GROWTH ASSESSMENT, PROCESSING AND USES OF *VITELLARIA PARADOXA* C.F. GAERTN

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ABSTRACT

*The shea tree (Vitellaria paradoxa C.F. Gaertn) is a multi-purpose tree daily used by rural African communities. A field experiment was carried out to investigate the provenance germination trial of shea tree and its early growth. The study was laid out in a 3 x 4 factorial experiment in a completely randomized design (CRD). The treatment was analyzed with respect to 3 Zones and 4 treatments methods, while growth variable measured were:- germination test, early root length, plant height, number of leaves, leave width and leave length. Correlation analysis was used to access the magnitude and the direction of relationship between the selected variable while the plan height was predicted using linear regression analysis. The result showed that the seeds collected from Akwanga had the highest germination value of 70.09%, followed by 66.95% in Keffi while Lafia had the least value of 64.04%. The result of growth variables revealed that, the average plant height was 4.54±1.46cm, 4.33±1.12 leave count, 3.31±1.07cm leave width while the average leave length was 6.08±1.86cm. However, analysis of variance showed a significant difference in early growth variables assessed at p<0.05. The result of Correlation analysis revealed that there was a significant correlation between leave width and leave length (0.648**). The result of regression analysis on the effects of growth variables on tree plant height had a coefficient of determination (R^2 = 0.769) meaning that the assessed growth variables had about 76.9% effects on plant height of Vitellaria paradoxa seeds. The very slow growth, which has hindered the domestication of the species, can be reversed significantly through the development of modern propagation techniques, which reduces periods of juvenility and the awareness of the need for the conservation of natural plant populations must be created to encourage the local communities to conserve the shea trees.*

KEYS WORDS: Provenance, germination, *Vitellaria paradoxa*, Shea tree, varieties.

INTRODUCTION

The sheabutter tree *(Vitellaria paradoxa* C.F. Gaertn) is a multi-purpose tree daily used by rural African communities. The species belongs to Ebenales order which contains 600 species distributed in 50 genera (Leroy, 1982; Guignard, 1986). The family Sapotaceae to which shea butter belongs contains 25 genera representing 50 species. Botanists, agronomists and farmers have made varietal descriptions using morphological and phonological traits (Chevalier, 1943; Okullo *et al.*, 2004; Diarrassouba *et al.*, 2007b). They reported that 3 varieties (mangifolium, poissoni and niloticum) are distributed in each specific ecological zone where sheabutter trees grow. According to the authors, mangifolium variety is found notably in the North-Soudanian zone in Mali, in Côte d'Ivoire and in Burkina Faso. The poissoni variety is present in Benin and in Ghana and the niloticum variety in East Africa. Domestication actions undertaken on sheabutter in Ghana and Uganda showed that hand pollination increased the number of fruits set in crosses between trees whilst selfing produced no fruit set. However, all cross-pollinated flowers produced fruits thus confirming that the trees are largely out crossing (Yidana, 1991; Okullo et al., 2003). Since colonial times, little studies have been led on sheabutter varietal description using qualitative traits. It is also difficult to distinguish varieties at the field.

The morphological describers have already been used on other savannas species and different phenotypes have been identified

within *Parkia biglobosa* populations (Ouédraogo, 1995) and within *Deutarium microcarpum* population (Kouyaté and Van Damme, 2002) and on *Andasonia digitata* (Assogbadjo et al 2005; 2006) using fruit shape and other related traits measured on the fruits and the leaves. However, in spite of the knowledge on quantitative and molecular characterization level, little studies have been led on sheabutter varietal description using qualitative traits since colonial times. This present study aimed at investigating the provenance germination trial, growth variation and physiological or morphological traits of the species.

Occurrence of *Vitellaria paradoxa*

The sheabutter tree, *Vitellaria paradoxa Syn. Butrospermum paradoxa* of the family Sapotaceae, is typically a Savanna woodland tree species. Its natural habitat stretches over Africa south of the Savannah, from the eastern part of Senegal to the north of Uganda. This stretch covers an area of over 5,000km long and 400 – 750km wide. In Nigeria the sheabutter tree also occurs in the wild. It thrives well within the Guinea and Savannah areas as well as the lower Sahel regions of the country. The rainfall requirement is 600 – 1,500mm annually. Although the sheabutter tree appears to be a rather obscure wild species, it is widely known, valued and exploited by the natives in all the areas where it occurs. The English call it shea, a vernacular name in Bambara language while the French call it karate, a name given to it in Senegal by Wolofs. It also has vernacular names in many Nigerian tribes: The Ibos call it okwuma: Yorubas call it orioyo while the Hausas call it marke. In the traditional farming systems of its areas of occurrence, the sheabutter tree grows wild in the field with arable crops, and is subjected to the annual rituals of bush burning, thus giving the tree the characteristic dark rough appearance of the trunk.

