

Break Dormancy of Some Forage Shrubs Seeds by Chemical and Mechanical scarification

Mohamed A. Abd El-Hady*, Mohamed E. El-temsah** and Yasser M. Abd-Elkrem***

Agronomy Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt,

*doctorhady@agr.asu.edu.eg; ** dreltemsah@agr.asu.edu.eg; ***yasser_abdelkareem @agr.asu.edu. eg

Received: 11 Oct. 2020 / Accepted 10 Dec. 2020 / Publication date: 30 Dec. 2020

ABSTRACT

Several laboratory experiments were carried out at room temperature ($26^{\circ}\text{C} \pm 2$) in the Agronomy Department laboratory, Faculty of Agriculture, Ain Shams University (during 2019) to study the chemical and mechanical scarification on seed germination of the range plants species, *Leucaena leucocephala*, *Acacia saligna*, *Acacia arnesiana* and *Acacia victoria*. Results indicated that H_2SO_4 concentrations, soaking times and their interaction were significant effected on all germination of all studied plant species, H_2SO_4 concentration 100% gave the highest values in: - Germination% and seedling fresh weight of *L. leucocephala* – Germination % and seedling fresh weight of *L. leucocephala* – Germination % and plumule & radicle lengths of *A. victoria*. – Plumule length of *A. farnesiana*. – Seedling fresh weight of *A. saligna*. Whilst, 75 % of H_2SO_4 – concentration was recorded the highest values in: - Germination %, radicle length and seedling fresh weight of *A. farnesiana* –Radicle lengths of *A. saligna* – plumule and radicle lengths of *L. leucocephala* seedling fresh weight of *A. victoria*. 25% of H_2SO_4 concentration was recorded the highest values in plumule length of *A. Salina* and seedling fresh weight of *A. victoria*. Results also showed that the soaking time of 10 minutes gave the highest values in radicle length and seedling fresh weight of *L. leucocephala*. Soaking time 20 minutes was recorded the highest values in plumule length of *L. leucocephala* and seedling fresh weight of *A. victoria*. Whilst, soaking time 30 minutes gave the highest values in :- Germination % of four studied plant species.- plumule and radicle lengths of *A. saligna* and *A. victoria* - seedling fresh weight of *A. farnesiana* and Soaking time 40 minutes was recorded the highest values in plumule and radicle lengths of *A. farnesiana* and seedling fresh weight of *A. saligna*. In respect to soaking time in boiling water, results showed that *L. leucocephala* was recorded the highest values in germination % and Plumule length at 20, 15, 10 and 25 minutes, respectively, *A. farnesiana* gave the highest values in germination % at 20 minutes. Plumule and radicle lengths and seedling fresh weight at 25 minutes. While, *A. saligna* was recorded the highest values in germination % at 20, 25, 15 and 10 minutes, respectively, plumule and radicle lengths and seedling fresh weight at 5 and 25 minutes, whereas, *A. victoria* gave the highest values in previous traits at 5 minutes.

Keywords: *Leucopenia leucocephala*, *Acacia farnesiana*, *Acacia saligna*, *Acacia victoria*, Soaking time, Chemical and mechanical scarification.

Introduction

The genus *Acacia* (Fabaceae: Mimosoideae) is a large tropical and subtropical group of trees and shrubs with about 1200 species. It is fast growing and a great importance in nitrogen fixation in a great importance in nitrogen fixation in forest ecosystems. The trees can be used for emergency fodder, a forestation purposes, soil improvement, windbreaks and shelter belts. Its woods have highly economic values in furniture industries, interior ornamental work, railway carriage building and fuel (Kumar and Saikia 2020)

Leucopenia leucocephala is probably the most widely planted multipurpose tropical legume tree (Shelton and Brew-baker, 1994) and has considerable relevance to social forestry and agroforestry in the tropics.

Seed dormancy, which occurred in many *Acacia* and other species, was attributed mainly to the physical and/or chemical strode of seeds. The seed coats enforce dormancy as a result of is impermeability to water and/or to gases, and/or they constitute a mechanical obstacle to embryo

Corresponding Author: Mohamed A. Abd El-hady, Agronomy Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt,
E-mail: doctorhady@agr.asu.edu.eg

expansion a mechanical obstacle to embryo expansion. While the presence of endogenous affecting germination substances (inhibitors or promoters) in coats and cotyledons plus embryo may play a dominant role in controlling germination.

Generally, seed dormancy may be broken by in from the following agents:

- 1) Puncturing the seed coat by mechanical or acid treatment.
- 2) Exposure to high temperatures.
- 3) Subjection to low temperature stratification.
- 4) Soaking in specific solutions containing certain growth co-factors such as K_2NO_3 thiourea, coumarin, GA_3 and cytokinins (Taylor son and Hendricks, 1977)

Several authors studied different procedures to break seeds dormancy of different plants, i.e., Rosales *et al.*, (2003) and Al-Abdullah (2005); Bradbeer, (2013); Ayuso *et al.* (2017) and Cui *et al.*, (2019).

The aim of the present investigation is mainly concerned to study the effect of some chemical and mechanical scarification treatments on seeds germination traits of leucaena and some Acacia species

2. Materials and Method

Several laboratory experiments were carried out at room temperature ($26^\circ C \pm 2$) in the laboratory of the Agronomy Department, Faculty of Agriculture, Ain shams University (during 2019) to study the effect of chemical and mechanical scarification on seed germination of some range shrubs and select the best suitable method for increasing germination percentage of the studied range shrubs.

The studied range plants species were *leucaena leucocephala*, *Acacia saligna*, *Acacia farnesiana* and *Acacia victoria*. The used seeds were obtained from the Desert Research Center (DRC) at Al-Matareya, Ministry of Agriculture, Cairo, Egypt.

