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Improving Seed Germination and Seedling Growth of Some Economically Important Trees by Seed Treatments and Growing Media

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Abstract: The present work aimed to improve seeds germination and seedlings growth of two important ornamental trees, Orchid tree (*Bauhinia variegate*) and royal poinciana (*Delonix regia*). Experiments were conducted at the Agriculture Experimental Farm of Sohag University, Egypt during two successive seasons from September to December 2007 and 2008. For germination experiment, four growing media (sand, peat moss, loam and mixture 2:1 of sand and farmyard manure) and four seed treatments (scarification, soaking in water for 12h, soaking in ethanol 10% for 3h and control without treatment) were studied under wire house conditions. One month later, seedlings were transferred individually to pots containing respected media for studying seedlings growth under open field conditions. Sand media allowed the highest germination percentage, germination index, germination value, germination period and speed of emergence compared to other media for both species. Similar good results were obtained with seeds scarification compared to other seed treatments for both species. Transferring seedlings to sand medium also increased roots development and subsequently seedlings growth for both trees. The optimum treatment for maximum seeds germination and seedlings growth was to sow scarified seeds in sand media for three weeks followed by transferring seedlings to sand medium for two months. The obtained results revealed that seed germination and seedling growth of *Bauhinia variegate* and *Delonix regia* can be improved by simple and economic method. It could be very beneficial for the production of such important ornamental trees for commercial and environmental purposes.

Key words: *Bauhinia* · *Delonix* · Orchid · Poinciana · Trees · Germination · Seedling · Soil · Media · Pre-treatment · Sowing · Sand · Loam · Farmyard Manure · Scarification · Soaking · Ethanol · Development · Commercial · Environment

INTRODUCTION

Seeds of some species are prevented from completing germination because of coat enhanced dormancy; embryos of these seeds are not dormant. In other species, dormancy is related to embryo; the embryos themselves are dormant. Germination starts by the uptake of water by the dry seed-imbibition and is completed when a part of the embryo, usually the radicle, penetrates seed coat [1]. Rapid and uniform field emergence is an essential prerequisite to increase yield, quality and ultimately profits in crops. Various seed priming techniques have been developed, including hydropriming (soaking in water), halopriming (soaking in inorganic salt solutions), osmopriming (soaking in solutions of different organic osmotica), thermopriming (treatment of seed with low or high temperatures), solid matrix priming (treatment of seed with solid matrices) and biopriming (hydration using biological compounds) [2]. Several studies on seed germination and seed emergence revealed the beneficial effects of seed priming by several ways including heat, smoke, soaking, leaching, temperature, scarification and NaCl salinity [3].

Treatment of seeds by chemicals (KNO_3 or $NaHClO_3$) or growth regulators (GA_3 or BA) to improve germination was widely investigated [4-6]. To improve germination of *Cassia* species, seeds were dropped in water at 21°C or 50°C then soaked in water for 24, 48, 72 hours duration before sowing. The highest germination percentage was obtained with H_2SO_4 scarification at 50°C for 24h and H_2SO_4 scarification at 21°C for 48h for *Cassia siamea* and *Cassia roxburghii* respectively [7]. Ethanol was used at different concentrations from 0.1 to 3% and for different soaking times from 4 to 24h in 10% ethanol solution for seed germination of three turfgrass genera. Germination percentage increased with higher concentrations of

