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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# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedication</td>
<td>i</td>
</tr>
<tr>
<td>Declaration</td>
<td>ii</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>iii</td>
</tr>
<tr>
<td>List of contents</td>
<td>v</td>
</tr>
<tr>
<td>List of tables</td>
<td>x</td>
</tr>
<tr>
<td>List of figures</td>
<td>xiv</td>
</tr>
<tr>
<td>List of maps</td>
<td>xvi</td>
</tr>
<tr>
<td>List of plates</td>
<td>xvii</td>
</tr>
<tr>
<td>English Abstract</td>
<td>xviii</td>
</tr>
<tr>
<td>Arabic Abstract</td>
<td>xxii</td>
</tr>
</tbody>
</table>

## Chapter One

### Introduction

1.1 Background                                                      | 1    |
1.2 *Acacia tortilis*                                               | 3    |
1.3 The study area                                                  | 6    |
1.3.1 White Nile (Elgetiana)                                        | 6    |
1.3.2 Kassala (Halfa Elgadida)                                      | 7    |
1.3.3 River Nile (Shandi)                                            | 8    |
1.4 Research problems                                               | 8    |
1.5 Justification                                                   | 9    |
1.6 Main objective                                                  | 9    |
1.7 Specific objectives                                             | 10   |
1.8 Research hypothesis                                             | 10   |
Chapter Two
literature Review

2.1. *Acacia tortilis* ................................................................. 14

2.1.1 Taxonomy and Botanical description ......................................... 14

2.1.1.1 Taxonomy ............................................................... 14

2.1.1.2 Botanical description ..................................................... 14

2.2.1 Subspecies raddiana .......................................................... 15

2.2.2 Subspecies spirocarpa ....................................................... 15

2.2.3 Distribution ................................................................. 15

2.2.4 Site requirement ............................................................ 16

2.2.5 Ecology ................................................................. 16

2.2.6 Cultivation ................................................................. 17

2.2.7 Natural regeneration ....................................................... 17

2.3 Economic importance .......................................................... 18

2.4 Importance of seed characterization ........................................... 18

2.4.1 Seed weight and morphometric characters ................................ 19

2.4.2 Seed size and seed weight patterns ..................................... 19

2.4.3 Seed viability and dormancy ............................................... 21

2.5.1 Seed storage ............................................................... 22

2.5.2 Soil seed banks ........................................................... 24

2.6. Adaptive traits ............................................................. 26

2.6.1 The importance of provenance ......................................... 27

2.6.2 Provenance variation ...................................................... 28

2.6.3 Seeds and seedlings provenance variation ............................ 28
Chapter Three
Variation in seed characteristics, chemical contents and germination of *Acacia tortilis* subspecies raddiana and subspecies spirocarpa

3.1 Introduction

3.2 Material and methods

3.2.1 Seed source

3.2.2 Seed collection

3.2.3 Seed extraction and cleaning

3.2.4 Seed characterisation

3.2.4.1 Seed weight and number of seed/kg

3.2.4.2 Seed parameters (seed length, width and thickness)

3.2.4.3 Germination behaviour

3.2.5 Determination of seed chemical composition

3.2.5.1 Seed chemical characteristics

3.2.5.2 Estimation of total soluble sugars (T.S.S)

3.3 Result

3.3.1 Variation in seed morphometric characteristics

3.3.1.1 Seed weight and number of seed/kg

3.3.2 Seed length, width and thickness

3.3.3 Seed germination

3.3.3 Seed chemical content

3.4 Discussion

Chapter Four
Burial soil storage effects on *Acacia tortilis* seed longevity

4.1 Introduction

4.2 Materials and methods

4.3 Results
Chapter Five

The effect of Cold and Dry Storage on Acacia tortilis Seed Viability

5.1 Introduction

5.2 Materials and methods

5.2.1 Seed storage

5.2.1.1 Cold and dry storage

5.2.2 Seed moisture content

5.3 Results

5.3.1 The effect of cold and dry storage conditions on the seed viability

5.3.1.1 Cold storage

5.3.1.2 Dry storage

5.3.1.3 Seeds behaviour of the two subspecies of the same provenance

5.3.2 Seeds moisture content

5.3.3 Seeds moisture content of the two subspecies of the same provenance

5.4 Discussion

Chapter Six

Effect of watering regimes on growth performance of Acacia tortilis subspecies raddiana and spirocarpa seedlings under nursery conditions

