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The Effect of Poultry Manure on the Early Growth Performance of *Milicia excels* Seedlings

Pengaruh Pupuk Unggas pada Pertumbuhan Awal Bibit Milicia excelsa

Philip Worlanyo Dugbley[1*] and Olivia Agbenyega[2]

[1]Department of Silviculture, Faculty of Forestry, IPB-Indonesia*
[2]Department of Agroforestry, Faculty of Renewable Natural Resources, KNUST-Ghana
*[1]*Correspondent address: [1]Department of Silviculture, Faculty of Forestry, IPB,*
Jl. Raya Campus IPB Dramaga-Bogor 16680, mobile 085717390036/081318038490.
E-mail: philidug87@yahoo.com[1] or Olivia_agbenyega@yahoo.com[2]*

ABSTRACT

Milicia excelsa adalah jenis pohon pionir yang termasuk ke dalam family Moraceae. Species ini biasa ditemukan di daerah berketinggian rendah menutupi hutan Afrika, membentang melintasi sub daerah Afrika Barat dari Senegal melewati Cote D' Ivoire, Ghana menuju Nigeria. Tempat lainnya meliputi Angola, Mozambique, dan Tanzania. Bibit dari Milicia excelsa dikembangkan untuk tujuan penanaman terlihat menurun dan jumlahnya sedikit dalam bentuk tegakan dalam kondisi cuaca yang tidak menguntungkan membuatnya sangat sulit dalam meningkatkan bibit yang sehat. Tujuan dari penelitian ini adalah untuk menentukan pengaruh dari pupuk unggas pada dosis yang berbeda pada pertumbuhan awal bibit Milicia excelsa. Percobaan telah dilakukan di Fakultas Pertanian Sumber Daya Alam yang dapat Diperbaharui, KNUST-Ghana. Rancangan Acak Kelompok (RAK) digunakan untuk penelitian ini dengan lima perlakuan. Perbedaan dosis perlakuan di antaranya T1 (kontrol), T2 (0.90 kg), T3 (1.80 kg), T4 (2.70 kg), T5 (3.60 kg) pupuk unggas. Data yang dikumpulkan di antaranya tinggi bibit, diameter, jumlah daun, dan persentase kemampuan hidup tiap dua minggu sekali selama kali berturut-turut. Data dianalisis menggunakan Analisis Variasi satu cara (ANOVA). Hasil menunjukkan bahwa perbedaan perlakuan memiliki pengaruh yang signifikan pada tinggi batang, dan rata-rata jumlah daun dari bibit Milicia excelsa. Perlakuan T5 terbukti memberikan rata-rata pertumbuhan tinggi tertinggi, yakni 29.82 cm dan rata-rata jumlah daun 7.33. Akan tetapi pupuk unggas tidak berpengaruh signifikan pada rata-rata pertumbuhan diameter dari bibit Milicia excels. Chi-Square menunjukkan pupuk unggas memberikan pengaruh yang tidak signifikan pada rata-rata daya hidup bibit Milicia excelsa.

Kata kunci: Milicia excelsa; penampilan pertumbuhan, pupuk unggas

INTRODUCTION

The growth of plants depends on the availability of nutrients from the soil. It is therefore important that the soil should be able to provide nutrients for the growth and development of plants. Prolonged uptake of nutrients by growing plants depletes soil of vital nutrients, adversely affecting the growth of plants. Organic manure can be added in order to compensate for the losses due to leaching and uptake by existing plants from the soil (Russell, 1998).

Milicia excelsa formerly called *Chlorophora excelsa* belongs to the family Moraceae. The tree is mostly found in West, Central and East Africa, extending from Guinea Bissau to Mozambique. *Milicia excelsa* is a durable wood used for the purposes of exterior and interior joinery, frames and doors, luxury cabinet works and garden furniture. Other uses include floorings, steps and stairs, paneling and moldings, decorative veneer, plywood and the construction of vehicle and truck bodies (Oteng-Amoako, 2006). The high demand for the wood and its other products has resulted in over exploitation.