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ethanol up to 3% (v:v) in one genus only but decreased in the two other ones. Soaking seeds of studied genera in 10% ethanol inhibited germination percentage for all studied genera at any studied time [8]. Soaking of rice seeds in different concentrations of ethanol for 48 h as pre-sowing treatment gave negative effect where no seed germinated/emerged following to 10 and 15% (v/v) ethanol treatment. However, Soaking rice seeds in 1 or 5% ethanol solution resulted in earlier and more uniform germination [9]. Manual nicking and acid scarification improved the germination percentage of *Albizia*, the most effective and practical method of pre-treatment to obtain quicker and higher germination was physical scarification followed by soaking in flowing water for 24 hours [10]. Treatment of *Plukenetia conophorum* seeds with hot water at 90°C, warm water at 60°C, overnight soaking in cold water and scarification resulted in significant effects on germination and growth of the crop. Scarification and overnight soaking in cold water produced best quality seedlings [11]. Hossain *et al.* [12] reported that depulping the fruits of *Terminalia chebula* and soaking in water for various periods significantly enhanced seed germination and seedling growth. The highest germination percentage was observed in the fruit depulped and soaked in cold water for 48 hours followed by the depulped seeds soaked in cold water for 24 hours. The effect of soil type of growing media was also investigated to improve germination and growth of *Plukenetia conophorum*. Results obtained with humus + manure or topsoil + manure at a 2:1 ratio showed that the types of nursery media used were significant only on seedling growth but not on germination. Topsoil produced superior plant growth in terms of plant height, collar girth and leaf number [11].

Trees play a major role in horticultural landscape activities and flowering trees can augment the aesthetic, landscape and recreational elements of the ecosystem. Planting of amenity trees in urban areas helps in mitigating air pollution by reducing energy use, carbon dioxide emissions and ground-level ozone. Seed dormancy is the most limiting factor for plant propagation in nurseries. Seeds of most tropical leguminous trees are dormant due to impermeability of the seedcoat. Orchid tree (*Bauhinia variegate*) and royal poinciana (*Delonix regia*) are among the most popular ornamental trees belonging to family Fabaceae (Leguminosae). Orchid tree has fragrant flowers largely used for food and fodder, fuel, fiber, resin, lipids, medical uses and streets decoration. Royal Poinciana is a beautiful flowering tree used as reclamation plant, shade tree, specimen and residential street tree. Very little literature are available on the germination of these economically important trees. The concentrated sulfuric acid soaking for 0.5 to 5h improved germination [13] and the hot-wire scarification proved superior to other means [14]. The present work aimed to study the effect of several seed treatments and growth media on seed germination and seedling growth of orchid tree and royal poinciana.

MATERIALS AND METHODS

Seed Materials and Treatments: Seed germination and seedling growth experiments were carried out at the Agriculture Experimental Farm of Sohag University, Egypt during two successive seasons from September to December 2007 and 2008. Orchid tree (*Bauhinia variegate*) and royal poinciana (*Delonix regia*) belonging to family Fabaceae (Leguminosae) were the studied trees. Seeds of both trees were obtained from the Floriculture Experimental Farm of Agriculture Faculty, Sohag University, Egypt. To improve their seed germination and seedling growth, two factors were studied. The first one was seed treatments including control without any treatment, soaking of seeds in water for 12h, physical scarification of seeds and soaking of seeds in ethanol 10% (v:v) for 3h followed by water washing. The second factor was the growing media where seeds were sown directly after treatment in pots of 30 cm in diameter, 25 seeds per pot, filled by sand, peat moss, loam or a mixture 2:1 of sand and farmyard manure. Each treatment contained four pots and all pots maintained under wire house until the end of germination experiment. Irrigation was done similarly for all treatments at 24h intervals until the first germination then 48h intervals until the end of germination experiment. One week later, seedlings of each treatment were transferred individually to pots of 8 cm in diameter filled by respected media. Twenty seedlings were selected and distributed randomizely in four replicates of five seedlings for seedling growth experiment. Seedlings of all treatments were maintained under open field conditions for two months where all standard agricultural practices were carried out similarly.

