
ASSESSMENT OF PHENOLOGICAL AND PHENOTYPIC GROWTH BEHAVIORS OF SOME SELECTED INDIGENOUS AND EXOTIC TREE SPECIES IN KEBBI STATE, NIGERIA

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Abstract

This study was conducted as an assessment of phenological and phenotypical behaviors of some selected indigenous and exotic tree species in Aliero, Kebbi state. Main objective of the study is to ascertain which among the exotic species can easily adapt to the environment of the study area, and which indigenous species can grow faster. The selected tree seedlings include: T1 Eucalyptus camaldulesis, T2 Diospyros myspeifomis, T3 Tamarindus indica, T4 Mangifera indica, T5 Gmelina arborea, T6 Khaya senegalensis, T7 Annona senegalensis, T8 Acacia niltica T9 Detarium microcarpa. Based on the result of the study T1 and T6 indicated a better robust growth in number of branches, collar diameter and tree heights. It was therefore recommended that T1, Eucalyptus camaldulensis and T6, Khaya senegalensis should be planted in Aliero local government area for plantation establishment and land reclamation, due to their ability to perform well even with the little amounts of rainfall in the study area.

Keywords: Indigenous, exotics, trees, phenological, phenotypical, plantation, reclamation, collar, diameter and branches

Introduction

Phenology is the study of the timing of recurring biological phases, and the interrelation among phases of the same or different species AFM, (2006). It involves the aspects of observation, recording and interpretation of the timing of their life history events of plants. Phenotypes are the visible characteristics of an organism resulting from the interaction between genetic makeup and environmental factors. These have impact on the physiological processes such as photosynthesis and final response of tree growth which can either be vigorous or stunted (Atiku et al., 2020).

Human needs that totally depend on forest are insatiable, very complex and diverse Okunomo, (2010). It is therefore necessary to preserve the earth ecological heritage and balance in order to support life system. The easiest way to protect land against further degradation is by planting trees and grasses and sand-filing with earth where necessary Atiku et al., (2014). Indigenous species are neglected in most African countries due to their slow growth, but were found more resistant and adapted to local environmental conditions than the exotic ones. They are also more integrated with the socio-cultural values of communities Udofia et al., (2011). The exotic species give wider spectrum of trees suited to the study site, they are not affected by natural pest and they grow faster than the indigenous trees, but they can be associated with problems of seed availability, soil moisture, humidity, wind or daily temperature changes Atiku et al., (2014). To combat these menaces, policy makers should have information on the growth performance and productivity of the tree species. Information on these phenological behavior is also necessary to adjust national policies that may directly or indirectly retards the degradation of the environment (Atiku et al., 2011).

Seedlings are very important for raising trees for plantations in forestry (Oludotun, 2011). Forest trees essentially support life on earth by absorbing carbon dioxide and releasing oxygen, thereby maintaining balance in the gaseous atmosphere and also in completion of hydrological cycle to cause rainfall. Forest plantation contribute directly to the reduction of poverty level, by proving jobs opportunities and alleviating hunger and increase the income generation to the local communities (Laba et al., 2008). Forests are sources of food, medicine, timber and many other products (Atiku et al., 2011). They play protective roles against soil erosion, drought, floods, intense radiation etc. Forest also performs accessory functions which include the role of forests in recreation, aesthetics and as habitat of diverse wildlife (Oludotun, 2011).

It is based on above importance of forests that the United Nations mandated that 25% of the surface area of every country should be conserved under permanent forest cover as the minimum ecological requirement for the socio-economic survival of the country. It is in compliance with the above mandate that plantation forest and natural forest reserves are found in different countries of the world Forest resource increasingly constitutes a significant element in the national economy of many countries. Research on the growth parameter of the selected trees species would provide requisite information that will assist in knowing which among the selected trees species have a vigorous and robust growth, so that when planning to establish a plantation, such selected trees can be used (Groninga et al. 2012).

