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Early Growth Response of *Khaya senegalensis* Seedlings to Water Requirement

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ABSTRACT

Water availability in quantity and quality is an important factor required during growth, development and for nursery seedling productivity. The study determined the response of *Khaya senegalensis* seedlings to water requirement and it effect on the growth. Levels of water required was determined by subjecting seedlings to four watering frequencies vis-à-vis Daily watering, watering every two days, watering every four days and once a week. The experiment was laid out in a complete randomized design (CRD) and parameters such as stem height, collar diameter, leaf area, leaf number were collected fortnightly while, dry weight, fresh weight, root to shoot ratio, root length, root weight, shoot length, turgidity weight and relative water content were evaluated after Twelve (12) weeks of growth. Data collected was subjected to One Way Analysis of Variance on SAS software and significant means was separated using Duncan Multiple Range Test (DMRT). From the result, morphological variables such as collar diameter (10.80mm), number of leaf (32.77), leaf area (403.65 cm^2) were significantly ($p<0.05$) increased in seedlings with highest requirement for water (daily watering). Also, physiological variables such as dry weight (17.35 g), fresh weight (36.28 g), turgid weight (47.93 g), root weight (14.02 g) and shoot weight (24.38 g) increased significantly ($p<0.05$) in seedling water daily. The early growth of *Khaya senegalensis* seedlings was enhanced due to availability of soil water in response to its requirement.

Keywords: Availability, Frequency, Growth, *Khaya senegalensis*, Requirement, Seedlings, Water.

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I. Introduction

The physical basis of living things in a plant is water. Isah *et al.* [1] stated that plant water requirement is important for the movement of mineral elements, food and the production of carbohydrates. One of the important natural resources that supports life and growth of plant is Water [2]. According to [3], water is an essential component of all living things and is engaged in biochemical process. In plant, water requirement is dependent on the botanic characteristics of the plants, its age of growth and the prevailing weather conditions of the region [4]. (Ogidan, Olajire-Ajayi and Adenuga [5] reported that in the growth, development and productivity of plant, water is one of the important factor. Aderounmu *et al*. [6] states that water is crucial to plant growth because it regulates the rate of transpiration, which in turn affects the inflow of nutrient solutions. According to Bongers, Pooter and Hawthorne [7], the most significant environmental element that has been found to have a significant impact on the species and distribution of trees in the tropics is water availability.

Water is important during reforestation and afforestation programmes especially when seedlings production is in large quantities [3]. According to [8], a nursery site's ability to produce tree seedlings depends greatly on the availability and quality of water, Mng'omba *et al*. [9] stated that regular watering is a must to produce good and quality seedling for nurseries trees. Water is also known to be a determinant factor for seed germination since it can affect parameters taken during germination in plants [10]. Although water requirement differs among plant species, water still has significant effects on growth of plants according to Aderounmu *et al.* [6]. Olajuyigbe *et al.* [11] revealed that the amount of water a plant receives and uses determines how much biomass it will produce during its lifetime.

According to [12], different plant species react differently to water availability, and various plant sections adjust differently to different water stress conditions. One of the biggest obstacles to the construction and management of fruit tree nurseries, particularly in the drier parts of the tropics and subtropics, has been the availability of a reliable water supply [8]. Water scarcity is a significant concern, especially for dry land forestry and seedlings raised in nurseries [3]. According to Mng'omba *et al*. [9], consistent watering is essential for tree nurseries to generate high-quality seedlings. This is due to the fact that a nursery operator may suffer financial loss if seedling growth stagnates or if there is a subsequent increase in mortality according to Mhango *et al*. [13], Mng'omba *et al*. [9] and [3]. Due to the lengthy time, it takes seedlings to reach the proper size for grafting, transplanting, or sale, Mng'omba *et al*. [9] stated that this loss can be significant. Economic losses result from water scarcity, but different plants have different water needs as well.

The best native species for producing timber is *Khaya senegalensis* A. Juss. (Melaceae), or mahogany. It can reach heights of 35 meters and a diameter of 1.5 meters when grown in fertile soil, and it has a clean bole that is 10 to 16 meters

long. The wood of this species is tough, dark and reddish in color. it has high composting resistance. The wood has a beautiful hue, a high luster, and a primarily straight grain orientation. It is utilized in the production of ornamental veneers, shipbuilding, and cabinetry. The mahogany shoot borer (Moore) infestation problem that commonly threatens the success of plantations in the species' native region in West Africa makes its natural regeneration insufficient [14]. Individual seedlings can be dug out during the wet season, and after being stripped of their leaves and having their roots pruned, they can either be potted in containers or put straight into the ground after receiving enough rain. For plantations, healthy individuals with straight and long stems should be used as the source of tree seed [15]. To achieve this, moisture requirement for nursery production is essential for optimal productivity.

