Competitive responses of selected species from a South African semi-arid savanna

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INTRODUCTION

- Competition is important in both natural and agricultural plant communities.

- Botanical composition and productivity of any vegetation is largely determined by competitive interactions

- These also explain species' relative abundances in a given community, and may also explain the nature of forces that structure such a community

- 'Resource-use-type competition' has long been recognized as the 'dominant law of relationships'

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- Competition is a result of plant density and size relative to available resources

- Habitat fertility and disturbance largely determine plant community organization, while competition determines species distribution and abundance along fertility gradients

- One of the problems facing farmers and range managers is compositional change & reduced productivity

- Studies of effect and responses attempt to explain these changes

Rationale and Objectives

- In the False Thornveld of the Eastern Cape, compositional change and bush encroachment are a problem

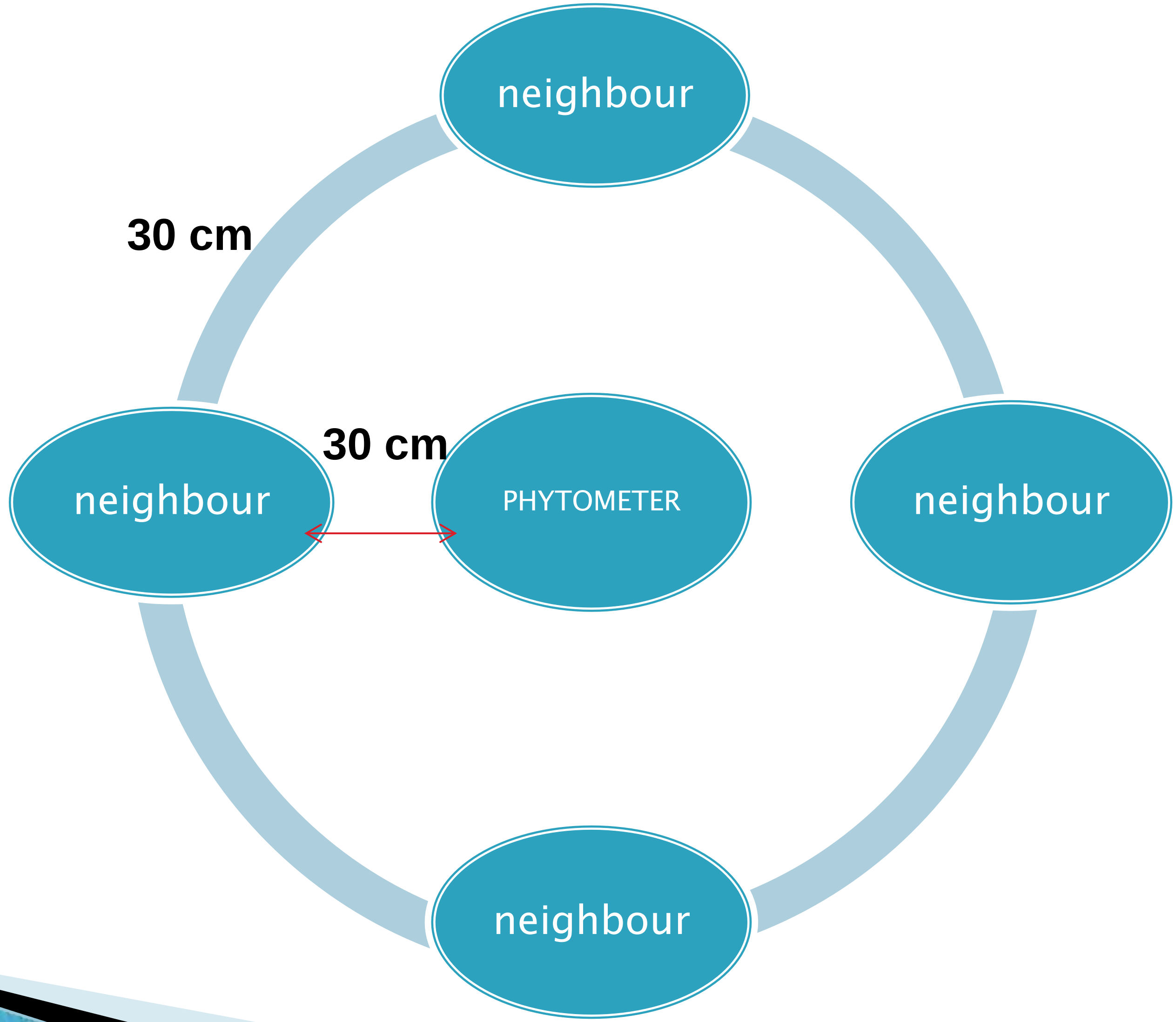
- A study was conducted to investigate competitive interactions between selected species in a simulated non-selective grazing environment across a soil fertility gradient.

