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EFFECT OF PRE-SOWING TREATMENTS ON SEED GERMINATION AND SEEDLING GROWTH OF *CALLIANDRA HAEMATOCEPHALA* HASSK. SHRUB

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ABSTRACT: The present investigation was conducted at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during 2013 and 2014 seasons to study the effect of different pre-sowing seed treatments, viz., untreated seeds (control), soaking in tap water for 24 h at room temperature, soaking in previously boiling water for 24 h at room temperature, boil/cold water dipping (thermal shock treatment), soaking in concentrated H_2SO_4 for either 2 or 4 min (chemical scarification) and abration testa with rough emery paper (mechanical scarification) on seed germination and seedling growth of Powder Puff (*Calliandra haematocephala* Hassk.) shrub.

The obtained results indicated that most of the used treatments improved germination % and velocity, mean germination rate, germination rate and vigour indices, seed viability and epicotyl length of germinated seeds, as well as seedling growth with various significant differences compared to control in the two seasons, except for thermal shock treatment which completely failed to induce germination. It was also noticed that seed viability markedly decreased as a result of mechanical scarification with emery paper to reach the least values at all. Content of total indoles and phenols in the untreated seeds was stable as they were not subjected to any treatment, but in treated seeds, it was increased where total indoles reached the maximum by soaking in either concentrated H_2SO_4 or boiling water, while these two treatments caused a nil increment in seed content of total phenols relative to control and other pre-sowing treatments. In addition, content of chlorophyll a, b, carotenoids and total soluble sugars in the leaves of seedlings raised from the treated seeds was greatly increased, especially by chemical and thermal scarification. Generally, the mastery in all previous measurements was for soaking in either concentrated H_2SO_4 for only 2 min or boiling water for 24 h, as they recorded the utmost high means in the majority of measured traits in both seasons.

Hence, it is recommended to treat seeds of *Calliandra haematocephala* pre-sowing by soaking in either previously boiling water for 24 h. or in concentrated H_2SO_4 for only 2 min. to obtain the best germination and seedling growth.

Key words: *Calliandra haematocephala* Hassk., germination, pre-sowing, treatments, seedling growth.

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INTRODUCTION

Calliandra haematocephala Hassk., Powder Puff that belongs to Fam. Leguminosae (Fabaceaae) is an upright evergreen shrub, 2-4 m high, leaves bipinnate, leaflets numerous, bears attractive pink fluffy globose heads or inflorescences during the period from autumn to spring. Native to Bolivia, propagated by seeds and cuttings which placed in sand over bottom heat. It is one of the few mimosoid leguminous shrub planted primarily for their showy flowers and for shade due to their dispersed branches everywhere (Bailey, 1976 and Kong and Lum, 1996). It is grown as a hedge or shrub in the landscape for its powder puff-type flowers. Very attractive to bees and butterflies.

Seeds of most leguminous species are usually have hard-seed coat, solid endosperm or both, but they respond well to various pre-sowing treatments, including thermal, mechanical and chemical scarifications. In this concern, Agba *et al*. (2005) mentioned that hot water treatment at 40-60 °C significantly enhanced germination of *Mucuna flagellipes* seeds compared to hot water treatment at higher temperatures (80 and 100 °C). Soaking in water at room temperature for 36-48 h resulted in higher cumulative germination over planting of seeds without pre-sowing treatment. Kak *et al*. (2007) revealed that hot water at 80 °C for 5 min was found to be most effective in breaking hardseededness in *Crotalaria laburnfolia*, while germination declined sharply in *C. retusa* when seeds soaked in water at 70 °C for 15 min. In *C. pallida* soaking seeds in hot water at 60 °C for 30 min enhanced germination. Likewise, Sharma *et al*. (2008) concluded that the best hot water treatment for seeds of *Albizia lebbek* and *Peltophorum petrocarpum* is 100 °C for 1 min (94 and 97%, respectively), *Lucaena leucocephala* is 100 °C for 5 min (100% germination) and for *Albizia procera* and *Acacia auriculiformis* is 100 °C for 10 min (94 and 98% germination, respectively). On *Acacia Melanoxylon,* Burrows *et al*. (2009) stated that short exposure to boiling water (60 second or less) gave high germination percentages of seeds collected from 3 widely differing provenances in Australia. Similarly, were those results declared by Bahar (2007) on *Acacia robusta*, Singh and Dhillon (2007) on *Acacia nilotica, Prosopis cineraria* and *Lucaena leucocephala*, Sanyang *et al*. (2008) on *Acacia senegal*, Raghavendra *et al*. (2010) on *Erythrina indica*, Azad *et al*. (2010) on *Albizia richardiana, Acacia catechu*, and *Melia azadirach,* Azad *et al*. (2012) on *Albizia procera* and Junior *et al*. (2014) who observed that short-term exposure to a hot water treatment is sufficient for the formation of a water gap in *Senna multijuga* seeds, and only the lens acts in the imbibition process.

