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Response of *Albizia lebbeck* to Moisture Stress on Seed Germination and Moisture Gradient on Seedling Growth

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ABSTRACT

The polyethylene glycol (PEG 6000) was used under laboratory conditions. The studied parameters viz., germination percentage, mean daily germination, peak value, germination value and hypocotyls length was significantly reduced with increase in moisture stress. The control treatment T1 had highest Germination percentage, mean daily germination, peak value, and germination value and hypocotyls length. There were decreases in the values of all the studied germination parameters with increase in moisture stress created by use of different concentration of polyethylene glycol (PEG 6000). The different irrigation interval (days) followed for seedling production in nursery exhibited that different moisture gradients in nursery soil effected significantly seedling growth parameters viz., seedling height, collar diameter, number of leaves, leaf area, number, fresh shoot weight, fresh root weight, chlorophyll a content, chlorophyll b content, nutrient uptake in leafs (N,P,K) and root: shoot ratio were significant. There was decrease in all the studied growth parameters (except root shoot ratio) recorded with increase in moisture stress caused by irrigation interval studied. Out of the three container size of hyco-trays studied, the container size T3 (300 cc) had significantly the highest seedling height, collar diameter, number of leaves, leaf area, fresh shoot weight, fresh root weight, total chlorophyll, nitrogen content in leaf, phosphorus content in leaf, potassium content in leaf and root; shoot ratio as compared to container size T1 (93 cc) and T2 (150 cc).There were increase in all the studied growth parameters (except root shoot ratio) studied with increase in size of root containers, which could be attributed to more growing media and nutrients, and higher water holding capacity in large sized containers.

Key Words: *Albizia lebbeck*, PEG 6000, Root pruners, Water stress, Nursery.

INTRODUCTION

Albizia lebbeck (Linn.) Benth. belongs to sub family mimosoideae and commonly known as Indian Siris or East Indian walnut and it is a tall, unarmed, and deciduous tree distributed throughout India from the plains up to 900m in the Himalayas. Seed quality plays an important role in the production of tree seedlings. Characteristics such as germination percentage, purity, vigor, and appearance are important for foresters for plantation of trees and to farmers for establishing agroforestry plantation. The first event of the plant life cycle is the germination of seeds that's why the uniform seed germination is very important to produce seedlings of uniform size. This can be achieved by the proper pre-sowing treatment which helps in better germination percentage of seeds. The tree planting succession depends upon the quality of plants. A poor quality seedling if planted on a well-prepared, good site there will be mostly chance of producing poor quality trees. In the field, there are wastage of space and resources if poor quality seedlings used which results in low site productivity. Hence, quality tree seedlings should be healthy, vigorously growing and free of diseases; stem should be solid and has a large root collar diameter. The shoot and root biomass should be balance and

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their leaves have a healthy, dark green colour. But due to a lack of quality seedlings production technology in our country of *A. lebbeck* , we are unable to introduce this tree into Agroforestry. Keeping in view this, the present study was undertaken with the following objective

To study the water stress sustainability during seed germination in vitro conditions and during seedling production of Siris in the nursery. Likewise, to evaluate the response of irrigation intervals and container size on the growth of *Albizia lebbeck* seedlings.

MATERIALS AND METHODS

The ripe pods of *Albizia lebbeck* were collected in February - March 2018 from mature trees grown at Punjab Agricultural University, Ludhiana. The seeds were extracted from pods and stored after cleaning in polythene bags. The study site is located at 30º 54` North (latitude), 75º 48` East (longitude) at altitude 247 m above the mean sea level. Moisture stress was applied using six concentrations of PEG 6000, corresponding to -1.0; -3.9; -8.0; -9.8; 11.3 and 12.9 bars of water potential (Table 1). These water potential were obtained by adding in 1000 ml of deionized water of 100, 200, 300, 325, 350 and 375 g of PEG 6000 following the method of Lawlor (1970) and Michel (1983). The seeds were scarified by treating with concentrated sulphuric acid for 10 minutes and then washed four times in running water. These seeds were soaked in distilled water for 24 hr Then seeds were surface sterilized by soaking them first in 70% alcohols for 30 seconds and then 5% calcium hypochlorite for 10 minutes. Seeds were finally rinsed five times with pure sterilized water before plating for seed germination in laboratory at 30±1oc temperature maintained in BOD incubator by taking 25 seeds per replication having four replications in each treatment. After 25 days of germination period, seedlings were evaluated for germination based on normal seedling characters and the results were reported in percentage. Seed germination percentage was calculated using the following formula (ISTA, 1999), Mean daily germination, peak value, and germination value and germination energy was calculated by using the formula given by Czabator (1962). During the process of germination, the seeds were observed for days to first germination and based on the germination observations taken on every day. The data were analyzed with one factor analysis of variance in Randomized block design.