Biology of *Vitellaria paradoxa*

The sheabutter is a big tree, 10 – 15m tall, that can reach 25m. The trunk diameter at height of 1 meter scarcely exceeds 1 meter. It is a deciduous tree, with simple leaves grouped in 20 – 30 leaves at the end of each branch. The inflorescence is composed of several flowers grouped at the axile of each leaf. The number of flowers per inflorescence varies extremely, and can reach 100 or more. Despite the abundance of flowers, only 3 – 5 fruits per inflorescence become ripe. The yield per tree is an average of 15 – 20kg f fruits or 3 – 4kg dry nuts annually. Some individual trees can yield 50 – 100kg of fruits per annum as stated by Diarrassouba *et al,* (2007a). Typically, the fruit consists of fleshly mesocarp with 30 – 40% nut; 811 – 84% kernel/nut and 45 – 50% oil/kernel. The kernel oil is the shea butter. The germination of the shea nut lasts about one month. In favorable environment, phyenological germination takes place within 7 – 10 days. Its growth is very slow and seedlings take 2 – 3 years to reach field planting. The juvenile stage of shea tree lasts very long, 15 – 20 years, hence the difficulty in its domestication. Flowering starts at about the age of 20 years and production reaches maturity at the age of 40 – 50 years. The shea tree can live for more than 200 years (Diarrassouba *et al,* 2007a) (Plate 1).

a. *b.*

Plate 1a: The shea tree *(Vitellaria paradoxa*), a multi-purpose tree
Plate 1b: Team collecting fruits of *Vitellaria paradoxa*

Processing of *Vitellaria paradoxa*

The shea nut is processed primarily through the traditional methods. It is a major occupation of women in some communities especially within the Guinea and Savannah areas as well as the lower Sahel regions of the Nigeria. The traditional method of processing involves minimum mechanical input, heavy drudgery and high input of firewood. It involves heating and kneading the crushed kernels and straining the resultant oil mass. The shea butter thus produced is considered unsuitable for export, because it is difficult and expensive to store as it deteriorates very rapidly. Locally produced shea butter is consumed locally, fetching very low price for the farmer. Export trade is on dry nuts. Local methods of processing deplete the shea tree population, which serves as the main source of wood fuel. It possesses a serious threat to the conservation of natural wood tree species.

Uses of *Vitellaria paradoxa*

Shea has multiple uses. The fruit contains sweet edible fleshly pulp or mesocarp, which is locally consumed like mangoes and other wild seasonal fruits. The trunk bark and cortex, the roots and leaves are all used for preparation of many traditional medicinal remedies. The trunk of shea makes excellent charcoal. It is the favoured sources of wood fuel. The butter extracted from the almonds contained in the kernels is the main economic product of the shea. It is a mixture of fasts and latex. It is locally used in traditional medicines and cosmetics. It is medicinal product of the shea. It is a mixture of fats and latex. It is locally used in traditional medicines and cosmetics. It medicinal uses include protection of the skin against harsh weather; wound healing, cure of superficial skin irritations and sore muscles. These uses have long been recognized by pharmacologists and nutritional chemists in Europe. Export trade on shea developed long, since in colonial times. It is used as valuable addition to moisturizers, creams, shampoos and soaps. The high linoleic acid content of shea butter makes it ideal remedy against dry skin, dermatitis, sunburn, redness, chapping and eczema. The shea butter has close similarity to cocoa butter; it is used as substitute to cocoa butter in the manufacture of chocolates and pastries Diarrassouba, *et al.* 2007b.