Materials and Methods

The Study Area

The study was conducted at the newly established mini plantation very closed to Division of General Studies, Kebbi State University of Science and Technology, Aliero, Kebbi State. The study site is located on approximately latitudes 11° 03'N, 12° 47'N and longitudes 3° 6'E and

4° 27'E north-western part of Nigeria. Aliero local government has a total area of 412square kilometers; it is bordered in east by Tambuwal local government, Sokoto state. In the northwest by Birnin Kebbi local government area and in southwest by Jega local government area of Kebbi state.

Topography, Vegetation and Climatic Conditions

Aliero local government is dominated by massive flood plains of the in-land river valley system. Thus, it is typically having a flat but undulating elevation of about 150m in the flood plains. The alluvial sediment in the flood plains ranges from gravel to clay level, this is the part which gets saturated during the rains, to store water in the sand for dry season use. The geology of Aliero local government is characterized by thick sedimentary deposits from the Sokoto-Rima River Basin. It is also under laid by pre-Cambrian basement rocks (Singh, 2013).

Natural vegetation consists of Sudan savannah type characterized by open woodland with scattered trees such as *Adansonia digitata*, *Vitalaria paradoxa*, *Acacia nilotica*, *Azadirachta indica* and *Manginefera indica*. Aliero local government area enjoys a tropical climatic condition, generally characterize by wet and dry season. The rainfall begins in June with the heaviest rainfall recorded in the month of August and September. The cold hamattan periods characterized by dust laden wind which prevails in the month of November to January, while the month of February and March are extremely hot. The mean annual temperature varies considerable but usually stand at 42° C. The mean annual rainfall is 500 mm (Singh, 2013).

Sampling Procedure

The seedlings were raised in the Forest Nursery of Kebbi state University for about three months, from January to March 2023 and had been watered once daily. They were later transplanted in early April at the Forestry Mini Plantation in the Division of General studies, Kebbi State University of Science and Technology Aliero. They were irrigated before the onset of the rainy season in May and June. The seedlings include: T1= *Eucalyptus camaldulesis*, T2 = *Diospyros mespilifomis*, T3 = *Tamarindus indica*, T4 = *Mangifera indica*, T5 = *Gmelena aborea*, T6 = *Khaya senegalensis*, T7 = *Annona senegalensis*, T8 = *Acacia nilotica*, T9 = *Detarium microcarpum*. The treatments were laid down in a Complete Randomized Block Design (CRBD). All the nine species were replicated four times with the fifth as control and the mean values were collected from the treatments.

Data Collection

Data was collected at the end of every month from three months in June, July, and August on the following parameters:

- Tree heights by measuring tape
- Collar diameter by the use of Vernier caliper
- Number of Leaves and branches by counting

Data Analysis

The data were analyzed using Descriptive Statistics and one-way analysis of variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS) 15.0 software (SAS, 2013). Mean separation was carried out at 5% level of significance using the Duncan's multiple range test (DMR T) as in (Udofia et al., 2011).

Results

Results of the study were presented in tables 1, 2, and 3. Table 1 below presents the findings of the mean phenological and phenotypic characteristics of selected tree species in the month of June. T1 recorded the highest number of branches 5.58 ± 0.47 followed by T6 5.03 ± 0.32 . The results were highly significantly different from records in T7 and T8 which was the lowest 4.13 ± 0.35 . T6 yielded the highest number of leaves 5.33 ± 0.14 closely followed by T5, 5.20 ± 0.19 . the result is significantly different from T8 which has the lowest number of leaves record 3.62 ± 0.44 .

Largest collar diameter was given by T6, 6.89 ± 0.55 which is closely followed T1 6.83 ± 0.72 with no any significant difference as shown (in Table 1). Longest plant height was recorded by T1 $10.83 \pm 0.38 \pm 0.55$ followed by 9.20 ± 0.65 in T6. The shortest plant height was in T7 and T8 with a highly significant difference from the later results 5.23 ± 0.66 .

