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EFFECT OF MACRONUTRIENTS DEFICIENCY ON THE SEEDLINGS OF *Mansoniaaltissima* A Chev. SEEDLINGS

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ABSTRACT

Mansonia altissima is an indigenous tree species that is fast disappearing from forest due to over exploitation. There is little information about mineral nutrition requirement for its satisfactory growth*and sustainability*; this study investigated the effects of macro nutrient deficiency in seedlings of *M.altissima*, seedlings were monitored under seven treatments which include complete nutrient solution (CNS) and complete Nutrient solution minus each macro nutrients: N,P,K,Ca,Mg and S; the experimental design was a Completely Randomized Design.

Result revealed significant ($P<0.05$) differences in height, collar diameter and leaf production on seedling raised. Seedlings grown on CNS were green, fast growing with an average height of 14.40cm, 3.59mm collar diameter and 8 leaves, while CNS-N had least height 8.07cm, CNS-S had least value of 2.40mm collar diameter and CNS-K had the least value of numbers of leaves respectively.

Conclusively, complete macronutrients solution is advocate for in successful establishment of *M. altissima* seedlings.

Keywords:- Over-exploitation, Nutrition requirement, macronutrient, deficient and *Mansonia altissima*.

INRODUCTION

One of the requirements for successful *and sustainable* plantation programme is adequate knowledge of nutrient relations of tree species particularly at the seedling stage. This is because the success of any plantation programme depends on the successful production of adequate number of seedlings of right quality at the right time. These seedlings should be properly raised so as to improve on the quality of planting stock used for the establishment of the plantation

With the advent of plantation of forestry and its expansion to soil of relatively low fertility, increasing attention is being paid to the nutrition of forest trees and correction of nutritional disorders through fertilizer application. The success and value of forest fertilization, however, depend on accurate diagnosis or soil nutrient deficiencies.

El-Kassaby (2000), describe the domestication of forest tree species as the process whereby plants are taken from the wild (natural), undomesticated state through a series of sampling and selection stages, with each stage curtailing the genetic variation and ultimately resulting in the production of a somewhat genetically uniform plantation.

The genus *Mansonia altissima* belongs to the family sterculiaceae, which consists of trees and shrubs. The genus consists of two species namely, *Mansonia altissima* and *M.kamerunica*. *Mansonia altissima* occurs in the drier areas of lowland rainforest in Nigeria while *M.kamerunica* occurs in Cameroons (Keay *et al*, 1989).

The flowering period of *M. altissima* is between June to August each year while the fruiting period is between October to January. (Keay *et al* 1989).The fruits are formed in small clusters at the end of branchlets. Each fruit has a distinctive elongated wing at one end of the fruit.

The use of chemical soil analysis for this diagnosis is limited as the method currently used cannot simulate, with sufficient accuracy, the absorptive activities of roots of forest trees (Gessel and Walker, 1958, Nwoboshi 1973). In higher plants, however, deficiency of most of the essential elements causes visual symptoms which are valuable indicator of nutritional disorder. Where visual symptoms are not characteristic enough or are masked by other deficiencies, the method of plant analysis is used to confirm the diagnosis.

Out of the 60 elements observed in the plant tissues, only 16 have been identified as essential for plant growth and development (Johnson, 1990). The essential plant nutrients are classified into two categories, viz; macro and micronutrients depending on the quantity of a specific element required for plant growth. Nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, carbon, oxygen and hydrogen are required in large quantities and thus fall under the same category while iron, boron, manganese, molybdenum, zinc, copper and chlorine are required in small amounts, therefore belong to the latter group. When plants suffer from their deficiency, they show symptoms of ill health in the form of abnormal growth or some peculiar appearance, which are specific to a particular element. This is because most of the essential nutrients perform critical functions and the plant growth and development were adversely affected if one or more of the elements are missing. The wood of *Mansonia altissima* is characterized by an excellent stability with little susceptibility to variation in humidity, small shrinkage rates during drying and a good natural durability. The wood is durable and treatment with preservative is unnecessary, even for usage in permanent humid condition or localities where wood attacking insects are abundant. (Oteng-Amoako, 2006) This means it an excellent wood for use in pleasure-crafts, especially for keels stems and panels for bridges, as well as interior fittings.