Per-germination treatments

Soaking in sulfuric acid (H_2SO_4), as a chemical scarification

Twenty-five seeds from each species were soaked in sulfuric acid at Concentrations of 0, 25, 50, 75 and 100 % (v/v) for 10, 20, 30, 40 and 50 minutes. The treated seeds were washed by tap water for 5 minutes and germinated on filter paper in petri dishes (10 cm diameter and 2 cm depth) and saturated with 5 ml of the distilled water in incubator for 21 days at $26^\circ C \pm 2$.

Soaking in distilled water, as a mechanical scarification

The seeds were soaked in distilled water for 2, 4 and 6 days. The seeds were germinated in petri dishes in an incubator for 21 days at $26^\circ C \pm 2$.

Soaking in boiled water, as a chemical mechanical scarification

The seeds were soaked in boiled water for 5, 10, 15, 20 and 25 minutes. The seeds were cooled, dried and germinated on filter paper in petri dishes and saturated with 5 ml of the distilled water in an incubator for 21 days at $26^\circ C \pm 2$. Germination tests were carried out in accordance with the technique specified by the International Seed Testing Association (Anonymous, 1966). In all cases germinated seeds were counted at the end of the germination period (after 21 days of soaking date).

The following data were recorded

- Germination percentage.
- Radicle and plumule lengths were measured to the nearest centimeter on 10 seedlings taken randomly from each replicate.
- Seedling fresh weight / mg.

The experimental design used a completely randomized design with four replicates of each treatment. Data were subjected to analysis by MSTATC, (Russell, 1991). Means were compared using Duncan's New Multiple range test as described by Waller and Duncan, 1969). Means having the same alphabetical letters in the same column are not significantly different at $p=0.05$ level.

Data of some studied traits were converted by square root method then analyzed with the original data; because there are significant differences between the values, which ranged between 100 and 0%.

Then the converted and original data were compared based on the Coefficient of Variation value, where it should range between 1 and 5%. From the CV values, it was necessary to convert the data, follow the normal distribution.

3. Results and Discussion

3.1. Effect of chemical scarification with H₂SO₄ on Germination percentage

3.1.1. Effect of H₂SO₄ concentrations

Data presented in Table (1) demonstrated the effect of H₂SO₄ concentrations on germination percentage of the studied plant species, i.e. *Leucopenia leucocephala*, *Acacia farnesiana*, *Acacia saligna* and *Acacia victoria*, Results indicated that increasing H₂SO₄ concentrations from 25 to 100 % caused significant increases of germination percentage for all studied plant species with one exception *A. farnesiana*. The highest values in germination percentage were recorded at 100 % H₂SO₄ concentrations in *L. leucocephala*, (78.11%) and *A. victoria* (82.33%) and at 75 % H₂SO₄ concentrations for *A. farnesiana* (67.56%) and *A. saligna* (58.61%).

Table 1: Effect of H₂SO₄ treatments on germination percentage of leucaena and Acacia species after 21 days of soaking date.

Times (min.)	Soaking				
	H ₂ SO ₄ concentrations				Mean
	25%	50%	75%	100%	
<i>Luciana leucocephala</i>					
Control(0)	2.67m	2.67 m	2.67 m	2.67 m	2.67 e
10	8.00 L	34.67 i	55.67 h	90.00 c	45.83 d
20	28.00 j	37.33 i	79.33 e	92.00 bc	59.17 c
30	52.00 h	84.00 d	95.33 b	96.00 ab	81.83 a
40	69.33 f	64.00 g	100 a	94.00 bc	81.83 a
50	18.67 k	52.00 h	92.00 bc	94.00 bc	64.17 b
Mean	29.78 d	45.78 c	70.00 b	78.11 a	
<i>Acacia farnesiana</i>					
Control(0)	0.00 i	0.00 i	0.00 i	0.00 i	0.00 e
10	0.00 i	0.00 i	18.67 g	30.67 f	12.34 d
20	4.00 i	98.67 a	100 a	63.33 c	66.50 b
30	5.33 hi	93.33 a	96.00 a	97.33 a	73.00 a
40	10.67 h	50.67 d	97.33 a	75.33 b	63.67 b
50	6.67 hi	37.33 e	93.33 a	96.00a	53.17 c
Mean	4.45 d	46.67 c	67.56 a	60.44 b	
<i>Acacia saligna</i>					
Control(0)	0.00 l	0.00 l	0.00 l	0.00 l	0.00 d
10	28.00 k	54.67 fgh	57.33 f	56.00 fg	49.00 c
20	52.67f-i	55.33 fgh	74.33 bc	73.33 cd	63.92 b
30	56.00 fg	64.67 e	93.00 a	92.00 a	76.42 a
40	68.00 de	72.67 cd	76.33 bc	80.00 b	74.25 a
50	41.33 j	49.33 hf	50.67 ghi	46.67ij	47.00c
Mean	41.00 c	49.45 b	58.61 a	58.00 a	
<i>Acacia victoria</i>					
Control(0)	18.00 i	18.00 i	18.00 i	18.00 i	18.00 d
10	29.33 h	56.00f	78.00 d	84.67 bcd	62.00 c
20	28.00 h	68.00 e	84.67 bcd	98.67 a	69.83 b
30	37.33 g	82.67 cd	90.67 b	97.33 a	77.00 a
40	40.00 g	64.00 e	85.33 bcd	98.00 a	71.83 b
50	69.33 e	52.00 f	65.33 e	97.33 a	71.00 b
Mean	37.00 d	56.78 c	70.33 b	82.33 a	