The West African annual production of shea nut in years of good crops is estimated at about 600,000 metric tons of dry nuts based on traded volume. These estimates are however less than actual production since the quantities of nuts not collected from the wild and those consumed locally are excluded from these estimates. Nigerian accounts for over 50% of the West African production. The Central Bank Annual Report of 1998 and the Oil Seeds Association of Nigeria (OSAN) report of 1997, shows that Nigeria produces rather significant quantities of shea nut

annually. The production level, which was recorded as 373,000 metric tons for dry nuts in 1997 had remained stable since 1991 (CBN,1998). The revenue earned from shea nut during 1995 (N3,580b) was higher than those earned from soybeans (N3.120b), cottonseed (N2.156b) and sesame seed (N3.480b) during the same year in Nigeria. The shea tree is a crop of great potentials and with improved technologies and popularization; the present level of production will definitely be surpassed.

Materials and Methods

This experiment was carried out at the Faculty of Agriculture, Lafia, (08^0 35'N, 08^0 33'E), located in the Guinea Savannah zone of North Central Nigeria at an altitude of about 177m above the sea level. The mean monthly maximum temperature range is between 35.06^0C to 36.40^0C and 20.16^0C to 20.50^0C respectively while the mean monthly relative humidity and rainfall are 74.67% and 168.90mm respectively. Two thousand four hundred (2400) polythene pots were purchased from the Ministry of Environment Lafia and the pots were perforated at the base to allow movement of water and aeration. Soil is a medium for plant growths; it serves as nutrient for plant uptake and maintenance of physiological function. For this study, top soil, river sand and poultry manure were collected and mixed properly in the ratio 2:1:1 respectively, it was then used to fill the polythene pots of size (6 x 9) inches, which serves as planting medium for raising the *Vitellaria p.* seedlings (Plate 2a). The *Vitellaria paradoxa* seeds were collected from three (3) different locations namely: Akwanga; Keffi and Lafia.

Plate 2: Layout of the experimental site about $60m^2$

Seed Collection and Processing

The seeds were picked from plus trees (with desirable characteristics) of *Vitellaria paradoxa*. A total of number 2400 seeds were collected, 80 from each of the various location (Table 1). The fruits collected were soaked in water for three (3) days so as to ease de-pulping of the seeds. Seeds were extracted manually by removing the pulp covering the seeds and after that, the seeds were subjected to different treatment. Planting was done two weeks after incorporation of organic manure into the soil.

Table 1: The coordinate of experimental field where seeds were collected (Akwanga, Keffi and Lafia Zones).

		Co-ordinate		
S/n	Location	Longitude	Latitude	Elevation
1	Akwanga	8.928	8.407	450
2	Keffi	8.725	7.830	273
3	Lafia	8.597	8.593	160

Source: (Jayeoba, 2013)

Plate 2: Weighing *Vitellaria paradoxa* seed sensitive weighs Balance

Seed Pretreatment

Seeds were subjected to three different pretreatment during the experimental research, they include:

i **Treatment One (Sundried for 72hrs)**
Six hundred (600) seeds were sun-dried for 72 hours, so as to break or reduce its dormancy. The sun drying lasted for two days, 6 hours per day that is from 10am to 4pm daily.

ii **Treatment Two (Sundry 36hrs and Soaking in water 72hrs)**
Six hundred (600) seeds were sun-dried for 36hours and then soaked in water for 72hrs in order to break its dormancy and improved its germination rate. According to literatures, sun-drying and soaking in water has been found beneficial for rapid germination of *Vitellaria paradoxa* seeds.

iii **Treatment Two (Sundry 72hrs and Soaking in water 72hrs)**
Six hundred (600) seeds were sun-dried for 72hrs and then soaked in water for 72hrs in order to break its dormancy and improved its germination rate.

iv **Treatment Three (Control)**
Six hundred (600) seeds were selected without any treatment to the seeds and kept in open air container. This is serves as control and it is used to check the performance of the other treatments.