MATERIALS AND METHODS

Two weeks old seventy seedlings of *Mansonia altissima* of relatively uniform size and height with good vigour were transplanted in to 2.5 litres buckets filled with sterilized river sand. 7 treatments (with ten replicate each) which include Complete Nutrient Solution (CNS) and Complete Nutrient Solution minus each of the macronutrients N, P, K, Ca, Mg and S labelled as CNS-N, CNS-P, CNS-K, CNS-Ca, CNS-Mg and CNS-S. The treatment were numbered as 1, 2, 3, 4, 5, 6 and 7 for CNS, CNS-N, CNS-P, CNS-K, CNS-Ca, CNS-Mg and CNS-S respectively.

The macronutrient composition of the nutrient solutions applied is shown in Table 1. To each solution was added a basal micronutrient solution made up of the following elements expressed as ppm: Fe (Fe - EDTA) 0.54; boron 0.54; Me 0.55; Cu 0.064; Zn 0.065; Mo 0.048; and 0.012 Co. All the reagents salt used in making the solutions were of analytical reagents grades. The pH of each solution was adjusted to 6.5 (Nwoboshi*et. al*.1982;Awodola 1989; Shinkafi 2000 and Ajekigbe 2014). Distilled water was used throughout in preparation of the solutions and watering of plants. The nutrient solution was applied at the rate of 50ml per bucket three times weekly, while the plants were watered every other day. The experimental design used for this study was completely Randomize Design (CRD), this is because there was only one source of variation which is macronutrient.

Periodically, height measurements were recorded and unusual foliage colours determined by comparison with munsell leaf colour charts and other distinctive differences were recorded until they become relatively stable. The final observations were considered by the true deficiency symptoms for a particular nutrient. The experiment was terminated after 16 weeks of growth.

Data were collected fortnightly on plant height, collar diameter, number of leaves while total plant dry weight (TDW), Shoot Dry Weight (SDW) and Root Dry Weight (RDW) were taken at 4 weeks interval.

The dry weight of individual plant parameters recorded was obtained using the method described by Nwoboshi*et. al* (1987) and Awodola (1991)

Table 1 Summary of the macronutrient composition of the applied solution (G/Liter)

Nutrient	KNO_3 (202)	$Ca(NO_3)$ (326)	$CaCl_2$ (222)	K_2SO_4 (174)	$MgSO_4$ ($7H_2O$) (184)	Na_2SO_4 ($10H_2O$)	$NaNO_3$ (340)	$Mg(NO_3)_2$ $8H_2O$ (340)	NaH_2PO_4 $2H_2O$ (208)
Complete	+	+			+				+
-N			+	+	+				+
-P	+	+			+	+			
-K		+				+		+	+
-Ca	+				+		+		+
-Mg	+	+				+			+
-S	+	+						+	+

1 ml of stock per liter of treatment solution

RESULT AND DISCUSSION

Morphological deficiency symptoms of *Mansonia altissima* to various deficiency treatment

Each of the macronutrient deficiency brought about characteristics and visible alterations in the appearance of seedlings. The complete nutrient medium were consistently taller and produced dark green normal shaped foliage throughout the experiment than the seedlings that were deficient.

The plants which were lacking with specific nutrients started to express the deficiency symptoms of the nutrient concerned within a couple of weeks. The seedlings grown in media deficient of various macronutrient showed the following symptoms.

NITROGEN DEFICIENCY

The seedlings of *Mansonia altissima* responded to the deficiency of nitrogen after 4 weeks of treatment application. At the incipient stage, the foliage colour turned from normal green (5GY 5/6) to pale green (2.5 GY 8/8). Later chlorosis set in (Plate 1)from the older leaves which turns brownish-yellow and defoliate prematurely. The younger leaves diminished in size, height and diameter growth were retarded and the entire plant was stunted as can be seen in (Plate 1).

