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INFLUENCE OF DRYING CONDITION ON DECOMPOSITION AND NITROGEN MINERALIZATION OF LEGUME LEAVES

[1]Akintan, C.I., [2]Ighodaro, B.U., [3]Akintan, A.O. and [4]Ajayi, O.K.
[1,3 and 4]Rain Forest Research Station, P.O. Box 17 Ore, Ondo State; Forestry Research Institute of Nigeria
[2]Moist Forest Research Station, P.O. Box 2444, Benin City; Forestry Research Institute of Nigeria
Email: cornial2000@yahoo.co.uk

ABSTRACT

The influence of drying condition on the rate of decomposition and nitrogen mineralization of *Gliricidia sepium* and *Acacia auriculiformis* leaves were studied when fresh, air dried and sun dried. These were packaged at 50 g/bag in polyvinyl bags and deposited on the field for decomposition. After 4, 8, 16, 32, 64 and 92 days, three bags of each treatment per species were collected at interval from the field for evaluating change in weight and nitrogen as decomposition progressed. Thereafter, the pattern of decomposition and the nitrogen mineralization of the leaves as affected by drying conditions were verified. For both samples, higher initial nitrogen content were obtained for air dried and sun dried compared with fresh leaves. *Gliricidia sepium* had higher rate of decomposition than *Acacia auriculiformis* for the different imposed drying conditions. Immobilisation as a result of high temperature were observed in both species. Both litters may supply sufficient nutrient to meet crop demand.

Keyword: Drying, Decomposition, Mineralization, *Gliricidia* leaves and *Acacia* leaves

INTRODUCTION

Increased interest in the management of nutrient and organic matter in relation to sustainability of agriculture and concerns over adverse effects of using inorganic fertilizers (high cost, non availability and environmental problems) have been identified in developing countries (Walpola *et al*., 2009).

Legume has been recognised to be effective in soil fertility maintenance (Swarup, 1997). They could be either annual or perennial, but due to the seasonal availability of annual legumes and limited nutrients inputs, perennial legumes are preferred. Crop residue decomposition and subsequent release of nutrients to soil can be altered by a number of factors, these include nutrient and water availability, soil temperature, physical and chemical nature of the crop residue and their amount, soil type and soil residue contact (Walpola *et al*., 2009). Decomposition and mineralization of plant material incorporated into soil reflects interaction between its quality and prevailing chemical and physical environment of soil (Walpola *et al*., 2009). The rate of decomposition and consequent mineralization of the litter is influenced by the physico-chemical quality of the litter and decomposer organisms, which inturn determines the rate of nutrient released from the chemical composition of the litter. The chemical composition being mainly: carbon, nitrogen, lignin and polyphenol with carbon to nitrogen as index of litter quality (Mafongoya *et al.,* 1998; Myers *et al.,* 1997; and Vanlauwe *et al.,* 1997b). Nitrogen plays an important role in litter decomposition as it determines the growth and turn over of the microbial biomass mineralizing the organic carbon. The high quality legume residue such as *Gliricidia sepium* (Oyun *et al.,* 2006) decomposes and releases much more nitrogen earlier than plant use leading to low efficiency of use. Also, low quality legume residue such as *Acacia auriculiformis* (Oyun *et al*., 2006) decomposes and releases nitrogen too slowly such that the nitrogen released does not form part of the crop plant need.

Hence, there is need to find ways of manipulating the nitrogen released from these organic residues so as to enhance the synchrony between nitrogen released and crop demand. General methods of such manipulation have been identified. One of such methods could be varying initial drying condition of fresh legume residue before use. This present study therefore was aimed to study the influence of initial drying condition on the rate of decomposition and nitrogen mineralization of *Gliricidia sepium* and *Acacia auriculiformis* fresh leaves.

METHODOLOGY

The experiment was carried out at The Teaching and Research Farm of the Federal University of Technology, Akure which lies between latitude 7^0 18'32.64^0 N and 7^0 16`34.93$^0$ N and longitude $5^0$ 10`35.79^0 E and 5^0 7'38.97^0 E. The experiment was carried out during a rainy season. The range of temperature during the experiment was between 16.5 ^{0}C and 33.9 ^{0}C. The soils of the study area are classified as ferruginous soils (Alfisol) on crystalline rocks of basement complex. The soils belong to the Egbeda series (Smyth and Montgomery, 1962).