In some cases, both hot water soaking and sulfuric acid scarification gave better results. In this regard, Bahar (2011) reported that hot water soaking for 24 h or sulfuric acid for 15 min soaking enhanced germination of *Acacia mangium* seeds to more than 92%. Similar observations were also recorded by Tadros *et al*. (2011) on *Acacia farnesiana* and *Lucaena leucocephacla* and Ghassali *et al*. (2012) on some species of Acacia.

Moreover, Singh *et al*. (2005) postulated that mechanical treatment enhanced germination of *Pongamia glabra* seeds up to 85% and the seeds treated with concentrated HCl for a minute showed 91.3% germination, while those treated with hot water (50 °C) exhibited highest germination (98%). On the other hand, Kalia *et al.* (2005) found that mechanical scarification by rubbing seeds of *Stylosanthes scabra* with commercial thin sand paper for 5 min recorded highest germination percentage (55.61%) followed by hot water treatment for 15 min (27.48%). On senna (*Cassia angustifolia*), Romamoorthy *et al*. (2005) noticed that commercial concentrated H_2SO_4 for 5 min minimized

hard seed content to 3% compared to 87% in control and caused maximum seedling length (13.7 cm). This was followed by sand scarification for the same duration (8% hard seeds and 13.9 cm seedling length). Hot water soaking for 15 min was less effective and furtherance to 30 min increased the percentage of dead seeds. On the same line, were those findings attained by Bhardwaj *et al*. (2006) on *Albizia lebbek*, Uniyal *et al*. (2007) on *Dalbergia sissoo*, Soliman and Abbas (2013) on *Cassia fistula* and Khan (2013) on *Cassia auriculata* and *Cassia tora*.

This work was done to detect the most practicable pre-sowing treatment to break the physical dormancy of Calliandra seeds.

MATERIALS AND METHODS

A study was undertaken at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during the two consecutive seasons of 2013 and 2014 to overcome the physical dormancy of Powder Puff shrub seeds due to hardiness of testa.

Therefore, olive green seeds of Powder Puff (*Calliandra haematocephala* Hassk.) were collected from brown pods immediately after dehiscence and before dropping on the land during May for each season. The mean weight of 10 seeds was about 0.59-0.60 g. The outer coats of the seeds were sterilized with 10% of Sodium Hydrochloride solution for 10 minutes, then rinsed several times with sterile distilled water and directly undergone on June, 1st to the following pre-sowing treatments:

1- Untreated seeds, to be control.

2- Soaking in tap water for 24 h at ambient conditions.

3- Soaking in previously boiling water for 24 h.

4- Dipping for 15 seconds in boiling water (100 °C) and suddenly in cold one (5 °C), as a shock treatment.

5- Soaking in concentrated sulfuric acid (98.5%) for either 2 or 4 min., as chemical scarification treatments.

6- Abration testa of the seeds at the two flattened sides with rough emery paper, as mechanical scarification treatment.

Immediately after treatment, the treated seeds and those of control were sown in 16-cm-diameter plastic pots filled with about 1.5 kg of sand and loam mixture at equal parts by volume. Some physical and chemical properties of the used sand and loam in the two seasons are shown in Table (1).

The pots were arranged under shade in a completely randomized design (Mead *et al*., 1993), with 3 replicates as each pot containing 10 seeds represents one replicate. Clearly visible epicotyl protrusion was used as a criterion for germination. All agricultural practices needed for care the seeds were done. Number of germinated seeds was counted daily and length of epicotyl (cm) was measured after a week from emergence to calculate germination characteristics as follows:

1- Germination percentage (G. %) from the following equation:

G. % = No. germinated seeds/total No. sown seeds×100

2- Germination velocity (G.V.) in days, which equal average number of days from sowing till emergence of the final epicotyl.

3- Mean germination rate (M.G.R.) in days = mean number of days till 50% germination (Odetola, 1987).

