ELSEVIER

Journal of Arid Environments 70 (2007) 1–17

Journal of Arid Environments

www.elsevier.com/locate/jaridenv

# A phenological study of dominant acacia tree species in areas with different rainfall regimes in the Kalahari of Botswana

M.B.M. Sekhwela[a,*], D.J. Yates[b]

[a]Office of Research and Development, University of Botswana, Private Bag UB00708, Gaborone, Botswana
[b]School of Integrative Biology, University of Queensland, Brisbane, Qld 4072, Australia

Received 21 April 2004; received in revised form 4 October 2006; accepted 13 December 2006
Available online 21 February 2007

## Abstract

The phenology of three dominant and economically important tree species; *Acacia erioloba*, *Acacia luederitzii* and *Acacia mellifera*, all widespread in the Kalahari in Botswana, was studied at Tsabong (25°56.65′S, 22°27.72′E) and Maun (20°09.60′S, 23°46.63′E) receiving 300 and 463 mm annual rainfall, respectively. The main aims were to investigate how possible environmental cues influence timing and development of phenophases and whether different tree species have different seasonal responses to these cues. Likely effects of climatic changes on phenological development patterns were also considered.

All three species studied had generally comparable seasonal responses irrespective of the mean annual rainfall at each site, but differed in the timing of certain phenophases. Both *A. erioloba* and *A. mellifera* flowered at the end of the cool dry season. *Acacia erioloba* produced new leaves simultaneous with flowers while *A. mellifera* produced fully developed fruits before leaves. On the other hand, *A. luederitzii* produced leaves and flowered after rain and well into the growing season, with leaves appearing before the flowers. For *A. erioloba* and *A. mellifera*, temperature and daylength appeared to be the most probable phenological cues, while in the case of *A. luederitzii*, it was rainfall. All species produced lower amounts of certain litter components during the year of lower rainfall at the Tsabong site, affecting fodder availability.

Livestock was observed feeding on newly emerged flowers, leaves and new twigs, relieved from scratching the ground for dry grass, fallen leaves and pods. Other studies have also observed new growth to provide valuable fodder in the dry season and drought periods, making phenological timing economically crucial. Any shift in climatic factors that affect this timing may have detrimental consequences. Drought is the best-known example of an extreme shift. There is need for more

*Corresponding author. Fax: +267 3957573.
*E-mail addresses:* sekhwela@mopipi.ub.bw (M.B.M. Sekhwela), d.yates@uq.edu.au (D.J. Yates).

0140-1963/$ - see front matter 
doi:10.1016/j.jaridenv.2006.12.006

information on the likely extent of other shifts and possible effects in vulnerable areas such as the Kalahari in the face of changing environmental and climatic conditions.


*Keywords:* Kalahari; Phenology; *Acacia luederitzii*; *Acacia erioloba*; *Acacia mellifera*; Litter

## 1. Introduction

In arid and semi-arid areas such as found in the Kalahari in Botswana, leaf flushing during dry periods has been observed to provide valuable fodder to livestock otherwise feeding on dry fallen leaves (Hunt, 1954). Cattle have been observed browsing leaves and fruits of certain bushes preferentially even during period of plentiful grass availability in Botswana (Moleele, 1998). Livestock in the Sahel has been observed to feed on leaves, flowers and fruits of various tree and shrub species, particularly during the dry seasons when grass is scarce (von Maydell, 1990). Similar observations have been made on browsing ungulates in Botswana during stressful transition from spring to summer (Styles and Skinner, 2000). These examples highlight the importance of woody plant phenology, not only as an indicator of plant responses to environmental conditions, but also economically, in terms of fodder availability for livestock production.

There have been few detailed studies on the triggers of phenological development in woody species in different vegetation types in the arid and semi-arid savannas of southern Africa (Shackleton, 1999; van Rooyen et al., 1986b). As an indicator of plant responses to stressful or favourable environmental conditions, phenology provides not only insights into how plant growth can be affected by such conditions, but also possible outcomes of management options.

The environmental factors that trigger growth in arid regions are still poorly understood. Working in the dry savannas of Zimbabwe, Kelly and Walker (1976) found new growth flushing in woody vegetation to be controlled by either day-length or temperature and that it began several weeks before the onset of the rains. Similar observations have been made on the Kalahari sand vegetation (Zimbabwe) where leaf fall in all species studied was related to decreasing soil moisture and minimum temperature (Childes, 1989). Certain woody plant species in South African savannas have also been shown to come into leaf and even flower well before rains start (Milton, 1987; van Rooyen et al., 1986a, b) and to reach maximum production rates early in the growing season (Cresswell et al., 1982). Similarly, Williams et al. (1997) found pre-rain flushing among dominant tree species in the mesic tropical savannas of Northern Australia. Such phenological patterns have also been observed in some tree and shrub species in Botswana (Tolsma, 1989; Timberlake, 1980; Miller, 1949). Trees that flush early are thought to use the previous season's stored resources (Bertiller et al., 1991; Borchert, 1994a; Childes, 1989; Rutherford, 1984). Whether there is, in fact, water uptake under these conditions is not well established although Childes (1989) and Borchert (1994a) believed that such trees have access to soil moisture. Borchert (1994a) and others have also demonstrated the importance of stem-stored water as an important source for species that flush prior to the rains. Irrigating trees during the dry period has been found to trigger flushing of new growth in tropical dry forest of Costa Rica (Borchert, 1994b). After an extensive review of available literature, Van Schaik et al. (1993) could not single out any specific predominant