

Studies on Mukwa (*Pterocarpus angolensis*, D. C.) Dieback in Chobe Forest Reserves in Botswana

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Received: May 30, 2012 Accepted: July 2, 2012 Online Published: August 20, 2012

doi:10.5539/jps.v1n2p154

URL: <http://dx.doi.org/10.5539/jps.v1n2p154>

Abstract

A study was carried out in forest reserves located in Chobe district in Botswana to assess the effect of dieback and associated causes on Mukwa tree, *Pterocarpus angolensis*. Fire, elephant damage and dieback were assessed in Chobe and Kazuma forest reserves and Pandamatenga farming area. Fire damage frequency on mukwa trees ranged between 60 to 100 % and was highest in Pandamatenga and Chobe forest reserves. The frequency of elephant damage in Kazuma and Chobe forest reserves was 75 and 100 % respectively. There was no elephant damage in Pandamatenga farms because the area is fenced out and minor dieback occurred in the area. All areas under study experienced 100 % incidence of dieback, but the severity ranged from 22 to 100 %, the highest being at Chobe forest reserve and the lowest at Pandamatenga. Severity of dieback was associated with elephant damage and age of *P. angolensis* trees. The incidence of dieback was correlated with DBH and tree age. The results indicate that the cause of dieback is mostly due to elephant and fire damage.

Keywords: *Pterocarpus angolensis*, dieback, fire, elephant, Botswana

1. Introduction

Mukwa (*Pterocarpus angolensis*) is a nitrogen fixing indigenous tree belonging to the Papilionoideae family, which is widespread in woodland and wooded grassland throughout Central, East and Southern Africa (Banda, Schwartz, & Caro, 2006). The tree grows throughout Northern Botswana and may be found in all woodland types as well as in dry evergreen and dry deciduous forests (Coates-Palgrave, 1992). *P. angolensis* is valuable in furniture making, flooring, musical instruments, and boats, charcoal making as well as being a source of firewood, tool handlings, carving, construction poles, medicine, fodder, bee forage and as an ornamental plant (Coates-Palgrave, 1992).

P. angolensis is one of the most well-known woods in southern tropical Africa (Banda et al., 2006) characterised by a durable heart wood which is resistant to fire, decay, wood rotting fungi, termite attack, terrestrial and marine borers (Coetzee & Van Vuuren, 1984; Monela, O’Ktin’ati, & Kiwele, 2003). The sapwood, however is susceptible to damage by powder post beetles and other borers implying that logs need to be converted into boards as soon as possible and planks pre-treated before air drying (Coetzee & Van Vuuren, 1984). *P. angolensis* in the forest reserves is affected by elephant damage, fire, drought and dieback which may have impact on the species populations. The effects of dieback on natural populations of *P. angolensis* on the Miombo woodlands in general have been reported by several authors (Anon, 1985; Banda et al., 2006; Kikula, 1986; Rampart, 2007; Rampart, Cahalan, Mmolotsi, & Kopong, 2010). The major factors causing dieback of *P. angolensis* include elephants (Ben-Shahar, 1993; Ben-Shahar, 1996; Rampart et al., 2010) and diseases (Mehl, Geldenhuys, Roux, & Wingfield, 2010). *P. angolensis* has been reported to be on decline in the Chobe Forest Reserves due to dieback (unpublished reports). However, knowledge on the severity of dieback and the casual factors in the Chobe District Forest Reserves is lacking. The objective of this paper was therefore to assess incidence and severity of dieback on *P. angolensis* and identify causal agents.

2. Materials and Methods

2.1 Description of the Study Site

The study was carried out in the Chobe District forest reserves in the northern part of Botswana. The area has an altitude of up to 1000 meters above sea level (Department of Meteorological Services, 2004). The Chobe forest reserves are characterized by harder, poorly drained soils, mainly near pans (Rommelzwaal, van Wavern, & Baert, 1988) and at some places slightly shallower and deep alluvial drier soils. The soils are generally neutral to acidic, poor in nutrients, with poor soil structure and low water holding capacity. The area is frequented by forest fire (Ben-Shahar, 1998). The climate of the area is sub-tropical with distinct summer and winter seasons. The Chobe forest reserves receive the highest annual rainfall in the country amounting to about 650 mm during the summer months between December and April. Temperatures vary between a mean monthly maximum of 34 °C and a mean minimum of 6°C (Bhalotra, 1985). The Chobe forest vegetation is dominated by *Baeikea plurijuga*, *Pterocarpus angolensis*, *Kirkia acuminata*, *Schinziophyton rautanenii*, *Guibourtia coleosperma*, *Combretum spp*, *Brachystegia spp*, *Burkea africana*, *Terminelia sericea* and *Colophospermum mopane* (Nowergian Forestry Society, 1992).