4- Germination rate index (G.R.I.), which calculated from Bartled equation indicated by Hartmann and Kester (1983). G.R.I. = A + (A + B) + (A + B + C) + … /N (A + B + C ….).
   - Where: A, B, C, …. etc. are number of germinated seeds counted at different times, and N is number of times at which the germinated seeds were counted.

5- Vigour index (V.I.) = G.% × mean length of epicotyl (Selvaraju and Selvaraj, 1994).

Table 1. The physical and chemical analysis of the used sand and loam during 2013 and 2014 seasons.

Soil texture	Seasons	Particle size distribution (%)				S.P.	E.C. (dS/m)	pH	Cations (meq/l)				Anions (meq/l)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sand	2013	89.03	2.05	0.40	8.52	23.00	3.72	7.92	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2014	90.10	1.95	0.50	7.45	22.86	3.74	7.80	19.42	8.33	7.20	0.75	1.60	7.00	27.10
Loam	2013	10.18	46.17	19.53	24.12	35.00	3.38	8.09	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2014	10.30	46.54	18.88	24.28	33.00	3.51	8.16	18.00	8.95	20.50	0.85	3.65	10.20	34.45

6- Seed viability (SV) = number of survived seedlings in each treatment after excluding the deteriorated and dead ones (Odetola, 1987).

At the end of experiment (on 30th of June for both seasons), the following data were recorded on the resulted seedlings from the different treatments: seedling length (cm), number of leaves/seedling, root length (cm), number of root branches/main root, as well as top growth and roots fresh and dry weights (g).

In fresh seed samples taken only in the second season, total indoles (A.O.A.C., 1990) and total phenols (William *et al*., 1965) were measured before and after treatment, while in fresh leaf ones, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) and the percentage of total soluble sugars were measured according to the methods explained by Saric *et al*. (1967) and Dubois *et al*. (1956), respectively.

Data were then tabulated and subjected to analysis of variance using SAS Institute program (1994), and Duncan's Multiple Range Test (Duncan, 1955), to explore the significance level among the means of various treatments.

RESULTS AND DISCUSSION

Effect of pre-sowing treatments on:

Germination traits and epicotyl length:

Data in Table (2) clear that germination % reached the maximum by soaking in both boiling water for 24 h and concentrated H_2SO_4 for either 2 or 4 minutes, as these treatments gave 100% germination in the two seasons, and followed by soaking in tap water for 24 h (75% germination in both seasons). The least improvement in germination % was attained by mechanical scarification with emery paper that increased such parameter to 62.50 and 55.78% against 50.00 and 40.36% for control in the first and second seasons, respectively. On the other side, seeds treated with thermal shock treatment failed to germinate giving 00.00 germination percent in the two seasons. This may be ascribed to the harmful effect of shock treatment on embryo vitality.

The least number of days to either final germination (100%) or half one (50%) was found due to chemical scarification treatment by soaking in concentrated H_2SO_4 for 2 min only, which was followed by soaking in such acid for 4 min, and then by soaking in previously boiling water for 24 h. However, the highest means of germination rate index, as a real indicator for germination accelerating was also achieved by soaking in concentrated H_2SO_4 treatment for 2 min, which significantly raised this parameter to 0.88 and 1.33 in the 1st and 2nd seasons, respectively, and also by soaking in boiling water for 24 h treatment that increased value of such index to 0.75 in the 1st season and to 0.86 in the 2nd one. Furthermore, the highest means of vigour index, seed viability and epicotyl length (cm) were also attributed to soaking in previously boiling water for 24 h treatment which registered the highest records in both seasons, followed by soaking in concentrated H_2SO_4 for 2 min, and then soaking in the same acid for 4 min. Seed viability recorded by mechanical scarification treatment was reduced to 1.00

Table 2. Effect of pre-germination treatments on germination traits and epicotyl length of *Calliandra haematocephala* Hassk. shrub seeds during 2013 and 2014 seasons.