The land area was demarcated in the site and cleared off debris. Leaf samples of *Gliricidia sepium* and *Acacia auriculiformis* were subjected to varying drying condition after removal from plants (Handayanto *et al,* 1997). The leaves were subjected to the following:

i. Sun-drying for 15 days
ii. Air-drying at room temperature for 15 days
iii. Fresh samples

Samples of each treatment were then sealed in a polyvinyl litter bag measuring 10 cm x 20 cm x 7 mm mesh at 50 g/bag in order to maximise access to all major soil fauna and to minimise artificial litter loss from the bags. 21 bags of each treatment per species were then placed randomly on the field in the experimental site. The design of the experiment was factorial experiment in Completely Randomized Design at three replicates per treatment. Statistical analysis of data was by analysis of variance (ANOVA). A follow up test was performed to separate the treatment means that were found to be significantly different.

After 4, 8, 16, 32, 64 and 92 days, three bags of each treatment per species were collected from the field for evaluating change in weight and nitrogen as decomposition progresses. Adherent soil was washed carefully from the plant residue with a minimum of distilled water to reduced artificial leaching. The litter were dried for 72 hours at room temperature. At day 120 the samples collected were evaluated for nitrogen by Kjeldahl analysis method.

RESULTS AND DISCUSSION

The N content in the fresh leaves of *Gliricidia sepium* is higher than that of *Acacia auriculi-*

Table 1 showing initial nitrogen content(%) of legume leaves

Legume leaf	Treatment		
	Fresh	Air Dried	Sun Dried
Gliricidia sepium	1.54	2.80	3.64
Acacia auriculiformis	0.98	3.09	2.52

formis. The same trend was observed when the samples were sun-dried. However, when the samples were air-dried the N content was higher in *Acacia auriculiformis* leaf sample.

The pattern of decomposition of fresh, air dried and sun-dried leaves of *Acacia auriculi*-formis and *Gliricidia sepium* is shown in figures 1, 2 and 3. The rate of decomposition in the first

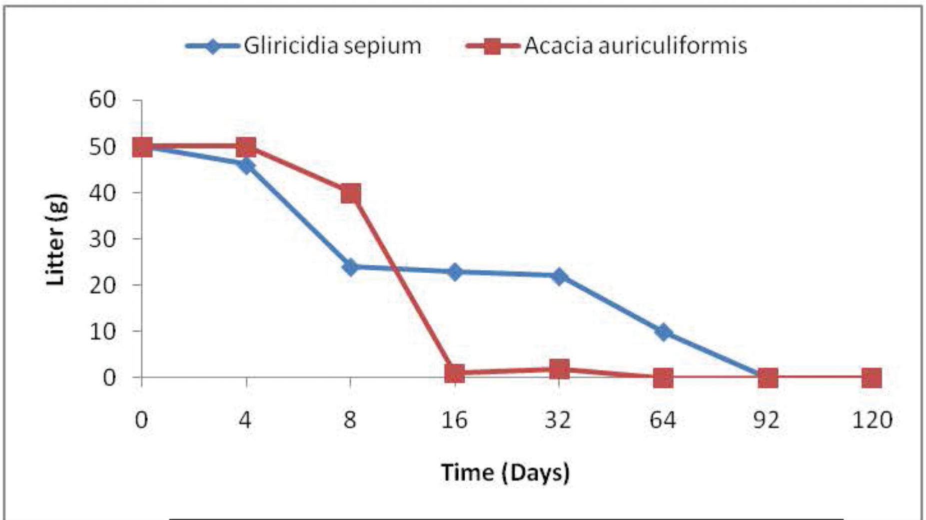

Figure 1: Pattern of decomposition of fresh leaves of *Gliricidia sepium* and *Acacia auriculiformis*

