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ORIGINAL ARTICLE

Effect of Salinity on Morphological Characters of the *Melia composita* Willd at the Establishment Stage

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ABSTRACT
The purpose of this study was to determine the degree of salt tolerance of Melia composita seedlings at the establishment stage and also to study the effect of salinity extents (control, 4, 8, 12, 16, 20, 24, 28, 32, 36 and 40 dSm^{-1}) on growth parameters. In this experiment, seeds from selected plus tree were grown in pots in screen house containing sand and soil in 2:1section. Required saline concentrations were prepared by adding calculated amounts of sulphate and chloride salts of Ca, Mg and Na as solutions on equivalent weight basis. It was observed that stress by salinity caused significant depletion in growth parameters such as stem radial diameter, shoot length, root length, leaf numbers and plant parts biomass comparative to control plants. All the growth parameters were determined only up to 12 dSm-1 level. After 8 dSm^{-1} plants could not survive due to ions toxicity and mortality occurred.
Key words: *Melia composita, growth parameters, salinity and salt tolerance*

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INTRODUCTION

Melia composita Willd. (synonym: *Melia dubia* Cav.), often familiar with name as white cedar, Burma dek, drek and Malabar neem belongs to the Meliaceae family, which is native to the subcontinent of India but now has broadened in numerous countries of Asia and also in different territories of the planet [13]. Owing to its fast growth, it has become a most preferred tree species by the farmers under agroforestry in northern India. It is deciduous and multipurpose commercial wood species worthy for making ceiling planks, packing materials, agricultural implements, building and construction materials, match boxes, pencils, splints, tea packages and musical gadgets. It has also been screened as an ideal tree species for pulpwood [18] and plywood production at commercial scale. Moreover, *Melia dubia* also aid in mitigation of climate change impacts and carbon sequestration [27]. Nearby, 400 Melia trees can be grown in an acre land which raises revenue almost Rs. 10-12 lakhs in a time period of 6 to 8 years [29].

Different biotic and abiotic stresses such as salinity, drought, low temperature, high irradiance and nutritional factors have great impact on various physiological and biochemical processes of plants [12] and they show a rapid molecular response to changing environmental conditions. In particular, salinity (both of soil and water) is a consequential issue in the arid as well semi-arid region of the sphere where the precipitation is not enough to leach the excess soluble salt from the root zone [17]. About 20% of the world's arable land, or nearly half of all irrigated areas, is affected by salt stress [31]. In India, about 7.4 m ha [23] and in Haryana, 0.53 m ha of land [5] are adversely affected by soil salinity. Salt-induced stress disables essential cellular functions in plants, largely through imbalanced ions, hyperosmotic stress, oxidative induced stress, and toxicity of ions associated with accumulated salt concentration. Reduce stomatal conductance and transpiration rate under high salt stress result in a decline in photosynthetic rate. Nutrient imbalances and ion homeostasis is responsible for causing conversion of biochemical as well as physiological processes in plant species. According to [20], when toxic ions accumulate above the threshold level, growth parameters such as number of leaves, shoot length decreases. Tree species have been classified as sensitive, moderately tolerant, highly tolerant, and extremely high tolerant based on their salt tolerance [4]. Growth of plant under salinity state is usually limited and inauspiciously pretentious because of high level of osmotic stress, toxicity, lack of specific cations. Growth inhibition is initiated at specific salinity thresholds that vary according to species tolerance. It is necessary to determine the salinity threshold at which a species can successfully grow in a particular location before significant losses of planting material occur. Salt stress is the most important stress among all abiotic stress affecting almost all aspects of physiology of plant and yield [6]. However, increased salt concentration has a variety of effects on the structure and functional characteristics of the plant [2] Systematic researches on growth attributes under salt stress conditions are sparse for this particular species. Therefore, the present study was planned and was carried out to sort out the problems of *Melia composita* establishment under saline condition.

