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Original Article

Response of Terminalia ivorensis (A. Chev) Seedlings to Different Levels of N.P.K.Mg. (15.15.17.2) Fertilizer Treatment.in west of Iran

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Abstract

The growth and dry matter accumulation of Terminalia ivorensis (A. Chev.) seedlings given different doses of inorganic (N.P.K.Mg: 12. 12. 17. 2) Fertilizer were investigated using a Completely Randomized Block Design with 3 treatments (0kg/ha; 100kg/ha & 300kg/ha) and 4 replicates. At 16 Weeks After Planting (WAP), there were significant differences ($p<0.05$) between the control (0kg/ha), and 100kg/ha & 300kg/ha in respect of most variables measured - height; number of leaves; collar girth; number of nodes; leaf area; and number of branches. The results of dry matter accumulation recorded at 0kg/ha, 100kg/ha and 300kg/ha also recorded significant differences ($p<0.05$). While some results were not significantly different among the 100kg/ha & 300kg/ha treated plants, it is apparent that the applied doses of N.P.K.Mg (12.12.17.2) fertilizer significantly enhanced the growth and dry matter accumulation of the seedling. It is recommended that the limit of the upper threshold of optimal growth performance, beyond which further application would be deleterious to the seedlings, be further investigated.

Keywords: Endemic Species, Seedlings, Soil Nutrients, Nursery, Plantation, Establishment.

INTRODUCTION

Terminalia ivorensis (A. Chev.) is a class 1 commercial rainforest timber species commonly called Black Afara (Redhead, 1971). This large forest tree which belongs to the family of Combretaceae is deciduous in habit and endemic to southern Nigerian. Known in Yoruba as Idigbo and Benin as Eghoin-nebi, this timber species, produces bunched fruits that are borne in terminal tufts. The slash is yellowish, darkening on exposure. A secondary pioneer, *Terminalia ivorensis* produces relatively resistant yellow multi-utility timber suitable for joinery in the building and construction industries.

This hitherto ubiquitous tropical rainforest pioneer has the potential for artificial large-scale regeneration in both derived and southern guinea savanna zones in Nigeria. Thus given favourable conditions *Terminalia ivorensis* would require less than four weeks in accomplishing the process of germination. However, its greatest constraints for commercial-scale reforestation are related to its phenology, niche differentiation as well as susceptibility to fire. In spite of the high fecundity and the fact that its hard coat and winged fruit confer some dispersal and seed bank advantage, the species generally exhibits a gambler strategy (Bazzaz and Pickett, 1980).

The tree grows to a height of 48m and 5m in girth (Keay, 1989). It is easily distinguished from its congener *Terminalia superba* by the dark fissured bark, often giving off in small flakes; small buttresses; monopodial branching pattern and wide spreading horizontal crown often lifted high in tufts by a characteristically straight bole with uniform tapering.

The declining rainforest estate in southern Nigeria and the paucity of relatively fast growing species with multi-utility commercial application in the wild has made it imperative to look inwards for endemic trees for use either as single monoculture or mixed plantation species. But there is no endemic species that stands out as possessing all the features for successful use among several indigenous candidates. *Terminalia ivorensis* has the morphological and genetic features to evade most constraints imposed by the dilapidated forest environment. But, the current paucity of mother trees of this species in the wild is of serious concern that calls for immediate attention. Akindele and Owoeye (1991) reported that *Terminalia ivorensis* could produce an exploitable timber volume of $300m^3ha^{-1}yr^{-1}$ with annual increment of over $15m^3ha^{-1}yr^{-1}$ as compared with $100m^3ha^{-1}yr^{-1}$ respectively for mature forest.

Most soils of southern Nigeria are highly acidic because they are typically sandy and easily leached - the soils being partly derived from the geological formation called the coastal plains sand (D' Hoore, 1964; Oguntala and Soladoye, 2000). The fragile nature and the low nutrient status of the soils are often circumvented by the efficient nutrient flux density between the soils and the roots; thus the growth rates of trees under natural conditions are regulated by this phenomenon.

