E-ISSN: 2278–179X

JECET; June – August-2013; Vol.2.No.3, 776-786.

Journal of Environmental Science, Computer Science and Engineering & Technology

An International Peer Review E-3 Journal of Sciences and Technology

Available online at www.jecet.org

Environmental Science

Research Article

Effect of Seed Pre-Treatment on Survival Percentage of Three Desert Tree Species

R.Dhupper

Amity Institute of Environmental Science, Amity University, Noida, (U.P.)India

Received: 18 July 2013**; Revised:** 3 August 2013; **Accepted:** 7 August 2013

Abstract: The effect of seed pre-sowing treatment and survival percentage of three desert tree species were studied. Seeds of *Acacia nilotica*, *Albizzia lebbeck* and *Prosopis cineraria* were germinated using cold and boiling water pre-treatments. Pre-treatment included immersion in cold water for 6hr, 12hr and 24hr; immersion in hot water for 15min, 30min, and 45min; abrasion of seed coat and control. Experiments were carried out on Petri dishes containing moistened filter papers and incubated in plant growth chamber. Seed pre-treatment significantly ($P< 0.05$) affected survival percentage in all the three species studied. Generally, cold water pre-treatment resulted in the best survival and growth behaviour of three species. Hot water also gave good survival for the three species. Survival behaviour of cold water soaking pre-treatment was different compared to hot water pre-treatment. More also, increasing the time of soaking in cold water increasing the growth parameters along with survival rate, while in contrast survival percentage decreased with increasing hot water soaking pre-treatment. Soaking for 24 hours in cold water and 30min in hot water resulted in higher survival percentage. Highly significant interactions ($P< 0.05$) were recorded between seed pre-treatment and seed source.

Key words: Pre-treatment, seed source, survival, soaking, hot water.

INTRODUCTION

Several trees have been identified as fast growing and are categorized as high biomass yielders. Certain estimations are required to know how much biomass can be generated in a particular situation with special reference to germination and survival percentage and then seedling growth. However, many of the tree species have seeds which possess hard seed coats that are impermeable to water. This is a typical feature of most leguminous species[1]. Seed coat impermeability has been reviewed by several authors[2], while its ecological significance has been discussed by Fenner[3]. Although seed dormancy is an annoyance to growers, it is actually a fascinating ecological adaptation that works to spread germination out over time and space[4]. This in turn increases the chances that some seeds will successfully germinate to complete the life cycle. The ability to remain dormant for a long period is associated with seeds of species from unpredictable environments and climate, with very variable rainfall trends, such as those found in arid or semi arid areas.

A high level of seed dormancy is a characteristic feature of many plants of dry regions and it either completely prevents germination or allows very few seeds to germinate over a long period of time. Therefore, to obtain rapid, uniform and high germination, the dormancy can be broken by subjecting the seeds to water soaking pre-treatment e.g. (cold / hot water). Seed germination and early seedling growth phases are considered critical for raising a successful crop as they directly determine the crop stand density and consequently the yield of resultant crop [5]. Seed pretreatment has been considered as a method for improving germination, seedling emergence and crop production[6]. Since soaking of seeds are simple, economical and safe it is generally used as an important tool for inducing resistance to moisture stress[7]. The ability of a plant species to tolerate low water availability means that the plants can continue metabolic processes during periods of water limitation.

The species tested for survival and growth behavior are known for their multipurpose uses **(Table 1)**. For many species of *Acacia* and *Prosopis*, their greatest value lies in the provision of highly nutritious pods, which can be stored for use as a dry season supplement and in other times of fodder shortage. In many cases the leaves also provide browse for goats, camels and sheep .Some species of *Acacia* and *Prosopis* are typically phreatophytic, forming a long taproot to reach underground water sources; some species *Prosopis* species, as well as the bipinnate *Acacias*, show surprisingly few xerophytic features. The leaves are not succulent, although in *Acacia* there is a trend towards increased pubescence and a decrease in size and numbers of leaflets in more arid habitats. Small leaflets are found in all the *Prosopis* species, allowing greater conductive heat loss when stomata closing prevent evaporative loss. As in *Acacia*, evapotranspiration losses from *Prosopis* leaves under drought conditions are high; when water stress becomes severe, however, transpiration is reduced by closing the stomata, though clearly this also prevents carbon dioxide uptake for photosynthesis[8]. *Albizzia lebbeck*, a robust, deciduous tree having umbrella of feathery foliage and produces white flowers in heads. It can grow well under a wide range of rainfall regimes (400mm to 2500mm).