The species is now considered as a scarlet species; species that are common but under more imminent threat. Currently it has over 200% exploitation rate and requires special permit for it to be harvested (The Ghana Forest Service, 1998). To replenish the stocking of such valuable species, its plantations were established. Seedlings of *Milicia excelsa* raised for plantation purposes appear weak and slender in form and hardly withstand the adverse conditions of the weather making it very difficult in raising healthy seedlings affecting the species growth performance as well as its survival rate in plantation establishments (Irvine, 1961). The introduction of *Milicia excelsa* into plantations as a native species can help decrease the exploitation rate in Ghana since it will reduce the high dependency on the natural forest for *Milicia excelsa* species for subsistence or commercial purposes. However, for a plantation program to yield maximum environmental and economic benefits, healthy and good seedlings should be supplied inexpensively (Appiah, 1998). Addition of poultry manure to improve the nutrient status of the growth medium (soil) can enhance the general growth performance of seedlings in a nursery and at planting sites.

MATERIALS AND METHOD

Study Area

The field experiment was conducted at the Faculty of Renewable Natural Resources Demonstration Farm (KNUST-Kumasi). This area falls within the Moist Semi-deciduous Vegetation Zone of West Africa. The area is characterized by a bimodal rainfall pattern with the major wet season between May and July. This area experiences a short dry season in August and a long dry season between December and March. The annual rainfall of the area ranges between 1250 mm and 1500 mm. The soil in the study site belongs to the family Ferric Acrisols in the soil taxonomy. Ferric Acrisols are loamy sand, well drained but strongly acidic (Adu and Asiamah, 1992).

Research Design and Layout

The experimental design used in this field research was the Randomized Complete Block Design. Two-months old *Milicia excelsa* seedlings were obtained from the Forestry Research Institute of Ghana (FORIG). The poultry manure was obtained from the Animal Science Department of the Faculty of Agriculture, KNUST-Ayeduase. Other tools and equipment used included cutlass, rake, watering can, tape measure, hand fork and hoe for the preparation of the planting bed. The study was carried out in three blocks, each block consisting of five plots. The poultry manure was applied at the rate of 17,500 kg/ha as recommended by Zublena *et al.,* (1993). Five levels of the poultry manure were used for the experiment. T1 (0.0 Kg), T2 (0.90 Kg), T3(1.80 Kg), T4 (2.70 Kg) and T5 (3.60 Kg). The plant parameters measured were the plant height (cm), stem diameter (mm), percentage survival and the number of leaves. According to Mohr and Schopfer (1995), height and stem diameter are some of the frequently used methods of measuring the growth of multi-cellular living systems and often advantageous to use several characteristics for the same system. Leaves are also an important part of plants; they help in the process of photosynthesis. Leaves have their own definite shape and arrangement according to requirements of the plant. Leaves trap energy from sunlight and convert it into pure compounds. Leaves were counted visually. An electronic caliper was used in measuring the stem diameter while the height was measured with a meter rule. Data on the height, stem diameter and number of leaves were collected two days after transplanting and fortnightly over the twelve weeks of the research. The experiment was conducted from 23rd November, 2010 to 19th February, 2011.

Experimental Procedures

Three beds representing the blocks of size 1.0 m × 7.0 m (7.0 m^2) each and plots with dimensions of 1.0 m × 1.0 m (1.0 m^2) were constructed with spacing of 50 cm between the blocks and plots. The various treatments were randomly allocated to the plots with eight seedlings per plot. Reference points of 1cm above the soil surface of the seedlings were marked with non-poisonous indelible ink to provide consistency at the point of the height and diameter measurement. The total number of experimental plots was fifteen. The poultry manure was applied at the rate of 17,500 Kg/ha as recommended by Zublena *et al.,* (1993). Rates of poultry manure application were therefore applied based on the following calculation; 10000 m^2 (1 hectare) = 17500 Kg.

$$1.0\ m^2 \text{ (plot size)} = \frac{1.0\,m^2 X 17500\,Kg}{10000\,m^2} = 1.75 \text{ Kg/plot}$$

≈ 1.80 kg/plot (average application).

