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PRELIMINARY STUDY ON EFFECTS OF DIFFERENT PLANTING DEPTH ON THE GROWTH POTENTIALS OF *VITELLARIA PARADOXA* C. F. GAERTN

Asinwa, I. O., Agbeja, A. O., Ojo, P. A and Ogundana, S. A.

Forestry Research Institute of Nigeria. P.M.B, 5054, Ibadan, Nigeria

* Corresponding author: israelasinwa@gmail.com /asinwa.io@frin.gov.ng / 08056953507

Abstract

Plantation establishment of tree crops requires appropriate planting techniques, management of air, moisture and nutrient interaction in the soil. Proper planting of tree seedlings will eventually enhance growth of trees. This study, therefore, investigated effects of different planting depths on the growth potential of *Vitellaria paradoxa*. Twelve months old uniform seedlings of *V. paradoxa* were planted at different planting depths in Forestry Research Institute of Nigeria. The study consisted of five treatments of varying planting depth in Completely Randomized Design and replicated eight times at espacement of 5 m by 5 m. Seedlings heights, girth, numbers of branches and canopy widths were assessed monthly for 24 months. Data collected were subjected to descriptive analysis and Analysis of Variance (ANOVA). Analysis of Variance showed that there was significant difference ($P < 0.05$) among the planting depths in canopy width but no significant difference in shoots height, number of branches, and the girth. The highest mean shoot height (80.33 cm) was recorded for T_3 (25 x 15 cm) while T_1 (15 x 15 cm) had the least values of 55.8 cm. The number of branches and canopy width revealed that T_3 had the highest mean value (7.75) and (102.55 cm) respectively. *V. paradoxa* utilized plethora mechanism to acquire sufficient and required amounts of mineral nutrients for proper growth and development. It is, therefore, recommended that for appropriate growth potential of *V. paradoxa* on the field and its stability in the soil, the planting depth must not lower than 20 cm.

Keywords: Plantation establishment, Growth potential, *V. paradoxa*, Planting depth.

1. Introduction

The Shea butter tree (*Vitellaria paradoxa* C.F Gaertn) which belongs to the family *Sapotaceae* grows widely in the savannah region of West African countries (Hall *et al.*, 1996). It is a deciduous dicotyledonous crop that has a gestation period varying from 15 to 20 years. It takes about 45 years to attain maturity but after this, it may continually produce Shea nuts for up to 200 years. The matured trees vary considerably in height with some reaching a height of over 14 m and a girth over 1.75 m (Yidana, 1994). It is recognized as a non-traditional export crop. The Shea tree is of high economic importance with high value attributed to its butter, obtained from dried Shea nuts, which is a ready source of fat in local diets (Lamien *et al*., 2007). Boffa (1999) described the butter to have characteristics similar to that of cocoa butter. It's use as a cocoa butter equivalent (CBE) in the manufacture of confectionery and as an important ingredient in pharmaceutical and cosmetic industries has greatly increased its global demand. It is appreciated for its skin healing and protective properties (Schreckenberg, 2004; Popoola and Norbert, 2001). Naturally, Shea tree grows and regenerates itself in the wild but it's slow and poor natural regeneration pattern due to long gestation period, impacts of bush fires and desertification have limited the domestication and genetic improvement of this crop. These limitations have necessitated the need for an alternative method of conserving this plants genetic resource outside the natural habitat (Bonkoungou, 2005).

Plantation establishment of tree crops require appropriate management of air and moisture interaction in the soil. This air and moisture relationship is dependent on proper planting of seedlings on the field. Proper planting of tree seedlings will eventually enhance growth of trees. AccordingHartmann*et al*. (1997) there are some factors that contribute to poor establishment of planted seedlings; planting too deep or shallow, under watering, over watering and over-mulching. Planting too deeply in compacted soil can lead to very slow root development and each of the above factors can lead to extensive tree death and poor growth after planting. If trees are thereby planted at the right depth and they are irrigated properly, the planting has a good chance of success. Therefore, in order to have a successful plantation of *Vitellaria paradoxa,* this study investigated the appropriate planting depth that canfavour the species growth potentials.

2. Materials and Methods

The study was carried out at the Forestry Research Institute of Nigeria, Ibadan arboretum. Located on the longitude 07º23'18′′ N to 07º23'43′′N and latitude 03º51'20′′E to 03º23'43′′E (FRIN, 2015). Forty (40) uniform seedlings of *V. paradoxa* (Twelve months old) were collected from the silviculture nursery of FRIN and transplanted to the arboretum on 22nd day of July, 2016.Planting holes of 15 cm width of different depths were dung (Plate 1). The study thereby consisted of five treatments of varying planting depth in Completely Randomized Design and replicated eight times at espacement of 5 m by 5 m.

