University of Pretoria etd – Marais, D (2006)

WATER USE OF PERENNIAL SUMMER GRASSES IN SOUTH AFRICA

by

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Submitted in partial fulfilment of the requirements for the degree :

PHILOSOPHIAE DOCTOR - PASTURE SCIENCE

in the Faculty of Natural and Agricultural Sciences

Department of Plant Production and Soil Science

University of Pretoria

PRETORIA

SUPERVISOR: PROF NFG RETHMAN

DECEMBER 2005

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ABSTRACT

Five subtropical perennial grass species, *Cenchrus ciliaris*, a *Cynodon* hybrid, *Digitaria eriantha* subsp. *eriantha*, *Panicum maximum* and *Pennisetum clandestinum*, were subjected to four levels of water availability in a small plot trial under a rainshelter during the summer growing seasons of 1996/97 and 1997/98. This work was carried out on the Hatfield Experimental Farm of the University of Pretoria, Pretoria, South Africa.

The average yields for the tufted species (*C. ciliaris*, *D. eriantha* and *P. maximum*) were lower in the 1997/98 than the 1996/97 season. *C. ciliaris*, however, produced the highest average yields in both seasons. The average yields of the *Cynodon* hybrid and *P. clandestinum* (creeping grasses) reacted differently, in that the average yields were higher in the 1997/98 than 1996/97 season.

The dry matter yields of all five grass species at slight water deficits, were not significantly different from yields under conditions of no water shortages, when the soil profile was brought to field capacity at the beginning of the growing season. The implication hereof is, that dry matter yields can be maintained, in conditions where slight water deficits occur, if there is some water stored in the soil profile.

C. ciliaris, a notable drought tolerant species, produced yields (11.7-20.0 t ha^{-1}) under non-control conditions (W1, W2 and W3) which were comparable to yields obtained from traditionally irrigated grasses such as the *Cynodon* hybrid (12.0-15.8 t ha^{-1}) and *P. clandestinum* (5.6-11.8 t ha^{-1}), under control conditions (W4). *P. clandestinum, D. eriantha* and *P. maximum* tended to be better adapted to wetter conditions, while the *Cynodon* hybrid was also able to produce good yields under both water limiting and non-limiting conditions.

Water use efficiency, regardless of the grass species, tended to be better under non-control conditions. Grasses were thus able to produce more dry matter per unit of water under conditions where water became scarce.

In vitro dry matter digestibility was not negatively affected by water scarcity, while crude protein content more often than not seemed to be better under control conditions. This could be due to the uptake meganism of nutrients, in which water plays a vital role.

The number of stoma per unit area was more under control than water limiting conditions. The expression of the different structures on the leaf surfaces, were not

altered by the level of water availability.

In the absence of water shortages, the growth rates of *C. ciliaris*, *D. eriantha* and *P. maximum*, were almost twice those of the *Cynodon* hybrid and *P. clandestinum,* as measured at the end of two growth cycles in an irrigated field trial.

In a pot trial, under glasshouse conditions, with *C. ciliaris*, the *Cynodon* hybrid and *P. clandestinum*, both the level of water availability, and the level of nitrogen were varied. Regardless of species and level of nitrogen, water was still used more efficiently under non-control conditions. Higher levels of nitrogen did, however, improve water use efficiency regardless of level of water available. As with higher levels of available water, higher levels of nitrogen also improved yields. In this trial, the *Cynodon* hybrid and *C. ciliaris* also out-yielded *P. clandestinum*.

In summary it can be said that *C. ciliaris* and the *Cynodon* hybrid are adapted to warm growing conditions in producing high yields regardless of the level of water available. *D. eriantha*, *P. maximum* and *P. clandestinum* would produce better in such growing conditions if water was not as limiting. Regardless of the species, the plants were able to use water more efficiently under non-control conditions, while *in vitro* digestibility was not negatively affected by water limiting conditions. Due to the uptake mechanism of nutrients, water limiting conditions may, however, decrease the crude protein content of the grass plants. Higher levels of nitrogen had a positive impact on dry matter yields and water use efficiency.

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WATER GEBRUIK VAN MEERJARIGE SOMER-GRASSE IN SUID-AFRIKA

deur

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DEPARTEMENT: Plantproduksie en Grondkunde

GRAAD: PhD - Weidingkunde

UITTREKSEL

Vyf subtropiese meerjarige grasspesies, *Cenchrus ciliaris*, ‘n *Cynodon* baster, *Digitaria eriantha* subsp. *eriantha*, *Panicum maximum* en *Pennisetum clandestinum*, is aan vier vlakke van waterbeskikbaarheid, in ‘n klein perseel proef, onder ‘n reënskerm, gedurende die 1996/97 en 1997/98 somer groeiseisoene blootgestel. Hierdie werk is uitgevoer op die Hatfield Proefplaas van die Universiteit van Pretoria, Pretoria, Suid-Afrika.