The recommended rate per plot was halved, doubled and multiplied by one-half to achieve the various treatment levels. Five levels of the poultry manure were used for the experiment.

T1=0.0 Kg, (control),
T2=0.90 Kg of poultry manure,
T3=1.80 Kg of poultry manure,
T4=2.70 Kg of poultry manure and
T5=3.60 Kg of poultry manure.

The poultry manure was applied to the soil two weeks before transplanting the seedlings to the experimental plots to allow the ammonia to be nitrified to avoid burning of the seedlings as recommended by Smith (1962).

Cultural Practices on Experimental Plots

Seedlings were transplanted from the poly bags at two months old. The transplanting exercise was undertaken late in the afternoon after the bed had been thoroughly watered. According to Hilary (2009), the best time of the day to plant is in the late afternoon when the sun is not so hot. By taking advantage of this time of day, the new plants are able to acclimatize overnight. Strong sun and wind have a potentially adverse effect on new transplants and unless watered carefully, and in some cases sheltered from the wind and sun, they can severely wilt. This puts the plants under stress at the very beginning of their growing cycle. Watering of the transplanted seedlings was done immediately after transplanting and twice daily and evenly with each plot receiving about the same volume of water. Plots were not watered after heavy rains due to high incidence of fungal infestation when the plant roots are overwatered.Weeds that appeared on the beds were controlled by hand-picking to prevent competition for water, nutrients, space and light. According to Townsend and Sinden (1999), weeds host pests and diseases and can spread to cultivated crops. Weeds also impose costs on producers in two ways; through reductions in the quality and quantity of yields, and increases in input requirements for weed control.

Data collection and Analysis

An indelible ink was used to mark each seedling 1cm above the soil, where the diameter and height readings were taken so that irregularity of the soil

around the seedlings would not affect the recording. Initial measurements of both the heights and the diameters were taken two days and two weeks after transplanting and application of the treatments respectively. Subsequent readings were taken every two weeks for a period of three months within which seven readings were recorded. All data collected were subjected to a Two-way Analysis of Variance (ANOVA). The mathematical model for the research design is as follows;

$Y_{ij} = \mu+\tau_i+\beta_j+\varepsilon_{ij}$

Where;

i =1, 2,3,4,5 and j = 1, 2, 3.
Yij = any observation for which X_i
μ = the general location parameter (the mean)
τ_i = the effect for being in i^{th} treatment
β_j = the effect for being in j^{th} block
ε_{ij} = random error

Microsoft excel was used to compute the increment of the various plant parameters measured and Minitab Version 16 software used in data analysis. Tukey's Honest Significant Difference method (HSD) was used to separate treatment means that differed significantly.

The Chi-Square method (φ^2)=

$$\sum\{\frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}\}$$

was used to compute and determine the significance of the poultry manure on the seedling percentage survival at a significant level of 5%.

RESULTS AND DISCUSSION

Mean height increment of *Milicia excelsa* seedlings

All the treatments increased in height throughout the study period. Analysis of Variance (ANOVA) tested at α = 5% significance level showed a significant effect of poultry manure on the mean height increments.

Table 1 Two-way ANOVA for Mean Height Increment (cm)

Source	DF	SS	MS	F	P
Treatments	4	224.002	56.0005	19.35	0.000
Blocks	2	7.880	3.9399	1.36	0.310
Error	8	23.152	2.8940		
Total	14	255.034			

S = 1.701 R-Sq = 90.92% R-Sq (adj) = 84.11%

However, the degree of increment varied among the treatments. The significant increase in the height of the *Milicia excelsa* seedlings might be due to the nutrient contribution from decomposing poultry manure. The effect of T4 (2.7 Kg of manure) was greater than that of T1 (0 Kg of manure). There was a sharper growth with increasing rate of manure application. This confirms the assertion by Duryea and Brow (1984) that seedlings grown at fairly higher fertilization levels produced higher growth rates. Smith, (1962) reported that poultrymanure may be of little immediate value in correcting nutrient deficiencies since it takes time for it to decompose and release nutrients to plants roots. The role played by the three primary nutrients (N P K) is vital in the process of plant development.

