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ROOT DISTRIBUTION IN AN ALLEY CROPPING SYSTEM

Investigations in base cation recycling potential of trees in alley cropping systems are being conducted in Sitiung, West Sumatra, Indonesia. Most of the soils in this high rainfall region (2500-3000 mm/year) are inherently low in base status and ECEC and high in aluminum saturation. Along with the potential ameliorative effects of tree organic material additions on reducing aluminum toxicity, trees in an alley cropping system may also provide a mechanism for recycling fertilizer amendments and thus in turn aid in the sustainability of the soil base cation pool.

Through an understanding of some of the spatial and temporal below-ground tree-food-crop interactions in an alley cropping system, the potential for this mechanism can be assessed. A goal of the overall work is to lead to the development of tree-food-crop management strategies which can exploit the potential nutrient recycling mechanism and allow trees to complement the food crop rather than compete with it for limited soil nutrients.

This report covers a preliminary observation of root distribution conducted as a guide to further studies. A four-year-old alley cropping trial located on a Typic Paledult is serving as the study system. Representative before- treatment soil analyses (0-15 cm) are: 2.21 Al+H, 0.76 Ca, and 0.28 Mg cmol/kg (1 N KCl); 0.07 cmol/kg K and 0.9 ppm P (Mehlich I).

A plot containing *Calliandra calothyrsus* Meissn., limed from 66% to approximately 25% acid saturation, was selected for root distribution observation. Each plot measures 5.5 x 12 m and contains three 5.5 m rows of trees with 4 m of alley between the tree rows and 2 m borders on the outer side of the two outermost tree rows. A pit was dug from outside the plot area to approximately 75 cm into the plot. The center tree row formed the left side of the profile wall and an outer tree row formed the right side of the profile wall with a 4 m alley in between the tree rows.

Root samples (using a 1382 cm3 steel core), bulk density, soil moisture, penetrometer, and soil samples for chemical analyses were taken at 15 cm depth increments at each of eight points across the alley (20, 70, 120, 170, 230, 280, 330, and 380 cm from the left tree row). Sampling was conducted in 15 cm depth increments, to a depth of 150 cm, at each of the eight locations across the alley. A total of 80 samples were collected.

Only the root data is presented here. Roots were washed, oven dried at 60 C for 48 hours, and then weighed. Both total root weight and fine root (<1 mm diameter after drying) weight were determined, but only fine root weight is presented.

The plots were essentially devoid of any other vegetation besides *C. calothyrsus* because weed growth was minimal and cowpea (*Vigna unguiculata*) had been harvested 39 days before. The calliandra had last been pruned on May 29, 1988, four months prior to the root sampling. Because live and dead roots were separated in sampling, and the plots were predominantly bare, some confidence is expressed that most of the roots collected were from *C. calothyrsus*. This is probably the case, both adjacent to the tree row and at deeper depths in the profile. However, all root weights are reported as being a combination of calliandra, cowpea, and weed roots.

The top 0-15 cm contained 78% of the total fine root weight. An additional contribution of 9% from the 15-30 cm increment resulted in 87% of the fine root weight distribution being located in at least the top 30 cm, if not at even a shallower depth.

The tota' fine root weight to 150 cm in relation to distance from the left tree row ranged from 1044 (at 330 cm) to 2046 (at 70 cm) g/m3. Remarkably, both these locations were 70 cm from their respective tree row. This variation is mostly accounted for by the difference in the top 15 cm root distribution (Figure 1a). The four locations nearest the left tree row had higher total amounts of fine root density than the four locations nearest the right tree row. Again, this difference is mostly accounted for within the top 0- 15 cm. It is quite obvious, however, that at depths lower than 15 cm much higher amounts of fine roots are located by the right tree row (Figures 1a and 1b).