MATERIAL AND METHODS

To conduct the experiment, *Melia composita* (Burma dek) plants were maintained in the poly house in April to July, 2021 at Lovely Professional University, Phagwara, (Punjab) which is located at 31.13^{0}N latitude, 75.47 ^{0}E longitude and 234 m above mean sea level. Phagwara has sub-tropical climatic condition with average annual temperature is 24.1 ºC and the average rainfall is 686 mm. During summer, maximum and minimum temperature ranges from 30ºC to 48ºC and from 10ºC to 12.7ºC, respectively. Seeds of *Melia composita* were collected from plus tree which is growing as avenue plantation by the road side along Malerkotla (Punjab) to Patran (Punjab). Seeds of uniform size were selected, surface sterilized with 1% mercuric chloride solution for 3–4 minutes, washed five times with sterile water to remove the disinfectant, and the seeds were soaked in water for 24 hours before sowing.
Filling the pot material includes four kg of soil accommodate sand and soil in 2:1 section was filled in earthen pots (size: 12 inch) lined with thick polythene bag to avoid the losses of leaching. The important Physiological and chemical properties of pot's soil are given in Table 1. Required EC values dominated by chloride (0, 4, 8, 12, 16, 20, 24, 28, 32, 36 and 40 dSm^{-1}) were attained by adding calculated amount of sulphate and chloride salts of Ca, Mg and Na as solution of salt on an equivalent weight basis.

Table 1: Physico-chemical characteristics of soil used

Particulars	Value	Method used
Texture	Sandy loam	International Pippette Method [19]
EC (dSm^{-1})	0.13	Conductivity Bridge Method [21]
Saturation percentage	22%	Centrifuged Method
Organic carbon (%)	0.20	Digestion Method [28]
pH	8.26	pH meter with glass electrode in 1:2 Soil Water Suspension method developed by [7]
Available nitrogen in kg per hectare	188.19	Alkaline Permanganate technique developed by [25]
Available potassium kg per hectare	171.28	Flame Photometric technique developed by [7]
Available phosphorus kg per hectare	18.39	Olsen's method developed by [16]

For sowing, each pot was sown with 6 seeds on April 3. Although, after the germination there were 3 plants kept in each pot. Each pot is watered normally for up to 90 days of growth (*i.e.* till July 3, 2021). Irrigation to the plants was given after ascertaining the field capacity condition in the pot soil. Three-month-old potted seedlings were exposed for 25 days to develop salt stress levels in the pot soil. Salinity stress extent (control to 40 dSm^{-1}) (Table 2) of the Specimen were artificially simulated in potting soil by adding salts of magnesium sulfate and chlorides of calcium, magnesium and sodium and by irrigation with saline water of required EC value. Saline water of different EC was prepared using the concentration of ions presented in Table 2. Irrigation water was applied alternatively at surface and through plastic tubes from bottom of the pot to prevent accumulation of salt below the root zone. At each irrigation schedule, 150 ml water was supplied to each pot. Since growth inhibition is initiated at a certain threshold of salinity exposure before significant loss of planting material occurs, seedlings of Burma dek were evaluated to simulate artificially during the plant establishment stage. Tolerance thresholds were determined under the specified salinity levels. Weeding was done as and when required. Collar diameter (mm) was recorded at the basal region of the seedling with the help of digital vernier caliper. Shoot length was calculated in cm from the base to the top of the stem. Root length in cm was also determined in a similar manner, but only after the last harvest from collar to root tip. The total number of leaves was counted before and after simulating salinity conditions in pots. Fresh weight (g) of seedling stems, roots, leaves and whole plant changed into determined after drying in oven at 60° C for 1 week. For the statistical analysis the plants were maintained in the screen house in completely randomized design with 11 salinity levels. Eight replications with three plants per replication were used for each treatment.

