



## OUTCOME OF PULVERISED FOLIAR COMPOST ON EARLY GROWTH OF *ACACIA SENEGAL* AND *KHAYA SENEGALENSIS* SEEDLINGS IN SEMI-ARID ECOSYSTEM

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**ABSTRACT:** Composting involves primarily the microbial decomposition of organic matter. The pulverized leaf compost of *Khaya senegalensis*, *Acacia senegal*, *Azadirachta indica* and *Ficus glumosa* were not applied directly for raising the seedlings. The leaves were grinded and mixed with river sand at various proportions of sand to leaf compost namely: 20:80, 30:70, 40:60, 50:50 and a control made up of pure river sand as the growth medium. Leaf samples of *Khaya senegalensis*, *Azadirachta indica*, *Ficus glumosa* and *Gmelina arborea* were pulverized by a grinding machine. The analysis of data was carried out using Fisher's least significant difference pair comparison procedure (LSD) based on Student's T-test. The results showed that there are significant differences among treatments at  $P < 0.05$ . This represents the highest growth in the experiment. Among all the paired comparison using LSD procedure, the 20% pulverized leaf compost in river sand had the best treatment effect on growth. Hence it is recommended for raising the seedlings of *A. senegal* and *K. senegalensis*.

**Keywords:** Pulverized, Leaf compost, Growth, Mixture, Comparison, Seedling, Height and Diameter

### 1. INTRODUCTION

Composting involves primarily the microbial decomposition of organic matter. It is an excellent example of the practical use of biotechnology. The overall wellbeing of the forest plant is the main goal of any tree establishment through application of nutrients. While foliar feeding of fertilizer is a technique of feeding plants by applying liquid fertilizer directly to their leaves, (Kuepper 2003). The pulverized foliar composting assist in reducing the time it takes to complete the process through root application and make the nutrients available to plants for growth through the soil. In composting, the end product is a dark, friable, partially decomposed substance similar to the natural organic matter found in the soil. Application of leaf compost have long been known to improve the physical conditions of many soils (Maynard and Hill 1994).

The organic matter content of the soil is very important to growth and development of plants. It influences the physical condition of the soil and its water holding capacity which affects the availability of water and mineral salts to the plant. Growers appear more likely to consider using leaf compost as a soil amendment than other solid waste composts (Maynard 2010). Most of the naturally occurring nutrients in compost are immediately available to plants, but are released slowly so that plants can use them throughout the growing season. This phenomenon makes further research into the intrinsic benefits of the foliage compost of

paramount importance in sustainable forest management (SFM).

The conscious application of leaf compost is a means toward amending the soil condition for optimum growth of the seedling. A lot of improvement was observed by Maynard (2003) working on eggplant and tomatoes. She observed that the amended plots (leaves or compost) had greater yields than the control plots. During composting, microbial decomposition aerobically transforms organic substrates into a stable, humus-like material (Brown and Subler 2007). The use of pulverized leaf compost is a nursery initiative that has the potential to contribute to rapid production of seedlings for afforestation or reforestation program in semi-arid ecosystem. This is taken into account the rate of decomposition enhanced by breaking the composting material into forms which the microbes could act faster upon; thus reducing the waiting time in traditional composting system considerably.

Forest soil fertility or mineralization is usually maintained by constant leaf falls through which essential minerals and nutrient uptake from the soils are recycled (Maynard 2000). Hence, the use of pulverized foliar compost in arid zone forestry development requires to be studied, establish mix ratios and determine suitability of wide range of plant species for application. The organic matter content of soils is very important, it influences the physical condition, water-holding capacity, and temperature of the soil, and especially the soil bacterial processes which affect the