While, the lowest values in germination percentage were noticed at 25% H₂SO₄ concentrations for all studied plant species. Similar findings were reported by several authors i.e., Rincon-Aosales *et al.*, (2003) studied the germination of *A. angustissima* seeds. They found that the exposure of seeds of *A. angustissima* to concentrated H₂SO₄ for 15 minutes appeared to be the best technique to stimulate

their germination, the treatment gave the highest percentage, of germination in the shortest time. Al-Abdullan (2005) studied the effect of several methods for breaking seeds dormancy of *A. saligna* and *L. leucocephala*. He indicated that the best germination % of *A. saligna* seeds were obtained when seeds were treated with either mechanical scarification or soaking in pure H₂SO₄ for 30 minutes. Meanwhile, the highest germination % of *L. leucocephala* seeds were noticed when seeds were soaked in pure H₂SO₄ for 20 or 30 minutes.

3.1.2. Effect of soaking times

Results in table (1) showed that soaking times in H₂SO₄ acid were affected significantly the germination percentage of *L. leucocephala*, *A. farnesiana*, *A. saligna* and *A. victoria*. Generally, increasing soaking period (time) from 0 (control) to 30 minutes caused significant increases in germination percentage of the previous forage shrub species, but, prolonging the soaking period more than 30 minutes decreased the germination percentage to different extents according to the plant species. The highest and the lowest values in germination % were recorded at 30 minutes and the control, respectively, in all studied plant species. Amodu *et al.*, (2000) indicated that seeds of *L. leucocephala* when immersed in sulfuric acid for 17.5 minutes had the highest percentage of germination. Marimuthu *et al.*, (2001) showed that the sulfuric acid treatment for 20 minutes recorded the highest germination of 98 % in *A. Senegal*. Girase *et al.*, (2002) found that *A. nilotica var. cuppressiformis*, *A. nilotica var. viviana*, *A. nilotica var. indica* and *A. farnesiana* responded well for breaking dormancy with sulfuric acid treatment for a period of 5 minutes, and this treatment effective for breaking the dormancy of *A. ebwnea* seeds. Generally, the available results revealed that the response of the investigated pasture shrubs seeds to the sulfuric acid treatments were not the same either with concentrations or soaking periods.

3.1.3. Effect of the interaction

Table (1) showed that the interaction between H₂SO₄ concentrations and soaking times was significant. The highest values in germination % of *L. leucocephala* (100%) was recorded at 75% H₂SO₄ concentrations and 40 minutes of soaking times, while, the highest values in germination % of *A. farnesiana* (100%) were obtained with 75 % of H₂SO₄ concentrations at 20 minutes soaking times. Moreover, *A. saligna* recorded the highest values in germination % at 75 or 100% of H₂SO₄ concentrations and 30 minutes of soaking times, and *A. Victoria* gave the highest value with 100 % of H₂SO₄ concentrations and 20 minutes of soaking time. These results indicated clearly that the effect of sulfuric acid concentrations was not the same under the soaking periods and this was true for the investigated species.

3.2. Plumule length (cm)

3.2.1. Effect of H₂SO₄ concentrations

Results in table (2) indicated that the highest values in Plumule length of *L. leucocephala* were recorded at 75 % of H₂SO₄ concentrations followed by 50% concentration. *A. farnesiana* and *A. Victoria* recorded the highest values in plumule length at 100 % of H₂SO₄ concentrations while, *A. saligna* recorded the highest values at 25% of H₂SO₄ concentrations. On the other hand, the lowest values in Plumule lengths were recorded at 25 % of H₂SO₄ concentrations in *L. leucocephala*, *A. farnesiana* and *A. Victoria* and at 75 % of H₂SO₄ concentrations with *A. saligna*.

3.2.2. Effect of soaking times

Results in table (2) showed that soaking for 20 minutes gave the highest value in Plumule length of *L. leucocephala* and *A. farnesiana* soaking for 40 minutes, Meanwhile, the 30 and 40 minutes of soaking time recorded the highest values in Plumule length of *A. saligna* and *A. Victoria* at 30 minutes only.

3.2.3. Effect of the interaction

Data presented in Table (2) showed that the effect of the interaction between H₂SO₄ concentrations and soaking times was significant. This means that the effect of H₂SO₄ concentrations on the plumule length of each of the investigated pasture shrubs was not the same with the soaking times. In respect to *L. leucocephala*, the tallest plumule length (13.10 cm) was recorded with 75 %

concentration and soaking time 20 minutes, while, *A. farnesiana* gave the highest values in Plumule length (6.97 cm) with 100% concentration and soaking time 30 minutes. Moreover *A. saligna* gave the highest value (6.47cm) with 25% H₂SO₄ concentrations and soaking time 40 minutes while, *A. Victoria* recorded the tallest plumule length (9.43, 9.30 cm) with 100% H₂SO₄ concentration and soaking times 10 and 20 minutes respectively.

Table 2: Effect of H₂SO₄ treatments on plumule length (cm) of leucaena and Acacia species after 21 days of soaking date.