Catalan *et al*.[9] reported that plants tolerant at the seed germination stage may not be tolerant at later growth stages. Tolerance during germination and early seedling is critical for plant survival in saline soils[10]. In view of this, the present investigation was carried out to study percent survival of seedlings of three multipurpose tree species of deserts after treatment with varying durations of water soaking. Thereafter the growth performance of seedlings produced from such pre-treated seeds was studied for a period of six month to determine whether the pre-treatment conditions which are considered as best for seed germination are also favourable for early seedling growth and whether seedlings alter their growth parameters in response to pre-treatment of seeds.

Table-1: Description of the three leguminous tree species studied

Tree Species	Common name	Habit	Habitat / Ecology	Distribution	Uses
Albbizia lebbeck (L.) Benth	Hindi name : Indian Walnut English name : Siris	Tree upto 30m, 1.3m in diameter	Deciduous, drought sensitive, light tolerant, superficial root system.	Central and southern India, Chota Nagpur region, Indian peninsula	Afforestation, fuel, fodder, timber, medicinal & miscellaneous
Acacia nilotica (L.) Willd.Ex Del	Hindi name: Desi babul English name :Indian gum tree	Tree upto 20m, 60-80 cm in diameter	Evergreen, drought tolerant, semi light tolerant, taproot system.	Dry & subhumid Rajasthan, Gujarat, Haryana	Afforestation, fuel, fodder, timber, medicinal & miscellaneous
Prosopis cineraria (L.) Druce	Hindi name : Khejri English name :Mesquite	Tree 25 to 30m, 1.8cm in diameter	Evergreen, semi light tolerant, drought tolerant, taproot system.	Dry & arid region: Rajasthan, Haryana, Punjab, Gujarat, Western U.P. and drier parts of Deccan	Afforestation, fuel, fodder, timber, medicinal & miscellaneous

MATERIALS AND METHODS

The germination studies were initially conducted in petriplates in Plant Growth Chamber with controlled environmental conditions. Thereafter the two leaf stage pre-treated germinated seedlings were sown in earthen glazed pots in a Green House in the Department of Bioscience and Biotechnology. Seeds of the three species *Albizzia lebbeck*, *Acacia nilotica* and *Prosopis cineraria* were subjected to following pre-treatment's in a separate study and the pre-treated seedling survival and their growth behaviour was studied.

Water soaking (Cold/Hot): For cold water soaking pre-treatment, the seeds soaked for 6hr, 12 hr and 24 hr were referred to as control (C_1), low (C_2), medium (C_3) and high (C_4) respectively. For hot water soaking pre-treatment, the levels were designated as control (H_1), 15 min (low, H_2), 30 min (medium, H_3) and 45 min (high, H_4). Each pre-treatment had a control (i.e. without any treatment) with the same number of seeds and replicates. The growth behaviour of seedlings raised from such treated seeds was studied for six months. Germinated seedlings of the three species subjected to five different pre-treatment were sown directly in experimental earthen glazed pots at the rate of 10 seeds per pot. Soil used in the experiment was sandy loam. The physico-chemical analysis of soil was done before sowing the seeds in pots. This soil had a pH of 8 and organic carbon was 2.5 g/kg.

The experiment was laid out in randomized block design with three replicates. The survival percentage of the seedlings produced was recorded. When the seedlings attained a height of about 10 cm, they were thinned out to retain only one healthy seedling in each pot. Care was taken to select seedlings of almost equal height. Observations for growth parameters including plant height, stem diameter, number of leaves and leaf area were recorded monthly. At the termination of experiment (after 6 months) whole plant was uprooted from the soil, washed thoroughly with distilled water and dried in the air. Average fresh weight and oven-dried weight of plants were recorded.

With the help of the above data the following growth parameters i.e. specific leaf area (SLA) and sturdiness were determined.