- Key question: How do disturbance and soil fertility affect competitive responses of these species?

METHODOLOGY

- Competitive responses of 8 species were investigated in an outdoor split-plot factorial experiment at Fort Hare farm.
- *Cymbopogon plurinodis Digitaria eriantha, Eragrostis curvula, Melica decumbens, Panicum maximum, Sporobolus fimbriatus, Themeda triandra & Acacia karroo*.
- Seedlings of phytometers were propagated in a glass house and transplanted onto 1m^2 plots. (*E. curvula* as neighbour)
- Competition intensity was used as whole-plot factor (3 levels), while clipping and soil fertility were sub-plot factors, each at 2 levels.
- Each was replicated 5 times in a randomised block design

Figure 1: Layout of the competition trial



Appearance of phytometer and 8 competitors at start of trial

Appearance of the competition trial just before harvest

Data analyses

- All aboveground material was harvested, oven-dried and weighed after a full growing season (September to April)
- Competitive response was expressed as the natural logarithm of the relative biomass of a species grown with competition compared to its mass when grown without competition.
- Treatment effects were tested using 3-way ANOVA, Tukey's test was used for mean pairwise comparisons at $\infty = 0.05$
- Relative Interaction Index for each species under different levels of competition, soil fertility and clipping was determined as:

$$Y = X_0 - X_1 \div X_0 + X_1$$

Where: Y= Relative Interaction Index

X_0 = species mass without competition

X_1 = species mass with competition

RESULTS

- Competition intensity, soil fertility and clipping had significant effects on biomass production of the phytometers ($p \leq 0.05$).

- Competitive responses to these variables varied significantly between species ($p \leq 0.05$)

- All possible interactions were not significant ($p > 0.05$).

Figure 2: Mean ±S.E. mass of the eight phytometer species for the main effect of competition