PHOSPHORUS DEFICIENCY

This deficiency manifested itself as chlorosis starting from the oldest leaves and moving upwards. Within each leaf, chlorosis moved from apex and margins to petiole in a green ground colour. At advanced stages, oldest leaves turned yellowish green (2.5 GY 8/10) and the youngest leaves still green (5 GY 5/6) as in Nitrogen deficiency the plant was stunted. (Plate 2)

POTASSIUM DEFICIENCY

Six weeks after treatment application, oldest leaves of *Mansonia altissima* became pale green with bronzing (5GY 7/8) which appeared as tip burn on old leaves with time the younger leaves turned backward. At more advanced stages, the leaves became necrotic in places deformed and wrinkled. (Plate 3)

CALCIUM DEFICIENCY

Symptoms of Ca deficiency appeared more quickly in the younger leaves and subsequently moved upwards. Initially, marginal teeth collapsed and became chlorotic followed shortly by necrosis. These symptoms gradually moved inter-veinally towards the petiole. With further developmental growth, the collapsed margin with or without necrosis, led to backward curvate of affected leaves. As the deficiency stage advanced, the leaves became bleached yellowish (5Y 8/4) with scattered necrosis (75 YR 6/8) and were defoliated.

The deficiency of calcium also drastically reduced growth of plant and roots, the new leaves maintain normal (5 GY 5/6) green colour throughout the experiment. (Plate 4)

MAGNESSIUM DEFICIENCY

Mg deficient manifested itself at early stage of seedlings with interveinal chlorosis mainly of the older leaves, producing a streaked effect in the leaves, oldest affected leaves turned completely yellow and subsequently fell off. The overall height growth was similar to those of the complete nutrient plant during the first 16 weeks of growth. (Plate 5)

SULPHUR DEFICIENCY

The youngest leaves turned pale-green as in –N deficiency, later chlorosis set in from petiole towards the apex and at a certain stage, left a marginal green band as in Mg deficiency except that the chlorosis was more intensely yellow in S deficiency. The older few pairs of leaves remained normal green (5GY 5/6) while the overall plant height growth was slightly lower than that of N deficiency seedlings.(Plate 6)

Table 2: Mean Separation for the effect of macronutrient on the growth of *M. altissima* seedlings.

Treatment	Height (cm)	Collar Diameter (mm)	Leaves Number
Complete	14.40 ± 0.36^{a}	3.59 ± 0.09^{a}	8.28 ± 0.20^{a}
-N	8.07 ± 0.19^{e}	2.49 ± 0.10^{bc}	7.99 ± 0.15^{ab}
-P	9.58 ± 0.34^{c}	2.60 ± 0.10^{bc}	6.71 ± 0.25^{de}
-K	9.32 ± 0.40^{cd}	2.66 ± 0.11^{bc}	6.20 ± 0.35^{e}
-Mg	11.88 ± 0.36^{b}	2.51 ± 0.09^{bc}	7.48 ± 0.17^{bc}
-Ca	8.52 ± 0.33^{de}	2.71 ± 0.06^{b}	7.03 ± 0.10^{cd}
-S	8.58 ± 0.27^{de}	2.40 ± 0.10^{c}	7.18 ± 0.17^{cd}

Means with same alphabet in columns are not significantly different from each other (p>0.05)

Effects of macronutrients deficiency in seedlings growth of *Mansonia altissima*

The mean shoot height for macronutrient deficiency was between 8.07cm and 14.4cm. Seedlings raised with Complete Nutrient Solution (CNS) performed better than those in other treatments that are lacking all other nutrients. CNS recorded the highest mean height of 14.40cm followed by CNS-Mg with 11.88cm while CNS-N had the lowest of 8.07cm (Table2). Mean separation table revealed that there was no significant difference between CNS-Ca (8.52cm±) and CNS-S (8.58cm±), CNS-P (9.58cm±) and CNS-K (9.32cm±). However, seedlings height from complete nutrient solution was significantly different from all other treatments. CNS-N was the least figure in shoot height.

