African Journal of Range & Forage Science 2010, 27(2): 105–108
Printed in South Africa — All rights reserved

AFRICAN JOURNAL OF
RANGE & FORAGE SCIENCE
ISSN 1022–0119 EISSN 1727–9380
doi: 10.2989/10220119.2010.502650

Research Note

The proposed colonisation sequence of woody species in the Sourish Mixed Bushveld of the Limpopo province, South Africa

JJ Jordaan

Towoomba Agricultural Development Centre, Private Bag X1615, Bela Bela 0480, South Africa
E-mail: Jordaanj@agric.limpopo.gov.za

Received 10 November 2009, accepted 14 May 2010

The long-term establishment sequence of the woody component of the Sourish Mixed Bushveld of the Limpopo province was studied and documented. Vegetation surveys were conducted at a protected site at the Towoomba Agricultural Development Centre during 1977 and 2000. Over the 23-year period, bush density at the site increased by 33%. Changes in the woody component indicated a shift from an acacia-dominated site to one dominated by broadleaved tree species. Early colonisers included mostly *Acacia* species (*A. karroo*, *A. robusta*, *A. nilotica*, *A. gerrardii*, *A. tortilis*, *A. caffra*, *A. habeclada* and *A. mellifera*), *Dichrostachys cinerea* and a few broadleaved species (*Ximenia caffra*, *Dombeya rotundifolia* and *Searsia* spp.). Intermediate colonisers included various shrubs (*Diospyros lycioides*, the *Maytenus/Gymnosporia* species group, *Euclea* species, *Carissa bispinosa* and *Grewia* spp.), a limited number of tree species (*Pappea capensis*, *Boscia albitrunca* and *Ziziphus mucronata*) and only two legumes (*A. robusta* and *Peltophorum africanum).* Late colonisers included only broadleaved shrubs and Waterberg Mountain Sourveld tree species (*Grewia flavescens*, *Tarchonanthus camphoratus*, *Berchemia zeyerii*, *Cassine transvaalensis*, *Schotia brachypetala*, *Ximenia caffra*, *Heteropyxis natalensis*, *Terminalia sericea*, *Vangueria infausta* and *Searsia lancea*). The leguminous and broadleaved components appeared to have distinct establishment sequences. *Acacia* spp. appeared to facilitate the early invasion of broadleaved woody species.

Keywords: Bush encroachment, tree density, tree succession

The Towoomba Agricultural Development Centre (ADC) was one of the first three Pasture Research Stations in South Africa, founded in 1934. It serves the Turf Thornveld of the Springbok Flats (Acocks 1988) as well as other adjoining bushveld areas of the Limpopo province.

During the 1930s and 1940s, research was concentrated entirely on veld management and reclamation (Lademann 1983). Consequently, several long-term experiments on grazing management were initiated during the 1930s to address these aspects. Increased development of dryland cropping in the area during the early 1950s resulted in the replacement of veld management experiments with cropping experiments (Donaldson and Rootman 1983). Subsequently, most of the long-term experiments on grazing management were terminated during 1950. Currently, two of these long-term experiments still exist, namely a protected site, fenced in during 1934/35, and four seasonal rotational grazing systems (or so-called 'maintenance experiments' or 'Irvine systems'), which were initiated by LOF Irvine during November 1935. While not designed for statistical treatment, both these long-term treatments are still running with minor alterations, and provide excellent information on the influence of different rest and grazing treatments on the vegetation. In this paper, available long-term botanical survey data of the woody component at the protected site were used to document long-term changes in the woody component and tree species establishment or succession sequence for trees the Sourish Mixed Bushveld in a similar way as was done by Jordaan et al. (2004) for Limpopo Valley Mopaniveld.

The experimental sites are situated at the ADC on the southern part of the Springbok Flats, approximately 4 km south-east of Bela Bela (Warmbad) in the Limpopo province (24°25′ S, 28°21′ E; 1 184 m above sea level). The vegetation type is classified as Sourish Mixed Bushveld (Acocks 1988). The woody layer is dominated by *Dichrostachys cinerea* and *Acacia* spp., and the grass layer by *Eragrostis* spp. (*E. barbinodis* and *E. rigidior*), *Panicum maximum*, *Themeda triandra* and *Heteropogon contortus*.