The seed were sown inside the pot at 4cm depth. It was sown two seeds per pot, 600 seeds were sown in the pots for treatment I (sundried 72hrs), 600 for treatment II (sundried 36hrs and soaked in water 72hrs), 600 for treatment III (sundried 72hrs and soaked in water 72hrs) and 600 for treatment IV (control). Watering was done in the morning and evening (4) four days, to enable the soil to dissolve properly before the seeds were sown. It also continues after planting was done for another two weeks and after then watering was done only in the evening. Hoeing and hand weeding was carried out in the site so as to reduce competition with the *Vitellaria p.* seedlings for water, sunlight and nutrients. Germination test was carried out on the seeds to determine its viability. The germination test was carried out by sowing the seed in a germination bed. Two thousand four hundred 2400 seeds were sown on the germination bed, germination rate was

observed for about twelve weeks and estimated thus:

% Germination = Number of germinated seeds x 100……1

Number of seed sown

The young seedlings were transplanted into polythene pots at 4 months after planting with 500 seedlings selected from each location. Systematic sampling of 360 tagged seedlings of *Vitellaria paradoxa* was done with 90 seedlings selected from each treatment and measured to determine the growth parameter. Plant height measurement was carried out for-nightly for a period of three months. This was taken in centimeters using the meter rule. Leaf count was carried out monthly. Leaves on selected seedling of all the treatments were counted till the end of the experiment. Root collar girth measurement was done by using thread and ruler taken in centimeters. White thread was placed at the root collar of selected seedling while leaf measurement was done using ruler. This was done forth nightly for three months.

Data Analysis

The study was laid out in a 3 x 4 factorial in a completely randomized design (CRD), resulting to 12 treatment combinations replicated 200 times as described by (Akindele 2004: Adesoye, 2004). Analysis of variance was performed to show the comparative performance of each treatment with another. Duncan's Multiple Range Test (DMRT) was applied to locate where the significant difference occur among the location and treatment in the measured variables. Correlation analysis was used to access the magnitude and the degree of relationship between the selected variable while the plant height of *Vitellaria paradoxa* was predicted using linear regression analysis described by using linear regression thus:

$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \ldots + b_nx_n + \mu$ …….2

Where Y = (dependent variable) the plant height, a = intercept, b_1--b_n, = regression parameters, x_1 ---x_n = independent variables

The coefficient of determination (R^2) and standard error of estimate (mean square error) were determined to know the proportion of variation explain by the regression equation.

RESULTS

The result of the mean values of seed weight on the basis of seed source

The result revealed that, the average weight of the seeds collected with pod was 44.47±1.97g, the highest weight of 49.73±9.35g was observed in the seeds collected from Lafia Zone, this was followed by 49.63±9.55g observed in the seeds collected from Akwanga Zone while the least weight of 35.68±5.26g was observed in Akwanga Zone. The average weight of the seeds without pods was 24.69±3.16g, the highest weight of 26.51±2.87g was observed in the seeds collected from Lafia Zone, this was followed by 26.31±2.88g observed in the seeds collected from Keffi Zone while the least weight of 23.26±3.36g was observed in Lafia Zone (Table 3).

The result of the mean values of seed germination on the basis of seed source and treatment

The result showed that the seeds collected from Akwanga has the highest mean germination value of 70.09±25.70%, followed by 66.95±25.24% in Keffi while Lafia had the least with a mean value of 64.04±22.20%. On the basis of treatment, (Sundry 72hrs & soaked 72hrs) treatment (T3) recorded the highest mean value of 70.23±22.65%, treatment (T2) (Sundry 36hrs and soaked 72hrs) recorded mean value of 69.33±23.65%, followed by treatment (T1) (Sundry 72hrs) with a mean value of 66.61±22.33%, while Control treatment (T4) recorded the least germination with a mean value of 65.14±27.24% (Table 2). The result of the ANOVA for germination test shows that the effect of both seed source and seed treatment method were not significantly

different on the seed germination and finally the interaction of seed source and treatments was not significant on seed germination at $p<0.05$ (Table 2).

The result of growth variables on the basis of seed source and treatment

The result of growth variables revealed that, the average root length was 11.48±3.72cm, the highest root length of 12.76±4.98cm was observed in the seeds collected from Keffi while the least root length 10.25±3.47cm was observed in Lafia Zone. In terms of plant height, the result showed that, the average plant height of *Vitellaria paradoxa* seedlings was 4.54±1.46cm, 4.33±1.12 leave count, 3.31±1.07cm leave width while the average leave length of 6.08±1.86cm (Table 3). However, analysis of variance showed a significant difference in early growth variables assessed as indicated by Duncan Mean Range Test used in separating the mean values at $p<0.05$ (Table 3). The observed growth variations was less in line with less variation observed between shea tree population (Lovett and Haq 2004; Bouvet et al., 2004; Fontaine *et al.*, 2004).