Variations were observed in the collar diameter of seedlings raised with CNS and CNS-Other macronutrients. The collar diameter ranged between 2.40mm – 3.59mm. CNS seedlings had 3.59mm, followed by CNS–K (2.66mm) while CNS-S had the lowest with 2.40mm (Table 2). However, there was no significant difference in collar diameter with seedlings raised with CNS-N, CNS-P, CNS-K, CNS-Mg and CNS-Ca solutions.

The number of leaves produced by *Mansonia altissima* varied between 6 and 8. Complete Nutrient Solution treatment produced more leaves than other treatments. It had mean value of 8.28 leaves while least mean value was observed in CNS-K with 6.2 (Table 2). However, shoot height, collar diameter and leaves production were significantly affected by the effects of macro nutrient deficiency on *Mansonia altissima*. (Appendix 1)

Table 3 Mean Separation result for leaf dry weight(LDW), root dry weight (RDW) and total dry weight(TDW) of *M. altissima* Seedlings

Treatment	LDW	RDW	TDW
Complete	0.57 ± 0.33^{a}	0.17 ± 0.33^{a}	0.85 ± 0.03^{a}
- N	0.57 ± 0.33^{a}	0.10 ± 0.0^{b}	0.77 ± 0.03^{ab}
- P	0.23 ± 0.33^{b}	0.10 ± 0.0^{b}	0.43 ± 0.03^{c}
- K	0.57 ± 0.33^{a}	0.10 ± 0.0^{b}	0.77 ± 0.03^{ab}
- Mg	0.47 ± 0.33^{a}	0.10 ± 0.0^{b}	0.67 ± 0.03^{b}
- Ca	0.13 ± 0.33^{b}	0.10 ± 0.0^{b}	0.33 ± 0.03^{d}
- S	0.47 ± 0.33^{a}	0.10 ± 0.0^{b}	0.67 ± 0.03^{b}

Means with same alphabet are not significantly different from each other ($p>0.05$)

Effects of macronutrient deficiency on the biomass accumulation of *Mansonia altissima*.

The dry weight of the seedlings of *Mansonia altissima* from each treatment were used as the biomass accumulated.

Mean values of leaf dry weight(LDW) presented in Table(3) showed that at the end of 16 weeks, CNS, CNS-N, and CNS-K had the same value of leaf biomass 0.57g followed by CNS-Mg and CNS-S which also had the same value of 0.47g while CNS-Ca had the least value of 0.13g. The result showed that there was no significant difference in LDW in CNS (0.57g±), CNS-N (0.57g±), CNS-K (0.57g±), CNS-Mg (0.47g) and CNS-S (0.47g) also CNS-P and CNS-Ca had no significant with 0.23g and 0.13g, respectively.

The mean seedlings root dry weight (RDW) for effect of macronutrient deficiency ranged between 0.1 – 0.17g, with the highest value recorded in CNS seedlings and other treatments CNS-N, CNS-P, CNS-K, CNS-Mg, CNS-Ca, CNS-S had the same mean value of 0.1g for RDW at the end of 16 weeks as showed in the (Table 3).

The result of the Total dry weight (TDW) presented in Table 3 showed that after four months, highest value of TDW was obtained from seedlings grown under CNS with the mean value of 0.85g while CNS-Ca gave the lowest TDW with the mean value of 0.33g (Table3). There was no significant difference in TDW between CNS-N (0.77g) and CNS-K (0.77g) and similarly between CNS-Mg (0.67g) and CNS-S (0.67g) seedlings. ANOVA revealed that LDW, RDW, TDW were significantly differences ($P<0.05$) among the seedlings raised with effect of macronutrient deficiency. (Appendix 2).

Table 4 Key of macronutrient deficiency for *M. altissima* seedlings is developed.

