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POTENTIALS OF MYCORRHIZA AND FERTILIZERS ON SEEDLING GROWTH OF *ADANSONIA DIGITATA.* Linn

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ABSTRACT

Adansonia digitata has numerous socio-economic values but its slow growing habit inhibits the domestication and mass seedling production of the tree species. This study therefore investigated the effects of fertilizers and mycorrhiza on the growth potentials of *A. digitata* seedlings with a view to ascertaining the proportion of fertilizers and mycorrhiza that is appropriate for the optimum growth of the species. Seeds of *A. digitata* were procured, germinated and four weeks old seedlings of uniform size were transplanted into potting mixture with different treatments. The treatments comprised: T_1 = 1kg of top soil (control), T_2 = 10mg mycorrhiza + 1kg top soil, T_3 = 20mg mycorrhiza + 1kg top soil, T_4 = 100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil, T_5 = 10mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil, T_6 = 20mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil, T_7 = 200mg of cow dung +200mg of NPK fertilizer + 1kg top soil, T_8 = 10mg mycorrhiza + 200mg of NPK fertilizer + 1kg top soil and T_9 = 20mg mycorrhiza +200mg of cow dung + 200mg of NPK fertilizer + 1kg top soil making 9 treatments. They were replicated 5 times and laid out in Completely Randomized Design (CRD). Data collected on collar diameter (mm), shoot height (cm), leaf area (cm^2) and leaf production were subjected to Analysis of Variance (ANOVA). There were significant differences ($P<0.05$) among the treatments. The T_9 had the highest mean values of 13.69±0.23 cm, 1.97±0.21mm, 16 and 174.5cm^2 for shoot height, collar diameter, leaf production and leaf area respectively, while T1 had least in all growth variables (shoot height; 12.03±0.13cm, collar diameter; 1.07±0.01 mm, leaf production; 8 and leaf area; 128cm^2) Amendment of potting mixture with different levels of Cow dung, NPK fertilizer and mycorrhiza contributed significantly to the vigorous growth of *A. digitata* seedlings.

Keywords: Organic manure, inorganic manure, *Pisolithus tinctorus Adansonia digitata*,

Introduction

Adansonia digitata (Linn) belongs to the family Bombacacea. It is commonly referred to as Baobab or monkey – bread tree, distributed throughout the dry tropical Africa and very gregarious (Arbonnier, 2004). The tree has diverse utility values to man and animals. Preliminary studies have shown that the wood has long fibres, and a mixture of bast and wood fibres could produce blended pulp that will be suitable for high quality paper (Oluwadare, 1998). The tree has great potential for Agro-forestry, serving as wind break, fodder for animals, food and aesthetics and so on. The increase in the demand of some major parts of the plant by man has encouraged the cultivation of *A. digitata* in homes, gardens, estates or large parks. Therefore, its presence could be said to be indicative of human habitation because only very few are still found growing in the wild. However, wherever it is found, it is so highly exploited that it sometimes fails to form fruits or disperse them leading to scarcity of its seedlings.

Baobab litters that were shed during the dry season enrich the soil by enhancing soil moisture and organic matter content. Decaying wood of baobab may also be used as fertilizer. The ashes from seed and its shells are rich in potassium and can be used as fertilizers (Orwa *et al*., 2009). The hollow trunks of baobab serve as nesting sites for birds such as rollers, hornbills, parrots and kestrels while their branches welcome eagles, vultures and storks nests (ICUC, 2002). It can withstand extreme drought and it is suitable on degraded lands where other species cannot survive. Its thick and fibrous bark is remarkably fire resistant, and the tree continues to live and regenerate even if its interior is completely burnt out (ICUC, 2002).

Despite the immense potentials of this plant, it is characterized by slow growing syndrome which significantly inhibits the domestication and mass seedling production of the tree species. More so, there is dearth of information on the growth ability in relation to the influence of mycorrhiza, organic and inorganic fertilizers.