Experimental Design and Measured Parameters: For seed germination and seedling growth experiments, treatments of both studied trees were arranged as a split-plot in randomized complete-blocks (RCB) design with four replicates, 100 seeds for germination experiment and 20 seedlings for growth experiment. The main plots were assigned for the four growing media while each main plot

consisted of four sub-plots represented the four seeds treatments. Data on germination was recorded starting from the first germination at two days intervals until no further germination. The imbibtion period, number of days from sowing to commencement of germination, was recorded for all studied treatments. The germination percentage (G%) was calculated as the percent of germinating seeds at the end of experiment in relation to the total number of cultivated seeds per pot. The germination index (GI) was calculated as described in the association of official seed analysis [15] by the following formula:

Germination index = Σ (GT/Tt) or

$$\left[\frac{\text{No. of germinating seeds}}{\text{Days of first count}}\right] + \ldots\ldots + \left[\frac{\text{No. of germinating seeds}}{\text{Days of final or last count}}\right]$$

The germination value (GV) was calculated according to Hossain *et al.* [12] by the following formula: Germination value = (ΣDGs/N) x GP/10

Where (GP) is the germination percentage at the end of experiment, (DG) is the daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing, (ΣDGs) is the total germination obtained by adding every DGs value obtained from the daily counts, (N) is the total number of daily counts starting from the first germination and (10) is constant.

The speed of emergence (SE) was calculated according to Islam *et al.* [16] by the following formula:

$$\text{Speed of emergence} = \left[\frac{\text{No. of seedlings emerged 13 days after sowing}}{\text{No. of seedlings emerged 23 days after sowing}}\right] \text{x } 100$$

Imbibtion period (IP), the number of days taken for first and last germination, was counted from the date of treatment. The germination period (GP) was calculated as the difference between the IP of first germination and IP of last germination. Seedling length (cm) and leaves number were recorded at the end of germination experiment.

For seedlings growth experiment, the following parameters were measured two months after beginning of experiment: stem height (cm), root length (cm) and number of leaves per plant. Stem and root were weighed to record stem and root fresh weight per plant (gm). After drying at 80°C for 48h, stem and root dry weight per plant (g) was recorded. Humidity percentage in stem or roots was calculated by dividing the difference between fresh and dry weight by fresh weight and then multiplied by 100.

Statistical Analysis: All data was subjected to analysis of variance (ANOVA) to determine significant differences followed by Tukey's test for the comparison of means at significant level of 5% using S-Plus V. 6 (Professional Release 1; 1988–2001). ANOVA was conducted on the average of the combined data of the two studied seasons for both studied trees independently. Least Significant Difference (LSD) was calculated for each parameter at significant level of 5%.

RESULTS

Seed Germination: Seed germination of *Bauhinia varigata* and *Delonix regia* as affected by seed treatments and growing media is presented in Table (1). Germination started at the fifth days of sowing on sand medium after seed scarification for both species. However, the first germination was shown at the six or seventh day of sowing for the other treatments. Germination continued until the twenty third day from sowing where no further germination was noticed. For both species, the highest germination percentage (G%), germination index (GI), Germination value (GV) and speed of emergence (SE) were obtained with sand medium compared to other tested media with significant differences. The loam medium showed the least results in most cases. Scarification of seeds was also the best treatment compared to control and other tested treatments. Seed treatment with ethanol showed the least results in most cases. Therefore, the combination between sand medium and seed scarification showed significantly the best results for both species. This condition also showed the least imbibtion period (IP) for first germination and the highest one for last germination which resulted in the good germination period (GP) for both species. Under this condition, germination percentage increased up to 54% and 68% in 9 and 11 days for *Delonix regia* and *Bauhinia varigata* respectively. Significantly higher seedling length and leaves number were also shown with scarification treatment. However, the sand medium showed similar or lower seedling length and leaves number compared to the loam medium.

The sand medium allowed an increasing germination from the beginning to the end of experiment compared to other media for both species (Figure 1, A1 and B1). The other media increased germination at the beginning (loam and mixture) or the end (peat moss) of experiment. Similar favorable effect along experiment was obtained with scarified seeds compared to other treatments for both species (Figure 1, A2 and B2). However, ethanol treatment and soaking showed the least accumulative germination

Table 1: Effect of seed treatments and growing media on the germination of *Bauhinia varigata* and *Delonix regia* after 23 days of sowing