Several studies have shown that essential nutrients in the rainforest ecosystem are stored in the vegetation (Jordan, 1985; Tivy, 1992). But one serious constraint to a balanced ecological nutrient dynamics between the rainforest soil and the vegetation is uncontrolled logging. Intensive logging, apart from compacting the soils and hence rendering them labile, disrupts the structure and texture thus making them susceptible to the vagaries of the elements – incapacitating the water holding capacity and the nutrient cycling potentials of the forest soils (Isikhuemen, 2005).

Table 1: Selected Physicochemical Properties of Soil before and after the Experiment.

(a) (*Before Experiment*).

pH (in H_2O)	N %	P (mg/kg)	K (Cmol/kg^1)	Mg (Cmol/kg^1)	Ca (Cmol/kg^1)
5.02	0.58	14.70	0.21	1.20	1.40

(b) (*After Experiment)* (16WAP)

Treatment (kg/ha)	pH (in H_2O)	N %	P (mg/kg)	K	Mg	Ca
0	5.04	.70	14.02	0.2	1.80	1.35
100	5.08	1.80	20.56	3.2	2.26	1.52
300	5.13	2.60	25.10	3.5	2.39	1.78

In Nigeria, large-scale afforestation using endemic species through assisted natural regeneration or enrichment planting has not go beyond experimental stage. Moreover, the application of fertilizers for early stage growth enhancement of indigenous seedling has received less pragmatic consideration as an option in most artificial regeneration programmes. The N.P.K.Mg. (12.12.17.2) is well suited for building up the apparent oligotrophic soils of southern Nigeria; particularly when applied as starter ration for post-germinated young seedlings of rainforest trees. This inorganic fertilizer is one main source N-supply that has been shown to affect all phases of vegetative growth in crop plants (Tayo, 1977). As source of macro nutrient elements, fertilizers of inorganic origin supplement soil organic residues by influencing root growth and catalyzing nutrient flux density in the soil-root medium.

Table 2: Growth Parameters (mean) of *Terminalia ivorensis* (A. Chev.) at 8WAP

S/No.	Kg/ha	Height (cm)	Leaf No.	Collar girth	Nodes	Leaf Area	Branches	Dry matter (g)
(1)	0	3.26	6.33	0.30	6.0	8.5	-	-
(2)	100	3.50	7.66	0.30	7.33	12.63	-	-
(3)	300	3.70	7.00	0.33	6.0	14.96	-	-
Se:		0.25	0.40	0.03	0.46	1.1	-	-

With increasing intensity of logging and conversion of most forestland to agricultural use, it is doubtful if indigenous timber trees can still muster enough resilience and regeneration potential to support their ecosystem functions and indeed sustain market demand for timber without any pragmatic human interference. In particularly, it is very doubtful if all the degraded landscapes with tacit evidence of deflected succession or where islands of 'fire climax communities' dominate most forest landscape can be restored ecologically through natural process.

The study reported herein was conducted to investigate the effect of inorganic fertilizer on the growth, development and dry matter accumulation of *Terminalia ivorensis* seedlings.

Table 3: Growth Parameters (mean) of Terminalia ivorensis (A. Chev.) at 16WAP

S/No.	Kg/ha	Height (cm)	Leaf No.	Collar girth	Nodes	Leaf Area	Branches	Dry matter (g)
(1)	0	17.83	24.33	1.53	23.33	509.26	2	21.81
(2)	100	21.40	32.66	1.70	31.66	644.66	3	42.99
(3)	300	22.44	33.33	1.90	32.00	673.36	3	51.03
Se:		1.70	3.06	0.14	3.10	97.61	0.74	6.39

MATERIAL AND METHODS

The study was carried out at the outdoor forest laboratory of the Department of Forestry and Wildlife, University of Benin, Benin City, Nigeria. Matured dry fruits were collected from the floor of *Terminalia ivorensis* plantation in Sapoba Forest Reserve ($06^0\ 4^1\ 13^{11}$N, $05^0\ 58^1\ 47^{11}$E; 84.6m above sea level). The fruits were de-winged, dried and kept in dry container for 4 weeks.

Soil sample was collected from the floor of the nearby mixed species stand in the outdoor Departmental field laboratory from 0 – 15cm depth and sieved to free it of large roots and debris. The soil was analyzed to determine the nutrient status using the Standard Laboratory Methods of IITA (1979), and thereafter packed into forty eight, 2kg polythene pots of uniform size.