The ADC is situated in the summer rainfall region with a long-term mean annual rainfall (60 years) of 627 mm (Warmbad Towoomba weather station data). The rainfall distribution during the season is the highest during the period November to February and the lowest during May to August. The annual rainfall distribution is erratic, and rain often occurs in short bursts of high intensity, associated with thunder storms and lightning. Hail occurs sporadically while seasonal droughts often occur during mid-January to mid-February.

The long-term daily mean maximum and minimum temperatures at Towoomba vary between 29.7 °C and 16.5 °C for December and 20.8 °C and 3.0 °C for July, respectively (Warmbad Towoomba weather station data). Light frost

occurs sporadically during June and July. Air temperatures above 30 °C and below freezing point can be expected for 87 d and 8 d of the year, respectively. The highest mean monthly air temperatures were recorded during January 1983 (monthly average 39.7 °C) and the lowest during June 1979 (monthly mean −7.6 °C).

The mean annual evaporation at Towoomba is 2 439 mm y^{-1}, with the highest evaporation occurring during January (average 277 mm) and the lowest during June (113 mm). Relative humidity varies between a mean high of 78% and a mean low of 31% during December. The experimental sites receive a mean of 8.7 h of sunlight per day (Warmbad Towoomba weather station data). According to the Soil Classification Working Group (1991), the soils of the experimental sites are of the Oakleaf form (Stella family). The experimental sites are flat with a 0.6% fall from a north-western to a south-eastern direction (Lademann 1983).

A site, 2.1 ha in size, was fenced in with barbed wire for protection against grazing and browsing by larger ungulates. The site is approximately 700 m long and 30 m wide, tapering to 20 m, with a contour bank at the end. Fire has been excluded from the site as far as possible, but the site was subjected to an extremely hot fire during 1976. Since earlier rangeland research was mainly aimed at the grass component, only two tree density surveys were conducted at the protected site between 1935 and 2000. During 1977, BH Robinson (Towoomba ADC, unpublished data) counted all trees at the site, while Jordaan (2004) repeated the survey during 2000.

Tree density increased from 3 410 to 5 078 trees ha^{-1} between 1977 and 2000 (Table 1). During 1977, leguminous tree species dominated, while broadleaved species dominated during 2000. Twelve new tree species were recorded at the site, with only two being leguminous (*Acacia habeclada* and *A. mellifera*). *Lantana camara* appeared as an invader throughout the protected site. Changes in the woody component clearly indicated a shift from an *Acacia*-dominated site to one that supported a wider variety of broadleaved, evergreen tree species.

Trends in the colonisation sequence of woody species are illustrated in Table 1. Woody species were grouped as early, intermediate or late colonisers based on their change in abundance between 1977 and 2000.

Tree species that were present during 1977 and decreased in abundance between 1977 and 2000 were classified as early colonisers. *Acacia karroo* and *Dichrostachys cinerea* showed the largest decrease in density. The percentage of total tree cover comprising *Acacia nilotica*, *A. gerrardii*, *A. tortilis* and *A. caffra* decreased substantially, but because of their lower overall density their absolute change in abundance was less dramatic than that of *A. karroo* and *D. cinerea*. The species included in this group appear to be early colonisers or pioneer species, consisting mostly of legumes. Several dead trees (especially *A. karroo* and *D. cinerea*) were recorded at the site in 2000, indicating that the populations of these species may have reached the end of their life span. *Sclerocarya birrea* decreased in abundance between 1977 and 2000, but the reason for this is unknown. Trees that occurred at the protected site during 1977 were mostly juveniles (<1.0 m) and trees probably died out due to a low survival rate. *Searsia pyroides* also decreased in abundance, but less so than the leguminous component.

Tree species where little or no density change occurred between 1977 and 2000 were classed as early to intermediate colonisers. These included *Acacia habeclada* and *A. mellifera*, both of which were absent during 1977 and present in small numbers during 2000, suggesting the beginning of their establishment. This coincides with decreases in the numbers of other leguminous species. The broadleaved component of this group included *Ximenia caffra* and *Dombeya rotundifolia*. These species could also, as in the case of *S. pyroides*, be regarded as species that were continuously present, but due to their low occurrence they could also be regarded as early broadleaved colonisers. *Searsia engleri* decreased in abundance, but was present in very low density at both dates.