		Bauhinia varigata									*Delonix regia*								
Media	Treatment	G%	GI	GV	SE	IP first	IP last	GP	Seedling length (cm)	Leaves number	G%	GI	GV	SE	IP first	IP last	GP	Seedling length(cm)	Leaves number
Sand		57.0	6.2	3.7	82.6	8.3	17.7	9.4	7.7	5.0	39.8	2.3	1.12	68.3	7.3	16.2	8.9	6.1	3.4
Peat		48.3	3.3	1.8	30.8	11.8	22.2	10.4	8.4	5.3	33.8	1.0	0.40	30.7	12.8	19.4	6.6	5.4	2.8
Loam		41.4	3.6	2.1	44.5	11.1	18.9	7.8	11.7	6.3	22.6	1.0	0.34	54.8	11.1	16.7	5.3	5.8	4.1
Mixture		51.9	5.1	2.9	64.9	8.8	18.0	9.2	9.4	5.5	23.2	1.4	0.48	70.2	8.9	14.9	6.1	6.4	2.1
	LSD 0.05	*4.7*	*0.6*	*0.5*	*7.4*	*1.5*	*1.5*	*1.9*	*1.0*	*0.6*	*6.2*	*0.4*	*0.30*	*13.1*	*1.9*	*2.0*	*2.3*	*0.8*	*0.8*
	Control	53.3	5.1	3.1	57.3	9.8	19.4	9.8	8.5	5.1	22.6	1.0	0.26	58.9	10.8	16.7	5.9	5.0	2.8
	Soaking	46.0	4.3	2.3	58.6	9.8	18.6	10.3	9.5	5.6	18.6	0.8	0.20	43.2	11.8	17.0	4.8	7.1	3.1
	Scarification	59.2	5.7	3.8	60.2	9.4	19.8	8.0	10.6	6.1	44.2	2.5	1.26	63.4	8.8	16.4	7.7	5.8	3.5
	Ethanol	40.1	3.1	1.4	46.6	11.0	19.1	8.7	8.6	5.3	34.2	1.6	0.64	58.4	8.8	17.1	8.3	5.8	3.0
	LSD 0.05	*4.7*	*0.6*	*0.5*	*7.4*	*1.5*	*NS*	*1.9*	*1.0*	*0.6*	*6.2*	*0.4*	*0.30*	*13.1*	*1.9*	*NS*	*2.3*	*0.8*	*NS*
Sand	Control	60.5	6.9	4.2	84.1	8.5	19.5	11.0	8.8	5.3	28.0	1.6	0.46	78.8	7.8	15.5	7.8	5.3	3.0
Sand	Soaking	52.3	6.2	3.6	92.7	7.8	14.5	6.8	7.0	4.5	26.4	1.3	0.44	51.6	9.3	16.0	6.8	7.3	4.0
Sand	Scarification	67.7	7.2	4.9	83.1	8.0	18.8	10.8	8.9	5.8	53.6	4.1	2.34	94.1	5.5	14.3	8.8	6.1	3.6
Sand	Ethanol	47.7	4.4	2.2	70.5	8.8	18.0	9.3	6.3	4.5	51.4	2.3	1.26	48.5	6.8	19.0	12.3	5.9	3.0
Peat	Control	44.8	2.7	1.4	30.3	12.0	22.3	10.3	7.3	5.3	28.4	0.8	0.24	34.2	13.3	20.5	7.3	5.1	2.0
Peat	Soaking	45.5	2.7	1.4	21.0	12.0	22.8	10.8	7.4	5.0	24.6	0.7	0.20	16.6	14.3	20.3	6.0	4.8	3.0
Peat	Scarification	59.7	4.9	3.1	44.1	11.3	21.3	10.0	10.4	6.0	46.6	1.3	0.66	17.4	12.5	19.5	7.0	6.4	3.0
Peat	Ethanol	43.0	2.7	1.3	27.7	12.0	22.5	10.5	8.6	5.0	35.6	1.3	0.48	54.4	11.3	17.3	6.0	5.3	3.0
Loam	Control	49.8	4.4	2.8	47.6	10.3	19.3	9.0	11.0	5.5	17.4	0.7	0.16	55.0	11.5	17.5	6.0	5.0	3.5
Loam	Soaking	32.2	2.7	1.2	42.0	11.8	17.8	6.0	12.5	7.0	9.6	0.5	0.08	57.5	12.0	15.3	1.8	6.6	3.8
Loam	Scarification	48.5	4.7	3.2	52.3	10.0	20.3	10.3	12.5	6.5	36.0	1.9	0.78	62.5	10.3	16.0	5.8	6.0	5.0
Loam	Ethanol	35.0	2.6	1.1	35.9	12.5	18.5	6.0	10.6	6.0	27.4	1.1	0.38	44.0	10.5	18.0	7.5	5.8	4.3
Mixture	Control	58.2	6.3	3.9	67.2	8.5	16.8	8.3	7.1	4.5	16.6	0.8	0.20	67.5	10.5	13.3	2.8	4.8	2.8
Mixture	Soaking	53.8	5.7	3.1	78.7	7.8	19.3	11.5	11.1	6.0	13.4	0.6	0.08	46.9	11.8	16.5	4.8	9.8	1.5
Mixture	Scarification	60.8	5.7	3.7	61.2	8.3	18.8	10.5	10.5	6.0	40.6	2.6	1.20	79.5	6.8	16.0	9.3	4.8	2.3
Mixture	Ethanol	34.8	2.6	1.0	52.4	10.8	17.3	6.5	8.9	5.5	22.4	1.6	0.46	86.8	6.5	14.0	7.5	6.3	1.8
	LSD 0.05	*9.4*	*1.2*	*1.0*	*14.9*	*2.9*	*3.0*	*3.8*	*1.9*	*1.1*	*12.4*	*0.8*	*0.58*	*26.2*	*3.8*	*4.0*	*4.6*	*1.6*	*1.5*

