

## **Dedication**

This work is dedicated to my family;  
my mother, my wife and beloved children,  
Alaa, Mohamed, Doaa and Muamer.

## **Declaration**

I herewith declare that this thesis is my own work, it has not been accepted in substance for any degree and has not been previously or concurrently submitted for any degree.

Candidate,  
Abdelbasit Elhussien Elmagboul.

## **Acknowledgement**

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## Abstract

This study was carried out to assess the extend of inter-specific variation among and within provenances of *A. tortilis* in seed morphometric characters, seed germination, seed mineral content, seed viability under cold, dry, soil storage conditions in addition to seedlings morphological and physiological characteristics under three irrigation levels.

The seeds were collected from three provenances, White Nile (Elgetiana), Kassala (Halfa Elgadida) and River Nile (Shandi) states, where the association of the two subspecies occurs in their natural habitats.

The seeds traits studied included seed weight, number of seed / kilogram, seed length, width, seed chemical content, germination percentage while seedlings traits among and within three provenances of *Acacia tortilis* subspecies raddiana and spirocarpa were examined. Highly significant differences ( $P \leq 0.0001$ ) were found in seed weight, number/kg, length, thickness, Ca, Mg chemical content and high significant difference ( $p \leq 0.005$ ) in P, Fe and significant differences ( $P \leq 0.04$ ) in K between the provenances. Highly significant differences ( $P \leq 0.0001$ ) were found between the subspecies in seed weight, number/kg length, width, thickness, germination % Ca, K, P content and significant differences ( $P \leq 0.04$ ) in Mg. Germination characteristics were evaluated in the germination room under control environment (light and temperature). The acid pre-treatment showed highly significant variation ( $P \leq 0.0001$ ) in seed germination percentage and the three sulphuric acid durations 20, 30 and 40 minutes improved the germination percentage over the control which showed very low germination percentage compared to treated seeds.

The viability and germination of artificially buried *Acacia tortilis* seeds in soil were studied with purpose of discovering some physio- ecological aspects of seed and evaluating their potential to constitute a soil seed bank. 2000 seeds of both subspecies of the three provenances were buried in soil at 5 cm depth in plastic container in open yard. The provenance did not show significant differences after 6, 12 and 18 month

test time, but the subspecies showed significant differences ( $P \leq 0.003$ ) after 6 month. The result showed that *Acacia tortilis* both subspecies had persistent soil seed banks in the three provenances. The seeds can remain viable in the soil for two rainy seasons and reach its maximum germination after 12 month, but viability started to decline with increasing storage time in soil. In three provenances subspecies *spiocarpa* seed started to germinate more rapidly than subspecies *raddiana* at 6 and 12 month storage time, also declined more rapidly in seed viability than *raddiana*. Both subspecies in the three provenances showed above 54% of decayed seeds from seed buried in soil during 18 month. This indicated that about 54 % of seeds buried in soil loose viability and fail to germinate. From the experiment observation that a proportion of seeds had started to germinate, but the seedlings fail to emerge above soil surface, this may be due to lack of enough moisture and erratic rainfall. The seeds of the three provenances were subjected to cold and dry storage conditions for 18 months, the seeds viability was tested every 6 months. The seeds were treated with electric burner (hot wire) and germinated and compared to control. The treatment showed highly significant differences ( $P \leq 0.0001$ ), but no significant differences were exist between the provenances. The subspecies showed significant differences ( $P \leq 0.03$ ) after 6 months and highly significant differences ( $P \leq 0.0001$ ) after 12 months storage time. The three provenances showed high seed viability in both storage conditions. The dry condition increased seed germinability with increasing storage time in both subspecies of the three provenances. Both subspecies in both storage conditions in three provenances retained high seed viability through 18 months storage time.

The seedlings were subjected to three water regimes. The seedlings root collar diameter, shoot length, root length, number of branch, shoot and root fresh, dry weight and shoot: root ratio was examined to determine the variability between and within the provenances. The water stress treatments caused large differences in seedlings growth leading to high significant differences ( $P \leq 0.0001$ ). The provenances showed high significant differences ( $P \leq 0.01$ ) in root collar diameter,

shoot length and ( $P \leq 0.002$ ) in number of branch. There is highly significant variation ( $p \leq 0.0001$ ) existed between the two subspecies in shoot length, root fresh and dry weight and ( $P \leq 0.0003$ ) in shoot: root ratio. Subspecies *raddiana* River Nile (Shandi) provenances exhibited the longest shoot at twice and once a week (91.03cm) and (72.66cm) respectively, Kassala (Halfa Elgadida) provenance at fortnight (49.17cm). The biggest root collar diameter and high number of branches exhibited by River Nile (Shandi) at once a week irrigation frequency. White Nile (Elgetiana) exhibited the heaviest root fresh and dry weight at twice a week irrigation frequency. Subspecies *spirocarpa*, Kassala (Halfa Elgadida) provenance exhibited the biggest root collar diameter at once and fortnight. River Nile (Shandi) provenance the high number of branches at twice and once a week, the longest root at fortnight and heaviest root fresh and dry weight at once a week irrigation frequency. Seedlings of *Acacia tortilis* representing three geographical origins were tested for drought tolerance. Seeds sources did not varied in their ability to survive drought. The irrigation treatment showed highly significant differences in relative growth rate, leaf relative water content and seedlings mortality % ( $p \leq 0.001$ ), No significant differences exist between the provenances. The subspecies showed highly significant variation in leaf relative water content % ( $p \leq 0.001$ ). Water stress increased leaf relative water content and decreased the seedlings mortality up 14 days than well watered seedlings. Drought preconditioning increased seedlings survival during the final dry- down by about 14 days compared to well- watered. Seedlings that had been preconditioned to drought survived 14 days longer than seedlings that had been well watered before being subjected to drought. Seedlings trait measured did not show clear cut division between the provenances. The results of this study highlight the importance of provenances testing in *Acacia tortilis* dry area. The variation was greater within subspecies than between the provenances, suggesting that selection within subspecies would yield genetic and requirements gain.

The provenances selection criteria of *Acacia tortilis* for particular site should be made according to relative importance of plantation in drylands, on the basis of this study, River Nile (Shandi) Provenance is most suitable one for a range of conditions in terms of their reasonable growth under water stress. The results of this study highlight the importance of provenances and subspecies testing in *Acacia tortilis* dry areas.