Tree species present during 1977 that increased between 1977 and 2000 were classified as intermediate colonisers. This group included only two leguminous species, namely *A. robusta*, which increased substantially, and *Peltophorum africanum*, which increased to a lesser extent. The remainder of this group included various broadleaved species, which could be further subdivided into two subgroups. The first group comprises species where increases exceeded 100 individuals ha^{-1}. This group consisted mainly of shrubs (*Diospyros lycioides*, the *Maytenus/Gymnosporia* species group, *Euclea* species and *Grewia flava*). The only tree that occurred in this group was *Searsia leptodictya.* The second group consisted of four broadleaved tree and one shrub species, which showed a lower rate of increase. Juveniles of three of these, namely *Pappea capensis, Boscia albitrunca* and *Carissa bispinosa*, established under tree canopies, coinciding with tree density changes at the site. The other species in this group was *Ziziphus mucronata*.

Late colonisers were tree species that were absent during 1977 and present during 2000 only. This group comprised broadleaved species only and included two indigenous shrubs (*Grewia flavescens* and *Tarchonanthus camphoratus*), one invader shrub (*Lantana camara*) and several species that occurred in small numbers in the adjacent Sour Bushveld (more specifically the Waterberg Mountain Sourveld), namely *Berchemia zeyheri, Cassine transvaalensis, Schotia brachypetala, Ximenia caffra, Heteropyxis natalensis, Terminalia sericea* and *Vangueria infausta*. The only species that increased substantially was *Searsia lancea*, which is known to germinate easily, and has high germination and fast growth rates (Venter and Venter 1996). *Lantana camara* appeared to establish in shady conditions, associated with a build-up of soil fertility, for example under *P. maximum* (Smit and van Romburgh 1993).

Broadleaf tree establishment appeared to depend on the occurrence of a leguminous component. Young individuals of certain broadleaved tree species (*P. capensis*, *C. bispinosa* and *G. flavescens*) were mostly found under established tree canopies. This suggests that certain broadleaved trees are associated with closed tree canopies (Hoffman and O'Connor 1999, O'Connor and Crow 1999), and agrees with the findings of Friedel and Blackmore (1988), who specifically identified *Acacia* spp. as the facilitators of the early invasion of broadleaved woody plants.

Table 1: Woody species groupings according to time of establishment at the protected site at the Towoomba Agricultural Development Centre

Colonisation status	Species	Tree density 1977 (individuals ha^{-1})	Tree density 2000 (individuals ha^{-1})	Increase/decrease (individuals ha^{-1})	Percentage change
Early colonisers: species present during 1977, decreasing between 1977 and 2000					
Early leguminous colonisers	*Acacia nilotica*	107	12	−95	−89
	Acacia karroo	636	156	−480	−75
	Acacia gerrardii	104	28	−76	−73
	Acacia tortilis	64	21	−43	−67
	Acacia caffra	162	94	−68	−42
Early broadleaf colonisers	*Dichrostachys cinerea*	841	623	−218	−26
	Sclerocarya birrea	16	1	−15	−94
	Searsia pyroides	56	43	−13	−23
Early to intermediate colonisers: species with little density change between 1977 and 2000					
Intermediate leguminous colonisers	*Acacia habeclada*	0	1	1	100
	Acacia mellifera	0	2	2	100
Early to intermediate broadleaf colonisers	*Ximenia caffra*	2	5	3	150
	Searsia engleri	2	1	−1	−50
	Dombeya rotundifolia	4	5	1	25
Intermediate to late colonisers: species present during 1977, increasing between 1977 and 2000					
Late leguminous colonisers	*Acacia robusta*	98	234	136	139
	Peltophorum africanum	12	25	13	108
Intermediate broadleaf colonisers	*Diospyros lycioides*	425	1 168	743	175
	Maytenus/*Gymnosporia* spp.	57	464	407	714
	Euclea undulata	41	258	217	529
	Euclea crispa	1	214	213	21 300
	Grewia flava	419	618	199	47
	Ehretia rigida	241	377	136	56
	Searsia leptodictya	52	173	121	233
	Boscia albitrunca	10	42	32	320
	Carissa bispinosa	12	40	28	233
	Ziziphus mucronata	42	68	26	62
	Pappea capensis	6	23	17	283
Late colonisers: species absent during 1977 and present during 2000					
	Berchemia zeyheri	0	1	1	100
	Terminalia sericea	0	1	1	100
	Vangueria infausta	0	1	1	100
	Heteropyxis natalensis	0	1	1	100
	Cassine transvaalensis	0	3	3	100
	Schotia brachypetala	0	5	5	100
	Grewia flavescens	0	13	13	100
	Tarchonanthus camphoratus	0	14	14	100
	Searsia lancea	0	103	103	100
	Lantana camara	0	242	242	100
Tree density leguminous species (individuals ha^{-1})		2 024	1 201	−823	−41
Tree density broadleaved species (individuals ha^{-1})		1 386	3 877	2 501	180
Total tree density (individuals ha^{-1})		3 410	5 078	1 668	49
Number of tree species		24	36	12	50