Average of 2007 and 2008 seasons. (G%) germination percentage, (GI) germination index, (GV) germination value, (SE) speed of emergence, (IP) imbibtion period for first and last germination, (GP) germination period

Table 2: Effect of seed treatments and growing media on the growth of *Bauhinia varigata* and *Delonix regia* seedlings after 2 months of transplanting

		Bauhinia varigata							*Delonix regia*						
Media	Treatment	Stem height (cm)	Root length (cm)	Leaves number	Stem DW*(g)	Root DW*(g)	Stem H%**	Root H%**	Stem length(cm)	Root length (cm)	Leaves number	Stem DW*(g)	Root DW*(g)	Stem H%**	Root H%**
Sand		9.2	9.3	5.5	0.19	0.07	66.2	68.4	7.4	6.0	4.8	0.13	0.04	71.9	66.3
Peat		9.0	8.8	5.1	0.15	0.07	72.0	70.6	7.5	5.4	3.6	0.10	0.02	74.7	80.0
Loam		6.8	5.6	5.1	0.12	0.06	68.2	68.6	6.3	5.6	4.3	0.13	0.03	67.2	68.6
Mixture		7.6	7.3	5.3	0.14	0.06	72.6	69.1	6.9	6.3	4.4	0.09	0.02	73.9	64.8
	LSD 0.05	*1.5*	*1.0*	*0.3*	*0.02*	*0.01*	*2.8*	*NS*	*NS*	*NS*	*0.4*	*0.02*	*0.01*	*3.0*	*4.9*
	Control	8.4	6.8	5.2	0.15	0.06	71.4	71.8	7.2	5.8	4.2	0.10	0.03	72.7	68.0
	Soaking	8.9	8.6	5.3	0.16	0.08	67.1	68.1	6.3	5.4	4.1	0.12	0.03	68.9	71.5
	Scarification	8.1	8.0	5.3	0.15	0.07	71.1	66.0	7.5	6.3	4.5	0.10	0.03	73.8	64.6
	Ethanol	7.2	7.6	5.3	0.15	0.05	69.3	70.8	7.0	5.8	4.5	0.10	0.02	72.2	75.6
	LSD 0.05	*1.5*	*1.0*	*NS*	*NS*	*0.01*	*2.8*	*3.1*	*NS*	*NS*	*NS*	*NS*	*0.01*	*3.0*	*4.9*

