ID # 18-06

HERBAGE CHARACTERISTICS AS AFFECTED BY THE CANOPIES OF DOMINANT TREES IN A SAVANNA OF SOUTHERN MOZAMBIQUE

J.P. Muir[1], A. Alage[2] and I.C. Maposse[3]

[1]Texas Agricultural Experiment Station, Box 00, Route 2, Stephenville, TX, 76401-9698, USA, jmuir@tamu.edu; [2]Instituto de Produção Animal, CP 410, Matola, Moçambique; [3]Universidade Eduardo Mondlane, CP 257, Maputo, Moçambique.

Abstract

This study surveyed the species composition, forage yield and forage nitrogen concentration of the herbaceous layer 50, 100 and 200% of the canopy radius from the trunks of many-stemmed false thorn, knob thorn, scented thorn and marula trees in a southern Mozambican savanna. Tree species did not affect herbaceous DM yield or species diversity. Neither direction nor distance from the tree trunk affected DM or specific diversity. Crude protein percentages were 15% higher for legumes and 9% higher for grasses at 50% canopy than at 200% canopy. Grasses under the marulas, the only non-legume tree in the study, had 18% lower CP than the average for the other three tree species. Green panic was the predominant grass species under the canopies while no single grass species predominated outside the canopy where common urochloa, *Themeda triandra* and *Aristida* spp. were the most common grasses. *Vigna* spp. and *Stylosanthes*

fruticosa were evenly distributed whereas *Tephrosia* spp. was found predominantly outside the canopy.

Keywords: shade, herbaceous forage, range, crude protein, Africa, savannah, Mozambique, species composition

Introduction

Deforestation to increase grass production is a common practice in semi-arid tropical and subtropical range. Ranchers believe that trees decrease herbaceous layer yield, quality and species diversity to the detriment of cattle nutrition on these native pastures. As a result, many tropical hardwood forests are destroyed, impoverishing both tree and herbaceous germplasm diversity. Tree canopies may, however, benefit forage plant diversity and quality by providing habitat for shade-tolerant herbaceous species.

Physiological differences between plants considered "sun-loving" and those considered "shade-tolerant" have been identified. Malkin and Fork (1981) found that shade plants had larger chlorophyll reaction centers. Kephart et al. (1992) found that grass leaf-area ratios decrease with increased irradiance levels but responses were much higher in C_4 than in C_3 grasses. Work presented by Givnish (1988) indicated that canopy structure (primarily width) was a further adaptation to irradiance while Watson et al. (1984) found that decumbent versus upright growth was favored by plants under shade. Temporal environmental differences such as soil moisture or organic matter breakdown may favor herbaceous plant growth under shade or full sunlight as well (Wilson, 1996).

Numerous experiments have attempted to categorize legume species as either sun or shade types. Izaguirre-Mayoral et al. (1995) identified some legumes as facultative shade-tolerant while others were intolerant. Muir and Pitman (1989), working with a range legume collected under tree canopies, likewise found that shade tolerance more adequately described a legume that had quadratic yield responses to shade levels. Working with a cultivated legume, Johnson et al. (1994) found, in contrast, lower total nonstructural carbohydrate (TNC) concentrations and DM yields with increased shade.

Grasses likewise have been divided into sun and shade tolerant categories (Ng et al. 1997; Smith and Whiteman, 1983). Wilson (1996) indicated that some grasses increased both dry matter (DM) yield as well as nitrogen (N) yield under shade while others increased only DM yields. Wong and Stur (1996) warned, however, that differential responses to defoliation by shade-tolerant grasses, primarily allocation of TNC, affect stand persistence.

The objective of this plant survey was to compare species composition, DM yields and herbaceous N concentration of savannah species growing under tree canopies with those in full sunlight. Independent variables used were:

1. Canopies of four tree species
2. East/West direction from tree trunk
3. Distance from tree trunk

Materials and Methods

The site of the data collection was located in Southern Mozambique in Maputo Province near the Chobela Experiment Station (33^{o} E longitude, 25^{o} S latitude and 45m

altitude). Soils in the area are infertile, slightly acidic sandy loams and had a hard clay pan from 30 to 70cm below the soil surface. Rainfall in the region, approximately 580mm for the study year, was below the long-term average of 720mm precipitation per annum. The paddock had a long history of cattle grazing but had been only lightly browsed by wildlife the 8 years immediately preceding the study.