availability of mineral salts to plants (Flannery 2004). Therefore, it is the objective of this study to explore the possibility of pulverizing leaf fall for compost as a smart approach to traditional composting which takes longer time to become compost. It serves as a mean of breaking down the leaves into tiny bits that the microbes can work upon quickly without affecting the nutrient contents. The use of river sand is to serve as a means of comparing the benefits of using the pulverized leaf compost of the selected species and their mixtures with river sand. However, while pure sand is not an ideal medium for growing plants, it can be used to successfully grow a number of different plant species (McLaughlin 2016). The experiments have shown that the river sand used has some effects on growth in some cases that require further investigations. But in most cases the results show that there is significant effect of the use of pulverized leaf compost.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The study area is half hectare of Department of Forestry and Wildlife Nursery, University of Maiduguri, Borno State. Located on latitude 11° 43' 34.6E and longitude 13°12' 33.1"N and altitude of 354m ASL. The climate condition is relatively hot and dry for a greater period of the year with a temperature ranging from 15°C - 20°C (minimum) and 37°C - 50°C (maximum) the climatic condition is characterized into dry and wet season. The wet season is normally from June to September with relative humidity of 49%. The mean annual rainfall is less than 600 mm, distributed within three to four months of the year ([wikipedia.org/wiki/Geography\\_of\\_Nigeria#Climate](http://wikipedia.org/wiki/Geography_of_Nigeria#Climate)).

### 2.2 Method

Leaves of four deciduous tree plant species namely: *Khaya senegalensis*, *Gmelina arborea*, *Azadirachta indica* and *Ficus glumosa* were selected for trial on pulverization of leaves for compost production and application in nursery growth of two species namely *Khaya senegalensis* and *Acacia senegal*. The leaf samples were collected under each of the mother trees and further sun dried to reduce the moisture content and make it easy to pulverize. The leaf samples were pulverized separately using a grinding machine. Other materials used include the digging implements, polypots, the measuring tape and a caliper for height and diameter measurements. The pulverized leaf samples of each species were collected inside labelled nylon bags and mixed with water to form a paste of the sample. The mixture was then poured into a sack and tied. Water was further added and thoroughly mixed. According to Trautmann and Richard (1996) the optimum moisture content of composting ingredient is 40-60% as different composting materials have

different practical moisture content. This follow why 15 litres of water was used to mix *Ficus glumosa* and *Khaya senegalensis* 20 litres for *Azadirachta indica* and 25 litres of water was used for *Gmelina arborea*. This is to help keep the pulverized leaves moist for microbes' decomposition activities. In addition, 500g of mashed fishmeal was added to facilitate bacterial activities (Flannery 2004). An indicator stick was inserted in each bag to assess the progress of decomposition. The sacks were then tied before being buried into the ground at a depth of 60cm. They were buried in the pit for 45 days during which water was added weekly until the compost became matured. They were then removed from the burial ground and spread out on a nylon sheet to air dry them under shade for 24 hours.

After composting of the four species for six weeks, the upshot of mixing different species leaf compost was further investigated by mixing equal volume from the single species composts. The mixtures tested are Gmelina/Khaya, Gmelina/Neem and Khaya/Neem in addition to the main four single species compost namely: Gmelina, Khaya, Neem and Ficus. This resulted in the seven treatments used for the experiment. The leaf compost was not applied directly for raising seedlings as river sand was used to mix at various proportions of pulverized leaf compost to river-sand as follow: 20:80, 30:70, 40:60, 50:50 and a control made up of pure sand growth medium. According to (Flannery 2004), no more than 25 to 30% of the potting soil should be leaf compost. In order to examine the reaction of semi-arid plants in the zone, higher percentages of 40 and 50% were experimented.

### 2.3 Pulverization Method

A grinding machine was used for pulverizing the leaf samples. Each leaf sample was fed into the machine while the pulverized leaf was then collected with a sack at the outlet. This process is repeated depending on the smoothness of the pulverized leaf. Leaves of *Khaya senegalensis* and *Ficus glumosa* were repeatedly passed through the grinding machine before getting a smooth pulverized sample. They were more difficult to grind than Gmelina and Neem species due to thickness of their lamina and pronounced leaf veins.