Table 2: Continued

Sand	Control	9.9	7.3	5.5	0.21	0.06	66.4	71.5	6.8	6.0	4.7	0.13	0.04	70.8	65.3
Sand	Soaking	10.0	10.5	5.7	0.25	0.11	60.3	64.8	6.7	5.0	4.4	0.14	0.04	70.6	60.4
Sand	Scarification	8.0	9.6	5.2	0.13	0.04	70.4	67.7	8.2	6.5	5.2	0.11	0.04	74.7	71.7
Sand	Ethanol	8.8	10.0	5.7	0.17	0.06	67.4	69.7	7.8	6.5	5.0	0.13	0.03	71.6	67.8
Peat	Control	9.0	7.6	5.0	0.15	0.06	76.0	72.0	8.3	4.8	3.6	0.08	0.02	83.2	74.0
Peat	Soaking	9.8	9.6	5.2	0.13	0.06	69.0	68.6	7.0	4.9	3.4	0.07	0.02	72.9	79.6
Peat	Scarification	8.7	8.5	5.3	0.15	0.08	71.2	66.9	7.1	6.3	3.6	0.11	0.02	75.6	80.0
Peat	Ethanol	8.7	9.3	5.1	0.17	0.07	71.8	74.9	7.5	5.4	3.9	0.11	0.01	67.1	86.3
Loam	Control	6.8	5.4	5.1	0.10	0.05	69.7	67.3	5.9	5.6	3.8	0.11	0.02	68.3	72.4
Loam	Soaking	6.9	5.7	4.9	0.09	0.06	68.1	72.0	5.6	5.4	4.2	0.22	0.03	49.4	74.1
Loam	Scarification	8.4	6.7	5.4	0.18	0.09	67.9	60.9	7.4	5.5	4.8	0.09	0.04	78.0	53.9
Loam	Ethanol	5.0	4.5	5.2	0.13	0.04	67.0	74.2	6.1	5.8	4.4	0.09	0.02	73.0	74.2
Mixture	Control	8.0	7.0	5.4	0.14	0.06	73.6	76.2	7.7	6.6	4.5	0.10	0.03	68.5	60.4
Mixture	Soaking	8.9	8.7	5.6	0.17	0.08	70.9	66.9	6.1	6.3	4.4	0.06	0.02	82.7	72.1
Mixture	Scarification	7.2	7.1	5.2	0.14	0.07	75.1	68.7	7.4	6.8	4.3	0.10	0.03	67.1	52.7
Mixture	Ethanol	6.1	6.4	5.2	0.12	0.04	70.7	64.5	6.6	5.4	4.6	0.07	0.02	77.2	74.0
	LSD 0.05	*3.0*	*1.9*	*0.6*	*0.04*	*0.03*	*5.7*	*6.2*	*NS*	*NS*	*0.8*	*0.04*	*0.02*	*6.0*	*9.9*

Average of 2007 and 2008 seasons. * (DW) dry weight, (H%) Humidity percentage.

