DECOMPOSITION RATE AND CHEMICAL COMPOSITION OF LEAFY MULCH OF SOME TREE SPECIES IN GHANA

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ABSTRACT

The decomposition rates of fresh leafy mulches of seven species were studied. The dependence of the biochemical compounds of these mulches on their rate of decomposition was also investigated. The study was undertaken to determine the suitability of these native species for mulching farmlands whose fertility have been declining steadily. The study was conducted at the demonstration farm of the Faculty of Renewable Natural Resources (FRNR), Kwame Nkrumah University of Science and Technology, Kumasi. A split-plot experiment in completely randomized design was used with main-plot treatments as species leafy mulch with five replicates and sub-plot factor as time between October 1, 2010 and February 3, 2011. A sample of the leafy mulch of each species was sent to the FRNR laboratory for chemical analyses. Three groups of species were identified based on the trends of the decomposition rate modeled using the exponential decay function. The fastest decomposition group consisted of ***Ceiba pentandra, Ricinodendron heudelotii*** *and* ***Gliricidia sepium****, with respective half-life of 28, 34 and 39 days. The second group of species comprised* ***Albizia zygia, Albizia adianthifolia, Albizia ferruginea*** *with a moderate rate of decay and with respective half-life of 66 days, 85 days and 88 days. The last group of species consisted of* ***Baphia nitida*** *with a slow rate of decay and a half-life of 109 days.* ***R. heudelotii*** *and* ***G. sepium*** *are very rich in potassium with respective values of 0.802 and 0.860 %.* ***A. zygia*** *and* ***C. pentandra*** *had the highest crude protein of 21.0 % and 14.9 % of dry matter respectively.* ***A. zygia, A. adianthifolia,*** and ***A. ferruginea*** and also ***C. pentandra*** and ***R. heudelotii*** *can be used as suitable substitutes in mulching farmlands instead of the exotic leguminous species.*

Keywords: ***Decomposition rate parameter, biochemical compounds, half-life, Albizia spp., Ceiba pentandra, Ricinodendron heudelotii***

INTRODUCTION

Decomposition of leaf litter is an important source of nutrients in forest ecosystems and farming systems. In most forests and farming systems in the tropics the major source of nutrients for trees and food crops is from the decomposition of plant material. Decomposition refers to the process that converts fresh and dead organic matter into smaller and simpler compounds. Decomposition is mainly a biological process carried out by insects, worms, bacteria, and fungi both on the soil surface and in the soil. The products of complete decomposition include carbon dioxide, water, and inorganic ions (e.g. ammonium, nitrate, phosphate, and sulphate). The fresh and dead organic matter, which is referred to as mulch, is broken down by microbial decomposers and insects. Organically-bound nutrients are then released as free ions to the soil solution which are then available for uptake by plants. Vegetative materials that are used as mulching material include grass, crop residues and leaves from pruning of trees. It is mainly a practice in which organic materials are placed on the surface or incorporated in the soil to maintain and improve soil fertility (Food and Agriculture Organization, 1975).

The rate of decomposition of mulch is influenced by many interacting factors which include the composition of bacteria, fungi, invertebrates, temperature, soil moisture and quality of the mulch as a food source for the decomposers. For soil moisture, decomposition of mulch is inhibited in very dry soils because bacteria and fungi dry out. Decomposition of mulch is also slow in very wet soils because anaerobic conditions develop in saturated soils. Anaerobic decomposition of mulch is less efficient than aerobic and as a result is slower. Thus decomposition of mulch proceeds fastest at intermediate water contents.

In most parts of the humid tropics farmers rely on short cropping periods followed by long fallow periods to maintain and restore soil fertility in traditional crop production systems through mulch decomposition. However, increasing population pressure has led to shortening of the fallow period in many parts of the humid tropics (Altieri, 2002). Besides, severe problems occur in sustaining adequate food production without external chemical inputs like inorganic fertilizers that are costly and beyond the economic means of most farmers. Continuous use of these chemicals can result in environmental problems. Some of these inorganic fertilizers have negative side effects of building up aluminum ion (Al^{3+}) which results in soil acidity (Dolland *et al*., 1993).

In the long term, population pressures dictate that efficient and high-input systems must be developed. In the short term, however, production systems must conserve existing nutrient reserves and apply low-cost inputs. Productivity must also be increased in order to improve the cash flow of farmers to enable them adopt high productive systems.

Alternative sources of maintaining the productivity of the land is necessary. The efficient and scientifically sound application of mulch could provide a potential source for the restoration and improvement of soil fertility for high productivity if mulches are generally available to farmers in large quantities. With the inability of most resource-poor farmers to afford inorganic fertilizers, the use of nutrients from organic fertilizers have proven to be a viable alternative source of soil fertility replenishment in low-input smallholder farming systems (Makumba *et al*., 2007).

