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Decomposition and nitrogen release from *Leucaena leucocephala* in central India

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Most soils in the tropics are deficient in nitrogen, phosphorus or both (Sanchez & Logan 1992) and can not support sustainable crop production without external inputs of inorganic fertilizer (Mafongoya *et al.* 1998). Small scale farmers in the tropics have limited access to inorganic fertilizer due to high costs, in some cases, unavailability of such fertilizers (Mafongoya *et al.* 1998). Alley cropping is a system in which arable crops are grown in the spaces between two rows of planted woody leguminous shrub which is pruned periodically during cropping season to prevent shading and provide green manure which upon decomposition provides nutrients to companion crops (Bross *et al.* 1995; Lehmann *et al.* 1995; Mafongoya *et al.* 1998). In a previous study, Pandey *et al.* (1998) found that *Leucaena* prunings did not support the growth of maize crop in a *Leucaena* based alley- cropping system. This stimulated us to investigate decomposition timing (percent weight loss) and nitrogen release pattern from *Leucaena* because these parameters help deciding time of green manuring and thereby regulating the synchronization in nitrogen release and its uptake by crops in the system. Objective of this study was to investigate moss loss and nitrogen release patterns from leaves and twigs of *L. leucocephala* (Lam) De Wit in a *Leucaena* based alley cropping system.

The study was conducted in a well established (3 yr old) alley cropping sytem at Research Farm of Indira Gandhi Agricultural University, Raipur (21°4′N latitude and 81°31′E longitude) of Chhattisgarh state, India. The altitude was 293 m above mean sea level. The climate is sub- humid monsoonic with marked seasonality. Rainy season prevails from mid June to Sept., winter from Nov. to Feb. and summer from March to mid June. October constitutes transition month between rainy and winter seasons. Average annual rainfall is 1384 mm of which 88% occurs during rainy season. Soil is vertisols (FAO 1988), black in colour, clay-loam in texture and poor in nutrients (pH = 7.13, Organic C = 0.61%, Total N = 0.038% and Total P = 0.062%) (Pandey *et al.* 2000).

Six, parallel rows of hedge of *Leucaena leucocephala*, each twenty meter long, were raised at 4 m distance in an agricultural field in east-west direction in July 1994. Hedge rows were pruned to 1 m thrice in a year i.e. August, November and May as a general practice of the system. Prunings were used as mulch. Crops like soybean was sown during rainy season and *Linum usitatisimum* in winter season in between two hedge rows (alley). Thus, there were 5 alleys

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of 20 m x 4 m size. Leaves and twigs of *Leucaena* were collected from the hedge rows. Twigs of *L.leucocephala* with a diameter of 3 to 4.5 mm were cut into pieces of 10 cm. All materials were air dried for 24 h. Nylon litter bags were prepared with 1 mm mesh size in order to minimize artificial litter loss from the bags and to maximize access to all major soil fauna. Separate bags were used for leaf and twig components. Fifteen gram of air-dried leaf and twig samples were put into 20 × 20 cm litter bags. On 13 July 1998, 20 litter bags of leaf and twig components were placed randomly in each alley at 10 cm depth of the soil to simulate green manuring. Thus, 100 litter bags of each component were incubated.

Ten random litter bags (2 from each alley) of each leaf and twig components were retrieved at one month interval from the soil. Immediately after recovery the litter bags were placed individually in polyethylene bags and transported to laboratory. The recovered materials were carefully separated from soil particles, dried at 80°C to constant weight and weighted. Dried materials were ground in Wiley Mill to pass a 1-mm mess screen. Samples of initial as well as incubated materials were analyzed for ash content (after ignition at 600°C for 6 h) and microkjeldahl N. Carbon concentration was assumed 50% of the ash-free dry weight (McBrayer & Cromack 1980). C-to-N ratios were calculated. Statistical analysis of the data was carried out using SPSS (PC+) statistical package for analysis of variance (ANOVA). Means were compared using least significant difference test (LSD).

Weight loss of the leaves and twig varied due to sampling dates ($P<0.001$). Maximum 88% cumulative weight loss in leaves occurred quickly in the beginning within 30 days and nearly 100% over the sampling period (Fig. 1a). The weight loss in twigs was relatively slower and amounted only 80 % across the sampling dates (Fig. 1b).

Quick mass loss from leaves of *Leucaena* seems mainly due to leaching of water soluble compounds, though not measured, like sugars, amino acids and soluble phenolics. High soil moisture and optimum temperature during rainy season could have facilitated greater