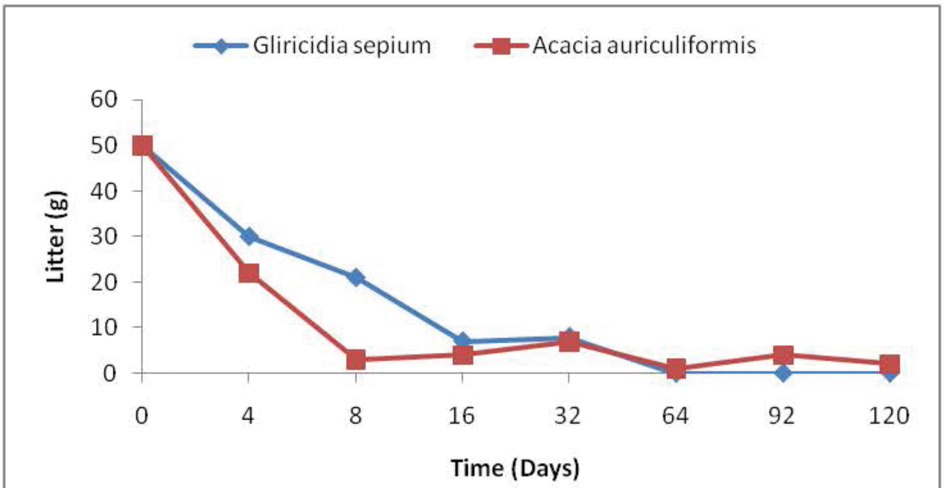

Figure 2: Pattern of decomposition of air dried leaves of *Gliricidia sepium* and *Acacia auriculiformis*

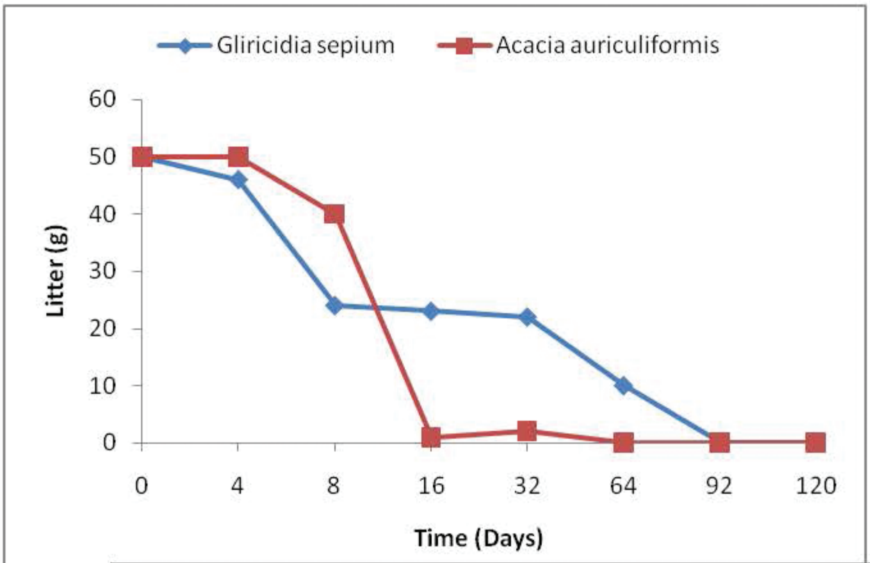

Figure 3: Pattern of decomposition of sun dried leaves of *Gliricidia sepium* and *Acacia auriculiformis*

four days for the fresh leaves was higher in *Gliricidia sepium*. However, at 8 days, *Acacia auriculiformis* decomposed faster than *Gliricidia sepium.* While after 16 days both species had similar rate of decomposition and at 92 days both species had virtually decomposed.

The trend of decomposition in the first 8 days for air dried leaves was highest in *Acacia auriculiformis.* However, after 16 days both had equal decomposition. At 64 days *Gliricidia sepium* had completely disappeared.

The rate of decomposition for the first 4 days is similar for both species when sundried. After 8 days, *Acacia auriculiformis* decomposed faster than *Gliricidia sepium*. *Acacia auriculiformis* completely disappeared at 64 days while *Gliricidia sepium* decomposed gradually from day 8 through 92 days after which it decomposed completely.

Analysis of variance (ANOVA) was done on the mineralised legume leaf samples collected on 4, 8, 16, 32, 64, 92 and 120 days. The result showed that the difference in nitrogen mineralisation between *Gliricidia sepium* and *Acacia auriculiformis* was not significant $P<0.05$ at 4, 16, 32, 64, and 120 days after decomposition. However at 8 and 92 days after decomposition, the difference in nitrogen mineralisation between fresh, airdried and sun-dried conditions of the species were significant $P<0.05$.