In Ghana, many studies on tree mulching materials have focused on the use of common agroforestry species such as *Gliricidia sepium, Leucena leococephela, Albizia lebbeck* and *Grevillea robusta* which are often not available on traditional farming lands. There is therefore the need to investigate the suitability of native tree species as substitute for these traditional exotic agroforestry species for mulching farmlands. *Albizia zygia, Albizia adianthifolia, Albizia ferruginea* and *Baphia nitida* are very important native leguminous tree species which are common on farmlands and fallow lands in the forest zone of Ghana (Nkyi, 1989). *Albizia zygia* and *Albizia adianthifolia* are also fast-growing and fix nitrogen in the soil (Wester and Hogberg, 1989). *Ceiba pentandra,* and *Ricinodendron heudelotii* (var. *heudelotii*) are fast growing and produce large amount of litter (Nkyi, 1989). These species can be potential agroforestry species.

In many cropping systems, the efficiency with which nutrients in plant residues are taken up depends on the rate at which they are decomposed and the time they are required by the plant (Tetteh, 2004). The rate of decomposition of leafy mulch of these native species remains largely unknown.

It would therefore be beneficial if the rate of decomposition of the leaves of the various tree species are known so that farmers could apply the mulch such that the release of nutrients from the mulch decomposition could take place at the same time as crop nutrient uptake. Furthermore, insights into factors which influence the rate of decomposition of the leafy mulches (especially the biochemical compounds in these leafy mulches) are important so that predictions on their rates of decomposition could be made. In this regard, the study was undertaken to determine the rate of decomposition and biochemical composition of fresh leafy mulch of *Albizia zygia, Albizia adianthifolia, Albizia ferruginea, Ceiba pentandra, Baphia nitida, Ricinodendron heudelotii and Gliricidia sepium* and also investigate the influence of biochemical compounds on the rate of decomposition of these mulches.

MATERIALS AND METHODS

Study area

The study was carried out at the demonstration farm of the Faculty of Renewable Natural Resources (FRNR) of Kwame Nkrumah University of Science and Technology, Kumasi. The area is located within the Moist Semi-deciduous forest South-east subtype (Hall and Swaine, 1981). The farm lies on longitude 06º 43' N and latitude 01º 36' W. The mean annual rainfall ranges between 1,300 mm and 1,600 mm while the mean daily temperature ranges between 22.0 ºC and 31.1 ºC (Hall and Swaine, 1981). The soils belong to the Asuasi series, classified as forest *Ochrosols* (Sarkodie-Addo *et al*., 2006). During the experimental period between October, 2010 and February, 2011 the amount of rainfall was unusually high with the mean rainfall being 16.89 $\pm$ 4.66 mm per week, while the respective mean daily temperature and mean daily humidity were 31.94 $\pm$ 0.16 ºC and 82.04 $\pm$ 3.14 %.

Experimental design

The wooden box method (Sraha and Ulzen-Appiah, 1997), which is a modification of the litter bag method, was used to study the decomposition rate. The square frames used measured 10 x 10 cm and 10 cm high. The two ends of each box were covered with a nylon mesh material with a mesh size of 2 x 2 mm, which prevented both the addition and removal of litter material by wind, water or large ants. One end of each box was deeply pressed into the ground to give a good soil dwelling of macrofauna such as arthropods and earthworms to ensure an unrestricted access to the decomposers.

The experimental design used was a split-plot in completely randomized design with the seven species fresh leafy mulches as main-plot treatments and replicated five times. Time was used as sub-plot factor. The fresh leafy mulches were randomly collected at all crown parts of mature trees identified around the Faculty of Renewable Natural Resources experimental farm. The 35 boxes served as plots and were randomly arranged on the experimental site measuring 50 x 50 m. Each box was filled with 1 kg of fresh leafy mulch of a specified species.

The experimental site was an open area without shade and kept free of weeds and other tree material during the period of the study. The experiment was conducted between October 1, 2010 and February 3, 2011. A weighing scale which read to the nearest 10 g was used to measure residual leafy mulch weight in its natural state at the end of every two weeks. A sample of the fresh leafy mulch of each species was sent to the faculty's laboratory for chemical analysis which was replicated five times.

Chemical analysis of leafy mulch

The venado-molybdophosphoric acid yellow colour method (Jackson, 1958) was used to determine phosphorus and potassium. The Ethylene-diamine tetra-acetic acid (EDTA) method, as described by Radov, *et al*. (1985), was used to determine calcium and magnesium. Organic carbon was determined by the Walkley-Black method (Walkley and Black, 1934).

Nitrogen and crude protein were determined using the micro Kjeldahl method (Cottenie, 1980). The leaf litter samples were also analyzed for polyphenolics using Folin-Denis method, and included hydrolysable tannins, as well as non-tannin polyphenolics (King and Heath, 1967).

Data analysis

Analysis of variance was obtained, after normality conditions were satisfied. Many mathematical models were explored using Statistical Package for Social Scientists (SPSS). The exponential decay model was the most appropriate function used to fit the relationship between time and residual weight of litter. Also the power and exponential functions proved to be the most suitable functions used to fit the relationship between levels of biochemical compounds of the species and decomposition rate parameter (k), as seen in the equation: $y = c.e^{-kt}$, where k is decomposition rate, c and e are constants, and t is time.