Table 1. Mean Phenological characteristics of Selected Tree species in the June Month

S/N	Treatments	Number of Branches	Number of Leaves	Collar Diameter	Plant Heights
1	T1	5.58 ± 0.47^a	5.05 ± 0.37^b	6.83 ± 0.72^{bc}	10.38 ± 0.55^b
2	T2	5.01 ± 0.36^a	4.54 ± 0.31^c	3.25 ± 0.82^{abc}	8.43 ± 0.44^{ab}
3	T3	4.70 ± 0.24^b	4.53 ± 0.26^c	2.93 ± 0.24^a	8.20 ± 0.52^{ab}
4	T4	4.33 ± 0.36^a	3.96 ± 0.46^a	2.97 ± 0.19^a	8.03 ± 0.66^a
5	T5	4.46 ± 0.47^{ab}	5.20 ± 0.14^a	5.38 ± 1.12^{ab}	7.93 ± 0.55^{ab}
6	T6	5.03 ± 0.32^a	5.33 ± 0.19^a	6.89 ± 0.55^{bc}	9.20 ± 0.65^{ab}
7	T7	4.13 ± 0.35^c	3.77 ± 0.44^a	2.82 ± 0.19^a	5.23 ± 0.66^a
8	T8	4.13 ± 0.35^c	3.62 ± 0.44^a	2.82 ± 0.19^a	5.23 ± 0.66^a
9	T9	4.33 ± 0.35^c	4.33 ± 0.44^a	2.93 ± 0.19^a	7.93 ± 0.55^{ab}

Key: T1= *Eucalyptus camaldulesis*, T2 = *Diospyros mespilifomis*, T3 = *Tamarindus indica*, T4 = *Mangifera indica*, T5 = *Gmelena aborea*, T6 = *Khaya senegalensis*, T7 = *Annona senegalensis*, T8 = *Acacia nilotica*, T9 = *Detarium microcarpum*.

Table 2 below presents the findings of the mean phenological and phenotypic characteristics of Selected Tree species in the month of July. T1 has the highest number of branches 5.90 ± 0.36 followed with a significant difference by T6 5.58 ± 0.22 . Lowest record of number of leaves that is highly significant was in T8 4.31 ± 0.37 . T6 had the highest number of leaves 5.94 ± 0.25 followed by T1 5.60 ± 0.18 . lowest number of leaves was by T7 4.38 ± 0.36 . Largest collar diameter (Table 2) was found in T6 7.88 ± 0.83 followed by T5 7.27 ± 0.92 . Lowest collar diameter was found in T7 and T8 with 3.22 ± 0.64 and 3.23 ± 0.53 respectively. Longest plant height was by T1 10.78 ± 0.65 followed by T6 with 9.63 ± 0.62 . Shortest tree species was recorded in T8 5.74 ± 0.55 .

Table 2. Mean Phenological characteristics of Selected Tree species in the July Month

S/N	Treatments	Number of Branches	Number of Leaves	Collar Diameter	Plant Heights
1	T1	5.90 ± 0.36^a	5.60 ± 0.18^a	6.98 ± 0.29^{bc}	10.78 ± 0.65^b
2	T2	5.11 ± 0.47^{ab}	4.83 ± 0.21^{ab}	4.28 ± 1.22^{abc}	8.83 ± 0.43^{ab}
3	T3	4.85 ± 0.31^{ab}	5.24 ± 0.12^{ab}	3.59 ± 0.34^b	8.33 ± 0.42^a
4	T4	4.60 ± 0.37^b	4.21 ± 0.39^a	3.25 ± 0.64^b	8.65 ± 0.72^b
5	T5	4.85 ± 0.24^a	5.33 ± 0.14^{bc}	7.29 ± 0.92^c	8.37 ± 0.62^{ab}
6	T6	5.58 ± 0.22^{ab}	5.94 ± 0.25^a	7.88 ± 0.83^{bc}	9.63 ± 0.62^{ab}
7	T7	4.30 ± 0.37^c	4.38 ± 0.36^a	3.22 ± 0.64^b	5.82 ± 0.55^{ab}
8	T8	4.31 ± 0.37^c	4.54 ± 0.45^{ab}	3.23 ± 0.53^b	5.74 ± 0.55^{ab}
9	T9	4.33 ± 0.37^b	4.90 ± 0.39^a	3.25 ± 0.64^b	8.03 ± 0.66^a