The response of seedling to different irrigation interval (moisture gradient) was studied by giving irrigations at different intervals viz., 7, 10, 14, 18 and 21 days interval (Table 2). The effect of container (hyco-trays) cell volume on seedling growth was studied using three container size viz., 93,150 and 300 CC volumes with requisite number of replications/treatments. Morphological parameters viz., plant height, collar diameter, leaf area, fresh weight of roots and shoots, root shoot ratio and seedling vigour index of *A. lebbeck* were studied. Leaf samples of *A. lebbeck* were collected for mineral analysis (N, P and K). Plant samples collected from the field, were washed in succession with tap water, hydrochloric acid, distilled water and deionized water in plastic containers. The samples were dried in oven at 60-70^{o}c. Plant samples were processed for total nitrogen, phosphorus and potassium estimation as per the methods given by (AOAC, 1975). This study was performed in a randomized block designed factor factorial and data were analyzed as per the procedure laid out by Panse and Sukhatme (1989).

RESULTS AND DISCUSSION

Effect of water stress on germination

Water stress induced by PEG had significant reduction in germination and related characters during seed germination of *Albizia lebbeck* (Table1). The seed germination percentage was highest (95.0%) in control treatment (T1) it was lowest (16.6 %) in treatment with highest water stress level of -12 bars (T7).

Table 1. Effect of moisture stress on Seed germination, Germination value, Mean daily germination, peak value and hypocotyls' length of *Albizia lebbeck*.

Treatment (bars)	Seed germination (%)	Germination value	Mean daily germination	Peak value	Hypocotyls' length (mm)
T1 (0.0)	95	7.0	2.7	2.6	10.3
T2 (-1.0)	88.3	5.7	2.5	2.2	10.0
T3 (-3.9)	70	3.7	2.0	1.8	8.5
T4 (-8.4)	48.3	1.8	1.3	1.2	7.1
T5 (-9.8)	35	0.8	0.9	0.9	6.1
T6 (-11.3)	23.3	0.4	0.6	0.6	5.3
T7 (-12.9)	16.6	0.1	0.4	0.3	4.1
C.D (P=0.05)	5.1	0.5	0.1	0.2	0.2

The germination value, mean daily germination and peak values were highest in the treatment of lowest moisture stress and it followed the decreasing trends in all the parameters with increase in moisture stress level. The decrease in values of each parameter was significant with increase in each stress level to its immediate lower stress level during germination. Drought is an important abiotic stress that plants face and may be responsible for the inhibition or delay of seed germination. The first physiological disorder, which occurs during germination due to polyethylene glycol, was the reduction of water imbibitions by the seeds, which resulted in a series of metabolic changes, including altered enzyme activities and a reduction in metabolism general hydrolysis use of the seed bank (Ahmad and Bano, 1992). Consistently, the activity of α-amylase and β-amylase in germinating seeds is reduced by water stress (Zeid and Shedeed, 2006). Muscoloa et al (2013) also showed PEG-induced water stress in four lentil genotypes and showed that water stress reduced seed germination percentage, root length, and seedling water content in all cultivars to a different extent.

The results confirmed the water stress caused by PEG-induced drought stress in *Albizia lebbeck* seeds and suggested that the variation in contrast stress sensitivity in *Albizia lebbeck* seeds may be related to their higher levels low osmoregulatory capacity. In case of stress, the activities of the hydrolytic enzymes may have an impact, in particular on the levels of α -Amylase and α -Glucosidase, which shows the greatest decrease of concentrated seeds with a high level of PEG 6000. Since cell expansion is dependent on cellular water potential, developing cells dilate less and their size is reduced under stress (Barlow, 1986).