RESULTS

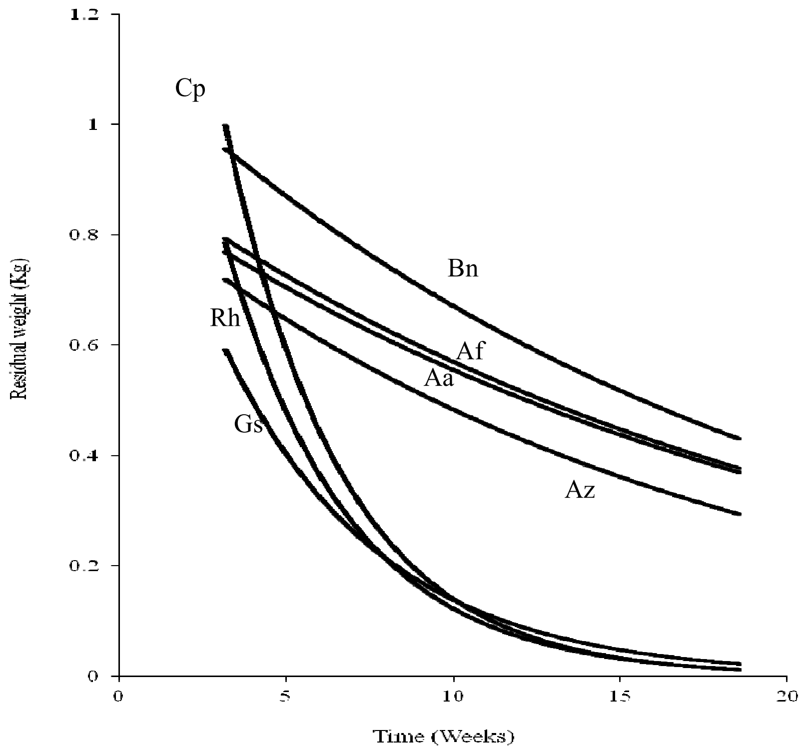
Table 1 shows the analysis of variance of the decomposition periodic residual weight of fresh leafy mulch of *Albizia zygia, Albizia adianthifolia, Albizia ferruginea, Ceiba pentandra, Baphia nitida, Ricinodendron heudelotii and Gliricidia sepium*. Species, time and species and time interaction significantly affect the residual weight of decomposing leafy mulch. *Ricinodendron heudelotii* and *Gliricidia sepium* had the lowest mean residual weight of decomposing leafy mulch of 0.117 kg week^{-1} and 0.122 kg week^{-1} respectively, while *Baphia nitida* had the highest value of 0.347 kg week^{-1}. *Ricinodendron heudelotii* had the highest weight loss, while *Baphia nitida* had the least weight loss, as the k value in the equation $y = c\ e^{-kt}$ portrays.

Table 1: Analysis of variance for residual weight of decomposing leafy mulch for *Albizia zygia, Albizia adianthifolia, Albizia ferruginea, Ceiba pentandra, Baphia nitida, Ricinodendron heudelotii* and *Gliricidia sepium*.

Sources of variation	Sum of squares	Degrees of freedom	Mean sum of squares	F-ratio
Species	7.494	6	1.249	73.145 ***
Error (a)	0.359	21	0.017	
Whole plots	7.853	27		
Time	8.269	8	1.034	486.123 ***
Time x Species	1.171	48	0.024	11.469 ***
Error (b)	0.357	168	0.002	
Subplots	17.650	251		

Legend: ***; significant at 0.5 %

Figure 1 shows the decomposition rate characteristics of leafy mulch of seven tree species. The exponential model $y = ce^{-kt}$ fits well the trends in residual weight of decomposing leafy mulch over time for tree species, with coefficient of determination (R^2) ranging between 76.90 % and 98.17 %. Three groups of species of almost similar leafy mulch decay trend could be seen. The first group of species consisted of *Gliricidia sepium*, *Ricinodendron heudelotii* and *Ceiba pentandra* with the fastest rate of decay and with respective half-life of 28, 34 and 39 days.



Ceiba pentandra (Cp); $y = 2.4753\ e^{-0.2883\,t}$; $R^2 = 94.28$ % ; t is time
Ricinodendron heudelotii (Rh); $y = 1.8509\ e^{-0.2724\,t}$; $R^2 = 76.90$ %
Baphia nitida (Bn); $y = 1.126\ e^{-0.0520\,t}$; $R^2 = 92.24$ %
Gliricidia sepium (Gs); $y = 1.15924\ e^{-0..21325\,t}$, $R^2 = 96.77$ %
Albizia zygia (Az); $y = 0.8638\ e^{-0.0583\,t}$; $R^2 = 96.81$ %
Albizia ferruginea (Af); $y = 0.9229\ e^{-0.0484\,t}$; $R^2 = 98.17$ %
Albizia adiantifolia (Aa); $y = 0.8928\ e^{-0.0477\,t}$; $R^2 = 90.12$ %

Figure 1: Trends of decomposition of leafy mulch of seven tree species.

Table 2: Mean nutrient composition (%) of dry matter in leafy mulch of six native and one exotic species in Ghana.