Key: T1= *Eucalyptus camaldulesis*, T2 = *Diospyros mespilifomis*, T3 = *Tamarindus indica*, T4 = *Mangifera indica*, T5 = *Gmelena aborea*, T6 = *Khaya senegalensis*, T7 = *Annona senegalensis*, T8 = *Acacia nilotica*, T9 = *Detarium microcarpum*,

Table 3 below presents the findings of the mean phenological and phenotypic characteristics of Selected Tree species in the month of August. T1 still has the highest number of branches in August 6.07 ± 0.47 it was followed by T6 and T5 with 6.03 ± 0.32 and 6.02 ± 0.48 . smallest number of branches per tree was exhibited in T8 4.85 ± 0.38 . T6 has the highest number of leaves 5.98 ± 0.19 closely followed by T5 and T1 with 5.93 ± 0.27 and 5.92 ± 0.37 respectively. Lowest number of leaves (Table 3) was found in T7 4.62 ± 0.45 . Largest collar diameter was in T6 8.21 ± 0.53 followed by T5 with 7.58 ± 0.12 . Smallest collar diameter was found in T7 which is highly significantly different 3.46 ± 0.13 .

Table 3. Mean Phenological and phenotypic characteristics of selected tree species in the August Month

S/N	Treatments	Number of Branches	Number of Leaves	Collar Diameter	Plant Heights
1	T1	6.07 ± 0.47^{ab}	5.92 ± 0.37^{ab}	7.58 ± 0.72^c	11.12 ± 0.56^b
2	T2	4.95 ± 0.36^{ab}	4.90 ± 0.32^a	4.33 ± 0.22^{bc}	9.43 ± 0.62^{ab}
3	T3	5.95 ± 0.23^{ab}	5.52 ± 0.26^{abc}	3.90 ± 0.35^a	9.37 ± 0.42^a
4	T4	4.87 ± 0.37^b	4.71 ± 0.45^{ab}	3.56 ± 0.19^{ab}	9.51 ± 0.65^{ab}
5	T5	6.02 ± 0.48^{ab}	5.93 ± 0.27^{abc}	7.53 ± 0.12^{ab}	8.88 ± 0.72^b
6	T6	6.03 ± 0.32^{ab}	5.98 ± 0.19^{bc}	8.21 ± 0.53^c	10.93 ± 0.66^b
7	T7	4.86 ± 0.38^b	4.62 ± 0.45^{ab}	3.46 ± 0.13^{ab}	6.53 ± 0.65^{ab}
8	T8	4.85 ± 0.36^b	4.85 ± 0.33^a	3.55 ± 0.19^{ab}	6.22 ± 0.65^{ab}
9	T9	4.87 ± 0.38^b	5.44 ± 0.45^{ab}	3.56 ± 0.17^{ab}	9.51 ± 0.75^{ab}

Key: T1= *Eucalyptus camaldulesis*, T2 = *Diospyros mespilifomis*, T3 = *Tamarindus indica*, T4 = *Mangifera indica*, T5 = *Gmelena aborea*, T6 = *Khaya senegalensis*, T7 = *Annona senegalensis*, T8 = *Acacia nilotica*, T9 = *Detarium microcarpum*,

Discussion

From the results obtained inferences can be made as follows:

Number of Branches per Plant: There was significant difference ($P \leq 0.05$) on number of branches per plant between all the treatments of the study. T1 has the highest number of branches in June, July and August. While T7 has the lowest number of branches per plant in June and July. But in August T8 was the lowest. These results were confirmed in a similar study by Atiku et al., (2020) and Annona and Kunii (1985). The study reveals an improvement in the growth of T7 which was initially having the lowest branches in June and July but had more branches than T8 in August.

Number of Leaves per Plant: T6 had the highest number of leaves in June, July and August. While T8 had the lowest number of leaves per plant in June but T7 had the lowest in July and August. The study indicates that even though T7 had the highest number of branches, it has lower leaves per plant from the results of the study. There was no significant difference ($P > 0.05$) on the number of leaves between T2 and T8 in August. The study was in conformity with the findings in Atiku et al., (2020). It also shows an improvement in T8 because it has the lowest number of leaves in June but in July and August it has more leaves than T7.