Table 2. Grouping of means using Tukey pairwise rate (HSD) method at 95.0% Confidence

Treatments	N	Mean ± SE Mean		
		Height	Diameter	Leaf
T5	3	29.8^a ± 1.07	3.460^a ± 0.386	7.333^a ± 0.667
T4	3	28.8^a ± 1.25	4.677^a ± 0.737	13.33^a ± 3.330
T3	3	28.2^a ± 0.29	4.137^a ±0.162	9.330^a ± 1.200
T2	3	23.4^b ± 1.25	4.053^a ± 0.335	7.667^a ± 0.882
T1	3	19.7^b ± 1.07	3.660^a ± 0.330	7.667^a ± 0.333

Means that do not share a letter are significantly different.

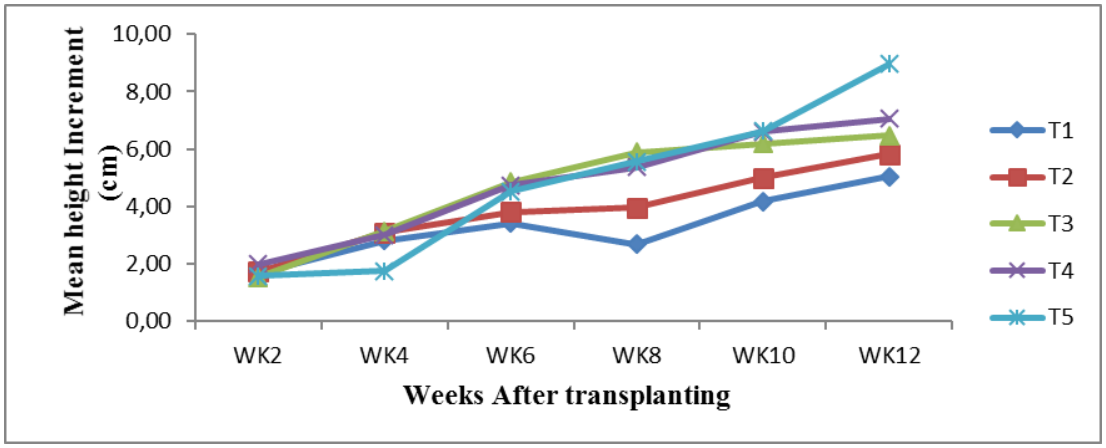

Fig 4.0 Graph of mean height increments of *Milicia excelsa* seedlings

The significant increase in the height of the seedlings might be due to the nutrient contribution from decomposing poultry manure. The application of 2.7 Kg (T4) of manure, performed better than when 0.9 Kg (T2) of manure was applied. The performance of T4 (2.7 Kg of manure) could be attributed to the increased supply of nitrogen (N). This might have increased the meristematic and developmental activities through the differentiation of tissues and have therefore increased growth with respect to the height of the seedlings. This result confirms the findings of Mohan and Sharma (1992) who worked on the effect of nitrogen and sulphur on the growth and yield of mustard seedlings.Hileman (1972) described poultry manure as organic manure with high fertilizer value which is successfully used on a variety of crops. Zublena *et al.* (1993) also noted that the organic matter in soil improves moisture and nutrient retention. These properties of high fertilizer value, improvement of moisture and nutrient retention aided in increasing the rate of growth and subsequently produced viable and healthy seedlings that can withstand adverse weather conditions. Therefore the presence of these nutrients in sufficient amounts resulted in vigorous growth of the seedlings.From the 10^{th} to 14^{th} week, the mean height increments continued to increase for all the treatments except for T1. Organic fertilizers are one of the options for creating a long lasting and healthy plant-soil environment that is ecologically responsible and economically viable for long term supply of nutrients for plant growth and development (Gale, 1997).

Diameter increment of *Milicia excelsa* seedlings.