The result of Correlation and regression analysis on growth variables

The result of Correlation analysis revealed that there was a significant correlation between initial weight and leave width (0.392*), between leave width and leave length (0.648**) (Table 4). The result of regression analysis on the effects of growth variables on tree plant height had coefficient of (R^2 = 0.769) meaning that the assessed growth variables had about 76.9% effects on plant height of *Vitellaria paradoxa* seed collected from different locations in Nasarawa State. The result is in line with Afuwape *et al*, 2007(Table 5).

DISCUSSION

The very slow early germination and growth, observed in the seeds of *Vitellaria paradoxa* may be one of the reasons which has hindered the domestication of the species could be due to the hard nature of the seed coat which probably made it to resist early germination. This can be reversed significantly through the development of modern propagation techniques, which reduces periods of juvenility. The result of growth variables revealed that, the average plant height of *Vitellaria paradoxa* seedlings was 4.54±1.46cm, 4.33±1.12 leave count, 3.31±1.07cm leave width while the average leave length of 6.08±1.86cm. However, analysis of variance showed a significant difference in early growth variables assessed at $p<0.05$. The significant effect of seed sources on virtually all the variables measured could be attributed to the fact that the seeds might have inherent climatic traits helped by poultry manure which contains the macro and micronutrients needed for plant growth and development (Brady, 1974). Less variation has been observed between shea tree population (Lovett and Haq 2004; Bouvet *et al.*, 2004; Fontaine *et al.*, 2004).

CONCLUSIONS

This investigation has brought out some morphological descriptors of early growth stage of shea trees. Some phenotypes were distinguished based on the observations made on the plants and leaves. Five growth variables were measured on the basis of the seed sources and treatment method.

RECOMMENDATIONS

To enhance the development *Vitellaria paradoxa,* the following recommendations were made:

i. the application of modern crop husbandry, management practices in the nursery and for field establishment will enhance growth and production
ii. New processing techniques must be developed to ensure that high quality shea butter is produced locally, which will have minimal wood fuel

input. Such technologies would produce shea butter suitable for export, improve the income earnings of local producers; reduce level of dry nut exportation and very importantly, result in the conservation of natural populations of wood trees species.

iii. The awareness of the need for the conservation of natural plant populations must be created to encourage the local communities to conserve the shea trees.

iv. Articulated research projects should be geared towards the achievement of these numerous potentials and prospects identified for the shea tree in the short and medium term (Lovett and Haq, 2004).

v. It is also recommended that further studies be carried out in this agro-ecology on the plant to corroborate these findings.

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Table 2: Mean value and Duncan mean separation value for Germination test on the basis of Seed source, Treatment and Duration

S/N	Source of Variations	Sample size	Mean (%)	% Coefficient of Variation
1.	**Seed source**			
	Akwanga	800	70.09 ± 25.70[a]	36
	Keffi	800	66.95 ± 25.24[a]	37
	Lafia	800	64.04 ± 22.20[a]	34
2.	**Treatment**			
	Sundry (72hrs)	600	66.61 ± 22.33[a]	33
	Sundry36hrs & Soak72hrs	600	69.33 ± 23.65[a]	34
	Sundry73hrs & Soak72hrs	600	70.23 ± 22.65[a]	35
	Control	600	65.14 ± 27.24[a]	41
3.	**Duration**			
	4 weeks	2400	18.00 ± 4.66[a]	25
	6 weeks	2400	47.22 ± 7.42[b]	15
	8 weeks	2400	72.11 ± 5.62[c]	7
	10 weeks	2400	82.55 ± 5.02[cd]	6
	12 weeks	2400	83.11 ± 4.91[cd]	5
	General mean	2400	**68.03 ± 24.16%**	

Figures with the same alphabet in the same column are not significantly different, ns = not significant