Times (min.)	Soaking		H ₂ SO ₄ concentrations		
	25%	50%	75%	100%	Mean
<i>Luciana leucocephala</i>					
Control(0)	4.70 l	4.70 l	4.70 l	4.70 l	4.70 e
10	8.18 i	10.43 def	11.83 bc	12.23 ab	10.67 bc
20	10.10 e-g	11.21 cd	13.10 a	10.93 de	11.34 a
30	10.16 e-g	10.75 de	12.60 ab	10.22 efg	10.93 b
40	9.77 fgh	10.13 efg	12.43 ab	9.13 h	10.37c
50	5.55 k	9.40 gh	12.33 ab	7.28 j	8.64 d
Mean	8.08 d	9.44 b	11.17 a	9.08 c	
<i>Acacia farnesiana</i>					
Control(0)	0.00 j	0.00 j	0.00 j	0.00 j	0.00 e
10	0.00 j	0.00 j	6.33 b-e	6.47 a-d	3.2 d
20	3.83 i	4.63 h	6.93 ab	5.83 ef	5.3 lc
30	5.00 gh	5.03 gh	5.97 def	6.97 a	5.74b
40	6.30 cde	5.73 ef	5.53 fg	6.60 abc	6.04
50	4.53 h	3.77 i	5.77 ef	6.63 abc	5.18 c
Mean	3.28 c	3.19 c	5.09 b	5.42	
<i>Acacia saligna</i>					
Control(0)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 e
10	1.83 l	2.77 jk	2.47 k	3.57 hi	2.66 d
20	5.57 cd	4.08 g	3.23 i	4.80 ef	4.42 b
30	6.37 ab	5.67 cd	3.80 gh	5.23 de	5.27 a
40	6.47 a	3.87 gh	4.70 f	5.97 bc	5.25 a
50	4.97 ef	3.13 ij	3.30 i	4.53 f	3.98 c
Means	4.37 a	3.42 c	3.08 d	4.18 b	
<i>Acacia victoria</i>					
Control(0)	3.60 j	3.60 j	3.60 j	3.60 j	3.60 d
10	3.68 ij	3.77 ij	6.85 def	9.43 a	5.93 bc
20	3.65 ij	5.30 f-i	7.33 b-e	9.30 a	6.40 b
30	5.83 e-h	6.20 d-g	8.23 abc	8.67 ab	7.23 a
40	5.50 fgh	5.23 f-j	7.72 bcd	7.48 b-e	6.48 b
50	4.75 g-j	4.44 hij	6.20 d-g	6.33 d-g	5.43 c
Mean	4.50 c	4.76 c	6.66 b	7.47 a	

3.3. Radicle length (cm)

3.3.1. Effect of H₂SO₄ concentrations

Results in table (3) indicated that H₂SO₄ concentrations significantly affected the radicle length of the four studied pasture species. Data revealed that the highest values in radicle length were recorded at 75% of H₂SO₄ concentrations for *L. leucocephala*, *A. farnesiana* and *A. saligna*, while, *A. Victoria* gave the highest value at 100 % of H₂SO₄ concentrations. On the other hand, the lowest values of this trait were recorded at 25 % of H₂SO₄ concentrations for all studied plant species except *A. saligna* which recorded the lowest value at 50% of H₂SO₄ concentrations.

3.3.2. Effect of soaking times

Results in table (3) demonstrated that the radicle length of the four pasture species differed significantly according to the soaking times. Data indicated that the highest values of radicle lengths were recorded at 10, 40 and 30 minutes of soaking times for *L. leucocephala*, *A. farnesiana* and *A. saligna* respectively. and at 20 and 30 minutes for *A. victoria*.

3.3.3. Effect of the interaction

Data in table (3) showed that the highest radicle length value of *L. leucocephala* (11.05 cm) was recorded with concentrated sulfuric acid (100 % H₂SO₄) at 10 minutes of soaking time, while, the lowest value (except the control) was noticed (4.13cm) with 25 % H₂SO₄ at 50 minutes of soaking time. In respect to *A. farnesiana*, the highest and lowest values (except the control) in radicle length (2.37 and 0.00 cm) were recorded with 25 and 50 % H₂SO₄ at 40 and 10 minutes of soaking time, respectively. The highest and lowest values in radicle length of *A. saligna* (1.83 and 0.40 cm) were recorded with 50% H₂SO₄ at 30 and 10 minutes of soaking time, respectively, while *A. victoria* recoded the highest and lowest values with 100% H₂SO₄ at 20 and 50 minutes of soaking time, respectively.

3.4. Seeding fresh weight (mg)

3.4.1. Effect of H₂SO₄ concentrations

Data in table (4) indicated that the H₂SO₄ concentrations significantly affected the seedling fresh weight of the four studied pasture species, i.e., *L. leucocephala* *A. farnesiana* *A. saligna* and *A. victoria*. The highest values of seedling fresh weight of *L. leucocephala* and *A. saligna* (270 and 65.3) mg), respectively, were recorded at 100 % of H₂SO₄ concentrations, while *A. farnesiana* and *A. victoria* were recorded the highest values (217.8 and 224.9 mg) at 75 % of H₂SO₄ concentrations, respectively, on the other hand, the lowest value in seedling fresh weight of *L. leucocephala* was recorded at 25 % of H₂SO₄ concentrations while *A. farnesiana* *A. saligna* and *A. victoria* were recorded the lowest values at 50 % of H₂SO₄ concentration.

Table 3: Effect of H₂SO₄ treatments on plumule length (cm) of leucaena and Acacia species after 21 days of soaking date.