6.1 Introduction

6.2 Materials and methods

6.2.1 Water stress

6.2.2 Seedlings growth traits measurements

6.3 Results
6.3.1 Morphological growth characteristics ................................................. 98
6.3.1.1 Subspecies raddiana ..................................................................... 102
6.3.1.2 Subspecies spirocarpa .................................................................. 106
6.3.2 Variation in morphological growth within subspecies .................... 110
6.4 Discussion ......................................................................................... 115

Chapter Seven

Variation in Acacia tortilis seedlings in relative growth rate, leaf relative water content and mortality under irrigation regimes

7.1 Introduction ...................................................................................... 122
7.2 Materials and methods .................................................................... 123
7.2.1 Relative growth rate (RGR) ............................................................ 123
7.2.2 Leaf relative water content (RWC) ................................................ 124
7.2.3 Seedlings survival (Mortality %) .................................................... 124
7.3 Results ............................................................................................. 125
7.3.1 Variation in relative growth rate .................................................... 125
7.3.2 Variation in leaf relative content ................................................... 128
7.3.2.1 Variation in leaf relative content within provenance ................. 128
7.3.3 Variation in Mortality % ................................................................. 131
7.3.3.1 Mortality % within the subspecies of the same provenance ....... 131
7.4 Discussion ....................................................................................... 135

Chapter Eight

Conclusions and Recommendations

8.1 Conclusions ..................................................................................... 139
8.2 Recommendations .......................................................................... 142

References ........................................................................................... 144

Appendix ............................................................................................... 167
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Seed sources of three provenances of <em>Acacia tortilis</em> subspecies raddiana and spirocarpa used in the study</td>
<td>33</td>
</tr>
<tr>
<td>3.1 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa seed weight and number of seed /kg</td>
<td>42</td>
</tr>
<tr>
<td>3.2 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa seed characteristics</td>
<td>42</td>
</tr>
<tr>
<td>3.3 Variations of the seed characteristics of <em>Acacia tortilis</em> subspecies raddiana and spirocarp from the three provenances</td>
<td>43</td>
</tr>
<tr>
<td>3.4 Variation of the seed characteristics of <em>Acacia tortilis</em> subspecies raddiana and spirocarpa of the same provenance</td>
<td>43</td>
</tr>
<tr>
<td>3.5 ANOVA on seed germination for four weeks</td>
<td>46</td>
</tr>
<tr>
<td>3.6 The effect of sulphuric acid treatment of <em>Acacia tortilis</em> subspecies raddiana and spirocarpa germination percentage from the three provenance</td>
<td>46</td>
</tr>
<tr>
<td>3.7 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa seed mineral contents, (Nitrogen, Protein&amp; Phosphorus)</td>
<td>49</td>
</tr>
<tr>
<td>3.8 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa seed mineral contents (Fe, Ca and Mg)</td>
<td>49</td>
</tr>
<tr>
<td>3.9 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa seed mineral contents (K and Carbohydrate)</td>
<td>49</td>
</tr>
<tr>
<td>3.10 Variation in seed mineral content of <em>Acacia tortilis</em> subspecies raddina and spirocarpa from the three provenances</td>
<td>50</td>
</tr>
<tr>
<td>3.11 Variation in seed mineral contents of <em>Acacia tortilis</em> subspecies raddiana and spirocarpa within the same provenance</td>
<td>50</td>
</tr>
<tr>
<td>4.1 ANOVA on germination of <em>Acacia tortilis</em> subspecies raddiana and spirocarpa buried seeds at 6, 12 and 18 months</td>
<td>61</td>
</tr>
<tr>
<td>4.2 ANOVA on <em>Acacia tortilis</em> subspecies raddiana and spirocarpa buried seeds (lab germinated, rain germinated and decayed seeds)</td>
<td>61</td>
</tr>
</tbody>
</table>
4.3 Variation in germination of soil buried seeds of *Acacia tortilis* subspecies raddiana and spirocarpa from the three provenances for 6, 12 and 18 months .................................................................62

4.4 Variation in germination of soil buried seeds of *Acacia tortilis* subspecies raddiana and spirocarpa within the same provenance for 6, 12 and 18 months .................................................................62

4.5 Variation in soil buried seeds characters of *Acacia tortilis* subspecies raddiana and spirocarpa from the three provenances .................................................................66

4.6 Variation in soil buried seeds characters of *Acacia tortilis* subspecies raddiana and spirocarpa within the same provenance .................................................................66

5.1 ANOVA on the effect of the cold and dry store on *Acacia tortilis* subspecies raddiana and spirocarpa treated and untreated seeds germination % during storage time .................................................................79

5.3 The effect of the cold and dry store on *A. tortilis* subspecies raddiana treated and untreated seeds germination % in the three provenances at 6, 12 and 18 months storage time .................................................................79