A mycorrhiza is a mutual symbiotic association between a fungus and a plant. The term mycorrhiza refers to the role of the fungus in the plant's rhizosphere and its rooting system (Andreote *et al*., 2014). Mycorrhizae play important roles in plant nutrition, soil biology and soil chemistry. They allow plants to draw more nutrients and water from the soil. They also increase plant tolerance to different environmental stresses. Moreover, these fungi play a major role in soil aggregation process and stimulate microbial activity (Antunes and Cardoso, 1991; Aidar *et al*., 2004). Based on these functions, the efficiencies of mycorrhiza, were investigated on the growth of *A. digitata*.

Organic fertilizers and chemical fertilizers are mineral nutrient rich materials that are used for soil amendment to improve the soil fertility for plant optimum growth. The growing media has to be enriched with nutrients either from organic manures or inorganic fertilizers in order to get healthy plants (Oso, 1995). The use of fertilizers has been reported to be vital in the replacement of soil nutrient and organisms which steadily make minerals available for plants uptake (Erin, 2007). Fertilizers contribute to soil physical properties through increasing water infiltration, water holding capacity, aeration, permeability and soil aggregation (Musa *et al*., 2018).

According to (Batino *et al*., 1998). Nitrogen, phosphorus and potassium are amongst the most important macro nutrients required for plant growth. These can be provided at desired level to soil through fertilizer application. Rational use of fertilizers promotes the production of environmentally friendly seedlings, accumulation of humus and improvement of soil structure (Uddin *et al*., 2012). As a result of the present economic constraints and negative effect of some inorganic fertilizers, attention is been shifted to organic soil amendments that enhances soil biota and through them supply nutrients to the plants as needed (Pattinson *et al*., 2004). This study therefore investigated the effectiveness of fertilizers and mycorrhiza on the growth potentials of *A. digitata* seedlings with a view to ascertaining the proportion of fertilizers and mycorrhiza appropriate for the optimum growth of the species.

Materials and Methods

Study Area

The experiment was carried out at the Federal College of Forestry premises, Jericho, Ibadan which is located on the latitude 07º23' 18"N to 07º 23' 40"N and longitude 03º 36' 20"E to 03º32' 41"E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days (FRIN, 2015). The mean maximum temperature is 31.9°C, minimum 24.2°C while the mean daily relative humidity is about 71.9% (FRIN, 2015).

Experimental Procedure

Seeds of *Adansonia digitata* were collected from seed store of Forestry Research Institute of Nigeria (FRIN). They were processed and soaked in water for twenty four (24) hours to facilitate germination before sown into a germination box filled with river sand and watering was done once a day. *Pisolithus tinctorus* mycorrhiza was collected from pine plantation and top soil from FRIN arboretum. Cow dung was collected from dairy farm along Ido village in Ido Local Government Area and air dried. Top soil and Cow dung were analyzed at FRIN soil laboratory to ascertain its initial physico-chemical status while NPK fertilizer was procured from Ibadan metropolis. The polythene pots with 1kg of top soil (1 x 10^{-3}kg/ha) were filled with mixture of different levels of Cow dung, NPK fertilizer and *Pisolithus tinctorus* mycorrhiza. The growing medium were allowed to mineralized for a week after which 45 healthy seedlings of 4 weeks old were pricked out from germination box and then transplanted into potting mixture.

The experiment was laid out in Completely Randomized Design (CRD) with nine treatments and five replicates to assess the effects of different levels of Cow dung, NPK fertilizer and mycorrhiza on shoot height (cm), collar diameter (mm), leaf production and leaf area (cm^2) of *A. digitata* seedlings.