Symptoms localized in older leaves	N, P, K, Mg
At the incipient stage, foliage colour turned from normal green to pale green, while chlorosis set in from older leaves, leaves diminished in size and the entire plant was stunted	N
Chlorosis moved from apex and margins to petiole in a green ground colour	P
Older leaves turn pale green with bronzing appeared as tip burn on old leaves and with time younger leaves turn backward, at more advanced stages, leaves became necrotic and wrinkled	K
Intervenial chlorosis mainly at the older leaves, producing streaked effect in the leaves and subsequently fell off, the overall height growth was similar to	Mg

those of the complete nutrient plant	
Initially, marginal teeth of leaves collapsed and became chlorotic followed shortly by necrosis, with further developmental growth, the collapsed margin with or without necrosis led to backward curvate of affected leaves. The deficiency calcium also drastically reduced growth of plant and roots.	Ca
Chlorosis set in from petiole towards the apex in localized young leaves	S

Plate 1: Complete nutrient solution seedlings Plate 2: Complete nutrient solution with phosphorus

with Nitrogen deficient plant. deficient seedling

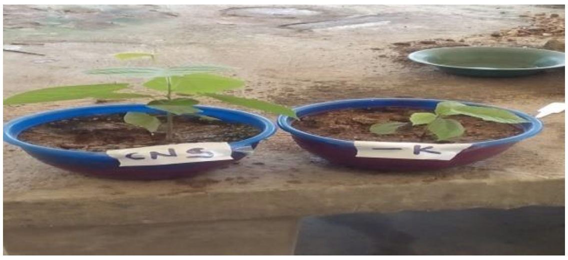


Plate 3: Complete nutrient solution seedling with Plate 4: Complete nutrient solution seedling with

Potassium deficient seedling Calcium deficient seedling


Plate 5: Complete nutrient solution seedling with Plate 6: Complete nutrient solution seedling with

Magnesium deficient seedling Sulphur deficient seedling

The Nitrogen deficiency symptoms observed in this study agreed with the findings of Nwoboshi (1980, 1982), Nwoboshi*et al.,* (1987), and Aluko and Aduayi (1987). Similarly, Awodola, and Nwoboshi (1990), Shinkafi, 2000 and Mengel and Kirkby (2001) found that poor growth was associated with nitrogen deficiency in *Parkia biglobosa.* The result of deficiency of nitrogen in the study indicated that plant height, collar diameter, number of leaves, dry weight, chlorophyll contents as well as root length of deficient seedlings were significantly lower than those on complete nutrient media at ($p<0.05$). Thus, Liv *et al., (*2007) revealed that N is essential element for the formation of chlorophyll which is a photosensitive catalyst in the process of photosynthesis.

Phosphorus deficiency seedlings became more severe as older leaves turned purplish while the leaves diminished in size and defoliate prematurely at the nursery stage. This is in agreement with findings of Nwoboshi *et al., (*1987), Awodola (1991) and Shinkafi (2000). These authors reported that deficiency of phosphorus resulted in movement of large fraction of Phosphorus from the older leaves to the actively growing younger tissues thus leading to initial chlorosis of older ones. Also, the Phosphorus deficiency affected the development of root system which is in line with findings of Brix (1993), Shinkafi (2000), Wang, (2000) and Ajekigbe, (2014) who reported that phosphorus deficient plant experienced reduced size in the root system.

Potassium (K) deficiency seedlings foliar symptoms manifested early 6 weeks after the commencement of the experiment in which leaves became pale green with 159 bronzing, which is characterized by chlorosis of plant commencing from foliage margin, and progressing inward towards the base in agreement with findings of Egbe (1986), Sands (1990), Nambiar (1990), Awodola (1995), Shinkafi, (2000) and Ajekigbe, (2014).