Treatments	Germination (%)	Germination velocity (day)	Mean germination rate (day)	Germination rate index	Vigour index	Seed viability	Epicotyl length (cm)
			First season: 2013				
Control	50.00d	30.00a	30.00a	0.75ab	128.00c	2.00c	2.56c
Soaking in tap water for 24 h	75.00b	30.00a	15.50b	0.67b	215.25b	3.00b	2.87bc
Soaking in boiling water for 24 h	100.00a	9.50cd	4.00c	0.75ab	483.00a	4.00a	4.83a
Boiling/cold water dipping	-	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 2 min	100.00a	4.50c	2.00c	0.88a	451.00a	4.00a	4.51a
Soaking in concn. H_2SO_4 for 4 min	100.00a	7.33c	2.00c	0.75ab	426.00a	4.00a	4.26a
Scarification with emery paper	62.50c	15.00b	15.00b	0.75ab	208.13b	1.00d	3.33a
			Second season: 2014				
Control	40.36d	30.50a	-	0.67bc	132.38d	3.00c	3.28c
Soaking in tap water for 24 h	75.00b	27.00a	13.96a	0.63c	278.15c	4.33b	3.71bc
Soaking in boiling water for 24 h	100.00a	10.33cd	4.35b	0.86b	630.00a	5.76a	6.30a
Boiling/cold water dipping	-	-	-	-	-	-	-
Soaking in conc. H_2SO_4 for 2 min	100.00a	5.76c	2.60b	1.33a	586.00a	5.00a	5.86a
Soaking in conc. H_2SO_4 for 4 min	100.00a	9.10c	2.76b	0.80b	547.00a	5.00a	5.47ab
Scarification with emery paper	55.78c	17.67b	16.97a	0.76b	238.18c	2.33c	4.27b

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

and 2.33 against 2.00 and 3.00 for control in the first and second seasons, consecutively due to death some of the produced seedlings under such treatment.

It seems from the previous gains that both boiling water and concentrated sulfuric acid improved the most germination characters because of their ability on softening the hard palisade layer that present in seed coat in most legumes and casually connected with their higher degree of impermeability (Khan, 2013). In this connection, Burrows *et al*. (2009) affirmed that structure of the lens in the coat of *Acacia melanoxylon* seeds was markedly altered after a 10-second exposure to boiling water. A wide diversily of altered lens structure was found from a circular hole between the macrosclereids, to a short fissure where the macrosclereids did not separate to their basis. Besides, Wen *et al*. (2009) demonstrated that seeds of *Vigna oblongifolia* first cracked in the hilum when pretreated with sulfuric acid, but they cracked in both the hilum and extrahilar regions when pretreated with hot water. However, in *Sesbania sesban* seeds, a crack formed only in the lens following either acid scarification or hot water treatments, and the seeds imbibed water only through the lens. This means that the primary site of water entry into seeds following physical dormancy break can vary with species and treatments. These results are in accordance with those detected by Singh *et al*. (2005) on *Pongamia glabra*, Bhardwaj *et al*. (2006) on *Albizia lebbek*, Sharma *et al*. (2008) on *Albizia lebbek*, *A. procera*, *Peltophorum petrocarpum*, *Lucacena leucocephala* and *Acacia auriculiformis*, Azad *et al*. (2010) on *Albizia richardiana* and *Lagerstroemia speciosa*, Tadros *et al*. (2011) on *Acacia*

farnesiana, Soliman and Abbas (2013) on *Cassia fistula* and Junior *et al*. (2014) on *Senna multijuga*.

Seedling growth traits:

As shown in Tables (3 and 4), it is evident that the best seedling growth was achieved by soaking seeds in boiling water for 24 h treatment, as this treatment produced the longest seedling and root lengths (cm), the highest number of leaves and root branches/seedling, as well as the heaviest fresh and dry weights (g) of top growth and roots with significant differences when compared to control and other treatments in most cases of both seasons. Soaking in concentrated H_2SO_4 for only 2 min gave better growth means closely near to those attained by boiling water treatment with few exceptions in the two seasons, while elongating duration of soaking in the acid did not cause any additional increment in growth of the resulted seedlings, but slightly reduced means of the most growth characters comparing with soaking for 2 min. The least improvement in growth, however was established by mechanical scarification with emery paper, and then by soaking in tap water for 24 h.

Improvement of vegetative and root growth of seedlings due to soaking in either boiling water or concentrated sulfuric acid may be attributed to that these two treatments softened the hard seed coats and altered lens structure, and that permites the seeds to absorb more water and gasses necessary for hydrolysis of the complex food reserves to absorbable forms. Moreover, early germination under these two treatments saving more time for the produced seedlings to grow more and more, whereas seeds under other treatments are still dormant. Similar observations were also explored by Kalia *et al*. (2005) on *Stylosanthes scabra*, Kak *et al*. (2007) on *Crotalaria laburnifolia* and *C. pallida*, Sanyang *et al*. (2008) on *Acacia Senegal*, Dhanda *et al*. (2011) on *Albizia lebbek*, *Acacia catechu*, and *Melia azadirach* and Khan (2013) on *Cassia auriculata* and *Cassia tora*.