The leguminous component appeared to have its own establishment sequence, with different *Acacia* spp. establishing at different time intervals. In the Sourish Mixed Bushveld, the first trees to establish were legumes (*D. cinerea, A. karroo* [on heavier soils], *A. tortillis, A. gerrardii, A. nilotica* and *A. caffra*). This is often seen in practice, where old lands are severely encroached by one or all of the above-mentioned tree species. During the mid-succession stage of the leguminous component, *A. habeclada* and *A. mellifera* appeared to increase at the protected site, with *A. robusta* and *P. africanum* establishing at a later stage (Table 1).

Similarly, different broadleaved tree species also appeared to establish at different time intervals. The general broadleaved pioneers appeared to be mainly shrubs (*Grewia* spp., *E. rigida*, *Euclea* spp., *D. lycioides*, *Maytenus*/*Gymnosporia* spp.) and *S. leptodictya*. The initial broadleaf establishment apparently depends on the success of the early leguminous establishment sequence, which create a suitable

microclimate to ensure successful germination conditions (Friedel and Blackmore 1988) and appeared to correspond with the mid-colonisation stage of the leguminous component (Table 1). Intermediate colonisers included a combination of shrubs (*Carissa bispinosa*) and trees (*Pappea capensis*, *B. albitrunca* and *Z. mucronata*), which appeared to establish at a stage when late leguminous colonisers were present. Waterberg Mountain Sourveld tree species appeared to be late colonisers. It appeared as if high-growing broadleaved tree species such as *Cassine transvaalensis, Berchemia zehyeri*, *Schotia brachypetala* and *T. sericea*, might finally replace leguminous species in this particular area.

References

Acocks JPH. 1988. *Veld types of South Africa* (3rd edn). *Memoirs of the Botanical Survey of South Africa* No. 57. Pretoria: Government Printer.

Donaldson CH, Rootman GT. 1983. Continuous grazing and fixed seasonal rotational grazing systems. Final report. Research project T5411/41/1/1. Bela Bela: Towoomba Agricultural Development Centre.

Friedel MH, Blackmore AC. 1988. The development of veld assessment in the Northern Transvaal Savanna I. Red Turfveld. *Journal of the Grassland Society of Southern Africa* 5: 26–37.

Hoffman MT, O'Connor TG. 1999. Vegetation changes over forty years in the Weenen/Muden area, KwaZulu-Natal: evidence from photo panoramas. *African Journal of Range and Forage Science* 16: 71–88.

Jordaan JJ. 2004. Bush encroachment dynamics and the effect of biological control in two veld types in the Limpopo Province Bushveld. PhD thesis, University of the North, South Africa.

Jordaan JJ, Wessels DCJ, Dannhauser CS, Rootman GT. 2004. Secondary succession in the Mopani veld of the Limpopo Valley, South Africa. *African Journal of Range and Forage Science* 21: 205–210.

Lademann EE. 1983. Towoombanavorsingstasie. *Agrivaal* 5: 3–7.

O'Connor TG, Crow VRT. 1999. Rate and pattern of bush encroachment in Eastern Cape savanna and grassland. *African Journal of Range and Forage Science* 16: 26–31.

Smit GN, van Romburgh KSK. 1993. Relations between tree height and the occurrence of *Panicum maximum* in the Sourish Mixed Bushveld. *African Journal of Range and Forage Science* 10: 151–153.

Soil Classification Working Group. 1991. *Soil classification: a taxonomic system for South Africa*. *Memoirs of the Natural Agricultural Resources of South Africa* No. 15. Pretoria: Department of Agricultural Development.

Venter F, Venter J-A. 1996. *Making the most of indigenous trees.* Pretoria: Briza Publications.