The dry seeds were broadcast on germination beds and watered twice daily. Pricking-out of the seedlings from germination tray to the polythene pots was carried out two weeks after emergence, using vigour as primary criterion for the selection of juveniles. The inorganic fertilizer was measured using Meter E200 weighing balance and applied same to the potted plants in ring form 2 weeks after the young seedlings were transferred into the pots.

The trial was a Completely Randomized Block Design (CRBD) with three N.P.K.Mg. (12.12.15.2) fertilizers treatment at 0kg/ha, 100kg/ha and 300kg/ha and replicated four times. The measurement of parameters commenced from 4 Weeks After Pricking-out (WAP) until 16 weeks when the experiment was finally terminated. Destructive analyses of selected seedlings were carried out at the end of the experiment. Transplanting (pricking-out) of young seedlings was used as the parametric threshold for determining the timeline to which all measurements relate.

Data Collection and Analysis
The parameters measured at intervals of two weeks in respect of each young seedling beginning from 4 Weeks After Planting (WAP) include: Height, Collar girth, Number of leaves, Leaf area, Number of nodes and Number of branches. Destructive analysis of seedlings selected from the three treatment levels was later carried out in the Laboratory to determine the dry matter accumulation using Meter E200 weight balance after oven drying at 70 ^{0}C for 48 hours.

The data were subjected to Analysis of Variance (ANOVA) with means separated using standard error values ($p<0.05$).

Results & Discussion
Seed germination was first noticed 3 weeks after sowing. The results of average seedling heights (17.83; 21.4 and 22.4cm), number of leaves (24.33; 32.66 and 33.33), and leaf area (509.26; 644.66 and 673.36 cm^2) recorded under 0kg/ha; 100kg/ha and 300kg/ha treatments respectively, between 8WAP and 16WAP differed markedly ($p<0.05$) (Table 3). Thus the fertilizer treated seedlings recorded higher increases but showed no significant differences among most measured parameters except with seedlings that received zero fertilizer treatment. However, the result of dry matter accumulation of 21.81g, 42.99g and 51.03g recorded under 0kg/ha, 100kg/ha and 300kg/ha levels respectively, were significantly different ($p<0.05$) at 16 WAP (Fig.1).

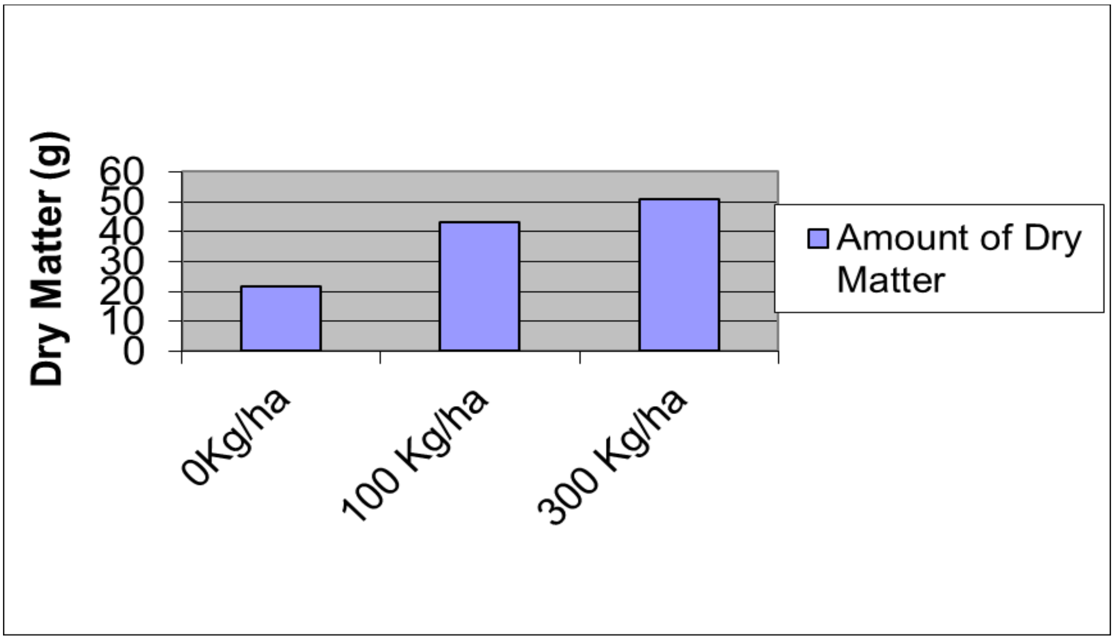

Fig. 1: Dry Matter Accumulation at 16 WAP.