Nutrient composition (%) of leafy mulch	Tree species						
	Gliricidia sepium	*Ceiba pentandra*	*Albizia zygia*	*Albizia ferruginea*	*Albizia adianthifolia*	*Ricinodendron heudelotii*	*Baphia nitida*
Nitrogen	7.787	6.122	6.907	4.385	4.483	7.593	4.287
Calcium	1.793	1.866	1.236	1.340	1.353	1.902	1.209
Potassium	0.860	0.928	0.255	0.192	0.361	0.802	0.396
Carbon	6.111	7.390	17.277	56.619	60.829	4.462	39.280
Carbon /nitrogen	0.889	1.207	2.501	12.912	13.569	0.588	9.163
Phosphorus	0.430	0.502	0.200	0.101	0.18	0.454	0.241
Polyphenols	0.246	0.250	0.310	0.360	0.390	0.230	0.320
Moisture content **	60.000	60.963	50.000	41.723	41.000	77.103	59.677
Magnesium	0.008	0.007	0.012	0.008	0.009	0.011	0.011
Crude protein	12.100	14.900	21.100	10.800	7.700	10.800	10.800

The second group of species comprised *Albizia zygia, Albizia adianthifolia, Albizia ferruginea* with a moderate rate of decay and with respective half-life of 66 days, 85 days and 88 days. The last group of species consisted of *Baphia nitida* with a slow rate of decay and half-life of 109 days. Table 2 depicts some of the biochemical composition of fresh leafy mulch of six native Ghanaian tree species (*Albizia zygia, Albizia adianthifolia, Albizia ferruginea, Ceiba pentandra, Baphia nitida* and *Ricinodendron heudelotii*) and an exotic tree species (*Gliricidia sepium*).

The most common chemical compound in fresh leafy mulch was water. *Ricinodendron heudelotii* had the highest moisture content of 77 %, followed by *Ceiba pentandra* and *Gliricidia sepium* with respective moisture content of 61 % and 60%. Organic carbon was the second most prevalent compound. *Albizia adianthifolia* had the highest carbon percentage of 60.3. *Albizia ferruginea* had the second carbon percentage of 56.6, followed by *Baphia nitida* with a carbon value of 39.3 %. The third most important compound in the leafy mulch was crude protein. *Albizia zygia* had the highest crude protein percentage of 21.1 of dry matter followed by *Ceiba pentandra* with a crude protein value of 14.9 % of dry matter.

Nitrogen was also an important chemical in the leafy mulch. *Gliricidia sepium* had the highest nitrogen percentage of 7.787 followed by *Ricinodendron heudelotii* with 7.6%. *Albizia zygia* had a nitrogen content of 6.9 % while and *Ceiba pentandra* had 6.1 % of nitrogen *Ceiba pentandra* also had the highest calcium value of 1.87 %; *Gliricidia sepium* had the highest potassium value of 0.86 %.

The minor chemical included Magnesium whose percentage value did not exceed 0.012. Figure 2 shows the relationship between nitrogen, calcium, potassium and carbon and leafy mulch decomposition rate parameter (k) of the seven tree species studied.