Specific leaf area (SLA): was calculated by using the formula given by Evans[11] .

$$SLA = \frac{\text{leaf area}}{\text{Unit Leaf mass}}$$

Sturdiness: was calculated by using the formula suggested by Chauhan and Sharma[12] .

$$\text{Sturdiness} = \frac{\text{Hight}}{\text{Diameter}}$$

STATISTICAL ANALYSIS

Regression analysis was done for different growth parameter of the species after different pretreatments[13]. The data collected were categorized for two-way analysis. The source of variation was treatments and species. The data was analyzed using two way ANOVA with n observation per cell [14].

RESULTS

Effect of cold water soaking pre-treatment of seeds

Survival percentage: Percent survival of all the species increased with increasing duration of cold water soaking pre-treatment **(Table 2).** The highest survival percentage was observed in *P. cineraria* (92 %) after 24 hrs cold water soaking pre-treatment (C_4 level). In case of *A. lebbeck* low values were observed, (60-89%). However maximum increase at 24 hr soaking pre-treatment relative to control was in *A.lebbeck* (50%), whereas the survival of *P.cineraria* at this level was least affected 9.5% increase **(Table 4).** Survival percentage was significantly positively related to treatment levels in *A.lebbeck* and *P. cineraria* at $p<0.05$ **(Table 5),** whereas the correlation was no significant for *A.nilotica*. Analysis of variance for survival percentage was significant for treatments and species at $p < 0.05$ but no significant for interactions.

Growth parameters : In all the species the values of **height growth, stem diameter** and **leaf production** of six months old seedlings increased with increasing duration of cold water soaking pretreatment **(Table 2).** Comparison between the three species showed that the highest height growth value was observed in *A. nilotica* (43cm) after pretreatment at C_4 level and in case of *A.lebbeck* though low height growth values were observed , but its height growth at C_4 relative to control, showed highest increase (36%) as compared to the other two species (26-33%), Table 4. The maximum stem diameter was observed in *A. nilotica* (4.91mm) under C_4 level and minimum in *P. cineraria* (3.60mm) at untreated control level. Height growth and stem diameter of three species was significantly positively correlated to pretreatment levels at Analysis of variance for height growth and stem diameter under different levels indicated significant difference between treatments, species and their interactions at $p < 0.05$.

Leaf production followed the same pattern as that of height growth, increasing with increasing duration of pretreatment, maximum number of leaves being produced in *A.nilotica* at C_4 level. The ***leaf area*** was maximum in *A. lebbeck* ($1.09cm^2$) under C_4 level and minimum in *P. cineraria* ($0.19cm^2$) at untreated control level.The highest ***root length*** and spread values were observed in *P. cineraria* (50cm and 3.5cm respectively) at C_4 level. In *A. lebbeck* the lowest root length was observed (29cm) at control (untreated) level, **(Table 2),** however ***root spread*** was high (3.5cm) at C_4 level.

Table- 2: Percent survival and morphological parameters of the seedlings after cold water soaking pre-treatment of seeds

Tree species	Levels	Survival (%)	Height (cm)	Stem diameter (mm)	Leaf production	Leaf area (cm^2)	Root length (cm)	*Root spread (cm)*
A.lebbeck	C_1	60	25	4.11	486	0.99±0.010	29±1.019	*3.3±0.102*
	C_2	75	27	4.20	630	1.01±0.005	30±0.588	*34±0.311*
	C_3	80	30	4.50	910	1.05±0.010	32±1.176	*3.4±0.311*
	C_4	89	34	4.80	1000	1.09±0.010	33±1.019	*3.5±0.256*
A.nilotica	C_1	80	34	3.42	1400	0.20±0.006	33±1.176	*3.0±0.102*
	C_2	86	35	3.80	1600	0.21±0.006	34±1.176	*3.1±0.059*
	C_3	90	42	4.56	1800	0.22±0.010	36±2.121	*3.2±0.156*
	C_4	91	43	4.91	2000	0.23±0.006	39±1.019	*3.4±0.311*
P.cineraria	C_1	84	27	3.60	985	0.19±0.010	44±1.556	*3.1±0.059*
	C_2	87	28	3.61	1000	0.20±0.006	46±1.556	*3.1±0.059*
	C_3	90	32	3.83	1340	0.22±0.010	49±1.019	*3.3±0.102*
	C_4	*92*	*36*	*3.90*	*1520*	*0.22±0.010*	*50±0.588*	*3.5±0.256*
SEm±		*19.9*	*0.4*	*0.04*				

