SITE FACTORS INFLUENCING THE DEVELOPMENT OF ROOT SYSTEM OF *GMELINA ARBOREA* IN SOME AREAS OF IMO STATE, NIGERIA

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MBAKWE, R. 1989. Site factors influencing the development of root system of *Gmelina arborea* in some areas of Imo State, Nigeria. The investigation on the effect of site on the development of root system of *Gmelina arborea* in some areas of Imo State, revealed that the roots of *G. arborea* in Egbema developed luxuriant tap-root and adventitious roots compared with that of Okigwe and Umuagwo areas. *G. arborea* in Egbema undergo periodic fluctuation of the ground-water and high organic matter content of soil. The luxuriant root development could prevent the tree from being blown down by the high wind of the area.

Key words: *Gmelina arborea* - root system - site factors - Nigeria

Introduction

The root is the part of the plant usually below the ground that holds the plant in position, draws water and nourishment from the soil and stores food for the plant. However, relatively little is known about the root systems of plants in the tropics because of the inherent difficulties in studying them without at the same time altering the conditions for plants' growth.

All the root systems of plants vary greatly as to type, extent, degree of branching and functions. The variations are the result of both inherent genetic properties of the species as well as the environmental conditions influencing the entire plant. According to Sutton (1969), when a tree is mature, the inherent juvenile characteristics of root development is completely dominated by conditions of site. In this study, I investigated the extent to which the environment influenced the development of root system of *Gmelina arborea.*

G. arborea trees are planted in various locations of Imo State which could be divided into two ecological zones, namely the drier equatorial rain forest zone around Okigwe and Afikpo areas within latitude 6° 19" and the wet humid equatorial rain forest zone around Egbema and Umuagwo on the latitude 4° 45". In view of these two distinct ecological zones, for this study *G. arborea* were

selected from Okigwe in the drier ecological zone and Umuagwo and Egbema in the wet humid area.

Figure 1. Location of towns in Imo State

Materials and methods

G. arborea were uprooted in the three sites of Egbema, Umuagwo and Okigwe, and the general shape and type of root formation were observed. The selected trees to be uprooted were based on the size and available space in and around the tree. A *G. arborea* tree with a minimum diameter of 10 *cm* at breast height and with a minimum spacing of 5 *m* in and around it was considered ideal for the exercise. Then, the vegetation around the chosen species was cleared. Pick axe was used to loosen the dry and hard surface of the soil. Okigwe zone especially is very stony and drier than any of the areas in question. After loosening the soil, a shovel was used to remove the soil particles around the excavated surface. A trench around the tree so dug exposed the root system. The tree tipped over, and then it was possible to measure the roots vertically and horizontally, as well as thickness of the prominent roots. Photographs were taken as well.

Results and findings

In all, *G. arborea* uprooted in all the areas had diameters ranging from 14.5 - 15.5 *cm*. In Umuagwo, the mean diameter of the trees uprooted was 15.5 *cm* with a mean height of 20 *m*. *G. arborea* in Okigwe measured 18.5 *m* in height with a mean diameter of 14.5 *cm*. Equally, *G. arborea* uprooted in Egbema had a diameter size of 15 *cm* with an average height of 18 *m*.

G. arborea growing in Umuagwo had no evidence of tap-root (primary root). Adventitious roots (secondary roots) were numerous and varied between 0.1 - 2 *cm* in diameter, spreading more or less obliquely downwards. Profused tertiary rootlets less than 0.01 *cm* were prominent. These eventually clothed the entire root system giving an impression of a dense fibrous root system. These tertiary rootlets underneath the adventitious roots hardly gave room for the downward movement of the rootlets. The entire root system occupied a depth of about 1.2 *m* (Figure 2).