Chemical composition:

From data averaged in Table (5), it can be say that content of either total indoles or total phenols (ppm) in the seeds before treatments was closely near together, as it ranged between 0.118-0.121 and 0.0019-0.0021 ppm for these two constituents, respectively. Content of these two components was not change in the untreated seeds after-treatment as they received no treatment. The opposite was the right regarding the treated seeds as their content of such constituents was markedly increased, especially by soaking in concentrated H_2SO_4 for 2 min treatment, which increased total indoles to 3.283 ppm, while prolonging soaking time to 4 min and soaking in boiling water for 24 h raised it to the only 2.717 and 1.838 ppm, consecutively. On the other hand, increment in total phenols content due to the aforementioned treatments was nil, as it ranged between 0.0020-0.0023 ppm against 0.0020 ppm in control seeds. So, the best enhancing for germination velocity was found due to these 3 treatments which induced germination within about 5-10 days. The thermal shock treatment increased total indoles content to 1.8-fold over control, but raised total phenols one to 12-fold over control, so seeds subjected to this treatment failed to germinate. This result may indicate the inhibitory effect of phenols which modify the activity of IAA-oxidase and might therefore be acting on plant activities through changes endogenous auxins activity (Kenneth, 1979).

As for leaf content of chlorophyll a, b and carotenoids (mg/g f.w.) and total soluble sugars (%), data in Table (6) show that a pronounced increment in their content was observed due to the different pre-sowing treatments used in this study, with the prevalence of soaking in both concentrated H_2SO_4 and boiling water treatments which elevated content of such components to the highest means contrary to control and other treatments. On the same line, were those results elicited by Agba *et al*. (2005) *Mucuna flagellipes*, Burrows *et al*. (2009) on *Acacia Melanoxylon* Azad *et al*. (2012) on *Albizia*

Table 3. Effect of pre-germination treatments on growth traits of *Calliandra haematocephala* Hassk. seedlings during 2013 and 2014 seasons.

Treatments	Seedling length (cm)		No. leaves per seedling		Root length (cm)		No. root branches per main root	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	5.70c	6.48c	2.00b	2.00c	5.30d	6.34d	1.40c	1.50c
Soaking in tap water for 24 h	6.56c	7.80c	2.67b	3.00b	8.23c	9.51c	2.80bc	2.99bc
Soaking in boiling water for 24 h	13.50a	16.21a	4.00a	5.00a	15.60a	18.03a	5.43a	6.00a
Boiling/cold water dipping	-	-	-	-	-	-	-	-
Soaking in conc. H_2SO_4 for 2 min	11.33ab	13.56ab	4.00a	4.67a	10.46b	1250b	3.50b	3.76b
Soaking in conc. H_2SO_4 for 4 min	11.20ab	13.40ab	3.33a	3.50b	9.50bc	11.50bc	3.10b	3.33b
Scarification with emery paper	9.33b	11.00b	3.00ab	3.26b	9.00bc	10.75bc	3.00b	3.21b

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table 4. Effect of pre-germination treatments on top growth and roots fresh and dry weights of *Calliandra haematocephala* Hassk. seedlings during 2013 and 2014 seasons.

Treatments	Fresh weight (g)				Dry weight (g)			
	Top growth		Roots		Top growth		Roots	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	0.17c	0.19c	0.04c	0.05c	0.054c	0.061d	0.018e	0.023d
Soaking in tap water for 24 h	0.22b	0.25b	0.07bc	0.08cb	0.071b	0.078c	0.034d	0.037cd
Soaking in boiling water for 24 h	0.41a	0.47a	0.15a	0.17a	0.136a	0.145a	0.073a	0.078a
Boiling/cold water dipping	-	-	-	-	-	-	-	-
Soaking in conc. H_2SO_4 for 2 min	0.32a	0.35ab	0.14a	0.15a	0.103ab	0.110ab	0.061b	0.063b
Soaking in conc. H_2SO_4 for 4 min	0.26ab	0.29b	0.10b	0.11b	0.081b	0.093b	0.045c	0.050c
Scarification with emery paper	0.20b	0.23bc	0.09b	0.11b	0.062c	0.074c	0.039cd	0.046c

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table 5. Effect of pre-germination treatments on total indoles and phenols in the seeds of *Calliandra haematocephala* Hassk. before and after treatment during 2014 season.