SEm = Mean standard error

Total seedling dry mass and ratios: Total seedling dry mass values of the three species increased with increasing duration of pre-treatment **(Table 3).** The highest total biomass value was observed in *A. nilotica* (38g) at C_4 level and showed the maximum increase relative to untreated control (22.5%) was also observed at this C_4 level **(Table 4).** In case of *P.cineraria* (28 g) low total dry weight values were observed (28-31g) and its biomass was least affected at this level (10.7%). Total dry weight was significantly positively correlated to pre-treatment levels in all the three species at $p < 0.05$ (Table 5). Analysis of variance for total dry weight under different levels indicated significant difference between treatments and species at $p < 0.05$, however it was no significant for interactions (Appendix Table 4). The proportional allocation of biomass into different components of the species at different pretreatment levels is depicted in Fig 1. In *A.lebbeck* the stem component increased at C_3 level, while leaf component increased at C_4 level. In *P.cineraria* root component increased at low level of pre-treatment, while stem component at high level.

In *A.lebbeck* and *P.cineraria* root: shoot ratio increased upto C_2 level decreased thereafter. Across the three pretreatment, the highest root: shoot ratio was observed in *P. cineraria* (1.231) at C_2 level and lowest in *A. lebbeck* (0.813) at C_1 level.

Leaf: stem ratio was observed maximum in *A.lebbeck* (0.900) at C_4 level and minimum in *P.cineraria* (0.667) at same level **(Table 3**). Maximum specific leaf area was observed in *A . lebbeck* (0.150 $cm^2 g^{-1}$) at C_3 level and minimum in *A . nilotica* (0.026 $cm^2 g^{-1}$) at C_4 **(Table 3).**

The height: diameter ratio of *A.lebbeck* and *P.cineraria* increased with increasing duration of cold water soaking pretreatment upto the highest level but in case of *A.nilotica* it increased only upto 12 hr level. Amongst the three species, the maximum sturdiness value was observed in *A. nilotica* (10.2) at C_3 level and minimum in *A. lebbeck* (6.1) under untreated control level **(Table 3).**

Table- 3: Parameters based on dry mass of the seedlings after cold water soaking pretreatment of Seeds

Tree species	Levels	Root wt(g)	Shoot wt(g)	Total biomass (g)	Root: Shoot ratio	Leaf: Stem ratio	Specific leaf area (cm^2 g^{-1})	*Height: Diameter ratio*
A.lebbeck	C_1	13	16	29	0.813	0.778	0.141	*6.083*
	C_2	13	15	30	0.867	0.875	0.144	*6.429*
	C_3	14	17	31	0.824	0.700	0.150	*6.667*
	C_4	17	19	33	0.824	0.900	0.121	*7.083*
A.nilotica	C_1	15	16	31	0.938	0.778	0.027	*9.942*
	C_2	15	17	32	0.882	0.700	0.030	*9.211*
	C_3	16	18	34	0.889	0.800	0.028	*10.219*
	C_4	18	20	38	0.900	0.818	0.026	*10.214*
P.cineraria	C_1	15	13	28	1.154	0.857	0.031	*7.500*
	C_2	16	13	29	1.231	0.857	0.033	*7.778*
	C_3	16	14	30	1.143	0.750	0.037	*8.356*
	C_4	*16*	*15*	*31*	*1.067*	*0.667*	*0.037*	*9.230*

