Correlation and Paths Analysis between Stem Diameter and other Juvenile Growths Traits in Twelve Gum Arabic (*Acacia senegal* (L) Willd) Provenances

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Abstracts: Twelve provenance of *Acacia senegal* were obtained from their natural habitats in Sudan and Sahelian Ecological Zone of Yobe State. The seeds were sown in poly bags and laid out in a Randomized Complete Block Design replicated three times at the main nursery of Rubber Research Institute of Nigeria, Gum Arabic Sub-Station Gashua. Seedling traits were measured and subjected to correlation and paths analysis to ascertain their possible use in *Acacia senegal* future crop improvement programmes. There was positive and highly significant genotypic association between seedlings height, root spread and stem length with stem diameter. Root spread had the highest positive direct effects on stem diameter followed by number of primary branches and stem length. Therefore, since stem diameter is very important to gum production in *Acacia senegal*, the positive and significant association of these traits such as seedling height, stem length, and root spread hold promise in the improvement of gum yield. [Report and opinion 2009;1(6):87-90]. (ISSN 1553-9873).

Keywords: *Acacia senegal* (L) Willd, provenance, seedling traits, genotypic and phenotypic correlation, paths coefficients.

1. Introduction

Nigeria is one of the most naturally endowed nations in the world with 93,700 square kilometers estimated land mass for agriculture including gum arabic (*Acacia senegal* L.Willd).The crop is economically and ecologically important specie. It produces gum, which is highly sought for its multifunctional utilization in industries such as pharmaceutical, beverages, confectionery, textile among others (Bell *et al,*1994; Anderson and Weiping, 1992).The tree improves soil mineral content through symbiosis with rhizobium (Ojiekpon, *et al,*2007) and is among the local woody specie used in agroforestry systems and in desertification control through sand dune stabilization and as wind breaks (Cossalter, 1991).*Acacia senegal* demonstrates great intraspecific variability with respect to gum production(Motlagh *et al*., 2006). Appropriate tapping time is governed by tree age of 5-7years old with a stem diameter of about 5cm and a plant height of 1.2-1.5m depending on management practices (Jamal and Huntsinger, 1993.).Annual yield from young trees may range from 188-286kg (5-7years) from older trees 379-754kg (in about 8-15years) (Hine and Eckman, 1993).

The ultimate goal of *Acacia senegal* breeding is to improve the specie gum quantity and quality. This could be achieved through selection of superior genotypes which is always pursued. Stem diameter is an important trait considered for gum exploitation and is associated with a number of component characters, which in turn are interrelated. As more traits are included in the correlation studies, the inherent association become complex. For this reason, paths analysis becomes necessary. This is because it measures the direct and indirect influence of one variable upon another and permits the separation of relative contribution of different traits to the traits of measured interest.

Correlation and paths analysis, though frequently used in many agricultural crops, has only recently been used in tree crops (Khosla *et al.*, 1985; Siddiqui *et al.*, 1993; Srivastava and Chauhan, 1996; Gera *et al.*, 1999). Abraham *et al,* (2008) observed positive correlation between seedling height and root collar diameter (rp = 0.95 and rg = 1.00) in *Millettia ferruginea*. Similarly, Mahadevan *et al*, (1999) reported higher positive correlation in juvenile diameter with both height and diameter of mature trees in *Casuarina equisetifolia*. Rongling *et al,* (2004) observed dependant relationship that increased stem diameter due to assimilates supplies attributable to both canopy spread and foliage.

Due to long gestation period of trees, the analysis of juvenile growths traits is an important technique to establish the relative importance of different genotype as the determinant for improvement (Chaturvedi and Pandey, 2005). Also Burley and Wood (1978) observed that if good correlations exist between measured traits at different stages of the tree's development, prediction of growth at an advanced age may be possible. The study aims at selection of better plants with higher stem diameter based on correlation with other juvenile growths traits of *Acacia senegal*.