5.4 The effect of the cold and dry store on *A. tortilis* subspecies spirocarpa treated and untreated seeds germination % in the three provenances at 6, 12 and 18 months storage time .................................................................80

5.5 The effect of the cold and dry store on *A. tortilis* subspecies raddiana and spirocarpa treated and untreated seeds germination % within same provenance at 6 months storage time .................................................................84

5.6 The effect of the cold and dry store on *A. tortilis* subspecies raddiana and spirocarpa treated and untreated seeds germination % within same provenance at 12 months storage time .................................................................84

5.7 The effect of the cold and dry store on *A. tortilis* subspecies raddiana and spirocarpa treated and untreated seeds germination % within the same provenance at 18 months storage time .................................................................85
5.2 ANOVA on *Acacia tortilis* subspecies raddiana and spirocarpa seed moisture content through test time

5.8 *Acacia tortilis* subspecies raddiana and spirocarpa seeds moisture content during storage time at cold store in three provenances

5.9 *Acacia tortilis* subspecies raddiana and spirocarpa seeds moisture content during storage time at dry store in three provenances

5.10 *Acacia tortilis* subspecies raddiana and spirocarpa seeds moisture content during storage time at cold store within the same provenance

5.11 *Acacia tortilis* subspecies raddiana and spirocarpa seeds moisture content during storage time at dry store within the same provenance

6.1 ANOVA on morphological growth characteristics

6.2 ANOVA on morphological growth characteristics

6.3 ANOVA on morphological growth characteristics

6.4 The effect of irrigation regimes on *A. tortilis* subspecies raddiana seedlings growth performance of the three provenances

6.5 The effect of irrigation regimes on *A. tortilis* subspecies raddiana seedlings growth performance of the three provenances

6.6 The effect of irrigation regimes on *A. tortilis* subspecies spirocarpa seedlings growth performance in the three provenances

6.7 The effect of irrigation regimes on *A. tortilis* subspecies spirocarpa seedlings growth performance fresh and dry weight in the three provenances

6.8 Variation in growth performance between the *A. tortilis* subspecies raddiana and spirocarpa in White Nile provenance in response to irrigation regimes

6.9 Variation in growth performance, fresh and dry weight between the *A. tortilis* subspecies raddiana and spirocarpa in White Nile provenance in response to irrigation regimes

6.10 Variation in growth performance between *A. tortilis* subspecies raddiana and spirocarpa in Kassala provenance in response to irrigation regimes
6.11 Variation in growth performance between *A. tortilis* subspecies raddiana and spirocarpa in Kassala provenance in response to irrigation regimes………..113
6.12 Variation in growth performance between *A. tortilis* subspecies raddiana and spirocarpa in River Nile provenance in response to irrigation regimes ……..114
6.13 Variation in growth performance between *A. tortilis* subspecies raddiana and spirocarpa in River Nile provenance in response to irrigation regimes……..114

7.1 ANOVA on relative growth rate between and within the provenances………..126
7.4 Variation in relative growth rate between *Acacia tortilis* subspecies raddiana and spirocarpa under three irrigation regimes……………………………………..126

7.2 ANOVA on leaf relative water content % among and within the *Acacia tortilis* provenances………………………………………………………………………………129
7.5 Provenances variation in leaf relative water content of *Acacia tortilis* subspecies raddiana and spirocarpa in the three provenances under irrigation regimes ……..129
7.6 Variation in leaf relative water content % of *Acacia tortilis* subspecies raddana and spirocarpa within the same provenance in response to irrigation regimes …………………………………………………………………..130