Where;

Treatments	Depth (cm)	Width (cm)
T_1	15	15
T_2	20	15
T_3	25	15
T_4	30	15
T_5	35	15

The following growth parameters were assessed monthly for twenty four months:

The heights of seedlings were measured from the root collar to apical bud using a graduated ruler. (Plate 1) while the girth of each seedling was measured at about 5 cm above ground level with the use of digital caliper (Plate 2). Numbers of branches produced by each seedling were counted and canopy widths of seedlings were measured with graduated ruler (Plate 3). Data collected were subjected to descriptive analysis and Analysis of Variance (ANOVA).

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Plate 1 Plate 2


Plate 3 Plate 4

Plate 1: Depth and Width Measurement of Planting hole
Plate 2: Measurement of Shoot height with Graduated ruler
Plate 3: Measurement of seedling girth with Caliper
Plate 4: Measurement of Canopy width with Graduated ruler

3. Results and Discussion

Study on growth and development characteristics of tree crops are important information for effective production and management of trees in the field or plantation. The depth at which trees are planted on the field has greater influence on the tree stability, growth and forms. At the end of 24 months of the study, Analysis of Variance showed that there was significant difference among the planting depths in canopy width but no significant difference in shoots height, number of branches, and girth (Table 1). Though, T_3 had the highest mean shoot height (80.33 cm) followed by T_4 (73.98 cm) while T_1 had the least values of 55.8 cm (Fig. 1). This is in consonance with Ruyssen (1957) who observed little variation in shoot height of *V. paradoxa* seedlings when planted at varying planting depth. In contrast, the value obtained for the shoot height within period of study were higher than what was observed (19 cm) by Breman and Kessler (1995) on 2 years old seedlings of *V. paradoxa* on the field in Cot d'Ivoire. The number of branches produced from each treatment revealed that T_3had the highest mean value (7.75) followed by T_1 (5.5) while the least values was recorded for T_2 (2.75) (Fig. 2). The value for canopy width was highest in T_3 (102.55 cm) followed by T_4 (95.98 cm) while T_1 (68.28 cm) was the least (Fig. 3). Figure 4 showed that T_1 (20.89 mm) had the highest girth followed by T_3 (19.68 mm) while the least was recorded for T_5 (15.9 mm).

The highest values of growth variables ascribed to T_3 could be attributed to availability of nutrients at the top soil. According to Morgan and Connolly (2013), growth and development of plants depend on mineral nutrients combination and concentration in the soil. It has been found that due to the relative immobility and restriction of nutrients in the soil at different depths, plants are constrained in obtaining an adequate supply of these nutrients to meet the demands of basic cellular processes (Jone and Ljung, 2012). Meanwhile, deficiency of any one of the nutrients could result in stunted growth or death of plant tissue. Plants are known to show different responses to different nutrient deficiencies and the responses can vary between species For example, soil profile that is deficient in P inhibits primary root growth, increase in lateral root growth and density is associated with N, P, Fe, and S deficiency while increase in root hair growth and density is associated with P and Fe deficiency (Hell and Hillebrand, 2001). Different mineral soil nutrients perform different functions in plant metabolism (Vance, 2001). Two classes of nutrients are considered essential for plants: macronutrients and micronutrients. Macronutrients are the building blocks of crucial cellular components like proteins and nucleic acids; as the name suggests, they are required in large quantities. Nitrogen, phosphorus, magnesium, and potassium are some of the most important macronutrients. Carbon, hydrogen, and oxygen are also considered macronutrients as they are required in large quantities to build the larger organic molecules of the cell; however, they represent the non-mineral class of macronutrients. These are commonly available in top and sub soil which ranges from 0 – 30 cm soil depth (Asinwa, 2018, Oyelowo, 2014).

Invariably, plant roots within this soil profile accessed more mineral nutrients for morphological developments. This implies that statistical difference in canopy formation and variation in mean growth of other parameters could be attributed to the efficiency of nutrient acquisition (Ferguson, 2010). For instance, the chemistry and composition of certain soils at certain level can make it harder for plants to absorb nutrients. The nutrients may not be available in certain soil depth, or may be present in forms that the plants cannot use. Soil properties like water content, pH, and compaction may worsen these problems. Also, some plants possess mechanisms or structural features that provide advantages when growing in certain types of nutrient limited soil depths. In fact, most plants have evolved nutrient uptake mechanisms that are adapted to their native soils and are initiated in an attempt to overcome nutrient limitations (Britto and Kronzucker, 2008). One of the most universal adaptations to nutrient-limited soil depths is a change in root structure that may increase the overall surface area of the root to increase nutrient acquisition or may increase elongation of the root system to access new nutrient sources (Britto and Kronzucker, 2008). These changes which are subjective to plant development can lead to an increase in the allocation of resources to overall root growth, thus resulting in greater root to shoot ratios in nutrient-limited plants (Lopez-Bucio, 2003).

