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Effect of Mycorrhiza, Fertilizer and Watering Regime on the Growth and Development of *Mansonia altissima* A CHEV. Seedlings

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ABSTRACT

A greenhouse investigation was conducted to determine the effect of Arbuscular mycorrhiza, N. P. K fertilizer and moisture supply on *Mansonia altissima* seedlings. The experiment was 3x3x3 factorial experiment in completely randomized design with each of factor has 3 levels and was replicated 5 times. Application of arbscular mycorriza does not have significant effect on growth parameters assessed, while N. P. K fertilizer and moisture supply had significant differences at (p<0.05) on seedling height, collar diameter and leaf production. Seedlings treated to 1g of fertilizer had the highest seedlings height mean value of 17.34cm, collar diameter of 3.63mm and leaf count of 8 while control had the least value of seedlings height, collar diameter and leaf production with 14.80cm, 3.02mm and 7 leaves respectively. Seedlings watered at pot capacity on daily basis had the highest seedling height and collar diameter of 16.99cm and 3.52mm respectively. Response observed in the present investigation revealed that more research work can be carried out to ascertain the appropriate arbuscular mycorrhiza to be used on the species based on compatibility.

INTRODUCTION

Forest and forest products play a very important role in the development of any nation. The utilization of forest resources range from the provision of raw materials for the ever increasing industry to yielding poles and firewood for domestic consumption, regulation of water regime and climate, protection from desertification and satisfaction of recreational needs. Increase in population and attendant increase in demand for forest and forest products have made plantation forestry attractive to tropical foresters.

The significant contribution of Mycorrhiza to plant is the symbiosis, which are characterized by bi-directional movement of nutrients where carbon flows to the fungus and in-organic nutrients move to the plant, thereby providing a critical linkage between the plant root and soil (Garbaye, 1994). In infertile soils, nutrients taken up by the mycorrhiza fungi can lead to improved plant growth and reproduction, as a result mycorrhiza plants are often more competitive and better able to tolerate environmental stresses than non- mycorrhiza plants.

Arbuscular mycorrhiza fungi belong to the order Glomales and form highly branched structures called arbuscules, within root cortical cells of many herbaceous and woody plant species. Arbuscular mycorrhiza fungi (AMF) can be found in almost all habitat and climates (Barea*et al.,* 1997) and at different depth of soil (Michelsen and Rosendahl, 1990).Although the occurrence and efficiency of AMF have been widely examined in most valuable undomesticated fruit trees (Mathur and Vyas, 2000), little is known of the mycorrhizal status and responsiveness of inherently slow growing indigenous timber tree species such as *Mansonia altissima*

However, in tropical agriculture systems where most soils are fragile with low fertility, a major beneficial effect of AMF is their role in maintenance and improvement of soil structure by their external hyphae and the production of a special protein called the glomalin (Diedhiou*et al* 2003). The mechanisms involved are as follows, the growth of external hyphae into the soil to create a skeletal structure that holds soil particles together and the formation of a 'sticky' string bag of hyphae by the glomalin, which contributes to soil aggregate stabilization (Elsen*et al* 2003).

It is therefore necessary to carry out studies on the effect of drought stress and inoculation of arbuscular mycorrhiza and nutrient application on the seedling performance of *Mansonia altissima* in order to know its growth behaviour and ascertain the best way to establish them in plantations, extensively both as mixed and single species stands. This will restore its pride of place in both local and international markets.

MATERIALS AND METHOD

Seeds of *Mansonia altissima* were sown directly into poly pots filled with top soil collected from Forestry Research Institute of Nigeria arboretum. The mycorrhiza used was supplied by Agronomy Department, University of Ibadan. The inoculations were carried out according to the method of Carling et al., 1978, Fagbola et al., 2005and Kareem et al., 2012. Also N:P:K fertilizer were added. Three (3) seeds each were sown directly into the poly pot and were arranged in screen house of Forestry Research Institute of Nigeria. After germination, thinning was carried out to reduce the number of seedlings to one plant per poly pot. A 3 X 3 X 3factorial experiment was used for the study. The treatments were replicated five times. The factors were mycorrhiza, N:P:K fertilizer and water supply. While N:P:K fertilizer and water supply had three levels(N:P:K 0g, 1g, and 2g and the water supply was once in a week, twice in a week and every day(1/7, 4/7 and 7/7 respectively), mycorrhiza also had three levels (myco 0g,10g and 20g (*Glomus deserticola*). The seedlings were watered regularly for six weeks to allow proper establishment before the drought stress treatment commenced.

Data were collected at two weeks intervals and the whole experiment terminated after 24 weeks. During the growth period, measurements of plant height and collar diameter were taken while leaf number was counted.