The herbage under mature many-stemmed false thorn (*Albezia petersiana* subsp. *evansii*; van Wyk, 1990; average 11.25m canopy diameter), knob thorn (*Acacia nigresensis;* average 8.0m canopy diameter), marula (*Sclerocarya birrea* subsp. *caffra*; average 7.25m canopy diameter) and scented thorn (*Acacia nilotica* subsp. *kraussiana*; average 8.5m canopy diameter) was sampled on a 3 km transect of the Quinta do Alva Ranch (N=8 per species). The selected trees were at least 20 m from the closest neighboring tree. Samples were taken mid-way to the canopy edge (50%), at the canopy edge (100%) and twice the canopy distance (200%) due east and due west from the tree trunks. Sampling took place in late rainy season when grasses were in early seed formation. Herbage in $1m^2$ quadrats was harvested at 5cm stubble heights to determine:

1. Species composition
2. Number of species
3. Biomass dry matter yield
4. Biomass crude protein estimate

Results and Discussion

Tree species did not affect herbaceous DM yield (628kg ha^{-1} on average; $P>0.5$; Figure 1) or species diversity (3.4 species on average; $P=0.32$). Neither direction ($P>0.5$)

nor distance from the tree trunk (P=0.29) affected DM yield (679 kg ha-1 at 50%; 630 kg ha-1 at 100%; and 573 kg ha-1 at 200%) or specific diversity (3.0 species/m^{-2} at 50%; 3.7 species/m^{-2} at 100%; and 3.6 species/m^{-2} at 200%; P=0.17). This would indicate that clear-cutting hardwoods does not increase forage production in these savannas.

Crude protein percentages were 15% higher for legumes and 9% higher for grasses at 50% canopy than at 200% canopy (Figure 2). This finding would indicate that tree canopies increase forage nutritive values. Grasses under *Schlerocarya birrea*, the only non-legume tree in the study, had 18% lower CP than the average for the other three trees, perhaps due to the higher N content in leaf litter of the leguminous trees.

Panicum maximum was the predominant grass species under the canopies while no single species predominated outside the canopy where *Urochloa mocambicensis*, *Themeda triandra* and *Aristida* spp. were the most common. *Vigna* spp. and *Stylosanthes fruticosa* were evenly distributed whereas *Tephrosia* spp. was found predominantly outside the canopy. Removal of the trees in this savannah would likely decrease the presence of the green panic but would not affect the presence of other grasses and legumes as much.

References

Givnish, T.J. (1988). Adaptation to sun and shade: a whole-plant perspective. Australian J. Plant Physiology **15**:63-92.

Izaguirre-Mayoral, M.L., Vivas A.I. and Oropeza T. (1995). New insights into the symbiotic performance of native tropical legumes: I. Analysis of the response of thirty-

seven native legume species to artificial shade in a Neotropical savanna. Symbiosis **19**:111-129.

Johnson, S.E., Sollenberger L.E. and Bennett J.M. (1994). Yield and reserve status of rhizoma peanut growing under shade. Crop Sci. **34**:757-761.

Kephart, K.D., Buxton D.R. and Taylor S.E. (1992). Growth of C_3 and C_4 perennial grasses under reduced irradiance. Crop Sci. **32**:1033-1038.

Malkin, S. and Fork D.C. (1981). Photosynthetic units of sun and shade plants. Plant Physiol. **67**:580-583.

Muir, J.P. and Pitman W.D. (1989). Response of the Florida legume *Galactia elliottii* to shade. Agroforestry Systems **9**:233-239.

Ng, K.F., Stur W.W and Shelton H.M. (1997). New forage species for integration of sheep in rubber plantations. J. Agric. Sci., Cambridge **128**:347-355.

Smith, M.A. and Whitman P.C. (1983). Evaluation of tropical grasses in increasing shade under coconut canopies. Expl. Agric. **19**:153-161.

van Wyk, P. (1990). Field Guide to the Trees of the Kruger National Park (2nd rev. ed). Stuik Publishers, Cape Town.

Wong, C.C. and Stur W.W. (1996). Persistence of tropical forage grasses in shaded environments. J. Agric. Sci, Cambridge **126**:151-159.

Watson, V.H., Hagedorn C., Knight W.E. and Pearson H.A. (1984). Shade tolerance of grass and legume germplasm for use in the southern forest range. J. Range Manag. **37**:229-232.