Soaking Times (min.)	H ₂ SO ₄ concentrations				Mean
	25%	50%	75%	100%	
<i>Luciana leucocephala</i>					
Control(0)	3.00 l	3.00 l	3.00 l	3.00 l	3.00 f
10	8.80 ef	9.60 cde	10.17 bc	11.05 a	9.90 a
20	7.03 gh	10.27 abc	10.92 ab	9.60 cde	9.45 b
30	6.60 gh	8.90 ef	9.88 cd	8.52 f	8.48 c
40	5.45 ij	6.63 gh	9.23 def	6.22 hi	6.88 d
50	4.13 k	5.20 j	7.20 g	5.52 ij	5.51 e
Mean	5.84 c	7.27 b	8.40 a	7.32 b	
<i>Acacia farnesiana</i>					
Control(0)	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d
10	0.00 d	0.00 d	2.30 a	1.57 bc	0.97 c
20	1.17 c	1.67 b	1.75 b	1.63 b	1.56 b
30	1.47 bc	1.37 bc	1.57 bc	1.67 b	1.52 b
40	2.37 a	1.70 b	1.73 b	1.37 bc	1.79 a
50	1.40 bc	1.50 bc	1.47 bc	1.50 bc	1.4 bc
Mean	1.07 c	1.04 c	1.47 a	1.29 b	
<i>Acacia saligna</i>					
Control(0)	0.00 g	0.00 g	0.00 g	0.00 g	0.00 e
10	0.50 efg	0.40 fg	0.63 d-g	0.67 d-g	0.55 d
20	0.63 d-g	0.70 d-g	1.17 a-e	1.70 ab	1.05 bc
30	1.13 a-e	1.83 a	1.53 abc	1.27 a-d	1.44 a
40	1.50 abc	1.07 b-f	1.80 a	1.03 b-f	1.35ab
50	1.27 a-d	0.63 d-g	1.20 a-e	0.83 c-f	0.98 c
Mean	0.86 ab	0.79 b	1.07 a	0.93 ab	
<i>Acacia victoria</i>					
Control(0)	1.20 i-1	1.20 i-1	1.20 i-1	1.20 i-1	1.20 c
10	1.37 g-k	1.63 c-g	1.40 f-k	1.70 b-f	1.53 b
20	1.76 bcd	1.73 b-e	1.48 d-i	2.43 a	1.85 a
30	1.55 c-h	1.83 bc	1.63 c-g	1.97 b	1.75 a
40	1.30 h-k	1.71 b-f	1.32 h-k	1.43 e-g	1.44 b
50	1.13 jki	1.10 kl	1.22 i-l	0.97 l	1.10 c
Mean	1.38 b	1.53 a	1.38 b	1.62 a	

3.4.2. Effect of soaking times

The highest and the lowest seedling fresh weights of *L. leucocephala* (272.4 and 201 mg) were recorded at 10 minutes and the control (untreated), respectively, (Table, 4). Whereas, the highest and lowest values of seedling fresh weight of *A. farnesiana* (276.2 and 130 mg) were noticed at 30 and 10 minutes, respectively, (except the control). In respect to *A. saligna* the highest and the lowest values (77 and 57.1 mg) were noticed at 40 and 10 minutes, respectively, (except the control). Whereas, the highest and lowest values of seedling fresh weight of *A. victoria* were recorded at the control and 10 minutes (267.8 and 202.5 mg) respectively

Table 4: Effect of H₂SO₄ treatments on seedling fresh weight (mg) of leucaena and Acacia species after 21 days of soaking date.

Times (min.)	Soaking	H ₂ SO ₄ concentrations				Mean
		25%	50%	75%	100%	
<i>Luciana leucocephala</i>						
Control(0)		201.00 hi	201.00 hi	201.00 hi	201.00 hi	201.00 e
10		279.00 c	253.6 d	246.6 d	310.3 a	272.4 a
20		215.3 gh	255.00 d	245.6 de	297.3 ab	253.3 b
30		227.6 efg	225.00fg	255.00 d	287.00 bc	248.6 b
40		202.00 hi	203.6 hi	241.6 def	228.3 efg	216.3 d
50		193.00 i	204.00 hi	240.00 def	228.3 efg	216.3 d
Mean		219.6 c	223.7 c	238.3 b	270 a	
<i>Acacia farnesiana</i>						
Control(0)		0.00 i	0.00 i	0.00 i	0.00 i	0.00 d
10		0.00 i	0.00 i	295.00 b	223 fg	129.6 d
20		215.3 g	216.3 g	244.6 de	227.3 fg	225.9 c
30		333.00 a	238.00 ef	260.3 cd	273.6 c	276.2 a
40		330.6 a	239.00 ef	233.6 ef	268.00 c	267.8 b
50		345.00 a	164.3 h	273.3 c	25900.cd	260.4 b
Mean		203.9 b	142.9 c	217.8 a	208.5 b	
<i>Acacia saligna</i>						
Control(0)		0.00 j	0.00 j	0.00 j	0.00 j	0.00 d
10		44.3 i	56.3 fgh	53.3 ghi	74.3 bcd	57.1 c
20		55.00 f-i	63.3 d-g	47.7 hi	83.3 abc	62.3 bc
30		63.00 d-g	57.7 e-h	56.3 fgh	84.3 ab	65.3 b
40		92.00 a	69.3 de	64.3 d-g	82.3 ac	77.00 a
50		72.00 cd	46.00 hi	63.00 d-g	66.3 def	61.8 bc
Means		54.6 b	48.9 c	47.6 c	65.3 a	
<i>Acacia victoria</i>						
Control(0)		267.6 a	267.6 a	267.6 a	267.6 a	267.6 a
10		191.6 jk	213.00 e-i	209.3 e-j	196.3 ijk	202.5 c
20		153.6 l	216.6 e-i	219.00 d-h	226.00 c-f	203.5 c
30		238.3 bcd	217.00 e-i	229.6 cde	210.6 e-j	223.9 b
40		242.00 bc	205.00 fg	223.6 c-g	204.00 g-j	218.6 b
50		251.6 ab	180.6 k	200.3 h-k	190.3 jk	205.7 c
Means		224.1 a	216.6 b	224.9 a	215.8 b	

3.4.3. Effect of the interaction

Results in table (4) revealed that *L. leucocephala* recorded the highest and the lowest values of seedling fresh weights (310.3 and 193.00 mg) with 100 and 25 % of H₂SO₄ concentrations at 10 and 50 minutes, of soaking times, respectively, *A. farnesiana* recorded the highest values (345 mg) in this trait with 25 % of H₂SO₄ concentrations at 50 minutes, of soaking times, while, the lowest values (0.00 mg) were noticed with 25 and 50 % of H₂SO₄ concentrations at 10 minutes, of soaking times. Whereas, *A. saligna* gave the highest and lowest values (92 and 44.3 mg) with 25 % of H₂SO₄ concentrations at 40 and 10 minutes, respectively, in respect to *A. victoria*, the control recorded the highest values (267.6 mg) in seedling fresh weight, while, the lowest values (180.6 mg) were noticed with 50 % of H₂SO₄ concentrations at 50 minutes, of soaking times.