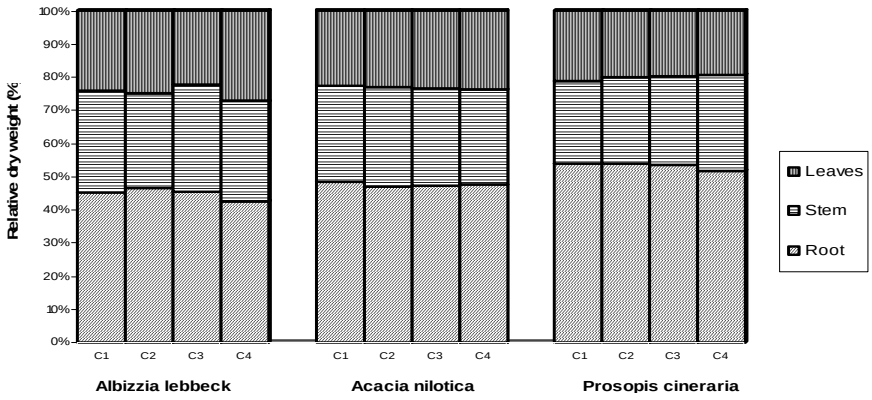

Figure 1: Proportional allocation of biomass of the species into differentcomponents at different levels of cold water pretreatment of seeds

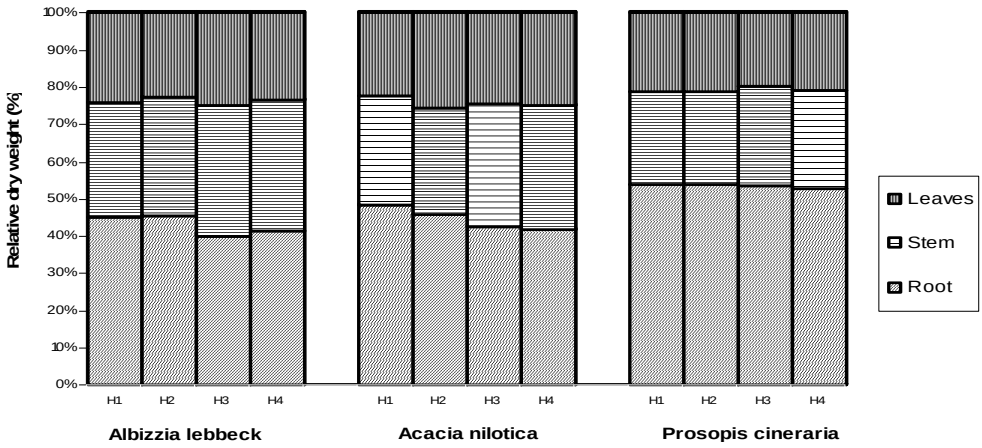

Figure 2: Proportional allocation of biomass of the species into different components at different levels of hot water pre-treatment of seeds

Table- 4: Percent reduction or increase in different growth parameters of the species relative to control (C_1, with no pre-treatment)

Tree species	Levels	Survival %	Height(cm)	Total biomass(g)
A.lebbeck	C_2	+25.0	+8.0	+3.4
	C_3	+33.3	+20.0	+6.9
	C_4	+50.0	+36.0	+13.3
A.nilotica	C_2	+7.5	+2.9	+3.2
	C_3	+12.5	+23.5	+9.7
	C_4	+12.5	+26.5	+22.5
P.cineraria	C_2	+2.4	+3.7	+3.6
	C_3	+7.1	+18.5	+7.1
	C_4	+9.5	+33.3	+10.7

Table- 5: Regression equations between cold water soaking levels and growth parameters of the species

Tree species	Survival (%)	Height (cm)	Stem diameter (mm)	*Total biomass (g)*
A.lebbeck	Y=69.5+0.9X	Y=25+.04X	Y=4.1+0.03X	*Y=29+0.2X*
	r=0.95*	r=0.99*	r=0.98*	*r=0.99**
	t=4.30	t=9.92	t=6.96	*t=9.92*
A.nilotica	Y=82.4+0.4X	Y=34.3+0.4X	Y=3.5+0.06X	*Y=30.6+0.3X*
	r=0.84	r=0.90*	r=0.95*	*r=0.99**
	t=2.19	t=2.92	t=4.30	*t=9.92*
P.cineraria	Y=84.8+0.3X	Y=26.6+0.4X	Y=3.6+0.01X	*Y=28.2+0.1X*
	r=0.96*	r=0.98*	r=0.93*	*r=0.98**
	t=4.84	*t=6.96*	*t=3.57*	*t=6.96*