2. Materials and Methods

Acacia senegal germplasm were collected from 12 provenances in Yobe state in 2007, covering the two principal ecological zones of the state with strong evidence of the species. Yusufari and Gashua for sahelian ecology while Damaturu and Gujba represented the sudan ecological zone. The selection criteria were based on the provenance trial recommendations (Burley and Wood, 1978).

The experiment was conducted in the nursery of Rubber Research Institute of Nigeria, Gum Arabic Sub- Station Gashua, located at latitute12^0 46'N, longitude 11^0 00' E and altitude 360m above sea level. Polythene bags measuring 7.5cm X 20cm were filled with a well decomposed potting mixture (2part topsoil: 2 part rivers and 1 part cowdung) and watered once to ease carriage and stacked in a Randomized Complete Block Design (RCBD) in three replications. Each treatment consisted of 30 polythene bags with 30cm X 50cm spacing between treatments and replication respectively. The stacked polypots were watered thoroughly for five days prior to sowing using watering can to soak and stabilize the soil. To enhance vigorous germination and development, pre-germination treatment was done by soaking seeds in tap water for 24hours at room temperature before sowing. 2–3 seeds were sown by hand at a depth of 1cm and were thinned down to one plant per polypot. The nursery was kept weed free throughout the experiment. Data was collected from 5 seedlings taking at random. These include: Emergence count, seedling height (cm), stem length (stem height at first branching) (cm), no of primary branches, canopy spread (cm), root length (cm), root spread (cm), and stem diameter (cm). The correlation and paths analysis were performed as suggested by Singh and Chaudhary (1985).

The correlation coefficients between different pairs of traits were determined at genotypic and phenotypic levels. The path coefficient analysis which is simply a standardized partial regression coefficient which divides the correlation coefficients into direct and indirect contributions of independent variables on the dependent variable (stem diameter) was determined.

3. Results and Discussion

In general, the genotypic correlation coefficient values were higher than corresponding phenotypic values (*Table1*): This could attribute to environmental influence inherent in the phenotypic correlation (Chaturvedi and Pandey, 2005).The genotypic correlation is an estimated value whereas phenotypic correlation is an estimated value from the genotype and environmental interactions. This explains why genotypic correlation is a more reliable estimate for examining the degree of relationship between pairs of character (Chaturvedi and Pandey, 2005).

Emergence count had negative and highly significant genotypic correlations with seedling height, stem length, stem diameter and root length. With number of primary branches, the correlation was positive and highly significant. Seedling height had highly significant genotypic correlation with stem diameter (r=0.968) and canopy spread(r=0.746).The phenotypic level also showed positive and highly significant correlation with stem diameter(r=0.729) and significant correlation with canopy spread(r=0.673).Stem length revealed positive significant genotypic correlation with stem diameter(r=0.660)and canopy spread(r=0.578).This type of relationship implies that stem growths may be as a result of assimilates supplied as influenced by canopy spread and foliage(Rongling *et al,* (2004).Root spread exhibited highly significant genotypic correlation with stem diameter(r=0.975), canopy spread (r=0.903) and root length(r=0.780), whereas only canopy spread showed positive association at the phenotypic level. Three traits, seedling height, canopy spread and root spread present evidence of positive and highly significant genetic correlation with stem diameter whilst two traits, seedling height and canopy spread were positively and highly significantly correlated with stem diameter at phenotypic level. However stem diameter had positive genotypic correlation with all the traits except emergence count, number of primary branches and root length. Such result has also been reported by Chaturvedi and Pandey (2005) in *Bombax ceiba;* Siddiqui *et al* (1993) in *Terminalia specie.* In *Acacia senegal,* one important traits considered for gum exploitation is stem diameter and traits positively and significantly associated with stem diameter such as seedling height, stem length, canopy spread and root spread are therefore of interest to the breeder, since selection of one or more of these traits is likely to improve the gum yield, if such correlation is maintained up to maturity stage of the tree.