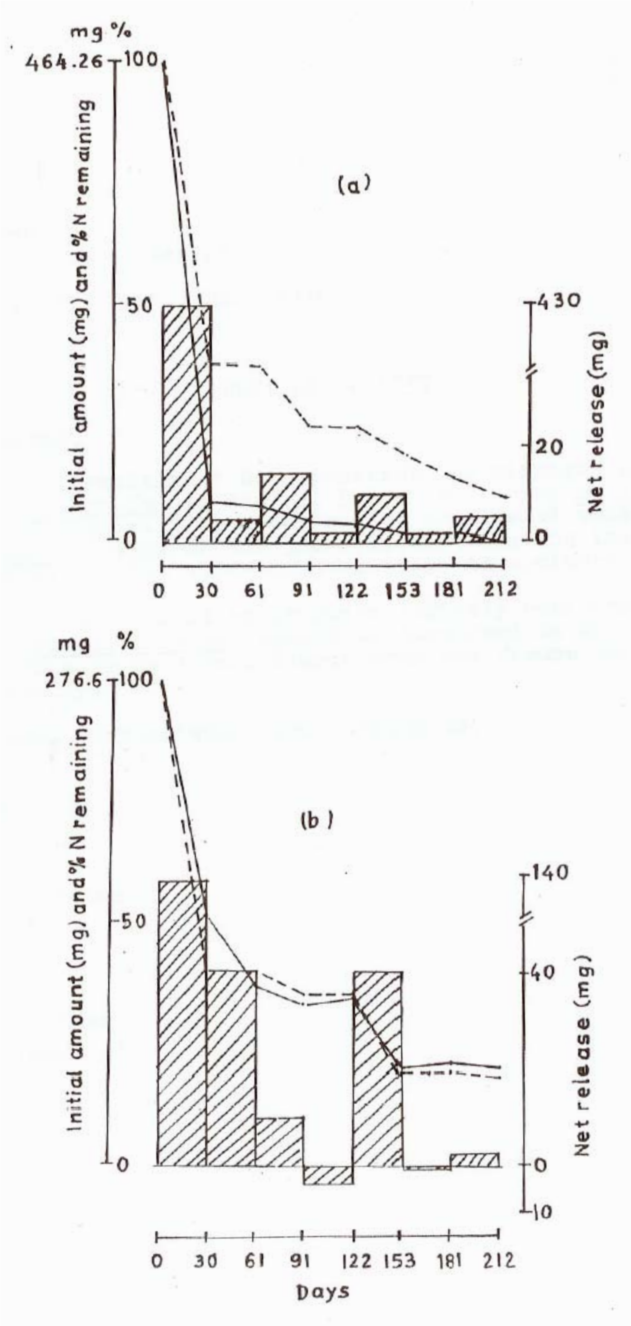

Fig 1. Changes in absolute amount of N in the (a) leaf, and (b) twig mass of *Leucaena leucocephala* enclosed in litter bags. The initial amount of nitrogen in the bags is given on the left side, Y- axis. The column indicates the net release between the decay periods (right side Y- axis). Broken curve indicates the percent weight remaining of enclosed leaf and twig mass.

growth in microbial population that could induce faster decomposition. However, quick weight loss in *Leucaena* leaves may also be attributed to structurally softer leaves (thinner cuticle and less sclerenchyma). Leaching seems to has played a dominant role in the nutrient release. Water content in the leaves of *Leucaena* was 64%. Quick weight loss may also be due to incorporation of leaves into the soil. Wilson *et al.* (1986) found much more rapid decomposition and greater N recovery of *L. leucocephala* when it was incorporated into soil. Similar results have been obtained with a large number of species with both high and low quality prunings (Mafongoya *et al.* 1997).

Initial concentration of nitrogen was 4.16% in the leaves and 2.35% in the twigs with C/N ratio of 11.8 and 20.8, respectively. Concentration of nitrogen in the leaves declined throughout the decay period. Unlike leaves, immobilization was observed in the twigs during the decay period. Variation in the N concentration was significant among the sampling dates ($P<0.01$). *Leucaena* released its maximum 92% nitrogen from its leaves within 30 days. But, release of N from the twigs was only 80% in 212 days.

Direct mineralization of nitrogen from the leaves may be attributed to low C/N ratio. Lehmann *et al.* (1995) also found direct release of most of the N from the leaves of *Gliricidia* without any immobilization. Sandhu *et al.* (1990) reported initial C/N ratio as a best predictor of N mineralization from leaves of *Leucaena*. In agroforestry systems where green foliage is incorporated in the soil, the soluble forms of carbon (including polyphenols) compared to the available nutrients (N and P) in organic materials will, in fact, have a dominating influence as microbial growth and activity, and the net nutrient mineralization or immobilization (Mafongoya *et al.* 1997).

Leucaena is found to produce 20 t ha^{-1} (fresh weight) prunings in a year (Pandey *et al.* 1998) indicating that green manuring with *Leucaena* may supply 254 kg N ha^{-1} yr^{-1} to crops in an alley cropping system. However, the temporal pattern of N release seems more important than the total amount. Soybean, which is a major crop in the study region during rainy season, requires 20-30 kg ha^{-1} nitrogen as a basal dose. After nodulation (2-3 weeks) the crop fulfill its N requirement from the atmospheric nitrogen. Maize is another crop which is grown in the study region during rainy season. It requires 120 kg ha^{-1} of nitrogen within 4-6 weeks after sowing (Lehmann *et al.* 1995). These indicate that time of green manuring should be different for different crops according to their nitrogen demand. For the former crop green manuring at the time of tilth preparation may be advantageous, whereas for the later at the time of sowing. However, further studies are required to confirm the assumptions.

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