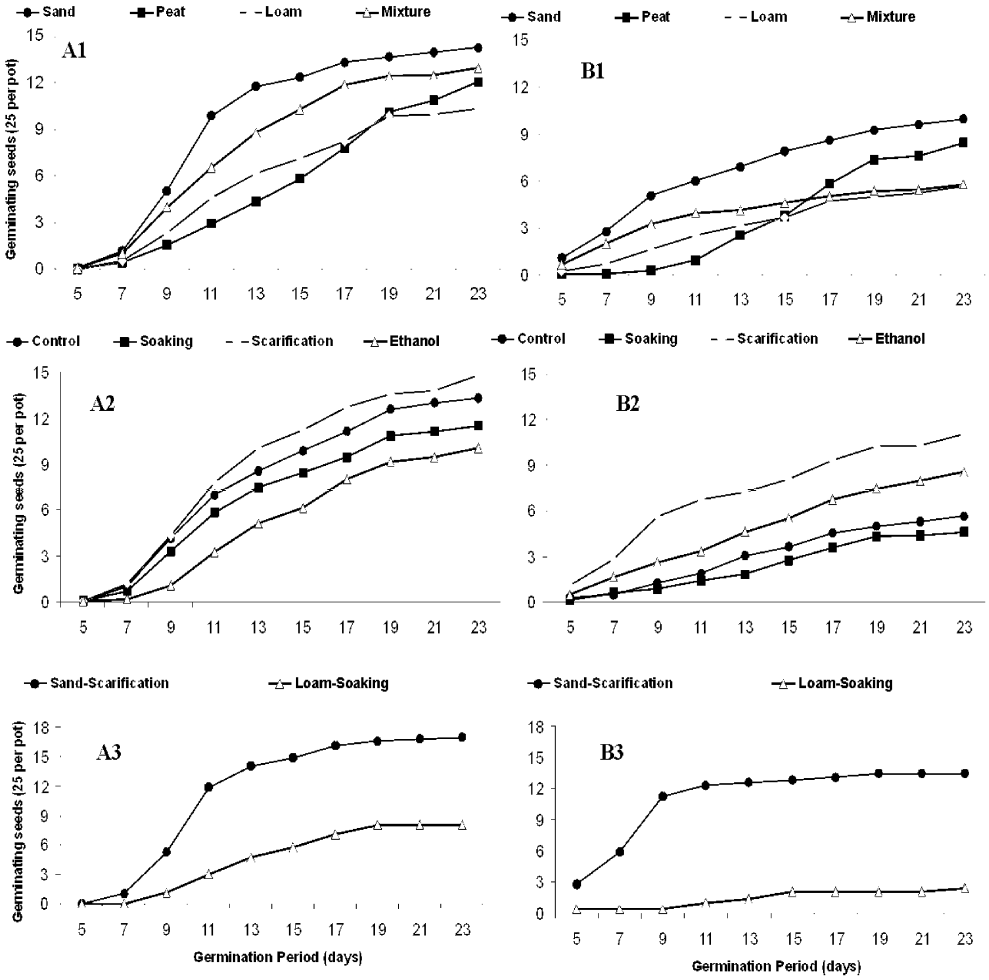

Fig. 1: Germination curve for *Bauhinia varigata* (A) and *Delonix regia* (B) as affected by growing media (1), seed treatments (2) and two different combinations (3) presented as average of two successive seasons

Fig. 2: Germination of *Bauhinia varigata* and *Delonix regia* scarified seeds on sand (A, C) and loam (B, D) media respectively

Fig. 3: (A) Growth of *Bauhinia varigata* seedlings resulted from control (1), soaking (2), scarification (3) and ethanol (4) treatments on sand media. (B) Growth of *Bauhinia varigata* roots on sand (1), peat moss (2), mixture 2:1 of sand and farmyard manure (3) and loam (4) media.

for *Bauhinia varigata* qnd *Delonix regia* respectively. The best germination rate for both species was obtained with seeds sowing on sand media after scarification treatment compared to other combinations including the traditional one; sowing in loam medium after soaking of seeds (Figure 1, A3 and B3). It was also clear that sowing scarified seeds on sand medium is better that sowing them on loam medium for both species (Table 1 and Figure 2). *Bauhinia varigata* showed higher response to treatments compared to *Delonix regia* (Table 1 and Figure 1-2).

Seedling Growth: Data presented in Table (2) show growth of *Bauhinia varigata* and *Delonix regia* seedlings as affected by seed treatments and growing media, two months after transplanting to respected sowing media. Stem height and root length were significantly affected by both studied factors for *Bauhinia varigata* only. The sand medium showed the highest stem and the longest and largest root compared to other tested media (Figure 3). Seedlings resulted from soaking and scarification treatments also showed better stem and root compared to ethanol and control