DISCUSSION

Higher value of nitrogen content observed in fresh leaves of *Gliricidia sepium* when compared with fresh leaves of *Acacia auriculiformis* (Table 1) confirms its classification as a high quality organic input. Mafongoya *et al.* (1997) and Palm, (1995) had shown that high quality organic inputs are those with high nitrogen but low lignin and polyphenol contents. While low quality organic inputs are those poor in nitrogen and high in polyphenol and lignin.

However, nitrogen contents are higher in air dried and sun dried samples than fresh leaves. This can be attributed mainly to moisture loss due to dry condition.

The figure on decomposition of fresh, air-dried and sundried leaves of *Gliricidia sepium* and *Acacia auriculiformis* (Figures 1, 2 and 3) conforms with existing decomposition pattern (Mafongoya *et al.,* 1997; Meetemeyer 1978; Sandhu *et al.,* 1990 and Swift *et al.,* 1979). *Gliricidia sepium* showed higher persistence in the first 4 days for the different drying conditions. This justifies the suggestion by Meetemeyer, (1989) that in the tropics, decomposition rates are controlled by substrate quality rather than by climate. There was a very rapid decomposition from day 8 through 16 days in *Acacia auriculiformis* as a result of termite activity. Termites prefer *Acacia auriculiformis* to *Gliricidia sepium* because of the lignin content (Sandhu *et al.*, 1990).

However, there was equal rate of decomposition between day 4 through 8 16, 32 till 64 days. This could be explained as being the result of equality in resource quality of the organic material, the environment and the decomposer organism present.

Mafongoya *et al.* (1998) had earlier pointed out that leaves which contain high nitrogen but low lignin and polyphenol (e.g leaves of *Gliricidia sepium* and *Sesbenia spp*) will decompose very quickly. While leaves that contain low nitrogen but high lignin and polyphenol will decompose very slowly. Thus all samples of *Gliricidia sepium* that had completely decomposed by day 92 and *Acacia auriculiformis* that continued decomposition to 120 days for fresh and dried samples agrees with this earlier report.

Gliricidia sepium indicated higher nitrogen content at 4, 32, and 64 days when subjected to drying condition than fresh and air dried leaves. This indicated immobilization due to increase in lignin and soluble carbon content as a result of the high temperature drying. The result affirms the study by Mafongoya *et al.* (1997) and Quemada and Cabrera (1995) that both lignin and soluble carbon contained in legume leaves increase when subjected to high drying temperature.

Also, *Acacia auriculiformis* had higher nitrogen contained in the decomposition of litter at 8, 16 and 32 days for sun dried condition and 8, 16, 92 and 120 days for air dried condition. This result equally confirms existing studies by Mafongoya *et al.* (1997) and Quemada and Cabrera (1995).

However, no net immobilization was observed during decomposition of both species for air dried condition at 4 days. The trend was observed in *Gliricidia sepium* for air dried at 16 and 64 days and for sun dried condition at 8 and 16 days. While *Acacia auriculiformis* showed no net immobilization for sun dried condition at 4 days and air dried condition at 4, 64 and 92 days respectively

The result of this study has practical implication for attaining synchrony between nutrient release and crop nutrient demand, hence for efficiency of nutrient use.

CONCLUSION

It is evident from this study that a considerable amount of nitrogen can be added to the soil from decomposing leguminous leaves thereby partly replacing mineral fertilizer. Hence, there is need to understand litter quality in relation to decomposition and nitrogen release which may lead to productivity through proper management.

However, the greatest challenge is to develop ways of managing decomposition rate of organic matter to optimize rates of short and long term nutrient release and also to maintain soil organic matter. The result of this study has shown that the nitrogen content of legume leaves had increased in proportion when drying conditions were imposed on them. Also the rate of decomposition was equally altered when drying was imposed on the litters.

The residual effect on nutrient release and long-term changes in soil fertility from application of pruning of different quality is a subject, which has received minor attention. It is clear from the previous discussion that altering the drying condition of legume residue as source of providing nitrogen to crop can provide a robust management option for altering decomposition and nitrogen release pattern from plant residues

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