The treatments combinations were:

T_1 = 1kg of top soil (control)
T_2 = 10mg mycorrhiza + 1kg top soil
T_3 = 20mg mycorrhiza + 1kg top soil
T_4 = 100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil
T_5 = 10mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil
T_6 = 20mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil
T_7 = 200mg of cow dung +200mg of PK fertilizer + 1kg top soil
T_8 = 10mg mycorrhiza + 200mg of NPK fertilizer + 1kg top soil.
T_9 = 20mg mycorrhiza +200mg of cow dung + 200mg of NPK fertilizer + 1kg top soil

The collection of data commenced two (2) weeks after transplanting and carried out fortnightly for twelve (12) weeks. Data collected on collar diameter (mm), shoot height (cm), leaf area (cm^2) and leaf production of *A. digitata* seedlings were subjected to Analysis of Variance (ANOVA) using SPSS 2016 version and significant mean separated at 5% level using Duncan Multiple Range Test (DMRT).

Results and Discussion

The pre-study physical and chemical properties of soil is presented in Table 1.The soil has a slightly acidic reaction (6.69). The soil is deficient in total N (0.03 g kg^{-1}), organic carbon (0.38 g kg^{-1}) and total organic matter (0.65 g kg^{-1}) which are below the critical range (Adeoye and Agboola, 1985). The soil is moderate in potassium k (0.13mg) however sufficient in exchangeable bases with sandy textural class.

There were significant differences ($p<0.05$) among the treatments in shoot heights, collar diameter, leaf production and leaf area. The post-hoc test reveals that T_9 (20mg mycorrhiza +200mg of cow dung + 200mg NPK fertilizer + 1kg top soil) had highest mean shoot height of 13.69±0.23cm followed by T_5 (10mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil) (13.20±0.27cm) while the control treatment T_1 had the least mean shoot height of 8.11±0.22cm (Table 2). Table 3 shows mean separation for collar diameter of *Adansonia digitata* as influenced by Cow dung, NPK fertilizer and mycorrhiza within period of study. The T_9 (1.97±0.21mm) is significantly different from other treatments most especially T_1 with the least mean collar diameter of 1.07±0.01mm. This implies that amendment of soil with the combination of fertilizers and mycorrhiza enhances positive soil nutrient plant relation.

The finding is in line with Husseini *et al* (2016) who found that the different soil amendments significantly ($P < 0.001$) affected growth variables. The highest growth parameters observed in other treatments aside the control is an indication that soil amendment influence development in terms of cells division in shoot, stems and leaves of the plant (Duca, 2015)

According to Suthar, (2009) cow-dung as an organic manure is a good source of the three main elements (nitrogen, phosphorus and potassium) which are needed by plants. It also improves the physical texture of the soil by helping it to retain moisture in the case of sandy soils and by improving aeration in clay soils. The organic manure is an eco-friendly, economically viable and ecologically sound that also played a significant role in soil biology, chemistry and physics (Suthar, 2009). Invariable addition of N.P.K fertilizer with the aid of mycorrhiza to the cow dung has tendency to skyrocket the plant growth. More so, the augmentation of crude oil polluted soils with cow dung enhanced remediation and restoration of crude oil polluted soil Essien *et al*. (2015). N.P.K fertilizer supplied the nutrients needed for initial development of the seedlings which was later backed up by those gradually released by cowdung as enhanced by mycorrhiza. The results agreed with the findings of Ojo (2008) that fertilization contributed immensely to the plant growth and development.

The result also conforms to the findings of Rafiqul-Hoque *et al*. (2004) where *Anthocephalus chinensis* treated with fertilizers was greatly superior to control seedlings. The significant degree of variability observed in the response of the seedlings to fertilizer treatments could then be ascribed to the edaphic and favourable climatic factors..

