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DECOMPOSITION DYNAMICS OF COCOA LITTER UNDER HUMID TROPICAL CONDITIONS

Litter acts as an input-output system of nutrients. Its decomposition is the primary mechanism by which organic matter and nutrients are returned to the soil for re-absorption by plants. Tropical trees retain a considerable portion of the nutrient capital incorporated in the leaf biomass. Litter dynamics studies are important in the nutrition budgeting of tropical ecosystems where vegetation depends on the recycling of nutrients in the leaf detritus.

The rate of decay of plant litter is governed by three factors, the physical and bio-chemical properties of the substrate, the environment under which decomposition takes place and the species active under the particular substrata and environmental conditions. Moisture and temperature are the most important abiotic factors governing the rate of biomass decomposition. In addition, the N content in the litter is also deciding the decay rate. The time taken for the decomposition of cocoa litter is of importance to consider its possible roles as a natural mulch and or as a nutrient reservoir in the heavy rainfall areas which are succumb to soil and nutrient erosion combined with non-rainy hot period of four to five months.

An experiment was conducted at the College of Horticulture, Thrissur in the full bearing cocoa plantations of KAU–Cadbury Co-operative Cocoa Research Project during 1995-97. The study was conducted using the standard litterbag technique (Bocock and Gilbert, 1957). Quadrants of size 1 m^2 were placed at 15 central points formed by four cocoa plants planted in rows and columns to quantify the litter fall. From this, the amount of fresh litter occurring naturally in a shaded cocoa field in 35 cm" area was found out. This was found to be 38 g on an average (the corresponding dry weight being 26.57 g). This much quantity of fresh cocoa litter was filled in litterbags, the sides of which were stapled. These bags were kept in the soil surface in 120 places on 7th July 1995. At bimonthly intervals, 20 bags each were withdrawn at random. The bags were washed to remove adhering soil particles. Extraneous materials like roots were removed and dry weight of residue remaining in each bag was recorded. The weight loss was worked out in percentage.

The decay rate coefficient was worked out for the constant potential weight loss by using the formula suggested by Olson (1963).

$$X_t / X_o = e^{-kt}$$

Where, X_t = the weight remaining at time 't' (g), X_o= original weight (g), e = base of natural logarithm, k = decay rate coefficient and t = time

The rate of decomposition of cocoa litter for one year is shown in Table 1. Within two months 40.53 per cent of the litter was decomposed. More than 95 per cent of the litter was decomposed within the first four months. A fast rate of decomposition had been reported for the litter of tropical tree species by many workers (Aranguren *et al.,* 1982; Kumar and Deepu, 1992; Kunhamu, 1994; Hegde, 1995). Favourable moisture and temperature regimes during this season (July-November) must have contributed towards the faster rate

Table 1. Decomposition of cocoa litter during a period of one year

Duration	Time (t) months	Weight (x) after 't' (g)	Decomposition %	Estimated wt. by the model, g
July 1995	0	26.57	0.00	26.57
Sept	2	15.80	40.53	10.87
Nov	4	1.17	95.56	4.45
Jan 1996	6	1.16	95.62	1.82
Mar	8	0.67	97.46	0.74
May	10	0.55	97.90	0.30
July	12	0.310	98.83	0.12

Model $Y = Y_0^{e^{-.4465t}}$
Predictability = 0.9644

of decomposition. There are reports that litter decomposed completely within 7 months in moist deciduous and moist evergreen forests in tropical environment and more or less one year in temperate deciduous forests (Ovington, 1962). Nevertheless, Singh *et al.* (1993) reported that only 3 to 5 months were required for complete decomposition of leaf litter of some important tree species in tropical deciduous forests.

After the fourth month, the decomposition process continued, though at a slow rate, gradually reached a maximum of 98.83 per cent by the end of the year. This implied that even after one year of exposure 1.17 per cent of the original material was not decomposed. Kunhamu (1994) had reported that 90 per cent of the litter of *Acacia auriculiformis* disappeared within six months and the residual mass was remaining up to 16 months. It is well known that consequent upon decomposition of any organic matter added to soil, the native soil organic matter also begins to decompose and in this process more quantities of nutrients are liberated for use by the plant through priming action.

The decomposition pattern was biphasic with an initial rapid phase followed by a slower phase. The initial rapid phase could be due to congenial environmental conditions associated with the presence of readily digestible water-soluble compounds in the litter. This might have triggered the activity of soil fauna and soil microbes, which are responsible for the decomposition. In addition, the high leaching losses of water-soluble fractions from the decomposing materials during the rainy periods might have resulted in a heavy mass loss during the initial phase (Hegde, 1995). The rapid rate of decomposition of cocoa litter from July to November indicates its significant role in crop production. It is an established fact that the yield of cocoa is at its peak both quantitatively and qualitatively during October-November in the tropical climatic condition of Kerala. The organic recycling achieved by litter decomposition and its subsequent impact on sustaining crop productivity in a cocoa plantation with large quantity of foliage is thus reiterated.

The latter slower phase could be due to absence of congenial condition such as high rainfall and also due to increased content of bio-decay resistant compounds and change in soil fauna responsible for decomposition, which may change with season. Most of the energy fixed autotropically found its way in the form of dead organic matter releasing different nutrients back to the soil by the action of biological and physical agencies. Kumar and Deepu (1992) reported that out of the structural chemistry attributes, nitrogen content of litter appeared to be a better predictor of decay rate constant. The litter under study contained 1.19, 0.09, 1.02, 1.58 and 0.72 per cent N, P, K, Ca and Mg respectively.

The rate of decomposition of cocoa residue was a function of time of exposure. The decay rate coefficient 'k' was worked out to study the constant potential weight loss by an exponential model. It was estimated by least square technique after logarithmic transformation. The value of k in the model was estimated to be 0.447. The value of k indicates the relative rate of decomposition in a month. Comparable k values had been reported for litter of tropical tree species by Hegde (1995).

The correlation ratio or predictability was 0.964 indicating a fairly good fit of the model to the observed data. The observed weight of cocoa litter along with the expected weights based on the estimated model is given in Table 1. Considering the substantially high quantity of litter produced and nutrients recycled, it can be concluded that litter fall has an important role in maintaining nutrient balance in cocoa ecosystem.

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REFERECNCES

Aranguren, J., Escalente, G. and Herrera, R. 1982. Nitrogen cycle of tropical perennial crops under shade trees: II Cacao. *Pl. Soil* 67: 259-269

Bocock, K.L. and Gilbert, O.J.W. 1957. The disappearance of litter under different woodland conditions. *Pl. Soil* 9: 179-185

Hegde, R. 1995. Nutrient content and decomposition of leaf litter of *Acacia mangium* Willd as affected by season and field conditions. M.Sc.(For.) thesis, Kerala Agricultural University, Thrissur

Kumar, B.M. and Deepu, J.K. 1992. Litter production and decomposition dynamics in moist deciduous forests of the Western Ghats in Peninsular India. *For. Ecol. Mange.* 50: 181-201

Kunhamu, T.K. 1994. Nutrient content and decomposition of leaf biomass of selected woody tree species. M.Sc.(For.) thesis, Kerala Agricultural University, Thrissur

Olson, J.S. 1963. Energy storage and balance of producers and decomposers in ecological systems. *Ecology* 44: 322-331

Ovington, J.D. 1962. Quantitative ecology and wood land ecosystem concept. *Adv. Ecol. Res.* 1: 103-192

Singh, O., Sharma, D.C. and Rawat, J.K. 1993. Production and decomposition of leaf litter in sal, teak, eucalyptus and poplar forests in Uttar Pradesh. *Indian For.* 119: 112-120