respectively (Table 2 and Figure 3). The least results were shown on seedlings grown on loam medium except those resulted from scarification treatment. Leaves number per plant was significantly affected by growing media only for both species. The sand medium followed by the mixture 2:1 of sand and farmyard manure gave the highest leaves number for both species. The best results were obtained on sand and mixture media regardless seedlings resource. Stem dry weight was significantly affected by media type where sand media was the best one for both species. No significant effect was recorded for seed treatment. However, this factor significantly affected root dry weight where scarification and soaking showed better results. Similar favorable effect on this characteristic was also noticed on sand media. Humidity percentage of stem was significantly affected by seed treatments and growing media for both studied species. The peat moss and the mixture 2:1 of sand and farmyard manure showed higher humidity percentage. Peat moss was also gave the highest humidity percentage in roots compared to other media. Seedling resulted from soaking treatment and those resulted from scarification showed the least humidity in stem and root respectively. The control and ethanol seedlings on peat moss showed the highest humidity percentage in stem and root respectively.

DISCUSSION

The present work aimed to improve germination of two ornamentally important trees, *Bauhinia varigata* and *Delonix regia*, showing little germination percentage under standard conditions. Seed treatments and growing media were found to be very effective factors. The sand medium showed the best germination compared to loam and other tested media. Finer textured soils may actually lose more moisture through capillary movement of water and through evaporation at the surface than in coarser textured soils. Due to larger pore size, in sand soil, capillary flow is more easily broken and water loss reduced. Therefore, less moisture will be lost in the top two centimeters where the seeds are located and will ultimately reduce the diurnal variation in moisture levels around the germinating seed [17]. The lower seedling length and leaves number with sand compared to loam can be explained by the competition caused by the high number of germinating seedlings on sand medium. After transplanting, the sand medium increased seedling growth compared to other media. The aeration available in sand soil facilitated root development and respiration as above mentioned which resulted in more nutrients uptake and subsequently good seedling growth. Scarification of seeds gave the best germination and seedling growth results compared to control and other seed treatments. This result is in according with that previously reported on *Plukenetia conophorum* [11]. The early germination of scarified seeds over other treatments is probably due to water and gases entering the embryo early through the cracks and causing a series of enzymatic breakdown resulted in the transformation of the embryo into a seedling early enough than other seed treatments [18]. The earlier germination and speed of emergence may result in earlier growth vigor compared to other treatments. Sowing of scarified seeds on sand medium was found better than sowing on loam medium which can explained by the essential role of growing media for water maintaining and seed germination. Ethanol gave the least results compared to other seed treatments. Salehi *et al.* [8] found that the high concentration of ethanol up to 3% had negative effect on *Lolium* seed germination percentage. They explained that the higher ethanol concentrations may cause embryo damage or death. The negative effect of ethanol was probably due to its toxicity [9]. Egharevba *et al.* [11] reported that the types of nursery media were significant only on seedling growth but not on germination. However, the seed treatments have significant effects on both germination and growth of the crop. The favorable effect of seed treatments on seedling growth was previously reported on *Terminalia chebula* [12]. The mixture 2:1 of sand and farmyard manure gave good seedling growth which ensures the necessity of more nutrients in sand medium for further growth of seedlings. Peat moss showed the highest humidity percentage which may relate to the high water retention of this medium. *Bauhinia varigata* showed higher response to treatments compared to *Delonix regia* which can be explained by the genotypic variation.

CONCLUSION

The sand was found to be the best medium for improving germination of *Bauhinia varigata* and *Delonix regia* compared to peat moss, loam or mixture 2:1 sand to farmyard manure. Scarification of seeds before sowing showed the best germination compared to control, soaking and ethanol treatments for both species. Sowing of scarified seeds on sand medium gave the best germination percentage (G%), germination index (GI), germination value (GV), germination period (GP) and speed of emergence (SE). Transfer of seedlings to sand

medium increased root development and subsequently seedling growth. Seed scarification also increased seedling growth before and after transplanting. The overall results revealed that sowing of seeds in sand medium after scarification gave the best seed germination and seedling growth. The reported results are very beneficial for improvement of seed germination and seedling growth of the studied species. It can contribute in the mass production of these important trees for commercial and environmental purposes.

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