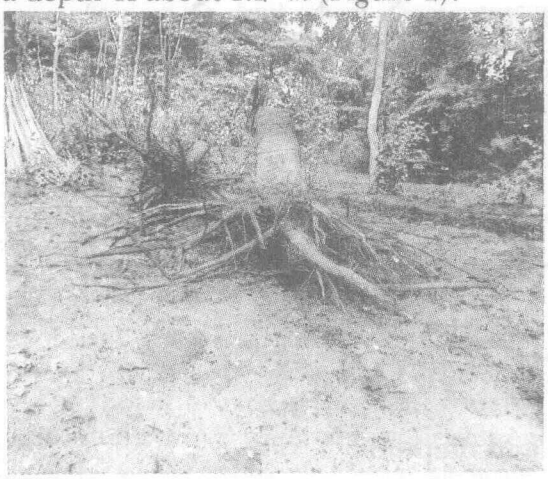

Figure 2. *Gmelina arborea* at Umuagwo

Figure 3. *Gmelina arborea* at Egbema

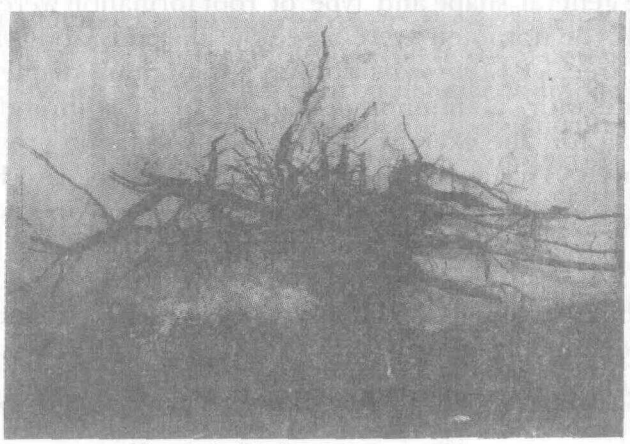

Figure 4. *Gmelina arborea* at Okigwe

In Egbema, the root system of *G. arborea* was conspicuous, with stout, long and fusiform tap-root of about 4 *cm*, branched at the tip, and was sparsely subtended by wiry rootlets. The adventitious roots (secondary roots) were several but not numerous, stout and more or less the same size as the tap-root. These adventitious roots of about 3 *cm* in diameter were directed obliquely downwards and subtended by wiry tertiary rootlets. On the whole, the entire root system occupied a depth of about 2.0 *m* (Figure 3).

For *G. arborea* at Okigwe, the tap-root was not conspicuous or outstanding, with numerous secondary roots generally spreading horizontally and tapering towards the end. What appeared as tap-root was > 0.3 *m* long and about 1 *cm* thick. The thickness of the secondary roots varied between 1 - 2 *cm*, tertiary rootlets were numerous and fibrous, measuring > 0.01 *cm*. These tertiary rootlets formed a dense fibrous root system in and around the unpronounced tap-root. The root system occupied a depth of about 0.55 *m* (Figure 4).

Discussion

This investigation revealed marked differences in the root systems of *G. arborea* growing in the various sites of Egbema, Umuago and Okigwe. *G. arborea* in Egbema developed conspicuous, stout and long tap-root whose secondary roots looked much like, both in size and length, the tap-root (Figure 3). On the other hand, *G. arborea* in both Umuagwo and Okigwe had no conspicuous or visible tap-roots. But their secondary and tertiary roots were numerous, dense and fibrous.

Generally, *G. arborea* is known to develop fibrous root system with adventitious roots forming the majority, there is no prominent or visible tap-root (Lanprecht 1983). Thus *G. arborea* in Egbema deviated from this general norm of root system of *Gmelina*. This deviation could be attributed to, either the climatic or edaphic factors of the area, or both.

Climatically, Egbema has a mean annual rainfall of 2329 *mm* with a mean annual temperature of 30°*C* (Table 1). The climate of Egbema differs very slightly from that of Umuagwo, but Okigwe is slightly drier (the annual rainfall is 1933 *mm*). All lie in the rain forest belt of Nigeria, and share similar climate; the difference in intensity exists but not distribution. Equally the mean annual temperature of all the areas lie at 30°*C* with a high humidity of 95% and a wind speed of about 120 $m\ s^{1}$ (Table 1).

The climate of the areas are basically the same and therefore not capable of effecting a major difference in the root development of *G. arborea* growing there.

Edaphically, there are differences in the soil structure of the various sites. Egbema is located on the alluvial soils of Niger River Terrace on a flat ground with small confined depression, oxbows and backswamps. The soils have a sandy horizon, margining in clay loam in the subsoil. They are generally

characterized by strong hydromorphism in the subsoil as a result of excess moisture caused by periodical fluctuation of the ground-water. The soil of the area developed over coastal plain sandy parent materials. The "A" horizon is deep porous, red or reddish brown, weakly structured, and slightly humid with rapid infilteration to the clay sub-soil from a depth of 30 - 40 *cm* where the soil appears strong, red or yellow mottle. The soil is acidic with a pH value between 4.5 and 5.0. But there is a moderate natural fertility throughout the profile with a high organic matter over the poor, highly leached soil.