Table 1: Physico-chemical properties of soil used for the study

SOIL PROPERTIES	VALUE
pH (H_2O)	6.69

Total organic carbon	0.38(g kg^{-1})
Total organic matter	0.65(g kg^{-1})
Total nitrogen	0.03(g kg^{-1})
K	0.13mg/kg
Na	1.39mol/kg
Ca	18.71mol/kg
Mg	13.35mol/kg
Mn	60mol/kg
Cu	18mg/kg
Zn	19.8mg/kg
Fe	16mg/kg
P	7.896mg/kg
Sand	86.5%
Clay	11%
Silt	2.5%

Table 2: Mean separation for shoot height (cm) of *Adansonia digitata* seedlings as influenced by Cow dung, NPK fertilizer and mycorrhiza within 12 weeks of study

Treatments	Mean
T_1	8.11 ± 0.22^{c}
T_2	12.03 ± 0.13^{ab}
T_3	12.84 ± 0.11^{ab}
T_4	12.10 ± 0.14^{ab}
T_5	13.20 ± 0.27^{a}
T_6	12.63 ± 0.21^{ab}
T_7	12.68 ± 0.32^{ab}
T_8	10.48 ± 0.61^{b}
T_9	13.69 ± 0.23^{a}

Means with the same superscript are not significantly different (p> 0.05)

Table 3: Mean separation for collar diameter (mm) of *Adansonia digitata* seedlings as influenced by Cow dung, NPK fertilizer and mycorrhiza within 12 weeks of study

Treatments	Mean
T_1	1.07 ± 0.01^{f}
T_2	1.62 ± 0.03^{bc}
T_3	1.72 ± 0.12^{b}
T_4	1.57 ± 0.04^{cd}
T_5	1.74 ± 0.19^{b}
T_6	1.28 ± 0.11^{e}
T_7	1.68 ± 0.20^{c}
T_8	1.42 ± 0.14^{d}
T_9	1.97 ± 0.21^{a}

Means with the same superscript are not significantly different (p> 0.05)

Figure 2 shows that T_9 had the highest number of leaves with a mean value of 16, followed by T_5 (10mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil) and T_6 (20mg mycorrhiza +100mg of cow dung + 100mg of NPK fertilizer + 1kg top soil) with mean leaf production of 14 while T_1 had the least mean value of 8. This corroborated the findings of Lehmann and Joseph, (2007) who reported on improvement of acidic soil using organic and inorganic fertilizer (NPK) as treatments. This indicates that soil augmented with materials that provide required nutrients can maintain sufficient plant nutrition for the crop towards optimum yield (Abubakari *et al*., 2015). Soil amendment for nutrient enrichment are very essential to the sustainability of plant growth since it forms important sources of vital mineral nutrients and it is also very critical in moderating pH and transportation of soil contaminants (Liang *et al*., 2012; Rinaldi *et al*., 2014; Abubakari *et al*., 2015).

Mycorrhizae increase plant absorption of soil nutrient physically by mycelia that are much smaller than the smallest root hair, and thus can explore soil material that roots and root hairs cannot reach, and provide a larger surface area for absorption. Chemically, the cell membrane chemistry of fungi differs from that of plants, they can secret organic acids that dissolve many ions and enhance plant growth in all ramifications (Coelho *et al*., 2010; Taylor and Peterson, 2005). The possible absorption of nutrients by mycorrhiza are made available by applied fertilizers which was found to compose of many major and minor elements that trees need for growth (Lehmann and Joseph, (2007).