Adaptation of *Khaya senegalensis* to the environment was the main reason for it to have recorded the highest number of leaves, because it is a fast growing exotic species (Anono and Kunii, 1985). A tree model is discussed that maximizes total leaf area while varying the

branching geometry Gregg and Dix (2001). The timing and duration of bud burst, leaf expansion, maturity, senescence and fall of individual leaves are all crucial to the fitness of plants (Fener, 1996).

Collar Diameter: From the results of this study, T6 has the largest collar diameter per plant in June, July and August. T7 and T8 were the lowest in July having the same result, but in July and August T7 has the lowest collar diameter. The mean collar diameter was significantly lower ($P \leq 0.05$) in T8 than T1 and T6 which were significantly similar ($P > 0.05$). According to Orwa et al., (2009), *Khaya senegalensis* is a good source of fire wood and timber, the wood is very strong, with high fungi and termite resistance. It is used for construction purpose, furniture, wood carvings, floors, stamping, blocks, pestles and walking sticks (Ball et al., 2007; Okunnono, 2010; Gregg and Dix, 2001).

Plant heights: There was no significant different ($P > 0.05$) between T1 and T6 in mean tree heights. Highest plant was recorded in T1 in June, July and August. There was no significant difference ($P > 0.05$) in mean plant height between all the treatments except T1 and T6 which were significantly higher than all other treatments in June July and August. The shortest treatments in June were T7 and T8 in June but in July and August T8 was the shortest. This indicates that T1 and T6 can easily adapt to low rainfall condition and to some extent can be resistant to diseases and insect attacks in related research by Atiku et al., (2011). This indicates that the exotic tree species were more vibrant form the results of the study. Akinyele (2007) reported a similar scenario where significant effect of light intensity at 50,75 and 100% on *Buchholzia corriacea* seedlings for diameter, leaf numbers and height.

Summary, Conclusions and Recommendations

Summary

The study conducted analyzed the mean phenological and phenotypic growth characteristics of seedlings of the selected tree species between the months of June to August. T1 was the highest followed by T6 in number of branches per plant. But they are closely followed by T5 and T3 and there was no any significant difference between them in August. T6 was the highest in number of leaves followed by T1 but T3 and T9 also shows prominence in their number of leaves per plant in August. T1 was the highest from the results obtained where as T1 has a better bole due to highest collar diameter in August. T4 and T5 has indicated a better plant height in August. There was improvement in T5 on collar diameter growth in August. Based on these findings, it was recommended that *Khaya senegalensis*, *Eucalyptus camaldulensis* from the exotic species and *Mangifera indica* and *Detarium microcarpa* from the indigenous species are good for establishment of tree plantation in Aliero local area due to their ability to grow with little amount of rainfall.

Conclusion

The results obtained in the study conducted has shown that from the seedlings of the selected trees species, *Khaya senegalensis* and *Eucalyptus camaldulensis* easily adapt to the local environment, and has a better growth with low rainfall condition in Aliero Local Government. The results also indicate that *Mangifera indica* and *Detarium microcarpa* are among the indigenous trees that can grow well and can be used for establishment of tree plantation in the study area.

Recommendations

1. *Eucalyptus camaldulensis* and *Khaya senegalensis* should be grown in Aliero local government area. These two species are the fast growing trees species because they can grow

with little amount of rainfall and they can also be used for productive role in timber and protective roles against soil erosion, drought, floods, and intense radiation etc

2. *Mangifera indica* and *Detarium microcarpa* can be used for establishment of tree plantations they can serve protective roles as wind-break and shelter belts, they can be a major source of fuel wood and can also be used as timber for furniture, construction works etc

3. The Government should encourage the use of *Khaya senegalensis*, *Eucalyptus camaldulensis* *Detarium microcarpa* and *Mangifera indica* by saw millers, furniture makers and carpenters. *Eucalyptus camaldulensis* wood is very strong and can be used for construction purpose, poles and walking sticks.

4. This type of studies should be encouraged so that many promising species can be identified from both indigenous and exotic species.

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