Land Use and Water Resources Research

Modelling the effects of leafing phenology on growth and water use by selected agroforestry tree species in semi-arid Kenya

C.W. Muthuri[1] C.K. Ong[2], C.R. Black[3], B.M. Mati[1], V.W. Ngumi[1] and M. Van-Noordwijk[4]

[1]*Jomo Kenyatta University of Agriculture and Technology, PO Box 62000, Nairobi, Kenya (Email: c.muthuri@cgiar.org)*
[2]*World Agroforestry Centre, United Nations Avenue, Gigiri, PO Box 30677, Nairobi, Kenya*
[3]*Plant Sciences Division/School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough, LE12 5RD, UK*
[4]*World Agroforestry Centre, SE Asia, PO Box 161, Bogor 16001, Indonesia*

Abstract

The WaNuLCAS (**Wa**ter, **Nu**trient and **L**ight **C**apture in **A**groforestry **S**ystems) model was used to investigate the impact of tree leafing phenology on growth and water use of selected agroforestry tree species in semi-arid Central Kenya. Three agroforestry species, grevillea (*Grevillea robusta*), alnus (*Alnus acuminata*) and paulownia (*Paulownia fortunei*), respectively providing evergreen, semi-deciduous and deciduous leafing phenologies, were intercropped with maize. It was hypothesised that the deciduous habit of alnus and paulownia would réduce demand for water relative to the evergreen grevillea under conditions of limited supplies. WaNuLCAS simulations showed that altering leafing phenology from evergreen through semi-deciduous to deciduous decreased water uptake and interception losses by the trees, but increased crop water uptake, drainage and soil evaporation rates for systems containing all three tree species. Drainage and soil evaporation were respectively 14 and 17% greater in the deciduous paulownia system than in the evergreen grevillea. Simulated water uptake and biomass accumulation by grevillea were more than double the corresponding values for paulownia, while crop water uptake in the grevillea and paulownia systems was reduced by 6% and 0.2% respectively relative to sole maize. The simulations imply that water use by paulownia is lower than for grevillea and suggest that leafing phenology is a key attribute affecting water use by trees. The significance of these observations for watershed management and stream flow are discussed.

Introduction

Increasing population pressure in Kenya and consequent shortages of arable land have induced considerable migration to semi-arid areas with low agricultural potential (Otengi *et al.*, 1995). This has been accompanied by rapid clearance of natural forests to provide land for cultivation (Lott *et al.*, 2000), supply timber products and meet basic community needs for commodities such as charcoal (KWS, 1999; Ayuk *et al.*, 1999; Okello *et al.*, 2001). This problem is particularly acute in the Naro Moru area west of Mount Kenya, where immigration has caused rapid changes in land use and increased demand for water (Njeru, 1995). Having originated