### 2.4 Seed sowing and growth measurement

After the preparation of the sowing medium, the seeds of *K. senegalensis* and *A. senegal* where soaked for two days in water at ambient temperature. The seeds were then sown in various treatments at 2cm depth and watered. The watering continued twice daily throughout the six weeks of raising the seedlings in the nursery and the data collection. Heights and diameters were measured. The rate of germination varied among species and between species. Measurements of growth parameters where taken after 70% of the seeds have

germinated in each treatment. The height measurement is taken from the ground level to the meristematic point on the seedling, while the diameter measurement is taken at the collar position on the seedling stem. Wherever the collar position is covered by the soil, the soil is carefully displaced to take the reading.

### 2.5 Experimental Layout

Using completely randomized block design of experiment (CRBD), with seven treatments, five block effect and five replicates, the experimental samples were laid out into seven groups for the pulverized leaf composts as the treatments without shading. Each group is arranged into five columns. In each group, five seedlings each of *Khaya senegalensis* and *Acacia senegal* were raised in the pulverized leaf composts mixed with unsterilized river sand in the following proportions (20:80, 30:70, 40:60, 50:50 and Control) as the block effect. Unsterilized river sand alone was used as the control experiment. In each group, 35 seedlings of *Acacia senegal* and 35 seedlings of *Khaya senegalensis* were raised. This was replicated five times to give a total of 175 seedlings each making a total of 350 seedlings for the experiment on both *Khaya senegalensis* and *Acacia nilotica*.

### 2.6 Data analysis

Using completely randomized block design (CRBD) the analysis of data was carried out using ANOVA and Fisher's least significant difference pair comparison procedure (LSD) based on Student's T-test to determine the level of significant effects of pulverized leaf compost on the growth performance of *Khaya senegalensis* and *Acacia senegal*. The significant levels were taken at  $P < 0.05$ .

## 3 RESULT AND DISCUSSION

The ANOVA of the data has shown that there is a significant difference among treatments at  $P < 0.05$ , hence further tests were carried out using the Fisher's least significant difference paired comparison procedure (LSD). In Table 1 the height growth of *Khaya senegalensis* vary significantly between control and other mix ratios of pulverized leaf compost. The results show that there are significant differences among pairs of means in height growth of *Khaya senegalensis* under different pulverized leaf compost such as *Gmelina:Khaya* (G:K). The treatment difference is significant at 30% and 50% mix ratio with 7cm and 38cm mean height difference respectively. The mix ratio at this level of significance cannot be justified for using *Gmelina* leaf compost because there are other species and mix ratios that have more significant effect on height growth (Flanerry 2004). Twenty one comparisons were carried out with LSD showing that there are significant treatment differences in the paired means of pulverized leaf compost on

height growth of *Khaya senegalensis*. The paired mean comparison of Neem and combination of *Gmelina:Khaya* (N:G/K) mixed pulverized leaf compost had the highest treatment effect on height growth of *K. senegalensis* with 49.7cm at 20:80 mix ratio. This performance is followed by F:G/K under the 40% mix ratio with 44.9cm which is not too different from 44.6cm still under N:G/K 20%. The results have shown that there are significant differences in the growth of *K. senegalensis* with various ratios of pulverized leaf composts. In the control experiment, the highest significant growth was 32.5cm which is obtained under paired comparison of N:F.

The result in Table 1 also shows that mixing pulverized leaf for compost has very little significant effect on height at 50% mix ratio except in K:N, K:F and K:(G/N) where the heights obtained are 37.5, 39.1 and 33.9cm respectively. The results also showed that pulverized leaf compost when mixed has better treatment effect on height than when used singly. The lower mean height growth performance in the control experiment shows the significant treatment effect of using pulverized leaf compost on height growth of *Khaya senegalensis*. *Ficus glumosa* had the best height of 44.9cm and 40.9cm where the means are compare F:G/N and F:G/K respectively under 20% mix ratio. This has also indicated that there is a significant advantage of using litter falls for rapid compost preparation. It has also shown the need to investigate further the differences between other types of compost for comparison (Maynard and Hill 2000).