The results in respect of number of nodes and number of branches - branching was first noticed from 13WAP - followed the same trend (Table 3). Miller (1981) reported that during the early growth stages, tree seedlings are very well dependent on soil nutrient supply; this is the time when conservators by judicious fertilizer application, can most influence the subsequent development of stands – perhaps saving many years in rotation length.

The observed differences in vegetative parameters among treatments: seedling sizes, larger leaf area and higher leaf number (Tables 2 & 3) could be attributed to the nutrient status of the different soil media at 16WAP. The significant differences recorded among the different treatments indicate the impact of the nutrients at varying levels on the seedlings as well as the apparent efficiency in nutrient uptake and yield build up by tree seedlings. These results are in agreement with the findings of Radin and Eidenbock (1984) and Wullschleger and Oasterhius, 1990). Tayo (1977) opined that the leaf area per plant as a measure of photosynthetic productivity is crucial in determining the dry matter accumulation and yield of plants.

Results obtained in respect of the collar girth were also significantly different for all seedlings that received the different fertilizer treatments, implying that this parameter could be a good measurable indicator for studying fertilizer impact on the growth and development of indigenous forest tree seedlings at the juvenile stage. Overall results revealed that the fertilizer-treated seedlings responded optimally through increases in all the vegetative parameters measured; they were markedly different from the control seedlings that had zero fertilizer (Figure 1). However, despite the different doses of inorganic fertilizer applied, the observed increases in some of the growth indices measured up to (and beyond 16WAP), suggest that the different levels of fertilizer applied might not have reached the optimum threshold beyond which any addition might be deleterious to the young seedlings.

It is imperative for Nursery managers operating on commercial scales, to apply fertilizers as starter doses to spur leaf chlorophyll development and photosynthetic enhancement particularly at seedlings' pre-establishment juvenile growth stages - acting as building blocks or synthesis of protein-enriching enzyme actions and helping in translocation of sugar and starch, nutrient uptake as well as reducing water and respiratory loses. The fact that most forested landscapes in southern Nigeria are increasingly being replaced by fire-climax trees, shrubs, forbs and associated herbal and grass communities - to the extent that most fast growing endemic tree species with multi-utility commercial application have become scarce in the wild – calls for concerted efforts by forest ecologists to search for the best cost-effective approaches to regenerate good candidate-timber trees on commercial scales either as single monoculture or mixed plantation species. Terminalia ivorensis also parades the ecological characteristics for large scale restoration of forest cover or as foster species for the improvement of gap-dynamics on severely degraded sites. However, this can be achieved by focusing on the ecology – early successional traits, species composition and spatial arrangement - so as to facilitate their rapid, early colonization, and catalyze forest succession processes (Parrotta, 1993).

Conclusion and Recommendation

The application of N.P.K.Mg (12.12.17.2) enhanced the post emergence growth and development as well as dry matter accumulation of Terminalia ivorensis seedlings at both the 100kg/ha and 300kg/ha levels. However, an upper threshold might not have been attained in this investigation. To this end, fertilizer doses of up to 500kg/ha or a two-phased application of 300kg/ha should be further investigated. However, as a measure of cost reduction, an optimum period of between 16 and 20 weeks is recommended for fertilizer-treated seedlings to remain in the nursery before planting-out in the field. Against the back-drop of cost-reduction and commercial production of T. ivorensis, it is recommended that the study should be extended to open soil (transplant-bed) trials.

If seed availability, viability and economy of scale are to drive the success of large scale commercial nursery, indigenous tree species selection - including their phenology must be weighed against timeliness, proper planning and management.

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