Morphological Characters

The morphological characters showed decreasing trends with increase in irrigation interval (Table 2.). The plant height, collar diameter, average leaf area, number of leaves and fresh weight of shoot was maximum 85.55cm,5.94cm,404.40cm^2,7.6 number and 18.15g in treatment T1(irrigation after 7 d),respectively. These parameters were minimum treatment T5 (irrigation after 21 d). The seedling vigour index also followed the same trend with maximum (6800) in T1treatment was minimum (1710) in T5 treatment. The root shoot ratio was minimum (0.18) in treatment T1 and T2. The total chlorophyll content was maximum (1.62 mg/g) in treatment T1. The total chlorophyll content was minimum (0.72 mg/g) in treatment T5. The nitrogen uptake of N, P and K in leaf content was maximum in T1 treatment it was minimum in treatment T5 (Table 3).

Table 2. Effect of moisture gradient on plant height, collar diameter, leaf area, fresh weight of roots and shoots, root shoot ratio and seedling vigour index of *Albizia lebbeck*

Treatment (irrigation interval)	Plant height (cm)	Collar diameter (mm)	Average leaf area (cm^2)	Number of leaves per branch	Fresh weight of shoots (g / plant)	Fresh weight of roots (g / plant)	Root shoot ratio	Seedling vigour index
T1 (7 d)	85.55	5.94	404.40	7.60	41.00	7.60	0.18	6800
T2 (10 d)	78.80	5.12	372.60	7.00	33.80	6.20	0.18	5616
T3 (14 d)	68.60	4.36	287	5.40	25.80	5.20	0.20	4080
T4 (18 d)	59.80	3.97	240.60	4.40	21.00	5.15	0.24	2832
T5 (21 d)	45.21	3.39	198.20	3.40	18.15	4.60	0.25	1710
C.D (P=0.05)	2.73	0.09	41.11	0.98	1.06	1.06	0.01	28.42

Table 3. Effect of moisture gradient on total chlorophyll, nutrient uptake (N, P and K) in seedlings of *Albizia lebbeck*

Treatment (irrigation interval)	Total chlorophyll (mg/g of fresh weight)	Nitrogen uptake in leaf (mg/g)	Phosphorus uptake in leaf (mg/g)	Potassium uptake in leaf (mg/g)
T1 (7 d)	1.62	24.78	1.88	13.45
T2 (10 d)	1.35	23.93	1.73	12.35
T3 (14 d)	1.16	22.81	1.66	11.35
T4 (18 d)	0.90	20.79	1.57	10.47
T5 (21 d)	0.72	18.61	1.48	9.71
C.D (P=0.05)	0.06	0.83	0.02	0.52

The plant height, collar diameter, average leaf area, numbers of leaves, fresh weight of shoots total chlorophyll and nutrient uptake (N, P and K) in leaf content was maximum in treatment T3 (300 cc) and were minimum in treatment T1(93cc), respectively (Table 4 & 5).

Effect of water stress on growth

The influence of water deficit on the growth of *Albizia lebbeck* plants showed significant variations at all stages of growth. The application of irrigation at 7 d intervals resulted in a significant improvement in plant height, collar diameter, and average leaf area, number of leaves and fresh weight of shoot compared with irrigation at 21d intervals. The most obvious effect of water deficit on the growth of *Albizia lebbeck* plants was inhibition of growth. Cell expansion is one of the most sensitive processes affected by a change in the water status of the plant. Kaewsuksaeng (2011) reported that there was degradation in Chlorophyll in horticultural crops due to moisture stress. Davies and Lakso (1979) observed a linear correlation between photosynthesis and stomatal conductance in trees under water stress and reported that such conditions were responsible for the reduction in leaf area and the rate of photosynthesis. Anjum et al (2011) reported that water stress affects the morphological parameters of the plants .Yordanov et al (2003) have pointed out that water stress influences biochemical and metabolic changes in cell organization, such as turgor pressure, membrane stability, cell size reduction, report water plant, which is directly related to the absorption of water and minerals. Leaf area and stem length are minimized due to

Table 4. Effect of container size on plant height, collar diameter, leaf area, fresh weight of roots and shoots, root shoot ratio and seedling vigour index of *Albizia lebbeck*.