Table 1: Paired comparison of height (cm) growth of *K. senegalensis* in pulverized leaf compost

Compost	Control	20%	30%	40%	50%
G:K	1.9 <sup>ns</sup>	7.0 <sup>ns</sup>	7.0*	1.6 <sup>ns</sup>	38*
G:N	23.1*	25.9*	1.9 <sup>ns</sup>	22.2	0.5 <sup>ns</sup>
G:F	9.4*	16*	1.1 <sup>ns</sup>	20*	8.9 <sup>ns</sup>
G:GN	5.1 <sup>ns</sup>	43*	21.9*	13.5*	4.1 <sup>ns</sup>
G:G/K	8.4*	23.8*	1.6*	24.9*	29*
G:N/K	9.6*	18.7*	6.9*	20.9*	0.0
K:N	2.5 <sup>ns</sup>	18.9*	8.9*	20.6*	37.*5
K:F	7.5 <sup>ns</sup>	23*	5.9 <sup>ns</sup>	21.6*	39.1*
K:G/N	7.0 <sup>ns</sup>	2.7 <sup>ns</sup>	28.9*	11.9 <sup>ns</sup>	33.9*
K:G/K	10.3*	30.8*	8.6*	23.3*	9.0 <sup>ns</sup>
K:N/K	11.5*	25.7*	13.9*	19.3*	
N:F	32.5*	41.9*	3.0 <sup>ns</sup>	42.2*	8.4 <sup>ns</sup>
N:G/N	18*	21.6*	20*	8.7 <sup>ns</sup>	3.6 <sup>ns</sup>
N:G/K	14.7*	49.7*	0.3 <sup>ns</sup>	2.7 <sup>ns</sup>	28.5*
N:N/K	13.5*	44.6*	5 <sup>ns</sup>	1.3 <sup>ns</sup>	0.0
F:G/N	14.5*	20.3*	23*	33.5*	4.8 <sup>ns</sup>
F:G/K	17.8*	7.8 <sup>ns</sup>	2.7 <sup>ns</sup>	44.9*	20.1*
F:N/K	19*	1.8 <sup>ns</sup>	8*	40.9*	0.0
G:N:G/K	3.3 <sup>ns</sup>	28.1*	20.3*	11.4 <sup>ns</sup>	24.9*
G:N:N/K	4.5 <sup>ns</sup>	23*	15*	7.4 <sup>ns</sup>	0.0
G:K:N/K	1.2 <sup>ns</sup>	5.1 <sup>ns</sup>	5.3 <sup>ns</sup>	4 <sup>ns</sup>	0.0

G = *Gmelina*, N = *Neem*, K = *Khaya* F = *Ficus* \* = significant, ns = not significant

In Table 2 the diameter growth of *Khaya* seedlings vary significantly among the treatments. In the control experiment the highest diameter growth is 7.7mm. In the 20% compost mixture with river sand the highest diameter growth was obtained under the treatment effect of *Khaya* and *Neem* leaf compost among all the treatments and treatment combinations. The use of *Khaya senegalensis* compost produced 8.6mm of diameter growth development making it to be the combination to choose for seedling diameter growth. Similarly, pulverized leaf compost combination of *Khaya* mixed with *Gmelina* had 8.6mm growth in diameter. The result shows that further mixture of the pulverized leaf compost with river sand beyond 20% does not give significant added advantage of doing so.