This type of result suggests that selection of root spread for stem diameter improvement in *Acacia senegal* may be worthwhile. Stem length at first branching had a direct positive effects on stem diameter and interrelationship(r=1.942 and r=0.660) respectively. Number of primary branches(r=3.505) had direct positive effects but recorded negative indirect effects with most of the other traits. Therefore, direct selection through this trait might be helpful in *Acacia senegal* improvement. The characters such as emergence counts, seedling height and canopy spread, although recorded a significant positive correlation, their direct effects were negative and this is due a higher negative values of the indirect effects of the other traits. In the same vain root spread had a highly significant correlation(r= 0.976) with stem diameter, but its direct effects was about six times the correlation value(r= 6.724) and this was due to the positive indirect effects of canopy spread and stem diameter. The correlation values of emergence count and its direct effects are both negative(r= -0.229 and r= -1.164, respectively).This type of result suggested that for improvement in stem diameter, selection for the emergence count should be increased. Such results are similar to the findings of Jindal, *et al*. (1987) in *Acacia senegal*.

Generally, root spread was identified as an important trait for *Acacia senegal* improvement in this study followed by stem length at first branching. This is due to the fact that apart from their highly significant genotypic and phenotypic correlations, they also had positive direct effects on stem diameter.

Table1: Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficients between eight quantitative growth characters in 3month old *Acacia senegal* seedlings

Characters	Emergence count	Seedling height (cm)	Stem length (cm)	No. of primary branches	Canopy spread (cm)	Root length (cm)	Root spread (cm).	Stem diameter (cm)
Emergence count	1	-0.905	-0.105	0.762**	0.520	-0.922	-0.576	-0.886
Seedling height (cm)	-0.324	1	0.298	0.009	0.747**	0.536	0.551	0.968**
Stem length (cm)	-0.515	0.411	1	-0.652	0.578*	0.405	0.447	0.660*
No. of primary branches	0.426	0.202	0.364	1	-0.254	-0.206	-0.455	-0.229
Canopy spread (cm)	0.427	0.673*	0.344	-0.032	1	0.504	0.904**	0.378
Root length (cm)	-0.179	0.538	0.254	-0.072	0.464	1	0.780**	0.541
Root spread (cm)	-0.475	0.414	0.306	-0.283	0.614*	0.377	1	0.976**
Stem diameter (cm)	-0.385	0.729**	0.338	0.020	0.816**	0.440	0.531	1

*, ** significant at P= 0.05 and 0.01, respectively.

Paths analysis revealed that at the genotypic level root spread had the highest positive direct effects(r=6.724) and greatest contribution with stem diameter (r=0.976) *(table2)*.

Table2**:** Direct (highlighted) and indirect effects of seedling growths traits on stem diameter

Variables	Emergence count	Seedling height (cm)	Stem length (cm)	No. of primary branches	Canopy spread (cm)	Root length (cm)	Root spread (cm)	Genotypic correlation
Emergence count	**-1.164**	0.323	-1.975	2.672	-1.102	4.230	-3.057	-0.886
Seedling height (cm)	1.053	**-0.357**	0.578	0.033	-1.583	-2.459	3.703	0.968**
Stem length (cm)	1.184	-0.106	**1.942**	-2.287	-1.226	-1.856	3.009	0.660*
No. of primary branches	-0.888	-0.003	-1.267	**3.505**	0.538	0.944	-3.057	-0.229
Canopy spread (cm)	-0.605	-0.267	1.122	-0.889	**-2.121**	-2.311	6.077	0.378
Root length (cm)	1.074	-0.192	0.786	-0.721	-1.069	**-4.586**	5.249	0.541
Root spread (cm)	0.670	-0.197	0.869	-1.594	-1.917	-3.580	**6.724**	0.976**

Residual effects = -1.45202

*, ** significant at P= 0.05 and 0.01, respectively.

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