*** Significant at 5% level of probability**

EFFECT OF HOT WATER SOAKING PRETREATMENT OF SEEDS

Survival percentage: Percent survival of *A.lebbeck* decreased with increasing duration of hot water soaking pretreatment. In *A.nilotica* survival percentage increased only upto low level (H_2), whereas in case of *P.cineraria* survival increased upto H_3 level, declining thereafter **(Table 6).** Amongst the species and all the levels, the highest survival percentage was observed in *P.cineraria* (89%) at H_3 level of pretreatment and lowest in *A.lebbeck* (47%) at H_4 level. However compared to untreated control, the maximum reduction in survival percentage under longest duration of pretreatment was observed in *A.nilotica* (25%) and minimum in *P.cineraria* 21% **(Table 8).** Survival percentage was negatively correlated to hot water soaking pretreatment in all the three species **(Table 9).** The correlation was significant for *A.lebbeck* and *A.nilotica* at $p<0.05$, however it was nonsignificant for *P.cineraria*. Analysis of variance for survival percentage under increasing durations of hot water soaking pretreatments indicated significant difference between treatments, species and their interactions at $p<0.05$

Growth parameters : The highest value for ***height growth*** and ***stem diameter*** was observed in *A.nilotica* (57cm and 4.4mm respectively) at H_2 level and lowest in *A.lebbeck* (15cm and 3.4mm respectively) at H_4 level , which showed maximum (40%) reduction at this level and least reduction in height was observed in *P.cineraria* (7.4%), Table 9. Height and stem diameter of *A .lebbeck* was significantly negatively correlated to hot water pretreatment at $p < 0.05$, however in case of *P.cineraria* height was significantly positively correlated at $p<0.05$ **(Table 9).** However the correlation were nonsignificant for height and stem diameter of *A.nilotica* and also stem diameter of *P.cineraria.* Analysis of variance for height growth under different levels indicated significant difference between treatments, species and their interactions at $p< 0.05$% but nonsignificant difference for stem diameter of species . The

maximum ***numbers of leaves*** were produced in *A.nilotica* (1400) at untreated control level and minimum in *P.cineraria* (370) at H_4 (45min hot water soaking pretreatment). Maximum ***leaf area*** was observed in *A.lebbeck.* (0.99cm^2) at control and lowest in *A.nilotica* and *P.cineraria* (0.19cm^2) at H_4 level (Table 6).The highest ***root penetration*** was observed in *P.cineraria* (48cm) at H_3 level and lowest was in *A.lebbeck* (25cm) at the highest level of pretreatment. However ***root spread*** was maximum in *A.lebbeck* (3.3cm) at control and minimum in *A.nilotica* 2.3cm, at H_4 level **(Table 6).**

Table- 6: Percent survival and morphological parameters of the species after hot water soaking pre-treatment of seeds

Tree species	Levels	Survival (%)	Height (cm)	Stem diameter (mm)	Leaf production	Leaf area (cm^2)	Root length (cm)	*Root spread (cm)*
A.lebbeck	H_1	60	25	4.11	486	0.99±0.010	29±1.019	3.3±0.102
	H_2	55	20	3.89	420	0.97±0.031	28±2.038	3.1±0.005
	H_3	49	18	3.70	400	0.97±0.032	27±1.556	3.0±0.102
	H_4	47	15	3.35	385	0.96±0.046	25±1.019	2.9±0.156
A.nilotica	H_1	80	34	3.42	1400	0.20±0.006	33±1.176	3.1±0.059
	H_2	82	57	4.37	1381	0.20±0.006	35±2.564	2.7±0.306
	H_3	65	30	3.31	1115	0.20±0.006	30±0.518	2.5±0.269
	H_4	60	27	3.04	744	0.19±0.010	28±2.038	2.3±0.059
P.cineraria	H_1	84	27	3.60	985	0.19±0.010	44±1.556	3.0±0.102
	H_2	87	29	3.65	1000	0.20±0.006	46±1.556	2.8±0.204
	H_3	89	35	3.75	1235	0.21±0.006	48±2.038	2.6±0.269
	H_4	80	25	3.65	370	0.19±0.010	30±0.588	2.4±0.311
SEm±		9.2	5.9	0.10				