Table 2: Concentration of ions used to maintain EC in growth medium

Treatment level	Amount of salts (m eq/l)				
EC	**Na**	**Ca**	**Mg**	**Cl**	**SO_4**
Control	(-)	(-)	(-)	(-)	(-)
4 dSm^{-1}	22	5.50	16.50	35.20	8.80
8 dSm^{-1}	44	11.00	33.00	70.40	17.60
12 dSm^{-1}	66	16.50	49.50	105.60	26.40
16 dSm^{-1}	88	22.00	66.00	140.80	35.20
20 dSm^{-1}	110	27.50	82.50	176.00	44.00
24 dSm^{-1}	132	33.00	99.00	211.20	52.80
28 dSm^{-1}	154	38.50	115.50	246.40	61.60
32 dSm^{-1}	176	44.00	132.00	281.60	70.40
36 dSm^{-1}	198	49.50	148.50	316.80	79.20
40 dSm^{-1}	220	55.00	165.00	352.00	88.00

RESULT AND DISCUSSION

The results obtained during the investigation were analyzed to assess the extent of salt tolerance by the *Melia composita* seedlings at the establishment stage; and their mean values along with the critical differences (CD) are presented in tables. Though, the salinity levels up to 40 dSm^{-1} were tested to determine the threshold limit of plant survival, however, after determining the threshold limit, all the growth parameters were determined only up to 12 dSm^{-1} level. After 8 dSm^{-1} plants could not survive due to ions toxicity and mortality occurred. The periodic gain in shoot length and basal diameter (Table 3) of *Melia composita* seedlings were determined from initiation of salt stress to harvesting of the seedlings (period of salt stress growth: 25 days). Salt stress resulted in a decrease in stem radial diameter and shoot length compared to control plants. These decreases were, however, less in radial growth in 4 dSm^{-1} adapted seedlings compared to the increased salinity stress. A significant increment in basal diameter was observed in control seedlings (67.41%) compared to 8 dSm^{-1} salinity level. Similarly, shoot length also decreased significantly in response to salt stress. The inhibitory effect of salt stress was greater beyond 4 dSm^{-1} and at ≥4 dSm^{-1}, respectively in radial growth and plant height. The perusal of the data clearly indicates that a significant increase in shoot length and radial growth was observed in control treatments. Beyond salinity level of 8 dSm^{-1}, plant could not survive due to toxicity of ions. Similarly, as reported in another study [3]. the number of basal diameters of *Melia composita* seedlings were dropped with increasing salt stress of the growing media.

Table 3: Effect of progressive increasing salinity levels on periodic increments in basal diameter and shoot length of *Melia composita* seedlings

Treatment (Salinity levels)	Basal diameter (mm)	Shoot length (cm)
Control	1.49	2.18
4 dSm^{-1}	1.16	1.18
8 dSm^{-1}	0.89	0.75
≥12 dSm^{-1}	0	0
CD at 5%	**0.72**	**0.69**

The root length (Table 4) of *Melia composita* seedlings was recorded finally at harvest and it was found that the root length decreased significantly at 12 dSm^{-1} compared to control, however, root build up was not negatively affected at 4 and 8 dSm^{-1} levels as also reported in other study on *Cassia angustifolia* [26], on *Azadirachta indica and Melia azedarach* [1] and on lemon grass [22].

Table 4: Effect of progressive increasing salinity levels on root development of *Melia composita* seedlings

Treatment (Salinity level)	Root length (cm)
Control	12.65
4 dSm^{-1}	11.75
8 dSm^{-1}	11.74
12 dSm^{-1}	7.94
CD at 5%	**0.51**

Number of leaves (Table 5) of *Melia composita* seedlings was recorded at 90 days (period of normal growth) and 115 days (period of salt stress growth: 25 days). A perusal of the data clearly indicates that increase in leaf number was observed significantly among the control treatment. It was found that salinity stress caused decrease in leaf numbers were significant at 4, 8 and 12 dSm^{-1} (14.07%, 19.72% and 40.30%, respectively) as compared to control plants. This devastating loss occurred in seedlings with the results of leaf drop and wilting but leaf drop and wilting were surprisingly more in high levels of salt treated plants. These decreases in number of leaves were, however, less in 4 and 8 dSm^{-1} adapted seedlings compared to the further increased salinity stress. Beyond 8 dSm^{-1} number of leaves decreased considerably and plant died. Similar results were also observed in *Melia dubia* [9].

