Plant and Soil **235:** 167–179, 2001.

Root distributions partially explain ^{15}N uptake patterns in *Gliricidia* and *Peltophorum* hedgerow intercropping systems

Edwin C. Rowe[1,2], Meine van Noordwijk[3], Didik Suprayogo[4], Kurniatun Hairiah[4], Kenneth E. Giller[1] & Georg Cadisch[1,5]

[1] *Department of Biology, Imperial College at Wye, University of London, Wye, Ashford, TN25 5AH, UK.* [2] *Current address: Institute for Environmental Science, Robinson Building, University of Wales, Bangor, LL57 2UW, UK.* [3] *ICRAF - S.E. ASIA, P.O. Box 161, Bogor 16001, Indonesia.* [4] *Fakultas Pertanian, Jurusan Tanah, Universitas Brawijaya, Jalan Veteran, Malang, Indonesia.* [5] *Corresponding author**

Received 11 July 2000. accepted in revised form 10 June 2001

Key words: competition, *Gliricidia sepium*, hedgerow, Indonesia, leaching, N uptake, N_2 fixation, *Peltophorum dasyrrachis*, subsoil

Abstract

The relative distributions of tree and crop roots in agroforestry associations may affect the degree of complementarity which can be achieved in their capture of below ground resources. Trees which root more deeply than crops may intercept leaching nitrogen and thus improve nitrogen use efficiency. This hypothesis was tested by injection of small doses of $(^{15}NH_4)_2SO_4$ at 21.8 atom% ^{15}N at different soil depths within established hedgerow intercropping systems on an Ultisol in Lampung, Indonesia. In the top 10 cm of soil in intercrops of maize and trees, root length density (L_{rv}) of maize was greater than that of *Gliricidia sepium* trees, which had greater L_{rv} in this topsoil layer than *Peltophorum dasyrrachis* trees. *Peltophorum* trees had a greater proportion of their roots in deeper soil layers than *Gliricidia* or maize. These vertical root distributions were related to the pattern of recovery of ^{15}N placed at different soil depths; more ^{15}N was recovered by maize and *Gliricidia* from placements at 5 cm depth than from placements at 45 or 65 cm depth. *Peltophorum* recovered similar amounts of ^{15}N from placements at each of these depths, and hence had a deeper N uptake distribution than *Gliricidia* or maize. Differences in tree L_{rv} across the cropping alley were comparatively small, and there was no significant difference ($P<0.05$) in the uptake of ^{15}N placed in topsoil at different distances from hedgerows. A greater proportion of the ^{15}N recovered by maize was found in grain following ^{15}N placement at 45 cm or 65 cm depth than following placement at 5 cm depth, reflecting the later arrival of maize roots in these deeper soil layers. Thus trees have an important role in preventing N leaching from subsoil during early crop establishment, although they themselves showed a lag phase in ^{15}N uptake after pruning. Residual ^{15}N enrichment in soil was strongly related to application depth even 406 days after ^{15}N placement, demonstrating the validity of this approach to mapping root activity distributions.

Introduction

Deep rooting trees have been recommended for simultaneous agroforestry systems (Schroth, 1995), on the assumption that root distributions reflect the distribution of nutrient uptake activity. The distribution of root activity will also depend on other factors such as the water content of different soil layers, but the presence of roots at least indicates that uptake can occur. Potential nutrient uptake rates are limited by the quantity of roots per unit soil volume, and are a function of the distribution of root surface area within the soil volume (de Willigen and van Noordwijk, 1987). Root surface area is difficult to measure in practice, and so root diameter is commonly assumed to be constant and only root length is measured. The length of roots per unit soil volume is referred to as root length density (L_{rv}).

* Fax no: +44-0-20-759-42640. E-mail: g.cadisch@ic.ac.uk