Treatments	Total indoles (ppm)		Total phenols (ppm)	
	Before treat.	After treat.	Before treat.	After treat.
Control	0.121	0.121	0.0020	0.0020
Soaking in tap water for 24 h	0.120	0.169	0.0021	0.0034
Soaking in boiling water for 24 h	0.120	1.838	0.0021	0.0023
Boiling/cold water dipping	0.121	0.215	0.0021	0.0233
Soaking in conc. H_2SO_4 for 2 min	0.118	3.283	0.0020	0.0020
Soaking in conc. H_2SO_4 for 4 min	0.121	2.717	0.0019	0.0021
Scarification with emery paper	0.120	0.320	0.0021	0.0029

Table 6. Effect of pre-germination treatments on pigments and total soluble sugars content in the leaves of *Calliandra haematocephala* Hassk. seedlings during 2014 season.

Treatments	Pigments Content (mg/g f.w.)			Total soluble sugars (%)
	Chlorophyll (a)	Chlorophyll (b)	Carotenoids	After treat.
Control	0.332	0.141	0.081	1.074
Soaking in tap water for 24 h	0.499	0.218	0.175	1.208
Soaking in boiling water for 24 h	1.150	0.401	0.360	1.252
Boiling/cold water dipping	-	-	-	-
Soaking in conc. H_2SO_4 for 2 min	1.784	0.631	0.433	3.088
Soaking in conc. H_2SO_4 for 4 min	1.376	0.387	0.400	2.327
Scarification with emery paper	0.597	0.246	0.193	1.200

procera and Khan (2013) on *Cassia auriculata* and *Cassia tora*.

From the aforestated results, it can be concluded that soaking in either previously boiling water for 24 h or concentrated sulfuric acid (98.5%) for only 2 min are considered the most practicable pre-sowing treatments for germination of *Calliandra haematocephala* Hassk. seeds and for the best growth of the produced seedlings (Fig. 1).

Fig. 1. Effect of soaking in boiling water (1) and concentrated H_2SO_4 for 2 min (2) on seedling growth compared to control.

REFERENCES

Agba, O.A.; Asiegbu, J.E. and Omaliko, C.P.E. (2005). Effect of length of soaking in water at room temperature and hot water treatment on the germination of *Mucuna flagellipes*, Vogel ex Hook seeds. Global J. Agric. Sci., 4(1):15-18.

A.O.A.C. (1990). Association of Official Agricultural Chemists "Official Methods of Analysis of the association of Official Agricultural Chemists". 15th Ed., Arlington, Virginia 22201: 877-878.

Azad, M.S.; Biswas, R.K. and Abdul Matin, M. (2012). Seed germination of *Albizia procera* (Roxb) Benth. In Bangladesh: a basis for seed source variation and pre-sowing treatment effect. Forestry Studies in China, 14(2):124-130.

Azad, M.S.; Paul, N.K. and Abdul Matin, M. (2010). Do pre-sowing treatments affect seed germination in *Albizia richardiana* and *Lagerstroemia speciosa*?. Frontiers of Agriculture in China, 4(2):181-184.

Bahar, N. (2007). Pod and seed characteristics and effect of pretreatment on seed germination of *Acacia robusta* Burchell. Indian J. Forestry, 30(3):333-336.

Bahar, N. (2011). Evaluation of pretreatment techniques to enhance seed germination of *Acacia mangium* Wild. Annals of Forestry, 19(2):221-226.

Bailey, L.H. (1976). Hortus Third, Macmillan Publishing Co., Inc., 866 Third Avenue, New York, N. Y. 10022. Printed in USA, pp. 1290.

Bhardwaj, N.R.; Chandel, R.S. and Pathania, N. (2006). Effect of pre-sowing treatments on germination behavior and seedling vigour index of *Albizia lebbek* seeds. Proc. of the IUFRO-ISTS-UHF Inter. Conf. of World Prespective on Short Rotation Forestry For Industrial and Rural Development, Nauni, Solan, India, 7-13 Sept., 276-278.

Burrows, G.E.; Virgona, J.M. and Heady, R.D. (2009). Effect of boiling water, seed coat structure and provenance on the germination of *Acacia melanoxylon* seeds. Australian J. Botany, 57(2):139-147.

Dhanda, S.K.; Verma, R.C. and Panwar, R.D. (2011). Seed and seedling quality of some multipurpose tree species of arid and semi-arid regions. Environment and Ecology, 29 (1 A): 442-447.

Dubois, M.; Smith, F.; Illes, K.A.; Hamilton, J.K. and Rebers, P.A. (1956). Colorimetric method for determination of sugars and related substances. Ann. Chem., 28(3):350-356.