Table 5: Effect of progressive increasing salinity levels on number of leaves of *Melia composita* seedlings

No. of leaves at 90 days	Treatment (Salinity level)	No. of leaves at 115 days
128.43	**Control**	134.56
124.36	**4 dSm^{-1}**	115.63
120.76	**8 dSm^{-1}**	108.03
121.83	**12 dSm^{-1}**	80.33
N.S	**---------**	**11.20**

The root fresh and dry biomass (Table 6) of Burma-dek seedlings was recorded finally at harvest and it was found that the salinity stress caused decreases in root fresh and dry biomass compared to control plants. No reduction in fresh as well as dry root biomass was evaluated at 4 dSm^{-1} compared to controls; however, significant reduction in fresh as well as dry root biomass was measured beyond 4 dSm^{-1} compared to non-stressed control plants. Similarly, reductions in shoot, leaf and whole plant biomass were not found in 4 dSm^{-1} stress adapted plants; however, significant decreases in shoot, leaf and whole plant biomass were measured at 8 dSm^{-1} and 12 dSm^{-1} compared to control. At 12 dSm^{-1}, root development was worst affected and reduction in root dry biomass accumulation was 49.59% compared to control plants, however, reduction in leaf dry biomass was about 30.14% comparative to controls. At 12 dSm^{-1} whole plant dry biomass was also reduced to 2.38 g, which was 36.93% less than the control value. Our study supports the gradual decrease in number of leaves, plant biomass plant height when plants exposed to increased salinity levels as found also when *Calendula officinalis* [11], *Dalbergia sissoo* [8, 24) and *Erythrina variegate* [14], *Acacia nilotica* [10], *Mentha canadensis* [30] and *Crocus sativus* [15] plants exhibited to salt stress.

Table 6: Effect of progressive increasing salinity levels on the plant parts and whole plant biomass of *Melia composita* seedlings.

Treatment (Salinity level)	Shoot biomass (Fresh) (g)	Shoot biomass (Dry) (g)	Root biomass (Fresh) (g)	Root biomass (Dry) (g)	Leaf biomass (Fresh) (g)	Leaf biomass (Dry) (g)	Whole Plant biomass (Fresh) (g)	Whole Plant biomass (Dry) (g)
Control	2.17	1.32	1.67	1.08	3.90	1.23	8.00	3.85
4 dSm^{-1}	1.78	1.10	1.43	0.87	3.20	1.03	6.67	3.26
8 dSm^{-1}	1.53	1.07	1.15	0.68	3.05	0.97	6.00	2.98
12 dSm^{-1}	1.39	0.82	0.91	0.48	2.97	0.82	5.53	2.38
CD at 5%	**0.37**	**0.11**	**0.03**	**0.05**	**0.57**	**0.09**	**1.22**	**0.58**

CONCLUSION

The growth parameters studied were adversely affected by high salt concentration, ultimately excessive amount cause growth retardation and finally death of growing plants. Increases in basal diameter and shoot length in *Melia composita* decreased with increasing extent of salinity stress levels, with a maximal and significant decrease in increase in both parameters observed at 8 dSm^{-1}, and a slight decrease in basal diameter at 4 dSm^{-1} was observed. The inhibitory effect of salt stress was greater beyond 4 dSm^{-1} and at ≥4 dSm^{-1}, respectively in radial growth and plant height. Root length decreased significantly at 12 dSm^{-1} compared to control, however, root build up was not negatively affected at 4 and 8 dSm^{-1} levels. Leaf numbers was found increase significantly in the non-stressed plants comparative to salt stressed plants. Thus, salinity stress caused significant decrease in number of leaves at 4, 8 and 12 dSm^{-1} compared to control plants. Beyond 8 dSm^{-1}, wilting symptoms were more conspicuous in leaves and as a result plants could not survive. Reductions in root, shoot, leaf and whole plant biomass were not found in 4 dSm^{-1} stress adapted plants; but, significant reductions were observed in all the plant parts biomass at 8 and 12 dSm^{-1} as compared to control.

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