

## Morphological and Wood Anatomical Study on Acacia nilotica (L.) Willd. ex Delile, Grown in Sudan

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## Introduction

□ Acacia nilotica is a multipurpose leguminous species, has an extensive and diverse natural distribution in Sudan. It is valuable mainly for timbers and fuel wood production; other benefits include environmental, tannin production and medicinal attributes. The diversity of site and climatic conditions under which Acacia nilotica grows led to the evolution of an extremely variable species. Thus, the taxonomic history and nomenclature of the species was puzzled. Three subspecies (subspecies nilotica, tomentosa and adstringen) are commonly recognized in Sudan's flora with wide range of distribution. Recently, a new group was identified with an intermediate morphology between subsp. *nilotica* and *tomentosa* and more studies are needed to clarify its taxonomic status. However, with no doubt there is not a complete and clear picture of the pattern of variation within and among Acacia nilotica with it's currently known sub-taxa. □ The overall objective of the present study is to update the taxonomy of Acacia nilotica and understand the level of morphological and anatomical diversity among its subspecies in the Sudan. Therefore, the taxonomic relationships among the three identified subspecies and the new group were studied by analyzing some quantitative and qualitative morphological characteristics at mature and seedling stage. The anatomical characteristics of seedlings among them were also studied using the stereological account technique.





# **Materials and Methods**

## **Materials:**

-Study area included 13 variables sites (Fig. 1). Acacia nilotica sub-taxa were identified by using pods morphological-based key of El Amin (1990).

-100 individuals (dbh<35 cm) were selected for each identified sub-taxa in each sites and used for materials collection (pods, seeds, leaves,...etc.). Methods used:

**Fig.1**: Map of the Sudan showing the study sites. Where: Alde: Aldeisa forest; Saw: Sawlail forest; Alm: Allmbwa forest; AbG: Abu Geili forest; Alden: Aldenaigila forest; Alst: Alsnait forest; Alsu: Alsunt forest; Sha: Shambat area; UmZ: Um Zibil forest; Kli: Klikis natural forest; Ela: El Ain natural forest; Nab: Nabak natural forest; Kadg: Kadogli natural mountainous area.



The results revealed significant variation in all of the studied morphological (Tab.1, 2 & 3) and anatomical (Tab. 4) characteristics among the new group and the three identified subspecies in this study.



#### Tab. 1: Variation in pods morphology

	Genotypes					
Characters	Nilotica	New group	tomentosa	adstringens		
od length (cm)	13.45b (±4.87)	14.92a (±7.45)	12.49c (±2.90)	11.37d (±2.27)		
od width (cm)	1.33d (±0.15)	1.67b (±0.14)	1.35c (±0.15)	1.80a (±0.14)		
od constriction width (cm)	0.25d (±0.11)	0.45b (±0.14)	0.39c (±0.13)	1.59a (±0.70)		
lumber of seeds per pod	10.22b (±2.04)	11.20a (±1.54)	9.51c (±1.87)	9.27d (±1.61)		
od colour	Dark brown or black-shiny	Pale brown to brownish	Grey to greyish	Grey to greyish		
od surface texture	Glabrous-Shiny	Fearly glabrous-Shiny	pubsecent-tomentose	pubsecent-tomentose		

Tab. 2: Variation in seeds morphology

### (1) Morphological data

- Morphological characterization of pods (6 traits) and seeds (10 traits).

- Morphological characterization of mature trees vegetative traits (17 traits).
- Morphological characterization of the seedlings vegetative traits (14 traits).





### (2) Anatomical data.

Examined in seedlings (1 year old) using the stereological count procedure (Ifju et al., 1983; Nasroun, 1978 and Ahmed Mohamed, 2010). Microscopic slides with 5 stained cross-sections (Fig. 2) were prepared using Slide microtome (Fig.4). A twenty five-point grid (4 x 4 cm) was prepared on a transparent paper and used for anatomical counting (Fig. 3) and characterization of vessels, parenchyma, fiber and rays cells.





#### **Fig. 5**: Variation in pods and seeds morphology between Acacia nilotica subspecies and the new group





Fig. 6: Variation in vegetative morphology of adult trees between Acacia nilotica subspecies and the new group





Fig. 7: Variation in seedling early growth morphology between Acacia nilotica subpecies and the new group where: C: the cotyledons; L: the cotyledony leaves.

Characters	Nilotica	New group	tomentosa	adstringens	
Seed length (cm)	0.76d (±0.06)	0.82b (±0.07)	0.78c (±0.07)	0.91a (±0.08)	
Seed width (cm)	0.69b (±0.08)	0.58c (±0.03)	0.59c (±0.06)	0.74a (±0.06)	
Seed thickness (cm)	0.34c (±0.05)	0.35b (±0.05)	0.35b (±0.05)	0.42a (±0.04)	
Seed size (cm)	0.60b (M)	0.58c (M)	0.57d (M)	0. 69a (VL)	
Weight of 100-Seeds (g)	11.49c (±0.83)	11.79b (±0.74)	11.74b (±1.19)	23.31a (±2.36)	
Number of seeds per Kilogram	8741a (±585.76)	8511b (±494.21)	8588b (±757.51)	4332c (±414.94)	
Seed shape index	1.10b (G)	1.34a (Ob)	1.32a (Ob)	1.22b (G)	
Seed colour	Dark brown, shiny	Brownish, shiny	Dark brown, shiny	Dark brown, shiny	
Seed surface texture	Smooth	Smooth	Smooth	Smooth	
Areole shape	Oval	Oblong	Oblong	Ovate & Oblong	