3.5. Effect of seeds soaking in tap water on Germination %

Data in table (5) indicated that the effect of soaking times on the germination % of seeds of the investigated pasture shrubs differed greatly from one species to another. Results showed that while *A. saligna* did show any response to the investigated periods of soaking in tap water, the other 3 species responded to different extents by increasing the soaking time. The highest germination % was obtained after 6 days of soaking and amounted 53.33, 12 and 9.33 % for *A. victoria*, *L. leucocephala* and *A. farnesiana* respectively, Le Houérou *et al.*, (2000) evaluated the effects of pre-germination treatments and temperature on germination characteristics of four Acacia spp. (*A. aneura*, *A. farnesiana*, *A. saligna* and *A. Victoria*) they found that the highest germination % was obtained with the acid scarification treatment (65.6%), followed by acid and tap water treatment (61.2%), acid and hot water (57.8%) hot water (52.8%), and tap water soaking treatment (43.6%), on the other hand seed germination of the untreated seeds was only 5.7%.

Table 5: Effect of soaking times (days) in tap water in germination traits of leucaena and Acacia species after 21 days of soaking date.

Plant species	Soaking times			
	Control	2 day	4 day	6 day
	Germination percentage			
<i>Leucana leucocephala</i>	2.67 b	10.67 a	10.67 a	12.00 a
<i>Acacia farnesiana</i>	0.00 c	4.00 b	4.00 b	9.33 a
<i>Acacia saligna</i>	0.00	0.00	0.00	0.00
<i>Acacia victoria</i>	16.00 b	14.67 b	18.67 b	53.33 a
	Plumule length (cm)			
<i>Leucana leucocephala</i>	3.83 b	3.57 b	3.47 b	6.40 a
<i>Acacia farnesiana</i>	0.00 c	2.47 b	3.03 a	3.27 a
<i>Acacia saligna</i>	0.00	0.00	0.00	0.00
<i>Acacia victoria</i>	2.33 a	2.47 a	2.37 a	2.06 b
	Radicle length (cm)			
<i>Leucana leucocephala</i>	2.27 a	2.70 a	2.57 a	2.57 a
<i>Acacia farnesiana</i>	0.00 c	1.37 b	1.60 b	1.93 a
<i>Acacia saligna</i>	0.00	0.00	0.00	0.00
<i>Acacia victoria</i>	1.07 b	1.70 a	1.80 a	1.57 a
	Seeding fresh weight (mg)			
<i>Leucana leucocephala</i>	163.47 b	186.72 a	165.23 b	163.40 b
<i>Acacia farnesiana</i>	0.00 c	176.61 b	186.64 b	240.00 a
<i>Acacia saligna</i>	0.00	0.00	0.00	0.00
<i>Acacia victoria</i>	216.62 a	183.32 b	196.61 b	156.63 c

3.5.1. Plumule length

Effect of soaking times in tap water on plumule length of the four plant species is shown in table (5). Data indicated that seeds soaking for 6 days recorded the highest values in plumule length of *L. leucocephala* and *A. farnesiana*. On the contrary, *A. victoria* was recorded the lowest value in plumule length at 6 days of soaking and no-significant differences were detected between the control, 2 and 4 days.

3.5.2. Radicle length

Results in table (5) demonstrated that the highest values in radicle lengths of *A. farnesiana* and *A. victoria* were recorded at 6 and 4 days of soaking times, respectively, and while, radicle length of *L. leucocephala* insignificantly affected by soaking time in tap water.

3.5.3. Seeding fresh weight

Seedling fresh weight of *L. leucocephala*, *A. farnesiana* and *A. victoria* were significantly affected by soaking times in tap water (Table,5) Results showed that the highest values in seedling fresh weight of *L. leucocephala* and *A. farnesiana* and *A. victoria* (186.72, 240 and 216.62 mg) were recorded at 2, 6 days and the control, respectively, while, the control gave the lowest values in seedling fresh weight of