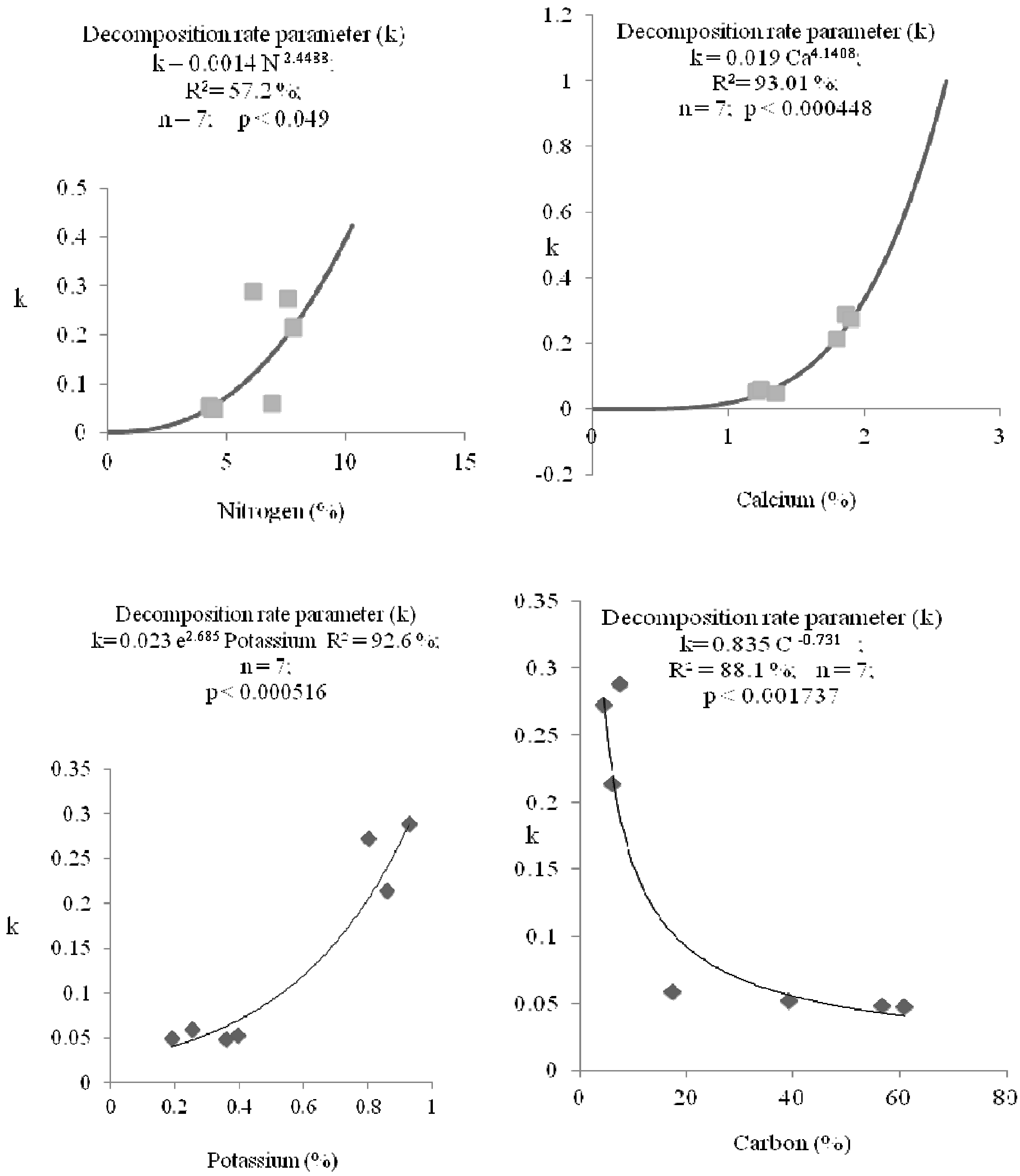


Figure 2: The relationship between mean percent of nitrogen (N), calcium (Ca), phosphorous (P) and potassium (K) and leafy mulch decomposition rate parameter (k) of some tree species.