### Tab. 3: Variation in seedlings morphology

	Genotypes							
Characters	Nilotica		New group		tomentosa		adstringens	
	Tow month	One year						
Shoot hight (cm)	12.64b (±1.68)	63.75a (±8.49)	13.08b (±1.14)	66.01a (±5.75)	12.96b (±1.01)	65.42a (±5.08)	12.19b (±1.16)	61.52a (±5.87)
Root length (cm)	10.60b (±1.64)	32.39a (±5.03)	10.12b (±1.31)	30.94a (±4.00)	10.62b (±1.16)	32.46a (±3.54)	9.72b (±0.93)	29.70a (±2.83)
Root colar diameter (cm)	0.43b (±0.07)	0.99a (±0.18)	0.43b (±0.07)	1.02a (±0.13)	0.52b (±0.21)	1.03a (±0.09)	0.54b (±0.16)	0.98a (±0.09)
Number of leaves per stem	7.52b (±1.10)	26.65a (±3.28)	12.09b (±1.72)	39.31a (±4.45)	7.92b (±1.16)	35.12a (±7.67)	7.16b (±0.68)	32.90a (±4.04)
Leaf length (cm)	3.34b (±0.60)	4.12a (±0.78)	4.33a (±1.01)	3.62b (±0.39)	3.58b (±0.80)	4.51a (±0.70)	3.04b (±0.49)	4.05a (±0.47)
Petiole length (cm)	0.86b (±0.09)	1.19a (±0.11)	0.82b (±0.11)	1.24a (±0.15)	0.79b (±0.09)	1.18a (±0.11)	0.79b (±0.08)	1.29a (±0.13)
Number of pinnae (pairs) per leaf	1.95b (±0.43)	2.73a (±0.57)	2.32b (±0.58)	3.1a (±0.46)	2.17b (±0.44)	2.81a (±0.54)	2.05b (±0.38)	2.15a (±0.36)
Pinnae length (cm)	1.51b (±0.21)	2.49a (±0.26)	2.48b (±0.28)	3.07a (±1.69)	2.00b (±0.33)	2.67a (±0.24)	2.22b (±0.33)	3.24a (±0.36)
Pinnae width (cm)	1.16b (±0.22)	1.37a (±0.27)	1.50a (±0.18)	1.28b (±0.16)	1.25a (±0.27)	1.22b (±0.18)	1.11a (±0.13)	1.02b (±0.18)
Number of leaflets (pairs) per pinnae	7.38b (±0.67)	10.13a (±0.94)	8.68b (±0.65)	11.87a (±0.82)	8.10b (±0.70)	11.35a (±4.34)	8.24b (±0.79)	9.43a (±0.85)
Leaflet length (cm)	0.48b (±0.11)	0.57a (±0.08)	0.68a (±0.08)	0.60b (±0.08)	0.51b (±0.05)	0.57a (±0.09)	0.55a (±0.07)	0.51b (±0.09)
Leaflet width (cm)	0.16a (±0.03)	0.14b (±0.03)	0.17a (±0.14)	0.15a (±0.14)	0.16a (±0.04)	0.13b (±0.02)	0.25a (±0.03)	0.26a (±0.05)
Number of stipular spines (pairs) per stem	7.47b (±1.05)	26.64a (±3.28)	12.09b (±1.71)	36.40a (±4.08)	7.76b (±1.13)	34.16a (±7.08)	7.16b (±0.68)	32.42a (±4.27)
Stipular spine length (cm)	0.43b (±0.10)	1.21a (±0.29)	0.67b (±0.08)	1.87a (±0.23)	0.50b (±0.19)	1.40a (±0.52)	0.53b (±0.06)	1.49a (±0.18)

#### Tab. 4: Variation in volume fraction of wood cells (%)

Volume fraction of	Genotypes				
wood cells (%)	Nilotica	tomentosa	New group	Adstringens	
Vessels	28a	24b	24b	21c	
Vessels wall	56c	58c	66b	71a	
Vessels lumen	44a	42a	34b	29c	
Parenchyma	25c	26a	25bc	26a	
Rays	14b	17a	14b	13c	
Fibers	33c	33c	37b	40a	





**Fig. 8**: Variation in seedling anatomy between Acacia nilotica subspecies and the new group of Acacia nilotica where: V: vessels; P: Parenchyma; F: Fiber; R: Rays.

Fig. 4: The 4X4 cm (400 mm<sup>2</sup>) Stereology grid (Stereology area). (1600 mm<sup>2</sup> grid = 0.08166 mm<sup>2</sup> at micro scale)

### (3) Statistical analysis

Mean of morphological and anatomical data were subjected to analysis of variance (one-way, two-way ANOVA) by using GLM procedure (Generalized Linear Model: GLM) calculated using SAS Version 9.0 (Statistical Analysis System) (2002) software. The mean separations were carried out using Duncan's multiple range tests and significance was determined at p < 0.05.



The study concluded that, the subspecies *nilotica*, *tomentosa*, *adstringens* beside the new group are representing the population of *Acacia nilotica* in the Sudan. Morphological and anatomical characteristics of seedlings are taxonomically important as floral one in delineation among the subspecies and the new group of *Acacia nilotica*. Further studies in mature anatomy, cytology and molecular are needed to confirm the taxonomic status of the new group within Acacia nilotica population in the Sudan.

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