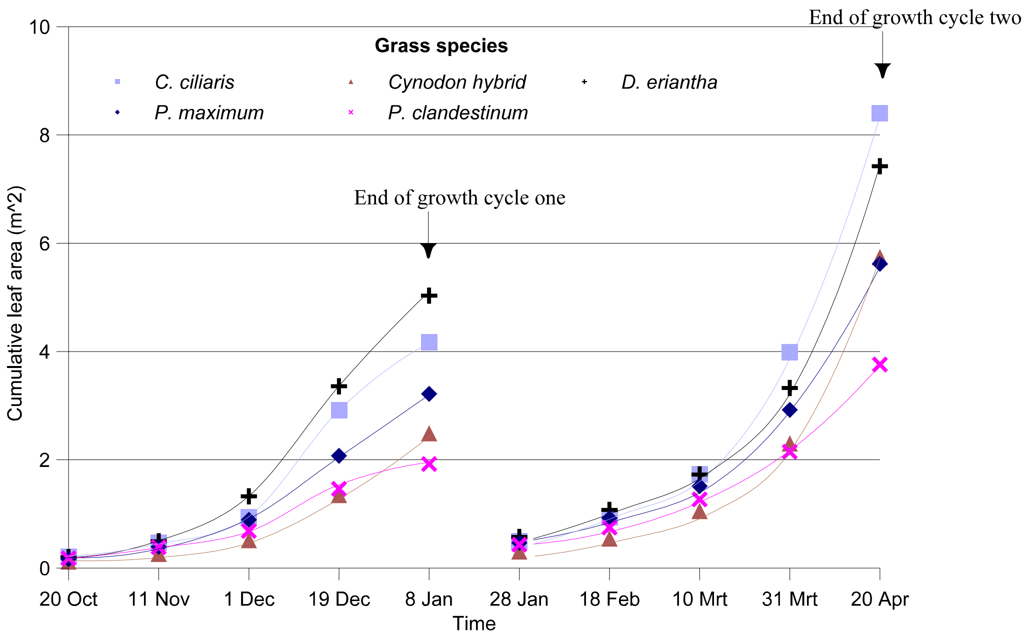

Figure 6.3 Cumulative leaf area of five grass species over each of two growth cycles.

6.3.3 Partitioning of assimilates to leaf, stem and inflorescence

The percentage leaf in the whole plant (Figure 6.4) was the highest in *P. clandestinum*, followed by *C. ciliaris* and the *Cynodon* hybrid. *D. eriantha* and *P. maximum* have the highest percentage stem, and the lowest proportion of leaf of these grasses.

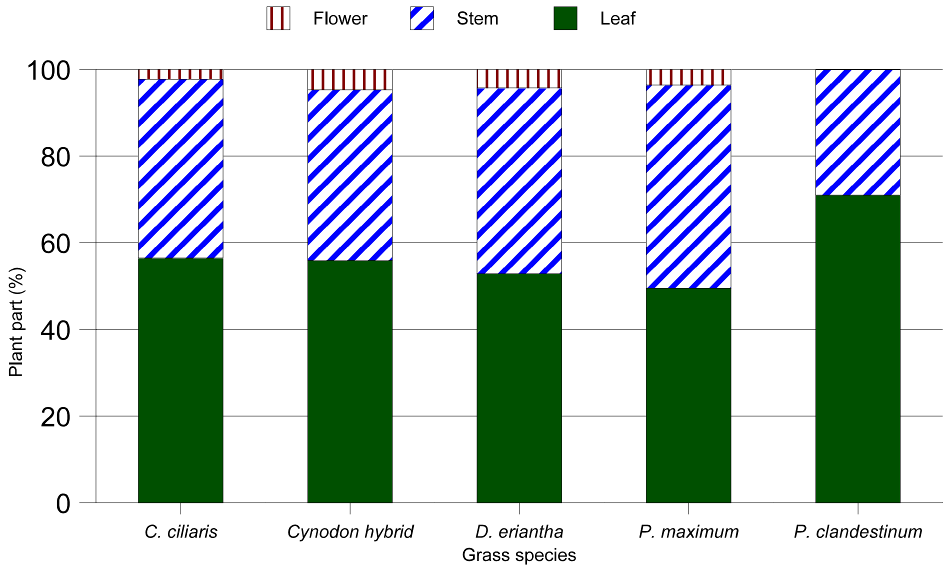

Figure 6.4 Partitioning of assimilates to leaf, stem and inflorescence of five sub-tropical grass species

6.4 Discussion and Conclusions

The growth patterns for the five grass species differed from each other. The tufted grass species (*C. ciliaris*, *D. eriantha* and *P. maximum*) tended to accumulate dry mass earlier in the season, compared to the creeping grass species (the *Cynodon* hybrid and *P. clandestinum*). From the point of view of utilization, *C. ciliaris*, *D. eriantha* and *P. maximum* are be able to supply fodder sooner than the *Cynodon* hybrid and *P. clandestinum* after cutting, possibly as a result of the higher stubble height and hence greater residual leaf area. These first three grasses, however, also reach maturity a lot faster with the creeping grasses which comparatively produce less stem and inflorescence.

P. clandestinum, for example, exhibits less fluctuation in growth rate over the season than the widely fluctuating tufted species. For future reference, one should take note that different cultivars may also have different growth rates and yield potentials (Goodenough *et al.*, 1984). Thus after identifying the best species for a specific purpose, the next step is to identify the best cultivar for that situation.

Due to the lower yields of *P. clandestinum* it is , however, necessary to adjust animal numbers and period of stay in each paddock very carefully. *P. clandestinum* is also prone to lodging if left to grow too tall, causing the lower leaves to senesce and thus reduce the productivity. The periods of absence should not, therefore, be too long.

C. ciliaris, the *Cynodon* hybrid, *D. eriantha* and *P. maximum* usually do not have a problem with lodging. These species can thus be left to grow out during the growing season to be used as standing hay in the winter months with the addition of supplementary licks, although it must be remembered that extended periods of stockpiling result in a higher proportion of stem in the standing hay with a corresponding decline in quality, because of the increase in percentage stem.

It must also be kept in mind that these grasses were subjected to a light to medium defoliation, resulting in a high growth rate during the second growth cycle. This might not have been the case if heavy grazing, which could reduce the photosynthetic leaf area, had been applied. The grasses were also grown without water stress, ensuring green material throughout the season (Taylor *et al.*, 1976; Pieterse *et al.*, 1988), which might not have been the case under dryland or rainfed conditions.

6.5 References

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