RESULT AND DISCUSSION

Effect of mycorrhiza on seedlings growth of *M.altissima*

The mean seedlings height for mycorrhiza ranged between 15.51cm and 17.22cm.Seedlings without mycorrhiza (M1) had the highest and seedlings inoculated with 20g of mycorrhiza (M3) had the least value (Table 1). There were no significant differences in seedlings height between M2 and M3 with 15.86cmand 15.51cm respectively (Table 1).

The mean seedling diameter ranged from 3.26mm to 3.63mmwith the highest mean observed for seedlings under 0g mycorrhiza (M1) while the least collar diameter was observed from M2 which is 10g (Table 1)

The leaf production increased with increase in age of the seedlings, mean leaf production in seedlings inoculated with mycorrhiza was 8 which indicates that there were no significant differences among the three levels of mycorrhiza used (p>0.05) (Table 1).

Table 1: Effect of Mycorrhiza on the growth of *M. altissima* Seedlings

Mycorrhiza	Height	Collar Diameter	Leaf Production
M1	17.22 ±2.62[a]	3.63 ±0.63[a]	8 ± 1.42[a]
M2	15.86 ±3.05[b]	3.26 ±0.54[b]	8 ±1.04[a]
M3	15.51 ±3.16[b]	3.25 ±0.44[b]	8 ±1.16[a]
Sig.	0.00	0.00	0.14

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

Effect of Fertilizers on the growth of *M. altissima* Seedlings

Table 2 shows that seedlings treated to 1g of NPK(F2) had the highest mean value of 17.34cm and seedlings without fertilizer(F1) had the least value of 14.80cm.

Result shows that seedlings treated to 1g of NPK (F2) had the highest mean value of 3.63mm while those without fertilizer application (F1) had the least value of 3.02mm (Table 2). It also reveals that value of collar diameter were significantly different among the three levels of fertilizer used (p< 0.05)

The leaf number increased with increase in age of the seedlings. Leaf production ranged between 7 and 8 with seedlings treated to 1g and 2g of NPK respectively. It also revealed that F2 and F3 are not significantly different from each other both having 8 leaves (Table 2). However, ANOVA for leaf production reveals that there were significant differences (P<0.05) in all the factors and interactions except for the interaction between mycorrhiza and watering regimes. (Appendix 1).

Table 2: Effect of Fertilizers on the growth of *M. altissima* Seedlings

Fertilizers	Height(cm)	Collar Diameter(mm)	NumberofLeaves
F1	14.80 ± 2.47^c	3.02 ± 0.42^c	7 ± 0.79^b
F2	17.34 ± 2.86^a	3.63 ± 0.62^a	8 ± 1.34^a
F3	16.46 ± 3.05^b	3.50 ± 0.45^b	8 ± 1.23^a
Sig.	0.00	0.00	0.00

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

Effect of watering regimes on the growth of *M. altissima* Seedlings

Seedlings watered daily to pot capacity (W3) had the highest mean value of 16.99cm and seedlings watered every other day to pot capacity(W2) had the least value of 15.08cm among the watering regimes (Table 3).

Analysis of Variance (ANOVA) reveals that there were significant differences (P<0.05) in the seedling height in watering regime and also among the interaction between mycorrhiza and fertilizer, fertilizer and watering regime and between the three factors. (Appendix 1).

Seedlings watered daily to pot capacity(W3) had the highest mean value of 3.52mm while those watered three times a week(W2) had the least value of 3.24mm (Table 3).

However, ANOVA for collar diameter revealed that there were significant differences at (P<0.05) among the mycorrhiza, fertilizer, watering regime and the interaction between fertilizer and watering regime, and with all the three factors. (Appendix 1)

Mean separation result for leaves production showed that it was the same number of leaf production for seedlings watered once a week (W1) and those watered daily (W3) had 8 number of leaves while seedlings watered three times a week(W2) had 7 leaves (Table 3).

Table 3: Effect of Watering Regimes on the growth of *M. altissima* Seedlings

Watering Regimes	Height(cm)	Collar Diameter	Leaf Production
W1	16.52 ± 3.03^a	3.39 ± 0.40^b	8.21 ± 1.04^a
W2	15.08 ± 3.66^b	3.24 ± 0.64^c	7.57 ± 1.38^b
W3	16.99 ± 3.35^a	3.52 ± 0.61^a	8.12 ± 1.22^a
LSD Value	8.33	0.19	0.94
Sig.	0.00	0.03	0.00

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

Interaction effect of Mycorrhiza, Fertilizers and Watering Regimes on the Growth of *M. altissima* Seedlings

On interaction between the three factors, it was revealed that seedlings without mycorrhiza treated with 1g of NPK and trice watering in a week at pot capacity(M1F2W2) had the highest mean height value of 20.95cm and the least value was observed under seedling without mycorrhiza, fertilizer and trice watering in a week at pot capacity(M1F1W2) with 12.09cm (Table 4).