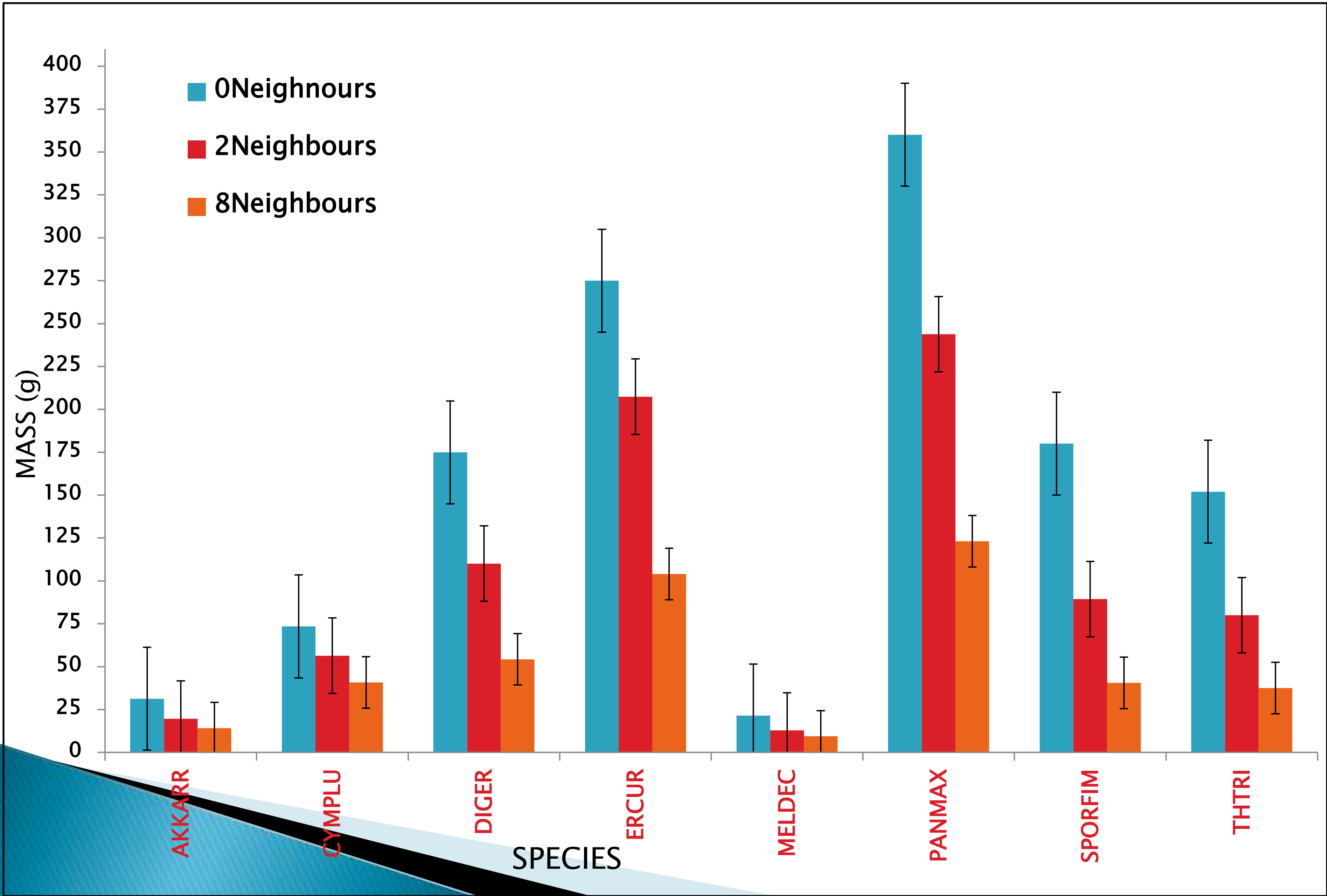


Table 1: Mean (log) mass per tuft phytometer species at different levels of clipping and fertility.

SPECIES	CLIPPING		FERTILITY	
	No clipping	Clipping	Low	High
Acacia karroo	1.40[b]	1.23[b]	1.32[b]	1.31[a]
Melica decumbens	1.19[a]	1.09[a]	1.11[a]	1.67[b]
Cymbopogon plurinodis	1.80[c]	1.69[c]	1.75[c]	1.73[b]
Themeda triandra	1.93[d]	1.84[d]	1.85[d]	1.94[c]
Sporobolus fimbriatus	2.01[e]	1.87[d]	1.93[e]	1.95[c]
Eragrostis curvula	2.10[f]	1.95[e]	1.97[e]	2.04[d]
Digitaria eriantha	2.31[g]	2.21[f]	2.16[f]	2.36[e]
Panicum maximum	2.34[g]	2.30[g]	2.33[g]	2.36[e]

Species Relative Interaction Indices

- Relative Interaction Indices (RRI's) of the phytometers varied significantly between the competition intensities and fertility levels ($p \leq 0.01$)

- Clipping, and all other possible interactions did not have significant effects on the RRI of the phytometer species ($p > 0.05$).