Calcium deficient *M. altissima* seedlings symptoms appeared in the youngest leaves, which became distorted with their tips hocked by tip burn which later affected the older leaves. The sub normal growth in calcium-deficient plants has been linked to the involvement of calcium in nitrogen metabolism because of its role in nitrate assimilation (Pearson, 1980). Calcium plays a vital role in the normal growth and development of plants. The effect of calcium deficiency in *M. altissima* seedlings in term of root length was observed to be the lowest among the treatments.

Magnesium deficient seedlings of *M. altissima* symptoms manifested on the leaves , but did not have significant effect on plant compared with seedlings raised with complete nutrient solution, which is in accordance with findings of Nwoboshi (1973) who reported that magnesium-deficient *Tectona grandis* did not differ significantly compared with the plants grown on complete nutrient solution in terms of plant height. According to Nwoboshi (1980), magnesium is an indispensable component of chlorophyll; it constitutes 2.7% of chlorophyll molecule.

Sulphur deficiency seedlings of *M. altissima* were significantly different in all variables assessed compared with the complete nutrient solution seedlings. The sulphur deficient seedlings foliage symptoms were similar to those of nitrogen deficiency. This is possibly because new cell elongation and division are severely limited by sulphur deficiency (Wang, 2000). Sulphur like nitrogen is a constituent of protein and the chlorophyll molecule (Mengel and Kirkby, 2001).

The location of deficiency symptoms also seems to vary with the elements. The symptoms of deficiencies of N, P, K, and Mg appeared first in the older leaves with the young leaves still looking healthy while Ca and S deficient plant showed the opposite trend appearing first in the younger leaves. According to Hacskaylo, (1966), nutrients considered to be mobile in the plant tissue exhibit their symptoms in the lower region, while those incorporated in the plant tissue and immobilized exhibit deficiency symptoms in the upper or apical regions of the plant. The present study thus revealed that N, P, K and Mg are readily mobile in *M. altissima* and that Ca and S are not readily mobilized. This is in accordance with the findings of Abbott 1986 and Nwoboshi (1973) who reported mobility of these nutrient elements in many other plant species.

CONCLUSION AND RECOMMENDATION

Deficiency of the macronutrient elements retarded the growth and development performance of all the growth parameters measured with Nitrogen deficient seedlings having the lowest growth and shortest growth period of only four weeks. After transplanting and application of stock solution. Also a key of macronutrient deficiency symptoms for *M. attissima* at seedlings stage is developed. It is therefore recommended that required quantities of macronutrient element should be supplied while raising the seedlings of *M. attissima in other to achieve its sustainability at the nursery stage and plantation establishment.*

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Appendix 1

ANOVA for the Effect of Nutrient Deficiency on the Growth of *Mansoniaaltissima* Seedlings.

Variable	SV	Df	SS	MS	F	Sig.
Height	Treatment	6	314.53	52.42	48.34	0.00*
	Error	63	68.32	1.08		
	Total	69	382.85			
Collar diameter	Treatment	6	9.68	1.61	17.969	0.00*
	Error	63	5.65	0.09		
	Total	69	15.33			
Leaves production	Treatment	6	30.91	5.15	11.525	0.00*
	Error	63	28.17	0.45		
	Total	69	59.08			

significant at (p≤0.05)

Appendix 2ANOVA for Biomass Assessment for effect of macro nutrient deficiency in seedlings of *Mansoniaaltissima*

Parameter	SV	Df	SS	MS	F	Sig.
Leaf Dry Weight	Treatment	6	0.56	0.09	27.81	0.00*
	Error	14	0.05	0.00		
	Total	20	0.60			
Stem Dry Weight	Treatment	6	0.00	0.00	1.00	0.46^{ns}
	Error	14	0.00	0.00		
	Total	20	0.00			
Root Dry Weight	Treatment	6	0.01	0.00	4.00	0.02*
	Error	14	0.01	0.00		
	Total	20	0.02			
Total Dry Weight	Treatment	6	0.64	0.11	33.35	0.00*
	Error	14	0.05	0.00		
	Total	20	0.69			

***significant at (p≤0.05)*ns- not significant (p>0.05)**

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