Table 2. Paired comparison of diameter (mm) growth of *K. senegalensis* in pulverized leaf compost

Compost	Control	20%	30%	40%	50%
G:K	3.5*	5.2*	2.9	5.0	5.2
G:N	2.9*	3.4*	0.3ns	3.1	6.9
G:F	9.0*	1.2ns	4.3	3.6	7.2
G:G/N	6.3*	1.6ns	0.3ns	0.4ns	1.7ns
G:G/K	7.5*	3.4*	2.7	2.6	4.1
G:N/K	7.7*	3.8*	0.3ns	0.6ns	0.0
K:N	0.6ns	8.6*	2.6	1.9ns	1.7ns
K:F	5.5*	6.4*	1.4	1.4ns	2.0ns
K:G/N	2.8*	6.8*	2.6	4.6	3.5
K:G/K	4.0*	8.6*	0.2ns	2.4	1.1ns
K:N/K	4.2*	1.4ns	2.6	5.6	0.0
N:F	6.1*	2.2ns	4.0	0.5ns	0.3ns
N:G/N	3.4*	1.8ns	0ns	2.7	5.2
N:G/K	4.6*	0ns	2.4	0.5ns	2.8
N:N/K	4.8*	7.2*	0ns	3.5	0.0
F:G/N	2.7*	0.4ns	4.0	3.2	5.5
F:G/K	1.5ns	2.2ns	1.6	1.0ns	3.1
F:N/K	1.3ns	5*	4.0	4.2	0.0
G/N:G/K	1.2ns	1.8ns	2.4	2.2	2.4
G/N:N/K	1.4ns	5.4*	0ns	2.2	0.0
G/K:N/K	0.2ns	7.2*	2.4	3.2	0.0

G = *Gmelina*, N = *Neem*, K = *Khaya* F = *Ficus* \* = significant, ns = not significant

In Table 3, the height growth of *A. senegal* vary significantly among the treatments and control. The growth performance of *A. senegal* in the control experiment was 84cm mean height. This represents the highest growth in the experiment followed by 70.9cm. The result of the ANOVA showed that there is a significant difference in treatment at  $p < 0.05$ . In the follow up test result of LSD, performance of seedlings under different growth conditions shows some level of significant differences.

*A. senegal* grown in the 20% pulverized leaf compost to river-sand had 50.9cm height growth with both K:N and K:G/K pulverized leaf compost. The choice of the mixture in this case will depend on which of the leaf species is available for pulverization. Otherwise, the result has shown there is no added advantage in using separate compost of *Gmelina* or *Khaya* to achieve maximum growth. Among all the combination of factors using LSD paired comparison, the 20% pulverized leaf compost in river-sand had the best performance hence it is recommended for the production of *A. senegal*.

Table 3. Paired comparison of height (cm) growth of *A. senegal* in pulverized leaf compost. (LSD value).

Compost	Control	20%	30%	40%	50%
G:K	39.4*	22.9*	20.2*	40.5*	33.8
G:N	42.8*	28.0*	2.1ns	17.5*	39*.1
G:F	84*	16.5*	27.2*	12.9*	37.9*
G:G/N	81.1*	14.5ns	27.2*	0.9ns	6.8ns
G:G/K	62.9*	28.0*	0.8ns	9.9ns	15.0*
G:N/K	70.9*	13.6ns	8.7*	4.9ns	0.0
K:N	3.4ns	50.9*	18.1*	23*	5.3ns
K:F	44.6*	39.4*	7ns	27.6*	4.1ns
K:G/N	41.7*	37.4*	21.7*	41.4*	27*
K:G/K	23.5*	50.9*	21.5*	30.6*	18.5*
K:N/K	31.5*	9.3ns	11.5*	45.4*	0.0
N:F	41.2*	11.5ns	25.1*	4.6ns	12ns
N:G/N	37.3*	13.5ns	3.6ns	18.4*	32.3**
N:G/K	20.1ns	0ns	3.4ns	7.6ns	24.1**
N:N/K	28.1*	41.6*	6.6ns	22.4*	0.0
F:G/N	2.9ns	2.0ns	28.7*	13.8*	31.1*
F:G/K	21.1ns	11.5ns	28.5*	3ns	22.9*
F:N/K	13.1ns	30.1*	18.5*	17.8*	
G/N:G/K	18.2ns	13.5ns	0.2ns	10.8ns	8.2ns
G/N:N/K	10.2ns	28.1*	10.2*	4ns	
G/K:N/K	8.0ns	41.6*	10*	14.8ns	