Table 3: Mean value of plant Height, leave count, root length and leave width

Zone	Location	Seed with pod (g)	Seed without pod (g)	Root length (cm)	Plant Height (cm)	Number of leaf	Leaf width (cm)	Leave length (cm)
Keffi	T I	44.98±8.12^{a}	24.63±2.8^{a}	12.76±4.9^{a}	4.96±1.5^{a}	4.50±1.51	3.07±0.7^{a}	6.53±1.7^{a}
	T II	44.37±8.99^{a}	24.55±3.1^{a}	10.99±3.6^{ab}	4.25±1.7^{a}	4.30±0.82	2.91±0.9^{ab}	5.79±2.1^{ab}
	T III	45.21±10.99^{a}	26.31±2.9^{ab}	11.26±3.5^{a}	3.65±1.4^{ab}	5.20±1.03	3.67±1.4^{a}	6.02±1.8^{a}
	T IV	44.33±11.36^{a}	23.28±3.4^{c}	11.91±2.3^{a}	4.96±1.5^{a}	4.50±1.50	3.07±0.7^{a}	6.54±1.8^{a}
Akwang	T I	48.30±7.40^{ab}	25.73±2.9^{ab}	11.71±4.4^{a}	4.96±1.5^{a}	4.50±1.50	3.07±0.7^{a}	6.53±1.7^{a}
	T II	49.63±9.55^{ab}	25.80±3.^{ab}	11.76±4.4^{a}	4.25±1.8^{a}	4.40±0.82	2.91±0.9^{ab}	5.69±2.10
	T III	35.68±5.26^{c}	23.55±2.8^{c}	10.98±4.1^{ab}	3.65±1.4^{ab}	4.20±1.03	4.65±1.4^{c}	6.02±1.8^{a}
	T IV	44.47±1.97^{a}	24.69±3.2^{a}	11.48±3.7^{a}	4.54±1.5^{a}	4.33±1.12	3.31±1.0^{a}	6.08±1.9^{a}
Lafia	T I	44.21±10.98^{a}	26.51±2.9^{ab}	10.26±3.5^{ab}	3.65±1.4^{ab}	4.20±1.04	3.65±1.4^{a}	6.02±1.8^{a}
	T II	44.33±11.36^{a}	23.26±3.4^{c}	11.91±2.3^{a}	4.96±1.5^{a}	4.50±1.50	3.07±0.7^{a}	6.53±1.7^{a}
	T III	49.30±7.40^{ab}	25.73±2.9^{ab}	10.71±4.3^{ab}	4.96±1.5^{a}	4.60±1.50	3.17±0.7^{a}	7.53±1.8^{c}
	T IV	49.73±9.35^{ab}	23.80±3.5^{c}	11.76±4.5^{a}	4.25±1.7^{a}	4.30±0.83	2.91±0.9^{ab}	5.69±2.1^{ab}
	GM	**44.47±1.97**	**24.69±3.16**	**11.48±3.72**	**4.54±1.46**	**4.33±1.12**	**3.31±1.07**	**6.08±1.86**

Note: value with the name alphabet along the column are not significant different at P<0.05, TM = Treatment

Table 4: Correction analysis of variable assessed

	Treatment	Location	Initial weight	Seed with pod	Root length	Leaf count	Plant height (cm)	Leaf width	Leave length
Treatment	1								
Location	0.000	1							
Initial weight	0.024	0.535**	1						
Seed with pod	0.082	0.285	0.025	1					
Root length	0.099	0.608**	0.184	0.019	1				
Leaf count	0.009	0.085	0.114	0.290	0.014	1			
Height	0.301*	0.063	0.014	0.117	0.121	0.274	1		
Leaf width	0.343*	0.293	0.392*	0.081	0.028	0.028	0.020	1	
leave length	0.379*	0.023	0.072	0.140	0.204	0.204	0.193	0.648**	1

*= Correlation is significant at the level, ** = Correlation is significant at the 0.01

Table 5: Regression analysis of the variable assessed

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Variable	B	Std. Error	Beta	B	Std. Error
(Constant)	7.644	1.209		6.322	0.000
Zone	0.055	0.072	0.062	0.762	0.448^{ns}
Location	-0.071	0.053	-0.111	-1.337	0.184 ^{ns}
Seed weight with pod	-0.029	0.010	-0.252	-2.931	0.004**
Seed weight without pod	0.078	0.025	0.368	3.159	0.002**
Root length	-0.250	0.068	-0.360	-3.666	0.000**
No of leaf	0.117	0.125	0.102	.931	0.354 ^{ns}
Leaf width (cm)	-0.291	0.101	-0.275	-2.879	0.005**
leave length	-0.082	0.084	-0.102	-0.972	0.333 ^{ns}

Dependent variable = Plant height, P<0.05, ** - highly significant, Ns = not significant, R^2 = 0.769