II. Materials and Methods

A. Study Site

The study was carried out at the forestry nursery unit of Forestry and Wildlife management in the Federal university of Agriculture, Abeokuta, Ogun state Nigeria. The site falls within longitude 3 º20′E and 3 º37′E and the latitude 7ºN and 7º58′N. The nursery has a gentle landscape and mild slope. The site is punctuated in parts by ridges, isolated, residual hills, valley and low lands. The soil is sand and clay with crystalline basement complex. The relative humidity of the area is 82.54% and the average monthly temperature should be 35.8 ºC.

B. Seedling Collection and Preparation

Two weeks old *Khaya senegalensis* seedlings were acquired from National Horticultural Research Institute (NIHORT). Forty (40) healthy seedlings were selected and transplanted in polythene pots of sizes 12 cm by 24 cm filled with the topsoil. Seedlings were raised at one seedling per poly pot and watered until stability of seedling were obtained.

Stable seedlings were subjected to four (4) levels of water requirement by watering at four (4) regimes viz-a-viz, Daily watering (WED), Watering every other day (WET), watering every four days (WEF), Once a week (WES). These Four (4) treatments were replicated 5 times with a total of sample 20 samples. The experiment was laid out in a Completely Randomized Design (CRD).

C. Data Collection

Morphological parameters such as seedling height, number of leaves, leaf area and stem collar diameter were taken fortnightly (every two weeks) for 12 weeks. After twelve weeks of experimental treatment, the seedlings were harvested from the pots and separated into roots and shoots, to determine the shoot weight and length and the root weight and length. Biomass accumulation, Root to shoot ratio, Fresh weight, Turgidity weight and Relative water content were determined.

Mathematically, relative water content was determined by:

$$\text{Relative water content} = \frac{Fwt-Dwt}{Twt-Dwt} \times 100 \quad [16]$$

Fwt – Fresh weight, Dwt – Dry weight, Twt – Turgidity weight

D. Data Analysis

Data collected was subjected to statistical Analysis of variances (ANOVA) on SAS software and significant means were separated using Duncan Multiple Range Test (DMRT).

III. Results

A. Effect of Watering frequencies on the Morphological Variables of Khaya Senegalensis Seedlings

From the study, the rate of water required for stem height was not significantly different ($p>0.05$) in *K. senegalensis* seedlings. Seedlings height increased (39.94 cm) with increase in water availability in response to daily watering (WED). This effect was not significantly different from seedlings (29.44 cm) watered at least twice a week (WEF) while the least effect (26.77 cm) was observed in seedlings with the watered once a week (WES) (Table I).

The result further shows that the rate of water application had significant difference ($p<0.05$) on collar diameter, number of leaves and leaf area of *K. senegalensis* seedlings. Daily watering (WED) had the highest significant effect on stem collar diameter (10.80mm), number of leaves (32.77) and shoot length (40.58 cm) while the least significant effect ($p<0.05$) 8.09 mm, 15.53 and 28.50 cm, respectively were measured in seedlings watered once a week (WES). Seedlings watered every four days (WEF) had the largest leaf area 403.65cm^2 ($p<0.05$) while the least effect 209.19 cm was measured in seedlings watered daily (WED) (Table I).

TABLE I: Effect of Watering Frequencies on the Morphological Parameters of *Khaya Senegalensis* Seedlings

Watering frequency	SH (cm)	CD (mm)	NL	LA (cm^2)	RL (cm)	SL (cm)
WED	34.94^a	10.80^a	32.77^a	209.19^b	27.48^a	40.58^a
WET	28.86^a	9.40^{ab}	29.20^{ab}	241.88^b	24.80^a	36.10^{ab}
WEF	29.44^a	8.02^b	19.47^{bc}	403.65^a	23.60^a	35.60^{ab}
WES	26.77^a	8.09^b	15.53^c	230.54^b	25.90^a	28.50^b

Mean values with the same subscript in each column are not significantly different (P> 0.05).
WED: Daily watering, WET: Watering every two days, WEF: Watering every four days, WES: Once a week.
SH- Stem Height, CD- Collar Diameter, NL-Number of Leaves, LA- Leaf Area, RL- Root Length, SL- Shoot Length.