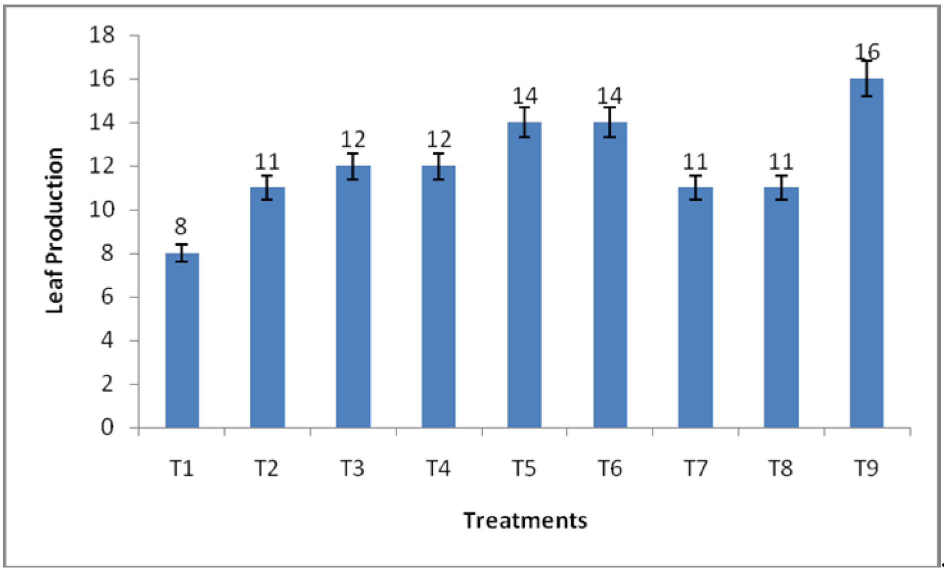

Figure 1: Effects of Cow dung, NPK fertilizer and mycorrhiza on leaf production of *Adansonia digitata* seedlings.

As shown in figure 2, T_9 had the highest mean leaf area of 174.5cm^2, followed by T_7 with a mean value of 164.3cm^2 while T_1 (control) had the least mean value of 128cm^2. This depicts that application of growth enhancer at an early stage of plant growth makes a huge difference later which probably might have accounted for the significant differences in mean leaf area subsequently (Dauda *et al*., 2009). Organic manure, particularly animal manures have been used for plant production effectively for centuries and have been considered an integral part of sustainable forestry and agriculture (Masarirambi *et al*., 2012), This results confirm the assertion of Glaser *et al.* (2002) that amelioration of physical and chemical properties of highly weathered tropical soil using fertilizers improves growth and plant development.

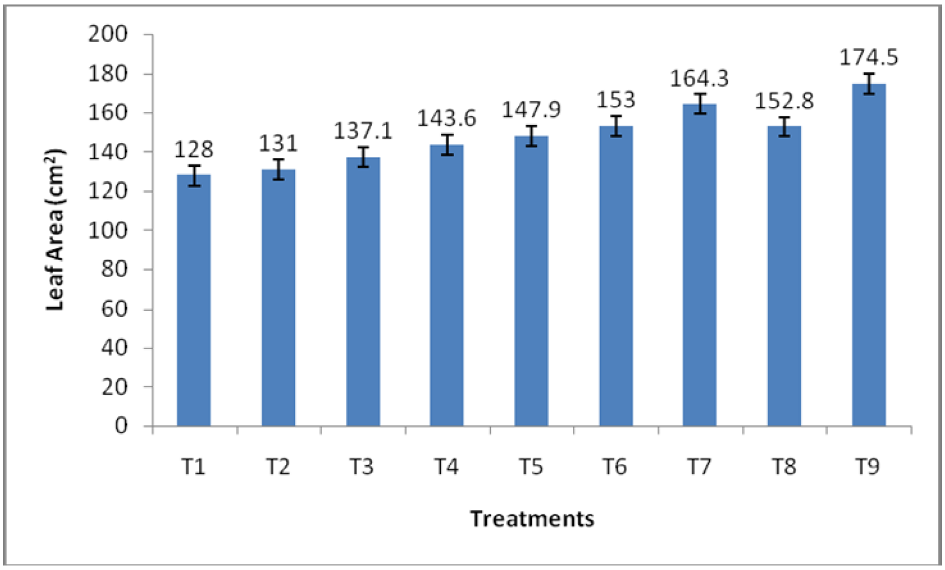

Figure 2: Effects of Cow dung, NPK fertilizer and mycorrhiza on leaf area (cm^2) of *Adansonia digitata* seedlings.

Conclusion

Amendment of potting mixture with different levels of Cow dung, NPK fertilizer and *Pisolithus tinctorus* mycorrhiza contributed significantly to the vigorous growth and development of seedlings of *A. digitata*. Although, the results from control treatment showed that *A. digitata* seedlings have the potential to grow in soil with limited nutrient status but application of fertilizers will increase the soil nutrient level towards production of healthy seedlings.

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