Figure 3: Mean RII coefficients for phytometer species

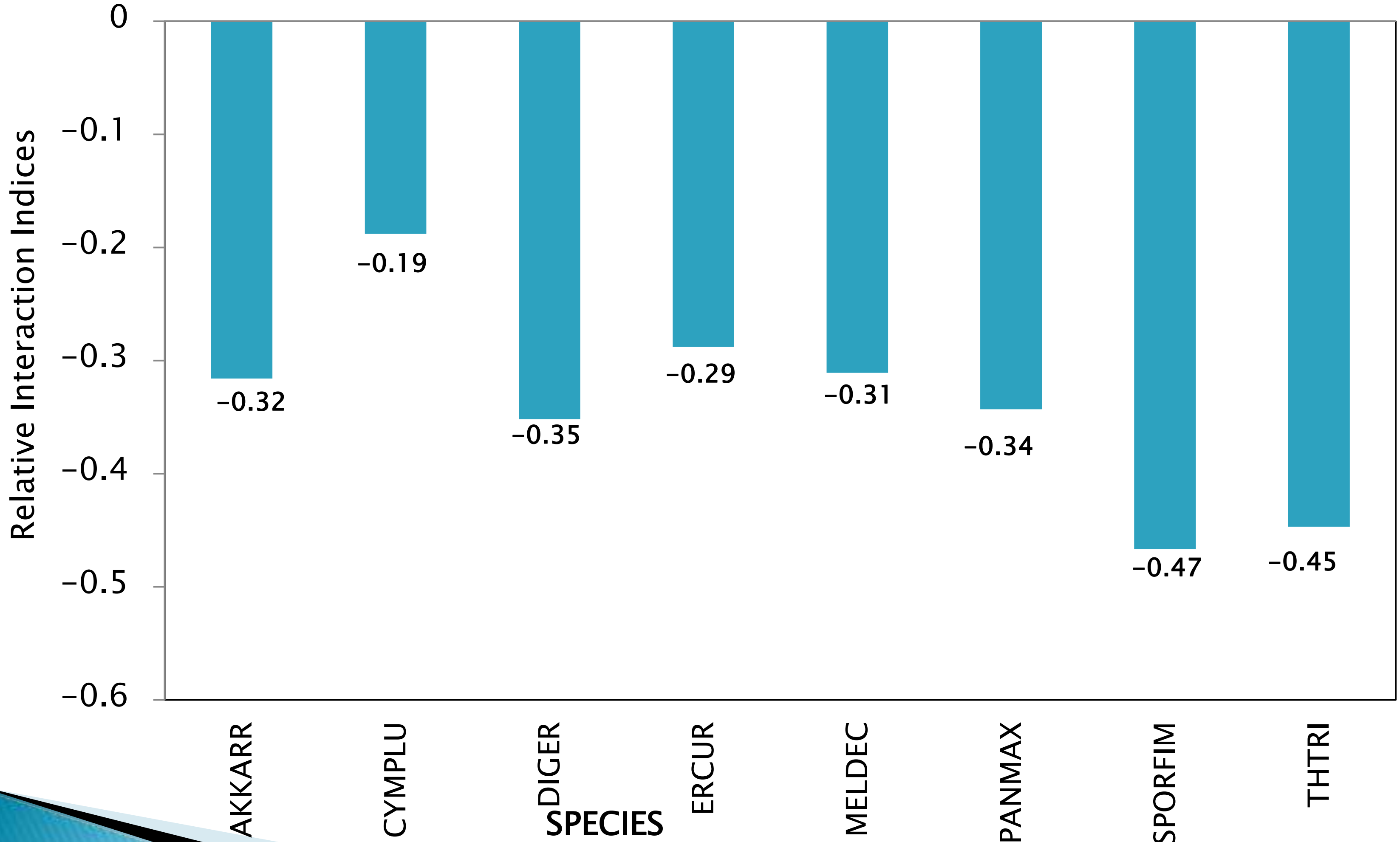


Table 2: Mean RII at low & high fertility levels with 2 neighbours

SPECIES	High fertility	Low fertility
Acacia karroo	−0.22[a]	−0.26[a]
Melica decumbens	−0.17[a]	−0.18[a]
Cymbopogon plurinodis	−0.29[ab]	−0.53[b]
Themeda triandra	−0.20[a]	−0.56[b]
Sporobolus fimbriatus	−0.17[a]	−0.31[a]
Eragrostis curvula	−0.27[ab]	−0.48[b]
Digitaria eriantha	−0.35[b]	−0.69[bc]
Panicum maximum	−0.30[b]	−0.61[b]

Table 3: Mean RII at low & high fertility levels with 8 neighbours

Species	High Fertility	Low fertility
Acacia karroo	−0.24[ab]	−0.55[a]
Melica decumbens	−0.07[a]	−0.33[b]
Cymbopogon plurinodis	−0.15[ab]	−0.49[ab]
Themeda triandra	−0.09[a]	−0.30[b]
Sporobolus fimbriatus	−0.34[b]	−0.42[ab]
Eragrostis curvula	−0.14[a]	−0.49[ab]
Digitaria eriantha	−0.30[b]	−0.55[a]
Panicum maximum	−0.30[b]	−0.57[a]

DISCUSSION

- Increaser II and Decreaser species exhibited stronger responses interchangeably
- Increaser I species (*C. plurinodis & M. decumbens)* had the weakest competitive interaction
- *Acacia karroo* exhibited a stronger competitive interaction than the three weakest grass species
- Relative competition intensity was generally higher at higher density and fertility levels
- Clipping had less influence on competitive interactions
- Shifts in interactions occurred at different density and fertility levels

CONCLUSIONS

- Competitive interaction was demonstrated to various degrees as opposed to facilitation
- Pioneer species *S. fimbriatus* on strongest response and while sub-climax/climax *C. plurinodis* at the weakest interaction
- Fertility has more influence on competitive interactions than disturbance
  - Taller grass species performed much better in higher than lower fertility
- The study supports the 'resource pre-emption' model, which states that larger plants usurp resources at the expense of smaller plants-survival strategies/size
- Leguminous tree seedlings can compete stronger with grasses in poorer soils

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