TABLE II: Effect of Watering Frequencies on the Physiological Variables of *Khaya Senegalensis* Seedlings

Watering frequency	DW (g)	FW (g)	R/S ratio	RW (g)	SW (g)	TW (g)	RWC
WED	17.35^a	36.28^a	0.62^a	14.02^a	24.38^a	47.93^b	66.60^a
WET	12.92^a	25.25^b	0.50^a	12.20^a	15.04^b	32.25^b	48.57^a
WEF	11.55^b	18.92^{bc}	2.37^a	8.01^b	10.92^{bc}	25.08^b	44.19^a
WES	6.89^b	13.12^c	0.75^a	4.17^c	5.36^c	12.98^c	220.0^a

Mean value with the same subscript in each column is not significantly different (P>0.05).
WED: Daily watering, WET: Watering every two days, WEF: Watering every four days, WES: Once a week.
DW- Dry weight, FW- Fresh weight, R/S- Root to shoot ratio, RW- Root weight, SW- Shoot weight, TW- Turgid weight, RWC- Relative water content.

B. Effect of Watering Frequencies on the Physiological Variables of Khaya Senegalensis Seedlings

The study observed that biomass accumulation increased with increased water application. Seedlings dry weight (17.35 g), fresh weight (36.28 g) and turgid weight (47.93 g) were significantly ($p<0.05$) increased as water application increased (WED). The least significant effect (6.89 g, 13.12 g and 12.98 g, respectively) was observed in seedlings watered once a week (WES). The weight of the measured root (14.02 g) and shoot weight (24.38 g) were significantly ($p<0.05$) increased in seedlings watered daily (WED) while least effect of moisture application (4.17 g and 5.36 g respectively) was recorded in seedlings watered once a week (WES). There was not significant affect ($p>0.05$) rate of watering frequencies on root to shoot ratio and relative water content (Table II).

IV. Discussion

A. Effect of Watering Frequencies on the Morphological Variables of Khaya Senegalensis Seedlings

The study clarified that the rate of water required by *Khaya senegalensis* directly related to the amount of water available for growth. The higher the rate of water applied to *Khaya senegalensis* seedlings, the higher the amount of water availability, the higher that growth rate. The growth rate of seedling collar diameter, leafiness, leaf area and shoot length increased with higher amount water in the soil rhizosphere. According Olajide *et al.* [17]-[19], stem collar diameter was significantly different to different watering regime in *Dialium guineense*, *Tectona grandis* and *Synsepalum dulcificum* seedlings respectively. Also, irrigation frequencies increased the number of leaves among five tropical species reported by Mohammed, Khalid and Talaat [20] and growth rate of *Khaya senegalensis* seedlings according to Isah *et al.* [1]. With water availability, there will be expansion of leaf area, thus increasing the rate of photosynthesis thereby enhancing overall growth rate. Fahad *et al.* [21] reported that the reduction in leaf expansion is directly proportional to the rate of water deficit in the soil. Furthermore, water deficit causes reduced leaf size and stem heights Farooq *et al.* [22] and Shahzad *et* al. [23] as well as the morphophysiological conditions in plants [Akram *et al.* [24]. [12] stated that different plant sections adapt differently to varied water stress circumstances, and different plant species respond differently to water availability. Soil water availability is necessary for microbial activity and nutrient availability and mobility in the soil rhizosphere [25]. Although there was significant effect of water availability on the root length, daily watering increased the length of the root. It can be inferred that, water availability increased the intake and distribution of nutrients from the root to different sections of the shoot Jalota *et al.* [26].

B. Effect of Watering Frequencies on Physiological Variables of Khaya Senegalensis Seedlings

Growth and development of plant is enhanced under moderate water condition. Observations from the study showed that physiological variables such as fresh weight, dry weight, turgid weight, shoot weight and root weight increased with availability of soil water in the soil rhizosphere. Vandoorne *et al*. [27] and [28] reported that water deficit reduces physiological and morphological variables of plants such as fresh weight, dry weight, leaf number, relative water content, total leaf area and resulting in loss of turgor, stomatal closure, reduces photosynthesis and metabolic rate in the newly planted. Increase in the glucose production and growth is directly related to availability of CO_2 to the photosynthetic site, a process enhanced by presence of moisture in plant component [29]. According to Hussain *et al.* [30] and Siddique *et al.* [31], water stress condition affects physiological processes such water relations, photosynthesis and respiration. These effect are more pronounced at the developmental stage of a plant and it reduces plant growth according to Fahad *et al.* [21]. To carry out crucial processes like photosynthesis and nutrient uptake, plants need a constant flux of water in addition to the level of water in their tissues [32]. Soil water availability did not contribute significantly to relative water content and the root to shoot ratio however, reduced water availability resulted in it increased. In contrast to this, is the submission of Taeger *et al.* [33] and Rose *et al.* [34] which stated that lower water availability in the soil results in lower relative water content.

V. Conclusion

The increased rate of water required by *Khaya senegalensis* seedlings determined the amount of water available for growth. It has been considered that water deficit has impact on morphological and physiological process in plant hence, reducing plant growth, while water availability enhances growth and development in *Khaya senegalensis* seedlings.

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