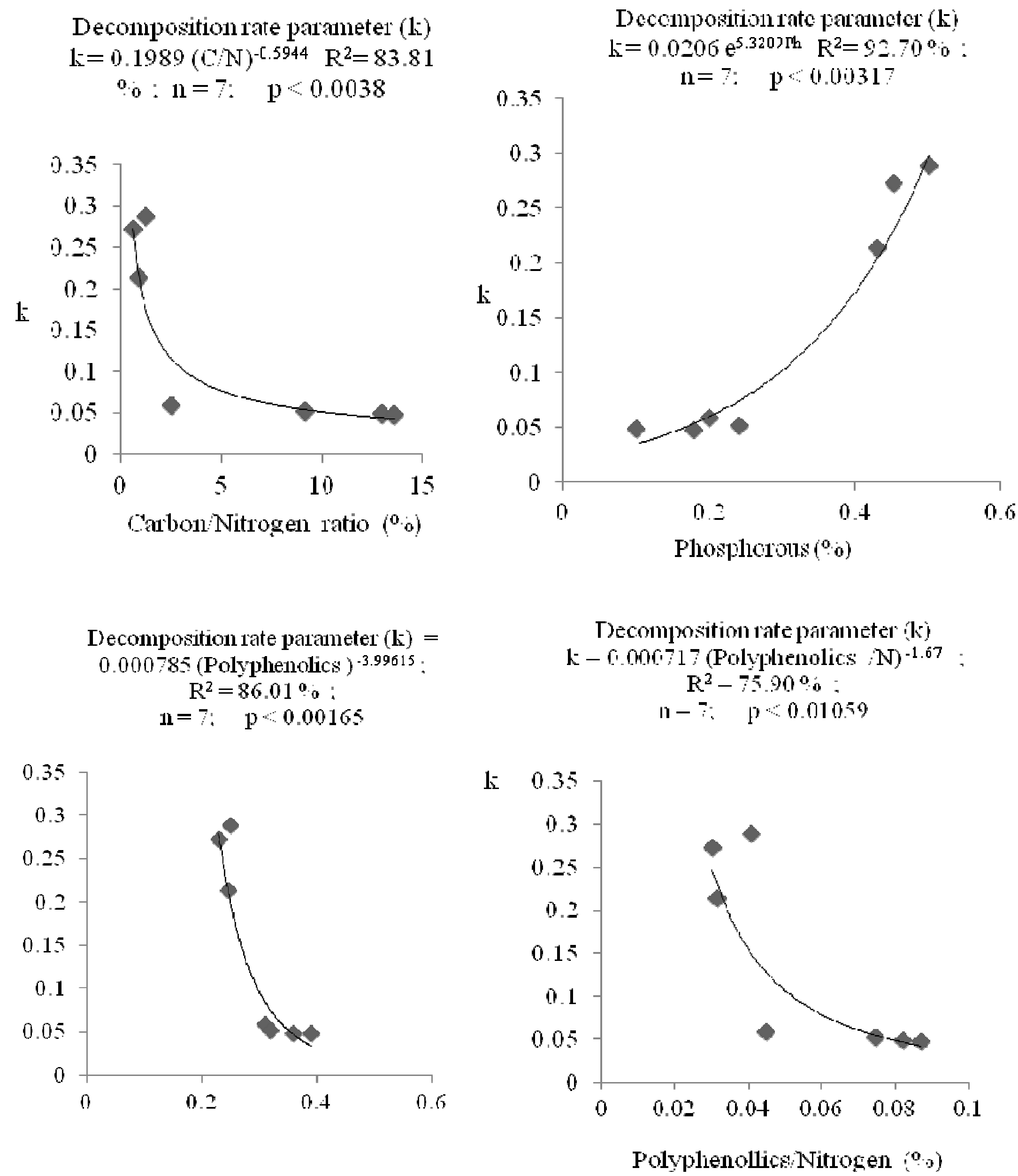


Figure 3: Relationship between mulch decomposition parameter (k) and leafy carbon/nitrogen ratio, phosphorous, polyphenolics and polyphenolics/nitrogen ratio of seven species studied in the work.

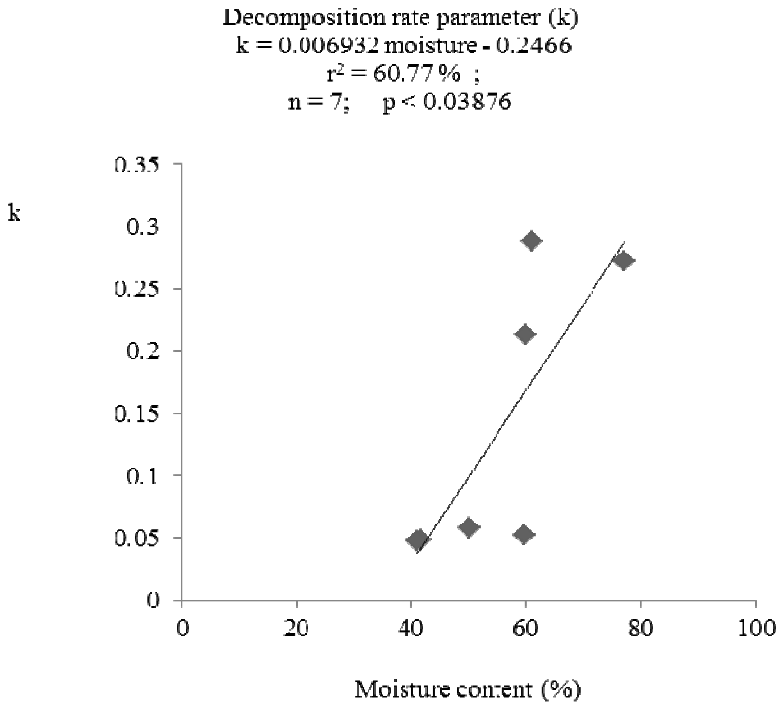


Figure 4: Relation between moisture content (x) and decomposition rate parameter (y) of leafy mulch of some tree species.

Figure 3 also shows the relationship between carbon/nitrogen ratio, phosphorous, polyphenenols and polyphenols/nitrogen ratio and leafy mulch decomposition rate parameter (k) of the seven tree species studied.

As the percentage of nitrogen, calcium, phosphorous or potassium increases, the decomposition rate parameter also increases exponentially. The rate of rise of decomposition rate parameter (k) is faster for calcium and phosphorous than for nitrogen and potassium. However, as the percentage of carbon, carbon/nitrogen, polyphenols or polyphenols /nitrogen ratio increases, the decomposition rate parameter decreases exponentially. The rate of decline of decomposition rate parameter (k) is faster for polyphenols than for carbon (Table 2). Also increase in moisture content of leafy mulch entails a corresponding linear increase in decomposition rate parameter (Figure 4).

DISCUSSION

The decomposition rate parameter or constant (k) plays an important role in the general assessment of mulch decomposition. This constant determines the active period of the material as a soil cover and the speed with which nutrients are released (Budelman, 1987). The rates of organic matter decomposition are crucial components of the global carbon budget (Prentice *et al*., 2001). In general, the combination of total nutrient of tree parts and their carbon/nitrogen ratio account for 70.2% of the variation in the litter decomposition rates of all materials (Zhang *et al.,* 2008).

The exponential decay of leafy mulch for each species studied in this work had a good fit with observed values. The exponential decay model had been used by many workers (Berg and Staaf, 1980; McClaugherty and Berg, 1987; Valenzuela-Solano *et al*., 2005). In the initial stages of leafy mulch breakdown small soluble carbon molecules, such as starches and amino acids, are lost first leaving behind the more recalcitrant molecules like polyphenols. Decomposition during this first phase is rapid because these soluble carbon molecules are easy to break down and release rich energy. In the second stage of decomposition, the breakdown of polyphenols and lignin-related compounds, are much slower because these consist of very large and complex molecules (Berg and Staaf, 1980; McClaugherty and Berg, 1987). The rapid initial breakdown followed by a longer period of slow decomposition results in a mass loss curve that resembles exponential decay curve consistent with the model used in fitting the observed residual mass. The decomposition rate of leafy mulch is also reflected in the exponential decay relationship between polyphenolic content and decomposition rate parameter.