The gemiddelde opbrengste van die polgrasse (*C. ciliaris, D. eriantha* en *P. maximum*) was laer in die 1997/98 as in 1996/97 seisoen. *C. ciliaris* het egter die hoogste gemiddelde opbrengs in beide seisoene gelewer. Die gemiddelde opbrengste van die *Cynodon* baster en *P. clandestinum* (kruipende-grasse) het die teenoorgestelde gereageer, met hoër opbrengste in die 1997/98 as in die 1996/97 seisoen.

Daar was geen betekenisvolle verskille tussen die droëmateriaal opbrengste van enige van die vyf grasspesies by geringe watertekorttoestande, in vergelyking met die geen watertekorte nie. Dit het geskied indien die grondprofiel aan die begin van die seisoen by veldkapasiteit was. Dit impliseer dat droëmateriaal opbrengste onderhou kan word in tye van geringe droogte, mits daar water in die grondprofiel gestoor is.

C. ciliaris, 'n bekende droogteverdraagsame spesie, het opbrengste (11.7-20.0 t ha^{-1}) onder nie-kontrole toestande (W1, W2 en W3) geproduseer, wat vergelykbaar is met opbrengste wat onder kontrole water toestande (W4) vir tradisioneel besproeide grasses soos die *Cynodon baster* (12.0-15.8 t ha^{-1}) en *P. clandestinum* (5.6-11.8 t ha^{-1}) verkry is. *P. clandestinum*, *D. eriantha* en *P. maximum* was geneig om beter aangepas te wees by natter toestande, terwyl die *Cynodon* baster instaat was om goeie opbrengste onder beide waterbeperkende en nie-waterbeperkende toestande te produseer.

Waterverbruiksdoeltreffendheid, ongeag die spesie, het geneig om beter by nie-kontrole toestande te wees. Die grasse was dus instaat om meer droëmateriaal te produseer per eenheid water verbruik, by toestande waar water beperk geraak het.

In vitro droëmateriaal verteerbaarheid was nie negatief deur watertekorte beïnvloed nie, terwyl ruproteïn inhoud meer dikwels, beter was by kontrole toestande. Dit kan toegeskryf word aan die opname meganisme van voedingstowwe waarby water 'n kern rol speel.

Die aantal stomas per eenheid oppervlakte was meer onder kontrole as by waterbeperkende toestande. Die voorkoms van die verskillende strukture op die blaaroppervlaktes, was nie deur die beskikbaarheid van water beïnvloed nie.

In die afwesigheid van watertekorte, was die groei van *C. ciliaris, D. eriantha* en *P. maximum*, bykans dubbel dié van die *Cynodon* baster en *P. clandestinum*, soos gemeet aan die einde van twee groeisiklusse.

In ‘n potproef, onder glashuistoestande, met *C. ciliaris*, die *Cynodon* baster en *P. clandestinum*, is beide die vlak van waterbeskikbaarheid en stikstof gevarieer. Onafhanklik van die spesie, en vlak van stikstof, is water meer doeltreffend verbruik onder nie-kontrole toestande. Hoër vlakke van stikstof het die waterverbruiksdoeltreffendheid verbeter, onafhanklik van die vlak van waterbeskikbaarheid. Soos met die toediening van meer water, het die toediening van meer stikstof ook tot ‘n verhoging in droëmateriaalopbrengste aanleiding gegee. In hierdie proef het *C. ciliaris* en die *Cynodon* baster weer beter opbrengste as *P. clandestinum* gelewer.

Ter opsomming kan die gevolgtrekking gemaak word dat *C. ciliaris* en die *Cynodon* baster beter aangepas is by warm groeitoestande deur hoë opbrengste te lewer, onafhanklik van die vlak van water beskikbaar. *D. eriantha, P. maximum* en *P. clandestinum* kan ook goeie opbrengste lewer onder sulke wye water reeks groeitoestande, mits waterbeskikbaarheid nie beperkend is nie. Onafhanklik van die grasspesie, het die plante water meer doeltreffend verbruik by nie-kontrole toestande, terwyl *in vitro* verteerbaarheid nie benadeel is deur watertekorte nie. As

gevolg van die opname meganisme van voedingstowwe, kan waterbeperkende toestande die ru-proteïn inhoud van grasplante wel benadeel. Hoër vlakke van stikstof het ‘n positiewe invloed op beide droëmateriaal opbrengste en waterverbruiksdoeltreffendheid getoon.

ACKNOWLEDGMENTS

First of all I thank Prof Norman Rethman, my supervisor, for the time and effort which went into this project. He did more than his share and without him I would never have gotten this far, not only in terms of my thesis, but also in my career.

Thanks to everybody in the Department of Plant Production and Soil Science who has encouraged me to complete this thesis. In particular Proff JG Annandale and ES du Toit, mr RW Gilfillan, Prof PS Hammes, mrs JJ Herman, and mr JH Marneweck.

Thanks are also due to the Water Research Commission for funding this project. The financial contribution has not only benefitted this project, but numerous other projects, due to the facilities which the University of Pretoria acquired.

A special word of thanks to mr T Sibanda for excellent technical support rendered.

Thanks to Dawid and Mona Marais, my parents, for never losing faith in me.

Finally all Thanks and Glory go to our Father in heaven, who placed me here together with all my wonderful friends, colleagues and family members.

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