All the treatments (T1, T2, T3, T4 and T5) had no significant effect on the seedling stem diameter throughout the study period according to the Analysis of Variance (ANOVA) test at 5% significance level ($p>0.05$). Also, the degree of increment varied among the treatments with T1 being the least and T4as the highest. Low increments in diameter were recorded for all the treatments between the 2^{nd} and 6^{th} week. This might be due to the fact that the poultry manure applied was being used for apical meristematic growth. Initially the growth is primary and involves developments which terminate when direct derivatives of apical meristems becomes mature. This growth produces roots, stem and leaves in the seedling. Secondary growth which result from the activities of the vascular cambium, occur in the latter stages and is responsible for the thickening of both roots and stem diameter (Kozlowski, 1971).

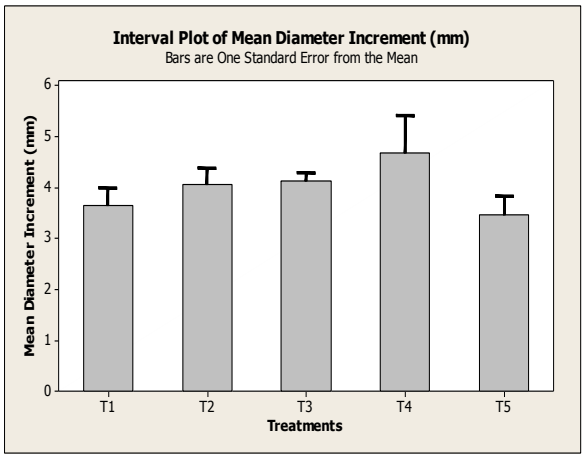

Fig.4.1 Interval plot of diameter increments of *M. excelsa* seedlings.

Leaf Count of *M. excelsa* seedlings

All the treatments showed increment in mean number of leaves throughout the research period. However, Treatment one (T1) showed the minimum increment and Treatment four (T4) recorded the highest increment. Analysis of Variance (ANOVA) at 5% significance level revealed no significant effect of poultry manure on the mean number of leaves ($p>0.05$). This non significant increment is due to the availability of nutrients for plant growth especially in the stem tissues. This confirms the assertion by Kozlowski (1971) that the initial growth of seedlings is primary and involves developments which terminate when direct derivatives of apical meristems becomes mature. This growth produces roots, stem and leaves in the seedling. Secondary growth which result from the activities of the vascular cambium, occur in the latter stages and is responsible for the thickening of both roots and stem diameter.

Percentage Survival of *M. excelsa* seedlings.

Three months after transplanting, the percentage survival of the *Milicia excelsa* seedlings ranged from 87.5 to 100 percent. A Chi-Square (x^2) test analysis revealed that, there was no significant difference between the treatment means over the control with a survival expectancy of 60 percent at significant level of 5% ($p=0.997$). All the treatments (T1, T2, T3, T4 and T5) recorded no mortality during the first six weeks after transplanting. However, three mortalities of plants were recorded after the first 8 weeks representing about 12.50% of mortality in the eighth week for treatment one (T1). Nwoboshie, (1982) reported that of all the factors controlling seedling growth, water is the most critical. Water is the vehicle for all physiological and biochemical process through which life is maintained. Whenever transpiration is greater than absorption, the plant becomes dehydrated. A decrease in hydration of protoplasm of cells in the meristematic tissues usually results in cessation or checking of cell division or cell enlargement or both.

CONCLUSIONS

The study indicates that poultry manure is a valuable source of fertilizer which can be applied to enhance stem height growth, and biomass of *Milicia excelsa* seedlings. However, there was no significant effect on the species diameter and mean leave increment. The actual rate of survival of *Milicia excelsa* seedlings could not be ascertained in this research due to time limit factor. An application rate of 27tons/ha however, provided an optimum plant growth and was capable of enhancing the growth of the *Milicia excelsa* seedlings by 10.10cm over the control according to this study. Poultry manure can therefore be applied to *Milicia excelsa* seedlings for enhancing the species' primary growth in the nursery as well as for its plantation establishment. It is recommended from this research that similar study should be carried out to investigate the actual effect of poultry manure on the survival rate of *M. excelsa* seedlings both in the in the nursery and on the field.

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