Leafy mulch quality can vary among species. Many studies have shown striking differences in decomposition rates among species (Adams and Angradi, 1996; Cornelissen, 1996). According to Currie and Aber (1997) and Moorhead and Reynolds, (1991), models used to estimate soil carbon, which also reflect mulch decomposition characteristics and also depicted by the results, is divided into explicit groups of species depending on chemical indicators related to mulch decomposability. Aerts *et al*. (1999) demonstrated that *Sphagnum* species leaves had lower N and P concentrations than other taxa and likewise had lower rates of mulch decomposition.

The results of this study indicated that the decomposition rate parameter increases exponentially with increase in nitrogen. This observation is in conformity with Aerts *et al,* (2001) who reported that higher N concentrations cause higher potential rates of decay of *Sphagnum* species litter. Contantinides and Fownes (1994) reported that initial nitrogen content of the materials was the variable which best predicted decomposition and release of nitrogen.

Three groups of species were identified in the study based principally on initial nitrogen and carbon levels. The fastest rate of decomposition was observed for *Ceiba pentandra* and *Recinodendron heudelotii* with high initial nitrogen content and low carbon percent, while *Gliricidia sepium* which had high nitrogen content belongs to this group. This grouping follows Simons and Stewart (1992) classification. Gosz (1981) reported that litter quality and rates of decomposition are more rapid on nitrogen-rich mulch than on nitrogen-poor mulch. Taylor *et al.* (1989) reported that there is often a good positive correlation between the initial nitrogen concentration in litter and the rate of decay. The slowest mulch decomposition rate group of only *Baphia nitida* had low initial nitrogen content and relatively high carbon percent.

The existence of significant differences in the rate of decomposition of leafy mulch among tree species, as the results showed is also consistent with other works. According to Jina *et al*., (2003), a high rate of mass loss was observed in *Ginkgo biloba* leaf litter followed by those of *Cinnamomum camphora* and *Firmiana simplex* and the least mass loss was observed for *Zelkova serrata* leaf litter. Coppens (2005) also observed that the biochemical components of leafy mulch is determined by individual tree species, and is the first factor that influences the kinetics of mulch decomposition.

Mugendi and Nair (1996) reported that decomposition patterns of three agroforestry multipurpose trees of *Calliandra calothyrsus*, *Cordia africana* and *Grevillea robusta* were best described by first-order exponential decline curves. The decomposition rate constants ranged from 2.1 to 8.2 yr^{-1}, and the rates of decomposition among the species was highest for *Calliandra calothyrsus*, followed by *Cordia africana* and *Grevillea robusta*. The decomposition rate constants for the seven species studied in this work ranged from 2.48 to 14.99 yr^{-1}. The rates of decomposition for *Calliandra calothyrsus*, *Cordia africana* and *Grevillea robusta* are lower than similar respective values of 14.99 and 14.16 yr^{-1} for *Ceiba pentandra* and *Ricinodendron heudelotii*.

The three *Albizia* species studied on average are capable of producing between 12.4 kg and 33.8 kg of nitrogen for 1 tonne of dry matter of leaf mulch. In particular, *Albizia zygia* yields 33.8 kg of nitrogen for 1 tonne of dry matter of leaf mulch. This figure is higher than similar value for *Gliricidia sepium* of 27 kg of nitrogen (Patil, 1989). The nitrogen content in microorganisms and in organic materials is given in proportion to the carbon content and is called the carbon to nitrogen ratio i.e. C:N ratio (Paymond, 1995). The C:N ratio determines whether mineralization or immobilization dominates during decomposition. The C:N ratio also provides an indication of how rapidly a material is likely to be decomposed (Frankenberger and Abelmagid, 1985). The results of this study show that decomposition rate of mulch decreases exponentially with increase in C:N ratio.

Several authors have confirmed the acceptance of the carbon/nitrogen ratio as being a good indicator for nitrogen mineralization and immobilization (Jama and Nair, 1996). If the material has a large C:N ratio then the amount of N available for growth of the microorganisms themselves will be limited and any mineralized N will tend to be immediately used by the microorganisms for growth or immobilized (Jama and Nair, 1996). Jama and Nair (1996) also assert that plant residues with a high C:N ratio, (such as those ratios greater than 30:1) are likely to decompose slowly with initial net immobilization of nitrogen, whereas residues with a smaller C:N ratio are likely to decompose more rapidly with a net mineralization of nitrogen occurring right from the beginning. The results of the work confirmed these observations by indicating that if C:N ratio is greater than 30:1, the decomposition rate parameter k is less than 0.026, whereas if C:N ratio is less than 0.6:1 the decomposition rate parameter k is greater than 0.27. Legume residues commonly have C:N ratios less than 30:1 and therefore tend to release nitrogen and decompose rapidly (Jama and Nair, 1996). Under tropical conditions, applications of readily degradable materials with low C:N ratios, such as green manure and leguminous cover crops, favour decomposition and a short-term increase in the nitrogen pool.