Duncan, D.B. (1955). Multiple range and multiple F. Tests. Biometrics,11: 1- 24.

Ghassali, F.; Salkini, A.K.; Petersen, S.L.; Niane, A.A. and Lauhaichi, M. (2012). Germination dynamics of *Acacia species* under different seed treatments. Range Management and Agroforestry, 33(1):37-42.

Hartmann, H.T. and Kester, D.E. (1983). Plant Propagation: Principles and Practices. Prentice-Hall Inc., Inglewood Cliffs, N. J., 662pp.

Junior, R.A.G.; Faria, J.M.R.; Vaz, T.A.A.; Nakamura, A.T. and Jose, A.C. (2014). Physical dormancy in *Senna multijuga* seeds: the role of seed structure in waste water uptake. Seed Science research, 24(2):147-157.

Kak, A.; Devi, L.C.; Gupta, V. and Singh, N. (2007). Response of seed treatments on seed germination in wild *Crotalaria species*. Acta Hort., 752:261-265.

Kalia, V.; Chandel, K. and Kumar, P. (2005). Effect of scarification treatments on germination of shrubby stylo (*Stylosanthes scabra*) seeds. Seed Research, 33(1):119.

Kenneth, V.T. (1979). Physiology of Plant Growth and Development. B. Willkins TaTa, McGraw-Hill Publishing Co. Ltd., New Delhi.

Khan, M.R. (2013). The effects of pretreatments on seed germination of *Cassia auriculata* L. and *Cassia tora* L. Advances in Plant Sciences, 26(1):253-256.

Kong, L. S. and Lum, S. (1996). A Guid to Common Horticultural Shrub. 1st Ed., Singapore Science Center, Singapore, 609081, p. 71.

Mead, R.; Curnow, R.N. and Harted, A.M. (1993). Statistical Methods in Agriculture and Experimental Biology. 2nd Ed., Chapman & Hall Ltd., London, 335 pp.

Odetola, J.A. (1987). Studies on seed dormancy, viability and germination in ornamental palms. Principes, 31(1):24-30.

Raghavendra, S.M.; Shankanur, M.; Venkatesh, L. and Nagarajaiah, C. (2010). Duration of hot water treatment on seed germination of *Erythrina indica* L. Environment and Ecology, 28(3 B):2123-2124.

Ramamoorthy, K.; Rajendran, C. and Sivasubramanian, S. (2005). Seed treatment for alleviation of hardseededness in senna (*Cassia angustifolia* L.). Advances in Plant Sciences, 18(1):429-430.

Sanyang, S.E.; Kabura, B.H. and Wenchi, H. (2008). Effect of some seed pretreatments on emergence of *Acacia*

senegal L. World J. Agric. Sci., 4(2):213-219.

Saric, M.; Kastrori, R.; Curic, R.; Cupina, T. and Geric, I. (1967). Chlorophyll Determination. Univ. U Noven Sadu Parktikum is Fiziologize Biljaka, Beogard, Haucna, Anjiga, p. 215.

SAS, Institute. (1994). SAS/STAT User`s Guides Statistics. Vers. 6.04, 4th Ed., SAS. Institute Inc. Cary, N.C., USA.

Selvaraju, P. and Selvaraj, J.A. (1994). Effect of pre-sowing treatments on germination and vigour of seed in marigold (*Tagetes erecta* L.). Madras Agric. J., 81(9):469-497.

Sharma, S.; Ranjana, N.; Varghese, B.; Keshavkant, S. and Naithani, S.C. (2008). Effect of hot water treatment on seed germination of some fast growing tropical tree species. J. Tropical Forestry, 24(3/4):49-53.

Singh, A. and Dhillon, G.P.S. (2007). Enhancing germination potential of three leguminous tree species through pre-sowing seed treatments. Indian J. Forestry, 30(2):145-146.

Singh, K.P.; Dhakre, G. and Chauhan, S.V.S. (2005). Effect of mechanical and chemical treatments on seed germination in *Pongamia glabra* L. Seed Research, 33(2):169-171.

Soliman, A.S. and Abbas, M.S. (2013). Effects of sulfuric acid and hot water pre-treatments on seed germination and seedlings growth of *Cassia fistula* L. American-Eurasian J. Agric. & Environ. Sci., 13(1):7-15.

Tadros, M.J.; Samarah, N.H. and Alqudah, A.M. (2011). Effect of different pre-sowing seed treatments on the germination of *Leucaena leucocephala* (Lam.) and *Acacia farnesiana* (L.). New Forests, 42(3):397-407.