2.2 Experimental Procedures

A survey following a systematic sampling method was carried out in the two Forest Reserves namely Kazuma and Chobe Forest Reserves to assess the extent of dieback. Using a compass and measuring tape five transects of 1 km long each (i.e. 200 m inter transects spacing) were established at 50-100 m intervals from the initial reference point. Five plots (25 m x 25 m) separated by 200 m along transects were marked and all the trees showing symptoms of dieback and disease attack were recorded and percentage of affected trees determined using the following formula.

$$\text{Average infection rate (\%)} = \frac{\sum (\text{\# of trees affected by dieback per plot})}{\sum \text{of the trees per plot}} / N * 100$$

Where N = number of sampling units per forest reserve.

Pest and disease assessment was done on felled trees, by cutting open the stem to investigate infestation. The sampled arthropods were then taken to the Botswana College of Agriculture Entomology laboratory for identification. Samples of plants showing signs of infection were collected and brought to the laboratory for identification of pathogens. Soil and root samples were collected from the bases of the stems of felled trees to assess and assayed for soil borne microorganisms such as nematodes, fungi and bacteria. These microorganisms were isolated from infected trees and cultured on various nutrient media in the laboratory and then identified.

3. Results and Discussion

3.1 Dieback, Fire and Elephant Damage

Fire and elephant damage and dieback severity are shown in Table 1. *P. angolensis* in the Pandamatenga farming area, showed the least number of damage trees. The highest fire and elephant damage was observed in the Chobe Forest Reserve which also showed the highest diameter range with aging trees. Mehl et al. (2010) reported that the occurrence of dieback was related to fire damage. McGregor and O'Connor (2002) reported that dieback may also be influenced by vegetation structure, soil surface structure and soil chemistry. Natural thinning due to competition in dense forests has also been reported to result in dieback (McGregor & O'Connor, 2002).

Table 1. Fire, elephant damage and dieback in the different forest reserves

Reserve	Fire damage (%)	Elephant damage (%)	Dieback frequency (%)	Dieback severity (%)	DBH (cm)	Height (m)
Chobe	100	100	100	100	96.73±1.5	17.27±0.8
Kazuma	60	75	100	22.2	40.49±2.9	13.25±0.4
Pandamatenga	100	0	100	10	41.72±2.3	14.26±0.5
P value					0.006	0.0013

3.2 Insect Pests

The main insect pest observed on trees in the forest reserves were termites and wood boring insects. The species of termites found were in the families, Termitidae (Apicotermitinae, Termitinae, Macrotermitinae) and Hodotermitidae. The wood boring insects observed were in the family, Cerambycidae, order Coleoptera. Other insects associated with dieback like scale insects were not found on trees sampled from the forest reserves during the study. The termites were mostly found damaging the pith and heartwood of mukwa trees producing hollow openings in the stem (Figure 1). However there was no evident connection between pith damage by termites and dieback. The tunnelling done by cerambycid larvae also could not be evidently associated with dieback. Dieback in *P. angolensis* was reported to be caused by scale insects (*Aspidoproctus glaber*) (Patterson, Saint-Cyr, & Russell, 2007).



Figure 1. Damage by termites (a and b) through tunnelling and Cerambycidae (c) tunneling in the sapwood



Figure 2. Mistletoe growing on mukwa trees

3.3 Diseases

Field observations could not link the mukwa dieback symptoms to fungal or bacterial pathogens isolated. However, plants with mistletoe infestations had dieback on the distal parts of the infected branches (Figure 2).

The dieback was however minor as compared to that associated elephant and fire damage. The fungus, *Fusarium oxysporum* was reportedly associated with Dieback in Zimbabwe due to relatively dry conditions existing during the sampling periods (Patterson et al., 2007). Mehl et al. (2010) reported several organisms that are associated with dieback in the *P. angolensis*. These included saprophytic species such as *Candida*, *Penicillium* and *Humicola spp.* The potentially pathogenic species included *Lasiodiplodia theobromae*, *Cytospora spp.* and *Fusarium spp.* (Mehl et al., 2010).

4. Conclusion

Dieback occurrence was highest in areas where fires and elephants occurred and the severity was lowest in areas without elephant activity. High incidences of dieback were therefore associated with increased occurrence of fires and elephants in the forest reserves. Termite activity was high with tunnelling in *P. angolensis* tree stems. The pest and disease connection to dieback problem could not be determined but further investigations are required to confirm these observations. The study need to be repeated in the future to compare the current damage with any future damage so that conservation and protection measured could be implemented expediently.

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