The C:N ratio trend could partially explain why *Gliricidia sepium*, *Ricinodendron heudelotii* and *Ceiba pentandra* had the fastest rate of decay and with respective half-life of 28 days, 34 days and 39 days. Similar explanation could be extended to the relatively high rate of leafy mulch decomposition of the local leguminous tree species of *Albizia zygia, Albizia adianthifolia, Albizia ferruginea.* The second group of species comprising *Albizia zygia, Albizia adianthifolia, Albizia ferruginea* have relatively high rate of decay with respective half-life of 66 days, 85 days and 88 days. These local species offer great potential for mulching soils under agroforestry systems in place of the popular traditional exotic tree species such as *Leucaena leucocephala*, *Gliricidia sepium,* and *Sesbania grandiflora*.

However, applications of plant materials with large C:N ratios such as cereal straw and grasses generally favour nutrient immobilization, organic matter accumulation and humus formation, with increased potential for improved soil structure development. *Baphia nitida* with a comparatively high C:N ratio has a slow rate of decomposition and could be used for improving soil organic matter.

The decomposition rate decreases exponentially for carbon and phenols. Carbon is the most significant factor slowing down decomposition rate of leafy mulch as the results depict. Preston *et al*. (2000) found that both phenolic and *O*-alkyl carbon were associated with reductions in decomposition rate. These trends can be attributed to the lignin and tannin components which are associated with phenolic carbon, and the resistant cellulose fractions of polysaccharides.

The rate of decomposition increases with increase in moisture content of leafy mulch as the results show. Coppens (2005) observed that the level of mulch water content is the main factor controlling mulch decomposition. Coppens (2005) noted that mulch water storage and retention capacity which is species-specific affects the degree of mulch decomposition rate. Water from soil and moisture of leafy mulch are important in aiding microbial activity to effect decomposition process through mineralization and subsequent diffusion and infiltration of the chemical elements.

Potassium is necessary for the synthesis of amino acids, and activates enzymes for glucolysis in plants (Lampkin, 1990). *Ceiba pentandra, Gliricidia sepium and Ricinodendron heudelotii*. have high potential as a source of potassium. Phosphorus has a positive significant influence on the decomposition parameter as the results of the study portrayed. According to Valenzuela-Solano *et al*. (2005) in the early phase of decomposition, high concentrations of nutrients such as nitrogen, phosphorus and sulphur exert a rate-enhancing influence on mass loss of those compounds in the leafy mulch that are not lignified. *Albizia zygia* and *Ceiba pentandra* leafy mulches have potential as a source of crude protein with respective crude protein of 21.1 % and 15 % of dry matter. *C. pentandra* leaves are used as vegetables in Ghana (Abbiw, 1990). Although the crude protein of leafy mulch of *Ricinodendron heudelotii* is 10.8 % of dry matter, the crude protein of the kernels of this species is high with a value of 49.9 – 65.2 %, as reported by Tiki Manga *et al*. (2002). Hence a combination of leafy mulch and its matured fruits has high crude protein content. The leaves of *Ricinodendron heudelotii* are used as vegetables (Food and Agricultural Organization, 1999; Abbiw, 1990).

The high crude protein of *Ricinodendron heudelotii* is comparable to *Gliricidia sepium, Chamaecytisus palmensis* and *Albizia lebbeck* leaves which has respective crude protein of 20-30% (Falvey, 1982; Chadhokar, 1982; Göhl, 1981; Adejumo and Ademosun, 1985), 21-24 % (Borens and Poppi, 1990) and 16-23 % (Lowry *et al*., 1992) of the dry matter content and important forage materials in cut-and-carry systems in the tropics. Moreover, leafy *Ricinodendron heudelotii*, *Ceiba pentandra*, *Albizia ferruginea, Albizia zygia* and *Albizia ferruginea* are pioneer species and leafy mulch of these species are likely to decompose faster and provide more nutrients than *Baphia nítida,* which is a shade-bearer, as confirmed by the results.

CONCLUSIONS

Decomposing litter is an important nutrient pool for crops. Leguminous leafy mulches of *Albizia zygia, Albizia adianthifolia,* and *Albizia ferruginea* and also *Ceiba pentandra* and *Ricinodendron heudelotii* are fast-growing and -decomposing species. They can be used as nutrient-rich organic and nitrogen for crops in place of the frequently used exotic leguminous species including *Gliricidia sepium*. These native *Albizia* species on average are capable of producing between 12.4 kg and 33.8 kg of nitrogen for 1 tonne of dry matter of leaf mulch and in particular, *Albizia zygia* yields 33.8 kg of nitrogen for 1 tonne of dry matter of leaf mulch. This figure is larger than similar value for *Gliricidia sepium* of 27 kg of nitrogen. *Ricinodendron heudelotii* has the highest pool of phosphorus of 4.54 kg per tonne of dry matter among the species studied in this work and can be used to supplement NPK inorganic fertilizer.

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