Interaction of mycorrhiza, fertilizer and watering regimes revealed that the highest mean collar diameter of 4.39mm was observed for seedlings without mycorrhiza treated to 1g of NPK and trice a week watering at pot capacity (M1F2W2) while the least value of 2.82mm was recorded in seedlings without mycorrhiza, without fertilizer and trice watering a week at pot capacity M1F1W2 (Table 4).

Table 4: Mean Separation for the Interaction effect of Mycorrhiza, Fertilizers and Watering Regimes on the Growth of *M. altissima* Seedlings.

M * F * W	Height	Collar Diameter	Number of leaves
M1F1W1	16.42 ± 2.14^{cd}	3.52 ± 0.33^{b}	8 ± 0.77^{c}
M1F1W2	12.09 ± 3.65^{a}	2.82 ± 0.35^{a}	7 ± 0.90^{b}
M1F1W3	14.87 ± 1.61^{bc}	3.17 ± 0.47^{ab}	7 ± 0.70^{b}
M1F2W1	16.87 ± 4.12^{d}	3.61 ± 0.58^{b}	8 ± 1.44^{c}
M1F2W2	20.95 ± 2.38^{f}	4.39 ± 0.57^{c}	10 ± 1.39^{e}
M1F2W3	20.21 ± 4.43^{f}	3.97 ± 0.69^{b}	9 ± 1.31^{d}
M1F3W1	18.93 ± 2.73^{e}	3.72 ± 0.37^{b}	9 ± 0.98^{d}
M1F3W2	15.90 ± 2.71^{c}	3.47 ± 0.50^{ab}	8 ± 1.54^{c}
M1F3W3	18.72 ± 1.01^{e}	4.01 ± 0.22^{bc}	9 ± 0.82^{d}
M2F1W1	14.83 ± 1.74^{bc}	3.04 ± 0.31^{ab}	7 ± 0.62^{b}
M2F1W2	13.93 ± 2.20^{b}	2.70 ± 0.48^{a}	7 ± 0.76^{b}
M2F1W3	15.80 ± 2.07^{c}	3.00 ± 0.54^{a}	7 ± 0.91^{b}
M2F2W1	16.99 ± 3.41^{d}	3.37 ± 0.36^{ab}	8 ± 0.48^{c}
M2F2W2	16.02 ± 4.24^{cd}	3.37 ± 0.58^{ab}	8 ± 1.50^{c}
M2F2W3	17.22 ± 3.49^{d}	3.65 ± 0.66^{b}	8 ± 0.75^{c}
M2F3W1	18.19 ± 2.06^{de}	3.53 ± 0.31^{b}	9 ± 0.57^{d}
M2F3W2	15.30 ± 1.99^{c}	3.26 ± 0.26^{ab}	8 ± 0.82^{c}
M2F3W3	14.47 ± 3.49^{b}	3.46 ± 0.64^{ab}	8 ± 1.53^{c}
M3F1W1	14.28 ± 1.69^{b}	$3.03 \pm 0.0.25^{ab}$	7 ± 0.71^{b}
M3F1W2	14.33 ± 1.70^{b}	2.89 ± 0.18^{a}	7 ± 0.48^{b}
M3F1W3	16.64 ± 2.13^{d}	3.00 ± 0.30^{a}	8 ± 0.83^{c}
M3F2W1	16.15 ± 3.42^{c}	3.44 ± 0.28^{ab}	9 ± 1.01^{d}
M3F2W2	12.86 ± 3.42^{a}	3.03 ± 0.42^{ab}	6 ± 0.40^{a}
M3F2W3	18.74 ± 3.10^{e}	3.84 ± 0.40^{b}	9 ± 0.61^{d}
M3F3W1	16.01 ± 3.08^{c}	3.22 ± 0.17^{ab}	8 ± 0.91^{c}
M3F3W2	14.31 ± 2.56^{b}	3.25 ± 0.48^{ab}	7 ± 1.51^{b}
M3F3W3	16.30 ± 3.53^{cd}	3.57 ± 0.44^{b}	7 ± 0.68^{b}

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

Arbuscular mycorrhiza are obligate biotrophs and the symbiosis formed between the host plant and fungal partner is normally mutualistic (Smith and Read, 2008). However, evidences suggest that the symbiosis can range from parasitic to mutualistic depending on the host plant and Arbuscular Mycorrhiza (A.M) fungal species involved (Kilronmos, 2003); soil physical, chemical and other associated characteristics as well as environmental conditions (Diop *et al.,* 1994, Loth 1996, Weber and Claus 2000). Hence, an attempt to specifically understand the contribution of introduced AMF in a controlled environment before the prevailing conditions in the field is important. Mycorrhiza inoculation can have positive effect (Michelsen and Rosendahl 1990, Osonubi *et al.,* 1991, Noyd*et al.,* 1995, Fagbola *et al.,* 2005 and Kareem *et al.,* 2012); negative effect (Hetrick*et al.,* 1990, Taylor and Harrier (2000) or non-significant (Manjunath and Habte, 1988) effects on the growth of plants.

