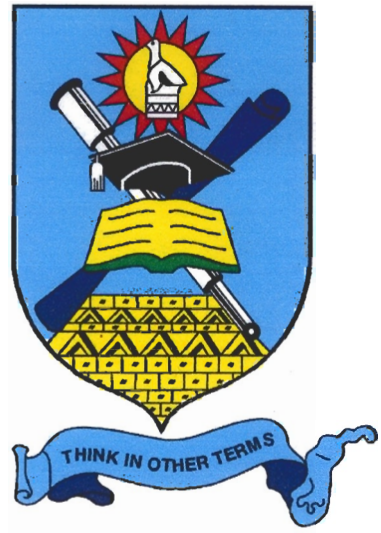

SOIL AND FOLIAR NUTRIENT DYNAMICS IN A SEMI-ARID MOPANE WOODLAND ECOSYSTEM IN ZIMBABWE

By
Donald Mlambo (N0032379D

A Thesis Submitted In Fulfillment of

DOCTOR OF PHILOSOPHY IN FOREST ECOLOGY

DEPARTMENT OF FOREST RESOURCES AND WILDLIFE MANAGEMENT

FACULTY OF APPLIED SCIENCES

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

Supervisors:

Dr P. Nyathi, Prof E. Mwenje and Prof P. Mundy

January 2009

ABSTRACT

The objective of this study was to investigate the role of trees in maintaining nutrient cycles in a semi-arid mopane woodland in Zimbabwe. The main hypothesis was that mopane trees improve soil fertility beneath their canopies, and not at the expense of intercanopy areas. Soil organic carbon, nutrients (N, P and K) and microbial biomass were more than twice as high beneath large trees as compared to the intercanopy areas. Herbaceous biomass was 128 g m^{-2} beneath trees and declined to 98 g m^{-2} in the intercanopy areas. Herbaceous species diversity (H′) was 2.7 in the intercanopy areas and declined to 1.8 beneath trees.

Mean annual total litterfall was 197, 83 and 35 g m^{-2} yr^{-1} beneath large and small trees, and in the intercanopy areas, respectively. The total potential annual element inputs via litterfall beneath large trees were two and five times greater than beneath small trees and in the intercanopy areas, respectively. Total litter standing crop was 405, 177 and 67 g m^{-2} beneath large, small trees and in the intercanopy areas, respectively. Concentrations of N, P and K in litterfall and surface soil were closely correlated with each other.

Canopy shade retarded decomposition of mopane leaf litter. Decomposition was fastest in the intercanopy areas, intermediate beneath small trees and slowest beneath large trees. Proportional release of N and P was slower than mass loss with slightly more N being released from litter beneath large than small trees and in the intercanopy areas.

Rainy-season net mineral N accumulation rate in the surface soil (0-10 cm) ranged from 3.71 μg g^{-1} mo^{-1} in the intercanopy areas to 8.80 μg g^{-1} mo^{-1} beneath large trees; correspondingly, net nitrate accumulation rates ranged from 1.33 to 3.60 μg g^{-1} mo^{-1}. Dry-season net mineral N and net nitrate accumulation rates were similar across sampling sites and did not exceed 2 and 0.4 μg g^{-1} mo^{-1}, respectively.

It was confirmed that isolated mopane trees improve soil surrounding them, creating fertile islands. The fertility improvement beneath trees is not at the expense of soil fertility in the intercanopy areas. The accumulation of litter and nutrients beneath isolated trees is affected by the tree's developmental stage. The improved soil fertility beneath trees is important for herbaceous biomass yield especially of shade-tolerant species. It may be concluded that the removal of large trees in semi-arid mopane savanna results in reduced nutrient input via litterfall and rapid decomposition of soil organic matter which in the long term may cause a deterioration in soil quality and fertility.