G = *Gmelina*, N = *Neem*, K = *Khaya* F = *Ficus* \* = significant, ns = not significant

In Table 4, the diameter growth of *Acacia senegal* varies significantly ( $p < 0.05$ ) among control and other treatments. In the follow-up test, the results show that pulverized leaf compost mixture with river-sand at 20% has more significant growth effect on diameter of *A. senegal*. The pulverized leaf compost of K:N and K:G/K with 8.6mm each that represents the highest growth among the experimental treatments with the exception of G:F having 9.0mm in the control experiment. The results shows that *Gmelina* compost has significant effect on growth in the control while *Khaya* has significant effect at 20% pulverized leaf compost mixtures K:N 8.6mm, K:F 6.4mm, K:G/N 6.8mm and K:G/K 8.6mm Hence, the choice of pulverized leaf compost is made between *Khaya* and a mixture of *Gmelina* and *Khaya* leaf compost.

Table 4. Paired comparison of diameter (mm) growth of *A. senegal* in pulverized leaf compost. (LSD value).

Compost	Control	20%	30%	40%	50%
G:K	3.5*	5.2*	2.9*	5.0*	5.2
G:N	2.9*	3.4*	0.3ns	3.1*	6.9*
G:F	9.0*	1.2ns	4.3*	3.6*	7.2*
G:G/N	6.3*	1.6ns	0.3ns	0.4ns	1.7ns
G:G/K	7.5*	3.4*	2.7*	2.6*	4.1*
G:N/K	7.7*	3.8*	0.3ns	0.6ns	
K:N	0.6ns	8.6*	2.6*	1.9ns	1.7ns
K:F	5.5*	6.4*	1.4*	1.4ns	2.0ns
K:G/N	2.8*	6.8*	2.6*	4.6*	3.5*
K:G/K	4.0*	8.6*	0.2ns	2.4*	1.1ns
K:N/K	4.2*	1.4ns	2.6*	5.6*	
N:F	6.1*	2.2ns	4*	0.5ns	0.3ns
N:G/N	3.4*	1.8ns	0.0ns	2.7*	5.2**
N:G/K	4.6*	0ns	2.4*	0.5ns	2.8*
N:N/K	4.8*	7.2*	0.0ns	3.5*	
F:G/N	2.7*	0.4ns	4*	3.2*	5.5
F:G/K	1.5ns	2.2ns	1.6*	1.0ns	3.1
F:N/K	1.3ns	5*	4*	4.2*	
G/N:G/K	1.2ns	1.8ns	2.4*	2.2*	2.4
G/N:N/K	1.4ns	5.4*	0.0ns	2.2*	
G/K:N/K	0.2ns	7.2*	2.4*	3.2*	

G = Gmelina, N = Neem, K = Khaya F = Ficus \* = significant, ns = not significant

#### 4 CONCLUSIONS

1. The results have shown that the early growth of seedlings of *K. senegalensis* and *A. senegal* was influenced by the pulverized leaf compost.
2. It has also shown that there is need to further develop pulverization of leaf compost. The composting experiment was carried out in 45 days. This is very significant when compared with four to nine months of some traditional composting or probably more if the compost is in a farm yard.
3. This study showed that 20% mixture with available soil will have a significant effect on growth. This level of mixture showed consistent significant effect on growth parameter such as height and diameter in both *K. senegalensis* and *A. senegal*.
4. Base on the properties investigated and the results obtained, it is evident that pulverization of leaves of the species investigated could be the best alternatives to the traditional compost preparation.

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