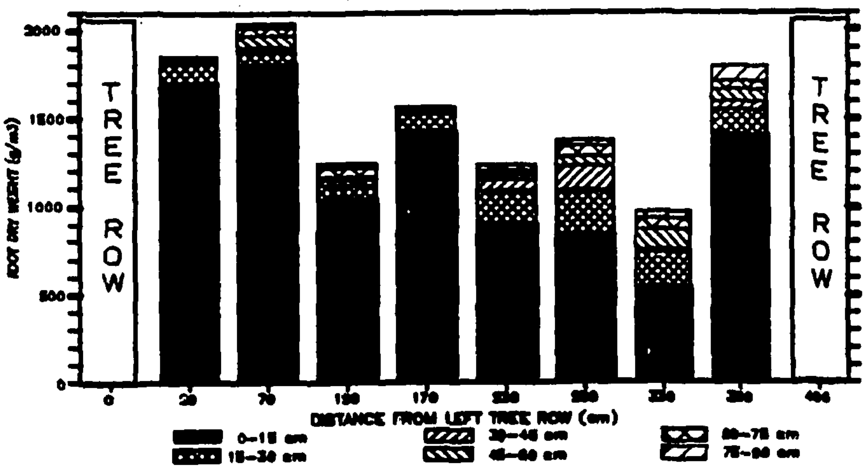

Figure 1a. Distribution of Calliandra + cowpea + weed fine roots (<2 mm) from a 0–90 cm soil depth in a 4 meter wide alley between two hedgerows of Calliandra (tree rows were not sampled).

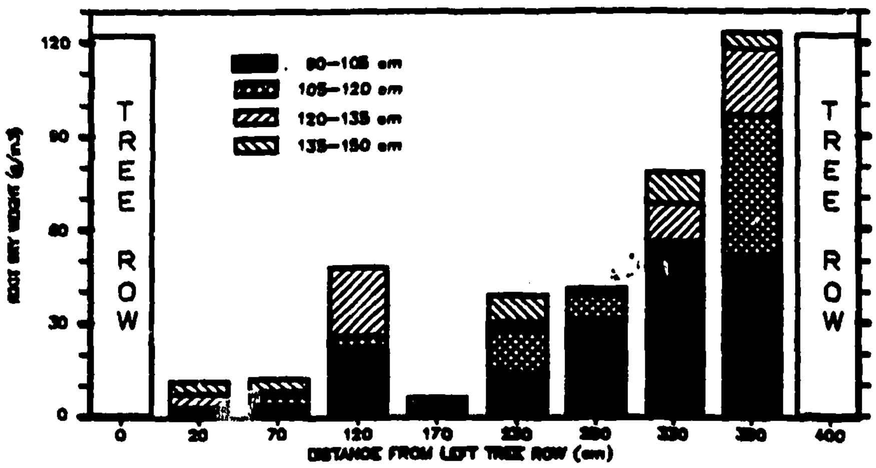

Figure 1b. Distribution of Calliandra + cowpea + weed fine roots (<2 mm) from a 90–150 cm soil depth in a four meter wide alley between two hedgerows of Calliandra (tree rows not sampled).

Roots were still obtained at 150 cm depth. All four locations nearest the right tree row still had relatively high amounts of roots down to a depth of 105 cm. In terms of nutrient recycling in these low base status soils it is probably more desirable to have a significant amount of roots located not far below the lowest depths of the food crop roots rather than to have roots located at deeper depths in the soil.

An indication of the variability encountered, due to either the sampling method or to actual tree root spatial variability, can be observed from the data. For example, if only the left half of the alley (up to 170 cm from the left tree row) had been sampled, the total amount of fine roots 20 cm from the tree row would have been 43 g/m^3 between a soil depth of 30-150 cm. However, sampling 20 cm from the right tree row would have resulted in a total of 368 g/m^3 of fine roots. A larger quantity of fine roots was observed at the 105-120 cm depth (46 g/m^3) at a distance of 20 cm from the right tree row than was obtained from the entire 30-150 cm depth at a distance of 20 cm from the left tree row.

The sampling transect was determined by selecting areas of trees, in both rows, that exhibited vigorous above-ground growth. The trees in the right row were, however, taller than the trees in the left row. Deeper root systems of several food crops grown in the Sitiung area have also been shown to be correlated with increased above-ground plant growth (Arya *et al.*, 1988).

This preliminary root observation confirmed the presence of roots at depths below those normally expected for annual food crops on this soil (Arya *et al.*, 1988). Further investigations will center on whether these roots can substantially contribute to nutrient recycling at deeper depths or if the trees take up most of their nutrients from the same soil volume as the food crops. The temporal effect of pruning on tree root activity at various soil depths will also be studied.

Reference:

Arya, L.M., B. Rusman, Kasli, R. Guyton, I. Amien, IPG Widjaja-Adhi, Sholeh, and O. Sopandi. 1988. Rooting patterns and plant production for food crops and nonfood vegetation in the upland acid soils of Sitiung, West Sumatra, Indonesia. Research Brief No. 46, TropSoils Project, Center for Soil Research, Bogor, and University of Hawaii, Honolulu.