L. leucocephala *A. farnesiana*, while, *A. victoria* was recorded the lowest value at 6 days of soaking time.

3.6. Effect of seeds soaking in boiled water on Germination %

Data in table (6) showed that the effect of soaking in boiled water on germination % of the four studied plant species was significant. In general, results indicated that increasing soaking times in boiled water from the control (0 minute) to 5, 10, 15 and 20 minutes caused significant increases in germination % of the four plant species. The highest values of germination % of all plant species were recorded at 20 minutes. In respect to *L. leucocephala* and *A. saligna*, no significant differences were detected between the following soaking times 10, 15, 20 and 25 minutes. São José *et al.*, (2019) and Rusdy (2017) indicated that the immersion of seeds in hot water at 80°C was the most optimum treatment as indicated by total germination (83.0%), germination index (187.5), germination speed (19.5) and accumulated germination speed (24.5). The elevation of incubation temperature from 20°C to 25°C enhanced the germination index by 7.4%. Also increased the speed and accumulated speed of germination by 8.7% and 10.1%, respectively. Getachew *et al.*, (2012) studied seeds germination of four important and useful leguminous species (*Acacia tortillas*, *A. Nilotic a*, *Leucaene leucocephala* and *prosodies cineraria*). They found that seeds immersed in boiled water for 20 minutes and mechanically scarified by coarse dune sand for 10 h also improved the germination in the four species. Amodu *et al.*, (2000) studied the effect of hot water and acid treatment on seeds germination of *Leucaene leucocephala*. They indicated that seeds immersed in hot water for 5 minutes had the highest germination percentage (79 %). Girase *et al.*, (2002) found that *Acacia nilotica var. cuppressiformis*, *A. nilotica var. indicia* and *A. farnesiana* responded well for breaking dormancy with boiled water treatment for 15 minutes Al-Abdullah (2005) studied the effect of several methods for breaking seed dormancy of *Acacia saligna* and *Leucaene leucocephala*. He indicated that the best germination % of *L. leucocephala* was noticed when seeds were soaked in boiled distilled water for 20 or 30 minutes.

Table 6: Effect of soaking times (min) in boiled water on germination traits of leucaena and Acacia species after 21 days of soaking date.

Plant species	Soaking times					
	Control	5	10	15	20	25
Germination percentage						
Leucocephala	2.67 c	90.67 b	96.00 a	97.33 a	100.00 a	96.00 a
Farnesiana	0.00 e	41.33 d	81.33 c	89.33 b	100.00a	80.00 c
Saligna	0.00 c	76.00 b	88.00 a	91.00 a	92.00 a	92.00 a
Victoria	18.00 c	86.67 b	88.00 b	92.00 ab	96.00 a	86.67 b
Plumule length (cm)						
Leucocephala	3.67 b	4.70 a	5.27 a	5.39 a	5.10 a	4.75 a
Farnesiana	0.00 d	1.40 c	2.20 bc	2.73 b	3.73 a	3.78 a
Saligna	0.00 d	7.80 a	6.40 c	7.50 a	6.77 bc	7.13 ab
Victoria	3.60 b	5.16 a	3.79 b	3.12c	3.36 bc	2.67 d
Radicle length (cm)						
Leucocephala	2.80 d	3.00 cd	5.09 a	3.96 bc	3.38 cd	4.66 ab
Farnesiana	0.00 b	1.10 a	1.27 a	1.17 a	1.27 a	1.38 a
Saligna	0.00 d	1.02 ab	0.86 bc	0.80 c	0.99 abc	1.20 a
Victoria	1.37 c	3.39 a	3.37 a	2.30 b	1.50 c	2.37 b
Seeding fresh weight (mg)						
Leucocephala	194.31 bc	152.62 d	208.61 b	181.00 c	244.62 a	215.62 b
Farnesiana	0.00 d	131.32 c	165.34 b	168.62 b	172.00 ab	190.63 a
Saligna	0.00 c	82.00 a	68.00 b	82.00 a	71.00 b	83.00 a
Victoria	266.32 a	255.33 ab	229.64 b	226.00 b	267.33 a	195.31 c

3.6.1. Plumule length

Results in Table (6) showed that plumule length of *Leucaena leucocephala* was not significantly affected by prolonging soaking times in boiled water from 5 to 25 minutes. The highest values in

plumule lengths of *L. leucocephala*, *A. farnesiana*, *A. saligna* and *A. victoria* were recorded with 15, 25, 5 and 5 minutes, respectively.

3.6.2. Radicle length

Results in table (6) showed that *Leucaene leucocephala* recorded the highest value in radicle length at 10 minutes of soaking. The radicle length of *A. farnesiana* was not significantly affected by soaking times more than 5 minutes. *A. saligna* gave the highest value in radicle length at 25 minutes of soaking in boiled water, whilst, the highest value in radicle length of *A. victoria* was recorded at 5 minutes.

3.6.3. Seedling fresh weight (mg)

Data presented in the Table (6) revealed that the responses of the four plant species differed according to the soaking times water. The highest and lowest seedling fresh weights of *L. leucocephala* were noticed at 20 and 5 minutes, respectively. While, *A. farnesiana* and *A. saligna* recorded the highest and lowest values at 25 minutes and the control, respectively. *A. victoria* gave the highest and lowest values in seedling fresh weight at 20 and 25 minutes, respectively.