Uniyal, A.K.; Singh, B. and Dhanai, C.S. (2007). Effects of pretreatment on *Dalbergia sissoo* seed germination. Progressive Research, 2(1/2):144-146.

Wen, H.X.; Wang, Y.; Wu, Y. and Baskin, C.C. (2009). Role of the lens in controlling water uptake in seeds of two Fabaceae species treated with sulfuric acid and hot water. Seed Science Research, 19(2):73-80.

William, M.; Chichlilo, P.; Clifford, P.A. and Reynolds, M. (1965). Official Methods of Analysis of the Association of Official Agriculture Chemists, 10th Ed., Washington D.C. 20044: 52-55.

تأثير معاملات ما قبل الزراعة على إنبات بذور ونمو شتلات شجيرة الكاليندرا

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أجري هذا البحث تحت الظل بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر، خلال موسمي ٢٠١٣، ٢٠١٤ وذلك لدراسة تأثير بعض معاملات ما قبل الزراعة وهى: بذور بدون معاملة (مقارنة)، النقع فى مياه الصنبور لمدة ٢٤ ساعة على درجة حرارة الغرفة، النقع في ماء سبق غليه لمدة ٢٤ ساعة، الغمس فى ماء مغلي (١٠٠ °م) لثوان قليلة ثم فى ماء بارد (٥ °م) بشكل مفاجئ (معاملة الصدمة الحرارية)، النقع فى حمض كبريتيك مركز (٩٨.٥ %) لمدة ٢ أو ٤ دقائق (خدش كيماوي) وأخيراً خدش القصرة بورق صنفرة خشن (خدش ميكانيكي) وذلك على إنبات بذور ونمو شتلات شجيرة الكاليندرا (*Calliandra haematocephala* Hassk.).

أوضحت النتائج المتحصل عليها أن معظم المعاملات المستخدمة بهذه الدراسة أدت إلى تحسين نسبة وسرعة الإنبات، متوسط معدل الإنبات، دليلي معدل الإنبات وقوة الإنبات، حيوية البذور وطول السويقة الجنينية العليا للبذور

المنبتة، بجانب تحسين نمو الشتلات الناتجة بفروق معنوية متفاوتة عند مقارنتها بالكنترول فى كلا الموسمين، باستثناء معاملة الصدمة الحرارية والتي فشلت تماماً فى إحداث الإنبات. لوحظ أيضاً أن حيوية البذور قد انخفضت بشكل واضح نتيجة للخدش الميكانيكي باستخدام ورق الصنفرة لتصل إلى أقل القيم على الإطلاق. أيضاً، فإن محتوى البذور غير المعاملة من الإندولات والفينولات الكلية كان ثابتاً (متقارباً) قبل وبعد المعاملة لعدم تعرضها لأى معاملة، بينما زاد هذا المحتوى فى البذور المعاملة بعد معاملتها بالمعاملات المختلفة ليصل محتوى الإندولات الكلية إلى أقصاه عند النقع إما في حمض الكبريتيك المركز أو الماء الذى سبق غليه، إلا إن هاتين المعاملتين أحدثتا زيادة طفيفة جداً فى محتوى البذور من الفينولات الكلية مقارنة بالكنترول والمعاملات الأخرى، لذا حدث الإنبات فى غضون ٥-١٠ أيام فقط. إضافة إلى ذلك، فإن محتوى أوراق الشتلات الناتجة من كلورفيللى أ، ب والكاروتينويدات والسكريات الكلية الذائبة للبذور المعاملة قد زاد بدرجة واضحة، خاصة عند المعاملة بالنقع فى حمض الكبرتيك أو الماء الذى سبق غليه. وبصفة عامة، فإن السيادة فى جميع القياسات السابقة كانت للنقع إما فى حمض الكبرتيك المركز لمدة ٢ دقيقة فقط أو فى ماء سبق غليه لمدة ٢٤ ساعة، حيث أعطت هاتين المعاملتين أعلى المتوسطات على الإطلاق فى معظم الصفات التى تم قياسها.

وعليه يمكن التوصية بمعاملة بذور الكاليندرا (*Calliandra haematocephala* Hassk.) قبل الزراعة إما بالنقع فى ماء سبق غليه لمدة ٢٤ ساعة أو فى حمض كبرتيك مركز لمدة ٢ دقيقة فقط للحصول على أفضل إنبات وأحسن نمو للشتلات الناتجة.