SEm = Mean standard error

Total seedling dry mass and ratios: The seedling dry mass values increased with increasing duration of hot water soaking pretreatment in *A.nilotica* (upto low level) and *P.cineraria* (upto medium level), whereas the dry mass of *A.lebbeck* decreased with increasing levels **(Table 7**). The maximum dry weight was observed in *A.nilotica* (35g) at H_2 level and minimum in *A.lebbeck* (17g) at H_4 level. The maximum reduction at longest duration of hot water soaking pretreatment was observed in *A.lebbeck* (41.4%) and minimum in *A.nilotica* (22.6%). Total dry weight of *A.lebbeck* and *P.cineraria* was negatively related to hot water soaking pretreatment, though the correlation was significant only for *A.lebbeck* at $p<0.05$ **(Table 9).** Analysis of variance for total biomass under different hot water soaking pretreatment indicated significant difference between treatments, species and their interactions at $p<0.05$. In *A.lebbeck*, with increasing pretreatment level, root component decreased while stem increased. In *A.nilotica*, root component increased at H_2 level only and got reduced at the expense of stem component at increasing level **(Fig 2).**

The maximum value for root: shoot ratio was observed in *P.cineraria* (1.154) at control and low level and minimum in *A.lebbeck* (0.667) at medium level of pretreatment. However leaf: stem ratio was highest in *A.nilotica* (0.900) at low level and lowest in *A. lebbeck* (0.667) at high level of pretreatment. The highest value for specific leaf area was attained in *A.lebbeck* (0.240 cm^{2}g^{-1}) at high pretreatment level and lowest in *A.nilotica* (0.022cm^{2}g^{-1}) at low level. The maximum sturdiness (height: diameter ratio) was observed in *A.nilotica* (13.04) at low level and minimum in *A.lebbeck* (4.48) at high level of hot water soaking pretreatment **(Table 7).**

Table 7: Parameters based on dry mass of the seedlings after hot water soaking pre-treatment of seeds

Tree species	Levels	Root wt (g)	Shoot wt (g)	Total biomass (g)	Root:Shoot ratio	Leaf:Stem ratio	Specific leaf area ($cm^2 g^{-1}$)	*Height: Diameter ratio*
A.lebbeck	H_1	13	16	29	0.813	0.771	0.141	*6.083*
	H_2	10	12	22	0.833	0.714	0.194	*5.141*
	H_3	8	12	20	0.667	0.714	0.194	*4.864*
	H_4	7	10	17	0.700	0.667	0.240	*4.478*
A.nilotica	H_1	15	16	31	0.938	0.778	0.027	*9.942*
	H_2	16	19	35	0.842	0.900	0.022	*13.043*
	H_3	13	17	30	0.765	0.700	0.029	*9.063*
	H_4	10	14	24	0.714	0.750	0.0316	*8.882*
P.cineraria	H_1	15	13	28	1.154	0.857	0.031	*7.500*
	H_2	15	13	28	1.154	0.851	0.033	*7.945*
	H_3	16	14	30	1.143	0.751	0.035	*9.333*
	H_4	*10*	*9*	*2.19*	*1.111*	*0.800*	*0.048*	*6.849*

Table 8: Percent reduction or increase in different growth parameters of the species relative to control (H_1, with no pretreatment)

Tree species	Levels	Survival (%)	Height (cm)	Total biomass (g)
A.lebbeck	H_2	-8.3	-20.0	-24.0
	H_3	-18.3	-28.0	-31.0
	H_4	-21.7	-40.0	-41.4
A.nilotica	H_2	+2.5	+67.6	+12.9
	H_3	-18.8	-11.8	-3.2
	H_4	-25.0	-20.6	-22.6
P.cineraria	H_2	+2.4	+7.4	0.0
	H_3	+5.9	+29.6	+7.1
	H_4	-21.4	-7.6	-32.4

Table 9: Regression equations between hot water soaking levels and growth parameters of the species