References

- Al-Abdullah, M.M., 2005. Studies on peregrination requirements and seedling treatments of some tree and shrubs in the nursery. M.Sc. Thesis, Fac. Of Agric., Aim Shams Univ., Cairo, Egypt.
- Al-Mudaris, M.A. Omara and B.I. Hattar, 1998. Maximizing germination percentage and speed of four Australian indigenous *Acaia* species through seed treatments. *Dirasat.-Agricultural, Sci.*, 25(2): 157-169.
- Amodu, J.T., A.T. Omokanye, O.S. Onifade and R.O. Balogun, 2000. The effect of hot water and acid treatment on establishment of *Leucaene leucocephala*. *Seed Research*, 25(2): 226-228.
- Anonymous, 1966. International Rules for Seed Testing. *Proc. Int. See Test Assoc.*, 31.
- Arif, A., J. Tiedeman and M. Acherkouk, 1994. Emergence response of five fodder shrubs to seed treatment. *Bibliographic Citation, Al-Awamia*, 84: 67-71.
- Ayuso, M., P. Ramil-Rego, M. Landin, P.P. Gallego, and M.E. Barreal, 2017. Computer-assisted Recovery of Threatened Plants: Keys for Breaking Seed Dormancy of *Eryngium viviparum*. *Frontiers in Plant Science*, 8: 2092.
- Barr, D.A. and W.J. Atkinson, 1970. Stabilization of coastal sands after mining. *J. Soil Cosorv. Serv. N.S.W.* 50:98-105.
- Bradbeer, J.W., 2013. *Seed Dormancy and Germination*. Springer Science & Business Media.
- Cui, D., Y. Yin, J. Wang, Z. Wang, H. Ding, R. Ma, and Z. Jiao, 2019. Research on the Physio-biochemical Mechanism of Non-thermal Plasma-regulated Seed Germination and Early Seedling Development in *Arabidopsis*. *Frontiers in Plant Science*, 10: 1322.
- Doran, J.C., J.W. Turnbull, D.J. Boland, and B.V. Gunn, 1983. *Handbook on seed of dry-zone Acacias A Guide for Collecting, Extracting, Leaning and storage the seed and for treatment to promote germination of dry-zone Acacias*. Division of forest Research, CSIRO, PO Box 4006, Canberra A.C.T., 2600, Australia
- Fagbayide, J. and M. Fawusi, 1994. Comparative studies in seed germination and seedling management in *Cassia Fistula* (L) and *Cassia nodose* (Buch-Ham exRoxb). *Indian J. Agric. Res.*, 28(2): 133-140.
- Getachew, S., S. Demissew, and T. Woldemariam, 2012. Allelopathic Effects of the Invasive *Prosopis juliflora* (Sw.) DC. on Selected Native Plant Species in Middle Awash, Southern Afar Rift of Ethiopia. *Management of Biological Invasions*, 3(2): 105-114.
- Girase, U.S., N.D. Jambhale and Y.B. Suryawanshi, 2002. Germination and seed dormancy studies in *Acacia* species. *Seed Research*, 30(1): 39-42.
- Kannan, C., K. Sodhakara, A. Augustine and P. Ashokan, 1996. Seed dormancy and pre-treatments to enhance germination in selected *Aibizia*. *Species. J. Tropical Forest.*, 8, 3: Keogh, G.A. and P. Bannister, 1992. A method for inducing rapid germination in seed of *Discaria toumatou* Raoui. *New-zealand J. of Botany*, 30m, 1: 113-116.
- Kumar, R., and P. Saikia, 2020. Forest resources of Jharkhand, Eastern India: Strategies for Sustainability, 61-101.

- Le Houérou, H.N., 2000. Use of Fodder Trees and Shrubs (trubs) in The arid and Semi-arid Zones of West Asia and North Africa: history and perspectives. In Fodder shrub development in arid and semi-arid zones, proceedings of the workshop on native and exotic fodder shrubs in arid and semi-arid zones, 1: 9-53. Aleppo, Syria: ICARDA.
- Maithani, G.P., V.K. Bahuguna, L. pyare and P. Lal, 1991 Seed germination behavior of *Desmodium tiliacifolium* G. Don-an imporyant shrub species of Himalayas. *Indina-forester*. 117(8): 593-595.
- Marimuthu, R., R. Swarnapriya, K. Vairavan and C. Dhanakodi, 2001. Pre-sowing treatment with acid strongly influences germination and seedling growth of gum arable. *Agroforestry*
- Martin, A. Avalos and C. Vicente, 1995. Factors affecting germination of *Animalia brasiliensis*, *Leucaene leucocephala*, *Clitoris ternate* and *Calopogonium mucnoides* seeds. *Seed Sci. & Technol.*, 23(2): 447-454.
- Nayak, G., and S. Sen, 1999. Effect of growth regulators, acid and mechanical scarification on germination of mechanical scarification on germination of bael (*Aegle marmelos* Correa). *Environ. And Ecology*. 17(3): 768-769.
- Rincon-Rosales, R., N.R. Culebro-Espinose, F.A. Gutierrez-Miceli and L. Dendooven, 2003. Scarification of seeds of *Acacia angustissima* (Mill) Kountze and its effect on germination. *Seed Sci. & Technol.*, 31(21): 301-307
- Rusdy, M., 2017. Enhancement of Seedling Emergence and Early Growth of *Leucaene leucocephala* by Hot Water, Mechanical and Acid Scarification pre-treatments. *International Journal of Applied Environmental Sciences*, 12(5):857-863.
- Russell, D.F., 1991. MSTAT C Directory Crop Soil Science Dept. Michigan Univ., 496.
- Sacheti, U. and Sh. Al-Rawahy, 1998. The effects of various pretreatments on the germination of important leguminous shrub-tree species of the Sultanate of Oman. *Seed Sci. and Technol.* 26(3): 691-699.
- São José, J.F.B., C.G. Volpiano, L.K. Vargas, M.A.S. Hernandez, B.B. Lisboa, G. Schlindwein, A. Beneduzi, L.S. Longoni and J.A.T. Sampaio, 2019. Influence of Hot Water on Breaking Dormancy, Incubation Temperature and Rhizobial Inoculation on Germination of *Acacia mearnsii* Seeds. *Australian Forestry*, 82(3):157-161.
- helton, H.M. and J.L. Brewbaker, 1994. *Leucaene leucocephala* –The most widely used forage tree tree legume. In: forage Tree Legumes in Tropical Agriculture. Gutteridge R.C. and H.M. Shelton. Ed. Pupil. CAB International. 379.
- Taylorson, R.B.D. and S.B. Hendricks, 1977. Dormancy in seeds. *Ann. Rev. Plant Phsiol.*, 28: 331-354.
- Waller, R.A. and D.B. Duncan, 1969. Abays rule for the segmmetric multiple comparison problem. *J. Stat. Assoc.* 1484-1503.