Table 1. Climatic data of Egbema, Umuagwo and Okigwe

	Parameter	Rainfall (mm)	Temperature (°C) Max.	Min.	Relative humidity at 07:00 (%)	Sun (h)	Wind speed ($m\ s^{-1}$)
Egbema							
	January	20	33.6	20.8	93.8	5.9	136
	February	48	34.11	23.5	93.5	4.9	125
	March	94	34.0	23.6	93.6	5.1	130
	April	190	33.0	23.6	93.6	4.4	127
	May	159	32.5	23.6	93.6	5.6	108
	June	272	29.6	23.2	92.2	3.3	109
	July	368	28.7	22.6	92.6	2.1	108
	August	261	29.11	22.3	92.3	2.6	106
	September	401	29.9	22.4	92.4	2.7	121
	October	290	30.6	22.6	94.6	4.2	125
	November	94	33.6	23.1	93.1	6.9	125
	December	25	34.0	19.7	90.7	6.3	126
	Mean annual	2329	31.0	22.1	93.1	4.4	120.0
Umuagwo							
	January	28	33.6	20.8	85	5.9	137
	February	58	34.1	23.5	85	4.8	104
	March	137	34.0	23.6	90	5.1	120
	April	165	33.0	23.6	91	4.4	111
	May	241	32.5	23.2	93	5.6	101
	June	272	28.6	22.2	94	3.5	101
	July	320	28.7	22.6	97	2.1	113
	August	295	29.1	22.5	97	2.6	112
	September	363	29.9	22.4	96	2.7	168
	October	254	30.6	22.6	94	4.7	114
	November	96	33.6	23.1	91	4.2	103
	December	33	34.0	19.7	86	6.9	124
	Mean annual	2263	31.9	22.5	92.0	4.4	117.3
Okigwe							
	January	23	31.0	20.1	90.1	6.5	142
	February	53	34.2	24.0	94.0	7.0	105
	March	91	35.0	25.0	95.0	6.0	130
	April	142	32.0	22.5	92.5	6.3	129
	May	231	30.0	23.0	93.0	5.8	110
	June	256	29.0	20.4	90.4	5.6	121
	July	284	30.2	20.1	90.1	3.0	122
	August	211	28.4	21.0	91.0	4.0	117
	September	317	28.0	22.0	92.0	3.5	128
	October	251	28.6	23.4	93.4	5.0	129
	November	56	34.2	24.6	94.8	6.0	139
	December	15	35.0	21.0	90.0	6.5	140
	Mean annual	1933	31.3	22.8	92.2	5.3	126.0

(Egbema & Umuagwo - based on the meteorological record of Michael Okpara College of Agriculture; Okigwe - based on the meteorological record of Imo State)

As indicated in the regional development master plan for Imo State (GISN 1984) and constructed by the agronomy students of the Michael Okpara College of Agriculture (Umuagwo 1982), the soil in Umuagwo is predominantly of sand and loam. Coarse sand occupied in all depths an average of 72.5% fine sand, 0.5% silt maintained in all the depth an average of 24% and clay 17%, hence, described as sandy loam soil (Table 2). The soil is low in mineral and organic matter (Table 2) with a pH value between 4.1 and 4.3. This indicates that the soil is acidic.

Table 2. Soil structure of Umuagwo based on the soil analysis carried out by the School of Agronomy in 1982

Depth (*cm*)	% Clay	% Silt	% Fine sand	% Coarse sand	pH	% Nitrogen	% Base saturation	Acidity me/100 *g*
0 - 13	11.0	4.0	6.0	79.0	4.30	0.064	66.07	0.26
13 - 35	17.0	3.0	5.0	75.0	4.20	0.041	58.06	0.26
35 - 75	19.0	5.0	7.0	69.0	4.10	0.006	46.67	0.44
75 - 120	21.0	4.0	8.0	67.0	4.10	0.006	41.33	0.44

The soil of Okigwe, however, is red Ferralsol clay loam. This is classified as highly leached, deep uniform, strong red sandy loam soil with a pH value of 5.0. According to Daniel *et al.* (1979), development of root system of matured trees depends largely on such factors like soil type, nutritional status, drainage characteristics, presence or absence of peat gley and organic matter. Some of these characteristics like periodic fluctuation of the ground water (gley), poor drainage characteristics and high organic matter content are predominant in Egbema soil. According to Bitterlish (1971) high soil nutrient layer over a normal poor soil structure or capillary attraction of the ground water could result in luxuriant growth or branching of the root system. This phenomena which is absent in Umuagwo and Okigwe but present in Egbema may be attributed to the luxuriant growth or branching of the root system of *G. arborea* in Egbema plantation zone. In the high wind zone of the area, *G. arborea* cannot easily be blown down as it would have been the case if it were shallow rooted.

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