Table 1: Analysis of Variance (ANOVA) for different Planting Depth on Growth Variables of *Vitellaria Paradoxa* within 24 months of study

Variables	SV	df	SS	MS	F-cal	P-val.
Shoot Height (cm)	Treatments	4	2176.560	544.140	0.649	0.631^{ns}
	Error	35	29340.120	838.289		
	Total	39	31516.680			

Number of Branches	Treatments	4	17.600	4.400	0.755	0.562^{ns}
	Error	35	204.000	5.829		
	Total	39	221.600			
Canopy Width (cm)	Treatments	4	8900.026	2225.007	4.200	0.007*
	Error	35	18542.498	529.786		
	Total	39	27442.524			
Girth (mm)	Treatments	4	234.803	58.701	0.791	0.539^{ns}
	Error	35	2597.297	74.208		
	Total	39	2832.100			

*****=significant at P<0.05
ns =not significant at P>0.05

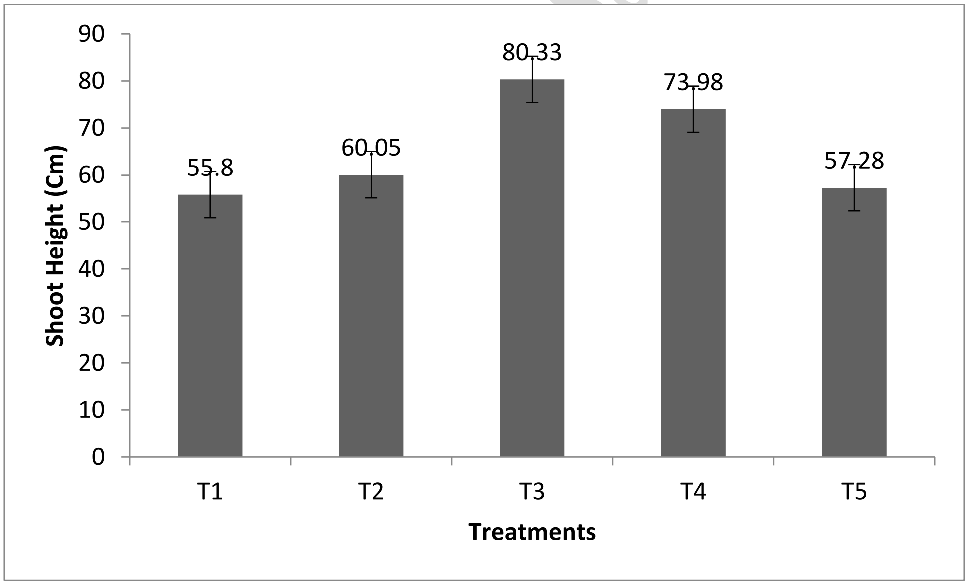

Fig 1: Mean Shoot height of *Vitellaria paradoxa* within 24 months of study

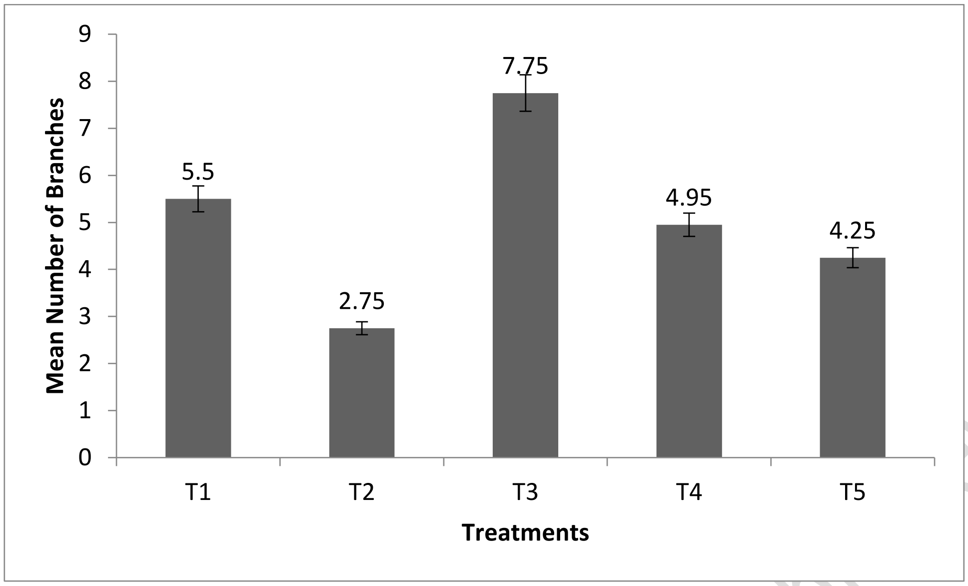

Fig 2: Mean Number of Branches of *Vitellaria paradoxa* within 24 months of study