7.3 ANOVA on mortality % among and within the provenance under three irrigation regimes………………………………………………………………………………133
7.7 Variation in mortality % between provenances of *Acacia tortilis* subspecies raddiana under the effect of three irrigation regimes…………………………134
7.8 Variation in mortality % between provenances of *Acacia tortilis* subspecies spirocarpa under the effect of three irrigation regimes…………………………134
7.9 Variation in mortality % between *Acacia tortilis* subspecies raddina and spirocarpa in response to irrigation regimes in White Nile provenance……..134
7.10 Variation in mortality % between *Acacia tortilis* subspecies raddiana and spirocarpa in response to irrigation regimes in Kassala provenance………..135
7.11 Variation in mortality % between *Acacia tortilis* subspecies raddiana and spirocarpa in response to irrigation regimes in River Nile provenance……..135
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Acacia tortilis subspecies raddiana and spirocarpa seed length among and within provenance</td>
<td>44</td>
</tr>
<tr>
<td>3.2</td>
<td>Acacia tortilis subspecies raddiana and spirocarpa seed width among and within provenance</td>
<td>44</td>
</tr>
<tr>
<td>3.3</td>
<td>Acacia tortilis subspecies raddiana germination behaviour</td>
<td>47</td>
</tr>
<tr>
<td>3.4</td>
<td>Acacia tortilis subspecies spirocarpa germination behaviour</td>
<td>47</td>
</tr>
<tr>
<td>4.1</td>
<td>Acacia tortilis subspecies raddiana buried seeds germination behaviour percent during storage time</td>
<td>63</td>
</tr>
<tr>
<td>4.2</td>
<td>Acacia tortilis subspecies spirocarpa buried seeds germination behaviour percent during storage time</td>
<td>63</td>
</tr>
<tr>
<td>5.1</td>
<td>Acacia tortilis subspecies raddiana seed germination behaviour at cold storage</td>
<td>81</td>
</tr>
<tr>
<td>5.2</td>
<td>Acacia tortilis subspecies raddiana seed germination behaviour at dry storage</td>
<td>81</td>
</tr>
<tr>
<td>5.3</td>
<td>Acacia tortilis subspecies spirocarpa seed germination behaviour at cold storage</td>
<td>82</td>
</tr>
<tr>
<td>5.4</td>
<td>Acacia tortilis subspecies spirocarpa seed germination behaviour at dry storage</td>
<td>82</td>
</tr>
<tr>
<td>6.1</td>
<td>Mean collar diameter of Acacia tortilis subspecies raddiana (White Nile) under different irrigation frequencies</td>
<td>104</td>
</tr>
<tr>
<td>6.2</td>
<td>Mean collar diameter of Acacia tortilis subspecies raddiana (Kassala) under different irrigation frequencies</td>
<td>104</td>
</tr>
<tr>
<td>6.3</td>
<td>Mean collar diameter of Acacia tortilis subspecies raddiana (River Nile) under different irrigation frequencies</td>
<td>104</td>
</tr>
<tr>
<td>6.4</td>
<td>Mean shoot length of Acacia tortilis subspecies raddiana (White Nile) under different irrigation frequencies</td>
<td>105</td>
</tr>
</tbody>
</table>
6.5 Mean shoot length of *Acacia tortilis* subspecies raddiana (Kassala) under different irrigation frequencies .......................................................... 105
6.6 Mean shoot length of *Acacia tortilis* subspecies raddiana (River Nile) under different irrigation frequency .......................................................... 105
6.7 Mean collar diameter of *Acacia tortilis* subspecies spirocarpa (White Nile) under different irrigation frequencies .......................................................... 108
6.8 Mean collar diameter of *Acacia tortilis* subspecies spirocarpa (Kassala) under different irrigation frequencies .......................................................... 108
6.9 Mean collar diameter of *Acacia tortilis* subspecies spirocarpa (River Nile) under different irrigation frequencies .......................................................... 108
6.10 Mean shoot length of *Acacia tortilis* subspecies spirocarpa (White Nile) under different irrigation frequencies .......................................................... 109
6.11 Mean shoot length of *Acacia tortilis* subspecies spirocarpa (Kassala) under different irrigation frequencies .......................................................... 109
6.12 Mean shoot length of *Acacia tortilis* subspecies spirocarpa (River Nile) under different irrigation frequencies .......................................................... 109
7.1 *Acacia tortilis* subspecies raddiana relative growth rate among provenances .................................................................................................. 127
7.2 *Acacia tortilis* subspecies spirocarpa relative growth rate among provenances .................................................................................................. 127
## List of Plates

<table>
<thead>
<tr>
<th>Plate</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 <em>Acacia tortilis</em> subspecies raddiana</td>
<td>11</td>
</tr>
<tr>
<td>1.2 <em>Acacia tortilis</em> subspecies spirocarpa</td>
<td>12</td>
</tr>
</tbody>
</table>
## List of Maps

<table>
<thead>
<tr>
<th>Map</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Approximate ecological range of <em>Acacia tortilis</em> in Sudan in relation to the main soil types</td>
<td>13</td>
</tr>
<tr>
<td>2.1 Map showing the study area</td>
<td>34</td>
</tr>
</tbody>
</table>
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* ≤ 0.0001) were found in seed weight, number/kg, length, thickness, Ca, Mg chemical content and high significant difference (*p* ≤ 0.005) in P, Fe and significant differences (*P* ≤ 0.04) in K between the provenances. Highly significant differences (*P* ≤ 0.0001) were found between the subspecies in seed weight, number/kg length, width, thickness, germination % Ca, K, P content and significant differences (*P* ≤ 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* ≤ 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 spirocarpa 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.