Treatment (volume of root container (cc))	Plant height (cm)	Collar diameter (mm)	Average leaf area (cm^2)	Number of leaves / branch	Fresh weight of shoots (g / plant)	Fresh weight of roots (g /plant)	Root shoot ratio	Seedling vigour index
T1 (93)	58.11	3.08	286.14	4.42	4.42	29.28	0.16	4814
T2 (150)	69.55	4.59	326	5	5	36.57	0.13	5658
T3 (300)	81.43	5.07	354.71	6.28	6.28	40.42	0.11	6885
C.D (P=0.05)	2.93	0.06	6.64	0.80	0.80	1.43	0.01	23.06

Table 5. Effect of container size of total chlorophyll, nutrient uptake (N, P and K) in seedlings of *Albizia lebbeck*.

Treatment (volume of root container (cc))	Total chlorophyll (mg/g of fresh weight)	Nitrogen uptake in leaf (mg/g)	Phosphorus uptake in leaf (mg/g)	Potassium uptake in leaf (mg/g)
T1 (93)	1.18	25.35	1.87	13.85
T2 (150)	1.30	26.40	1.93	14.21
T3 (300)	1.51	27.01	1.96	14.83
C.D (P=0.05)	0.03	0.39	0.03	0.33

decreased cell size, and decreased leaf area ratio reduces the photosynthetic area and ultimately the growth rate. Water stress has resulted in fewer and smaller leaves, smaller and more compact cells, and higher specific gravity, lower leaf area (Shao et al, 2008), and plant biomass due to reduction of the photosynthetic area (Thakur and Sood, 2005).

Arji and Arzani (2003) reported that vegetative traits such as dry and fresh root weight, bud and leaves, leaf surface, number of leaves, and tree height under the stress of drought decreased as compared to unstressed seedlings. Zheng et al (2010) reported that water deficit decreased shoot and leaf biomass and induced significant yield loss. According to Gorai et al (2010), the relative distribution of biomass in the root system increases relative to the epidemic, resulting in an increased root-to-sprout ratio in case of water deficit, which facilitates the increase of the absorption surface so that the plant absorbs more water and minerals (Wu and Cosgrove, 2000). Thomas and Turner (2001) also observed a decrease in chlorophyll content in banana cultivars, resulting in decreased photosynthesis. Baligar et al (2001) reported that the water deficit inhibits the absorption of nutrients from the soil due to a lower perspiration rate, narrower stomata and lower energy supply.

The height of the seedling, the diameter of the crown, the number of leaves, the weight of the fresh sprout, the weight of the fresh root, the root: shoot ratio and the quality index of the seedling were strongly influenced by the size of container.

The higher root weight in 300cc (T3) container was superior to the other root trainers of 150cc (T2) and 93cc (T1) due to the greater volume of container. Bali et al (2013) and Zalzaleh (2009) in a survey also reported that the percentage of seed germination, seedling height, crown diameter and the number of leaves increased with increasing container size in *Acacia saligna*. Similar results have been reported by Aburge and Oti-Boateng (2011) and Rathore et al 2004 in case of *Jatropha curcas* and *Casurina equisetifolia*, respectively. The results corroborate those of Zalzaleh (2009). Therefore, the present study revealed that container size has a profound influence on seedling growth and biomass parameters, since it plays an important role in the carrying capacity of the potting mix, which promotes growth and the development of seedlings in the nursery stage. A larger container provides more volume to retain water and a space for root development, which allows better seedling growth.

CONCLUSION

Water stress should be avoided during first week of sowing to obtain maximum seed germination of *Albizia lebbeck*. Overall better growth of seedlings can be obtained with frequent irrigation i.e. irrigation after seven days interval in nursery. Among the root trainers the root trainer with 300cc volume are good for producing seedlings with maximum growth.

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