Tree species	Survival (%)	Height (cm)	Stem diameter (mm)	Total biomass (g)
A.lebbeck	Y=59.5-0.3X	Y=24.3-0.2X	Y=4.1-0.02X	Y=27.7-0.3X
	r=-0.98*	r=-0.98*	r=-0.99*	r=-0.96*
	t=6.96	t=6.96	t=9.92	t=4.84
A.nilotica	Y=83.3-0.6X	Y=42.8-0.01X	Y=3.9-0.01X	Y=33.9-0.2X
	r=-0.91*	r=-0.46	r=-0.46	r=0.74
	t=3.10	t=0.73	t=0.79	t=1.56
P.cineraria	Y=89.3-0.3X	Y=30-0.1X	Y=3.8-0.02X	Y=30-0.2X
	r=-0.33	r=0.99*	r=0.51	r=-0.66
	t=0.49	t=9.92	t=0.84	t=1.24

*** Significant at 5% level of probability**

DISCUSSION

Seed pretreatment has been considered as a method for improving germination, seedling emergence and crop production[6]**.**The seedlings of the tree species tested in the present study responded differently after various pretreatments of seeds, in terms of survival and growth behaviour. After cold water soaking pretreatment to seeds all the species showed increase in survival percentage, height growth and total biomass relative to control. The seedlings of *P.cineraria* showed the maximum percent survival but its growth parameters, especially total biomass was least affected at this level. In case of *A. nilotica* though survival percentage was lower but the height growth and total biomass was maximum under longest duration of cold water soaking pretreatment. The effect of 24 hr cold water soaking pretreatment relative to untreated seedlings was maximum in *A.lebbeck* in terms of survival and height growth. After 30m hot water soaking pretreatment of seeds, a positive effect of pretreatment was seen in the survival percentage and other growth parameters of seedlings of *P.cineraria* but a negative effect was observed on *A.lebbeck* at this pretreatment level, however in case of *A.nilotica* there was a negative effect of pretreatment on survival percentage and other growth parameters but a positive effect was observed at 15 min level of pretreatment, where maximum increase in all the parameters occurred (upto 68% increase in height). Amongst all species maximum reduction relative to control was recorded for all the parameters after 45 min hot water soaking pretreatment. Earlier work on *Acacia* species (Larsen, 1964) has demonstrated that hot water pretreatments improved germination. These variations between survival percentage and growth parameters are probably associated with the difference in the degree of thickness of their seed coat. Imbibition of water is the first process of germination. The germination is of prime importance in the growth cycle of plants as it determines the stand establishment and finally the yield of crops [16]. The continuous layer of tightly packed palisade cells in the seed coat contains the major barrier to water entry into the seeds [16]. The nature of impermeability varies among species, although some similarities exist among closely related species.

Comparison between the three different levels of pretreatments showed that only cold water soaking (24 hr soaking) was most effective pretreatment for all the three species and resulted in high survival percentage, height growth, stem-diameter, leaf production and total biomass. Hot water soaking was least effective for *A .nilotica* and *P.cineraria.* Huck[17] reported that the distribution of root system through space and time is usually influenced by both genetic characters of the plant and localized soil conditions. The development of root should be rapid to overcome the adverse conditions. If the roots are able to go deep and meet the moist soils they are able to withstand the period of drought. The survival of plants in such cases is directly related to root: shoot ratio. The maximum root length and root biomass was observed in *P.cineraria* seedlings after cold water soaking level pretreatment of seeds. Although this may offer poor physical support to the shoot system, it probably provides enough absorptive surfaces to exploit water and nutrients from the top soil.

The results from the above data suggest that *A.nilotica* followed by *P.cineraria* and *A.lebbeck* survive in a relatively a wide range of stresses, once the seeds were released from their dormancy. The pretreatment recommended for seeds of a species may not necessarily be beneficial for it after its establishment i.e. for height growth and total biomass. For example 24 hr cold water soaking pretreatment increased survival and height of *A. lebbeck,* but its dry mass was least affected compared to other two species. Similarly, though survival of *A.nilotica* was not much affected by 15 min hot water soaking pretreatment, its height and dry mass increased and was much higher compared to other species. The fact that some seedlings showed good growth behavior following the above recommended pretreatment, has been considered as a strategy that allows increasing the chances of establishment in arid areas where plantations is at zero level.

CONCLUSION

The results from the above data suggest that *A.nilotica* followed by *P.cineraria* and *A.lebbeck* survive in a relatively a wide range of stresses, once the seeds were released from their dormancy.

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***Corresponding Author: R.Dhupper;** Amity Institute of Environmental Science, Amity University (Noida)