Wilson, J.R. (1996). Shade-stimulated growth and nitrogen uptake by pasture grasses in a subtropical environment. Aust. J. Agric. Res. **47**:1075-1093.

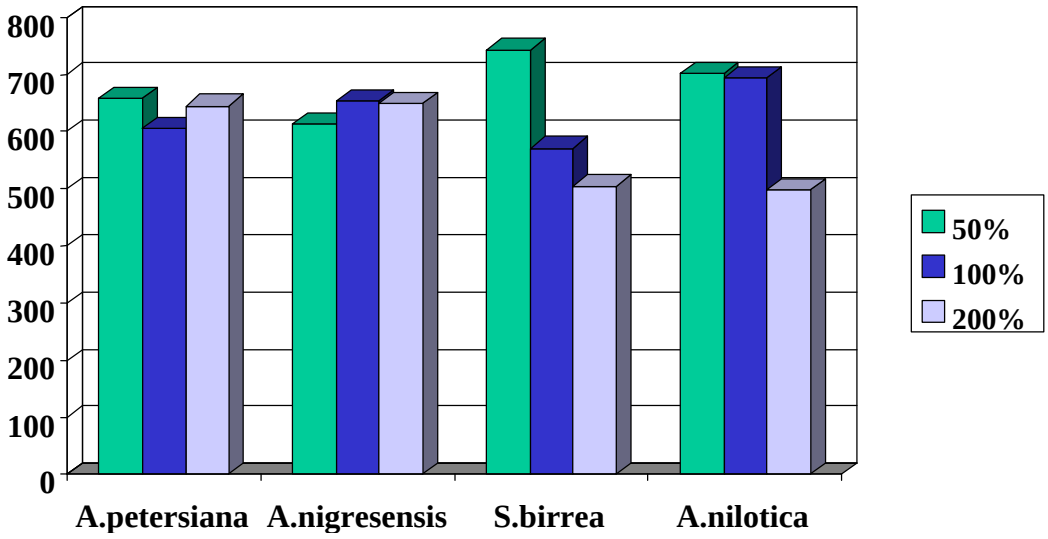

Figure 1 - Herbaceous aboveground biomass at 50, 100 and 200% of canopy distance from the trunk of four tree species in a southern Mozambican savanna.

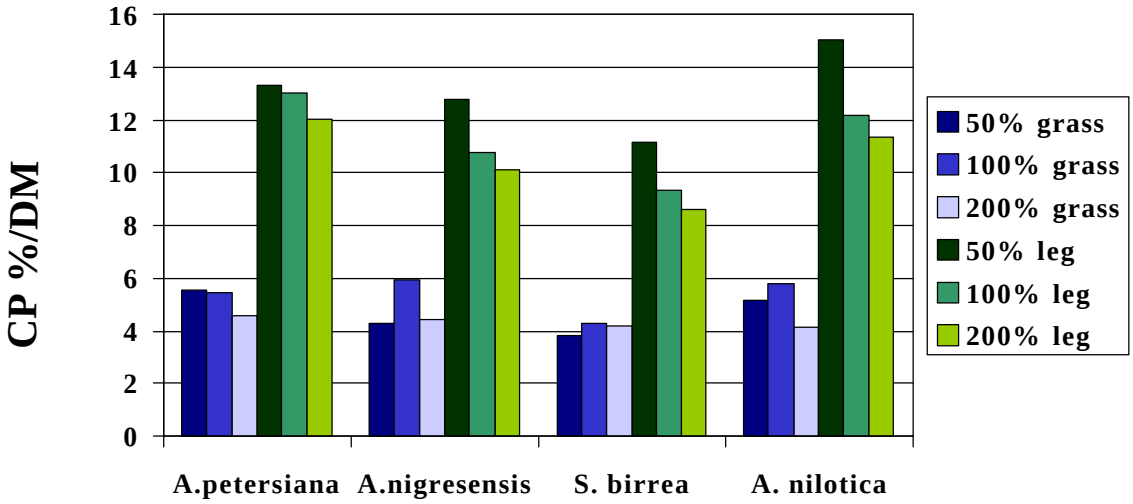

Figure 2 - Crude protein concentration in the herbaceous legume and grass aboveground biomass at 50, 100 and 200% of canopy distance from the trunk of four tree species in a southern Mozambican savanna.