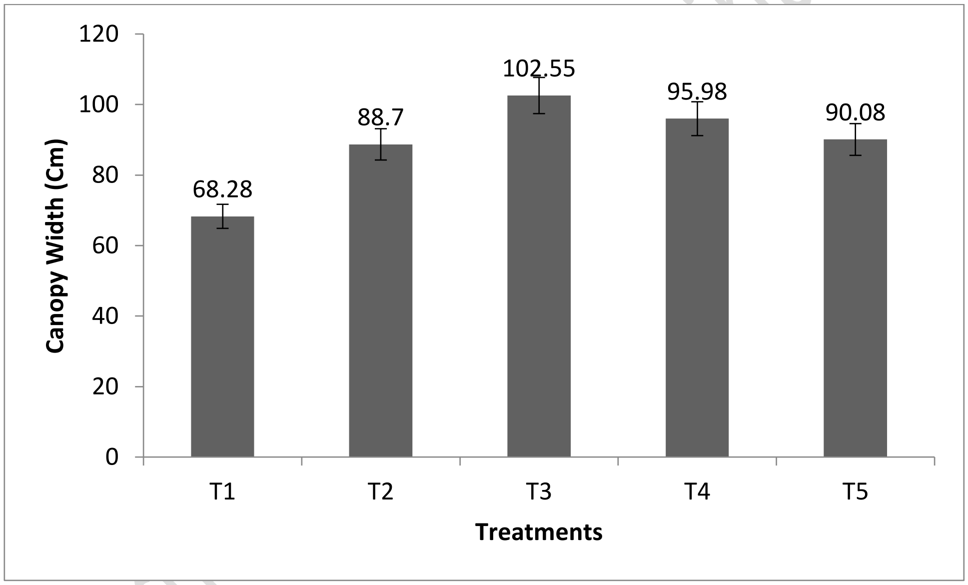

Fig 3: Mean Canopy Width of *Vitellaria paradoxa* within 24 months of study

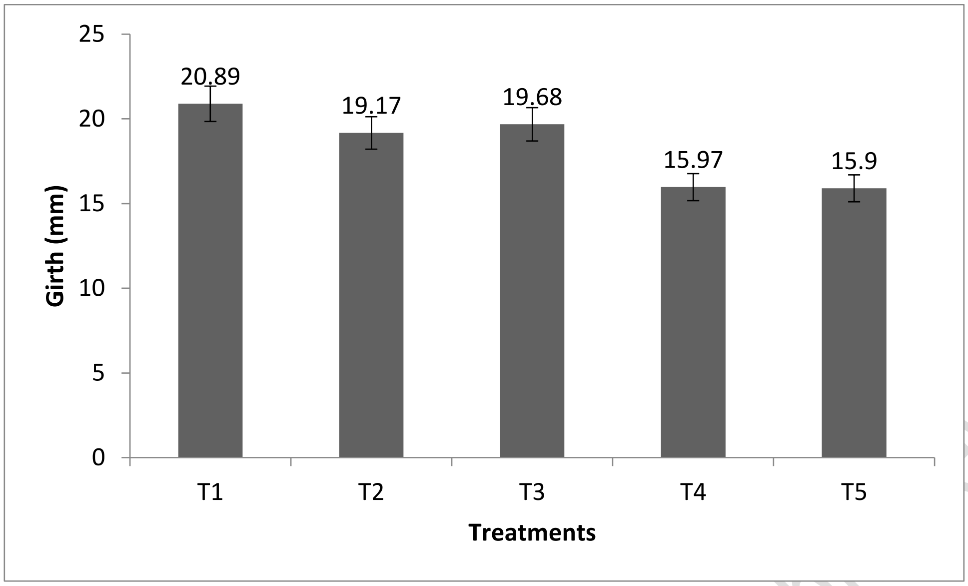

Fig 4: Mean Girth of *Vitellaria paradoxa* within 24 months of study

4. Conclusion

It could be inferred from the study that *V. paradoxa* utilized plethora mechanism to establish itself at various depth the species was subjected to. This potentials enabled the species to acquire sufficient and required amounts of mineral nutrients for proper growth and development. The soil depth profile of 25 cm with highest mean values of growth parameters suggests that the planting depth for the species must be within the range of 20 – 30 cm. Most especially for the vigorous seedlings of *V. paradoxa* that are at least 12 months old. Therefore, for appropriate growth potential of *V. paradoxa* on the field and its stability in the soil, the planting depth must not lower than 20 cm having considered various levels of root flare.

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