In this study, inoculation of *M. altissima* with *G. deserticola* had no significant effect on the growth variables assessed, which is in line with findings of

(Manjunath and Habte, 1990), this contradiction maybe due to lower physiological compatibility of *G. deserticola* with *Mansonia altissima* since variability in compatibility has been reported for various A.M symbiosis (Krishma *et al.,* 1985, Rajapakse and Miller 1987, Rao*et al.,* 1990 and Mercy *et al.,*1990).

The application of N.P.K fertilizer significantly increased the plant height, collar diameter and number of leaves in seedlings of *Mansonia altissima.* This might be due to the fact that Nitrogen is a major nutritional element required for tissue differentiation and its role in increasing plant growth and development which are well documented by various researchers (Shedeed *et al*., 1986, Aziz, 2007). Like Nitrogen, Phosphorus is an essential constituent of the genetic material and augments cell division (Aziz, 2007). The study clearly demonstrates the nutritional importance of N.P.K supply to *M. altissima* seedlings for better growth and development and the results revealed application of N.P.K 1g/seedling to be beneficial and therefore enhanced seedlings performance under tropical agroclimatic condition. The optimum level of fertilizer requirement for a tree species like *M. altissima* is dynamic and changes with the age of plant. Therefore, the fertilizer requirement studies need further long term evaluation for different agro-ecological regions.

Water is a significant factor in tree growth and development in the tropics (Awodola and Nwoboshi, 1993). Water is required by plants to manufacture carbohydrate and as a means for transportation of food and mineral elements. Various vital processes in plants such as cell division, cell elongation stem as well as leaf enlargement and chlorophyII formation depends on plant water availability (Price *et al.,* 1986). The knowledge of the response of the seedling under conditions of restricted moisture may provide an indication of its response to increased water stress. Also, the evaluation of the morphological and physiological growth of plants at period of restricted moisture is useful for the isolation of plants with seedling characteristics acceptable for afforestation in drought prone environments.

The finding from this study revealed that watering regimes applied to the seedlings of *M. altissima* had significant effect on the seedling height, collar diameter and leaf production. The highest value for seedling height, collar diameter and leaf production were observed in seedlings watered everyday to pot capacity. This is in agreement with the previous studies (Akinyele, 2007 and Ogunwande, 2014).The interaction effect of fertilizer and watering regimes had significant effect on the growth parameters assessed.

CONCLUSION

Interaction between mycorrhiza, fertilizer and moisture supply resulted in enhancement of growth and development of *Mansonia altissima* seedlings indicating that arbuscular mycorrhiza was not parasitic, However fertilizer was found to exert more influence than mycorrhizain respect of morphological characteristics of *M. altissima* seedlings.

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Appendix 1:ANOVA for the Effect of MFW on the growth of *M. altissima* Seedlings

Variable	SV	Df	SS	MS	F	Sig.
Height (cm)	M	2	145.76	72.88	8.75	0.00*
	F	2	298.74	149.37	17.94	0.00*
	W	2	179.52	89.76	10.78	0.00*
	M * F	4	142.03	35.51	4.26	0.00*
	M * W	4	71.50	17.87	2.15	0.08ns
	F * W	4	90.74	22.69	2.72	0.03*
	M* F * W	8	241.12	30.14	3.62	0.00*
	Error	243	2023.37	8.33		
	Total	269	3192.78			
Collar Diameter (mm)	M	2	8.40	4.20	21.98	0.00*
	F	2	18.83	9.41	49.29	0.00*
	W	2	3.40	1.70	8.90	0.00*
	M * F	4	1.10	0.28	1.45	0.22ns
	M * W	4	0.66	0.16	0.86	0.49ns
	F * W	4	2.73	0.68	3.57	0.01*
	M* F * W	8	5.91	0.74	3.87	0.00*
	Error	243	46.41	0.19		
	Total	269	87.43			
Leaf Production	M	2	21.80	10.90	11.65	0.00*
	F	2	68.99	34.50	36.87	0.00*
	W	2	21.28	10.64	11.37	0.00*
	M * F	4	12.14	3.03	3.24	0.01*
	M * W	4	5.70	1.43	1.52	0.20ns
	F * W	4	12.15	3.04	3.25	0.01*
	M* F * W	8	49.26	6.16	6.58	0.00*
	Error	243	227.34	0.94		
	Total	269	418.65			

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

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