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EFFECT OF DIFFERENT PLANTING TECHNIQUES ON SALINITY SUSCEPTIBLE ORNAMENTAL TREE SPECIES IN THE SEMI-ARID REGION OF BATHINDA, PUNJAB, INDIA

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ABSTRACT

On the basis of morpho-physiological, biochemical, and anatomical parameters during the 1st and 2nd years of the experiment, plants were classified as salt-tolerant and susceptible. From these plants, salt-susceptible tree species *(Milatia ovalifoloa, Bauhnia purpurea, Putranjiva roxburghii, Koelreutria paniculate,* and *J*acaranda *mimosifolia*) were planted with ridge and sub-surface planting methods at the PAU regional research station in Bathinda. The field experiments were conducted in a factorial randomized block design with 30 treatments and replicated three times. The treatments were comprised of two planting techniques (ridge method 15, 30, 45cm and sub-surface planting method 15, 30, 45cm) and five ornamental tree species. The pH and EC of the soil increased as it was irrigated with Saline water (underground water, pH 8.99, and EC 3.65 dS/m). Among different tree species, the highest mean value of all parameters in salt-susceptible tree species was found when the plants were plated with the ridge method (15cm) and irrigated with saline water up to the estimated salinity of 0.46 dS/m. The maximum plant height (95.93cm), stem girth (10.95mm), and survival percent (100%) were observed in the ridge planting method (15cm), and in the *J. mimosifolia* tree species, the maximum plant height (130.83cm), stem girth (13.43cm), and survival percent (100%) were observed as compared to other salt-susceptible tree species.
***Keywords* :** Saline water (underground water), salt susceptible ornamental tree species, ridge and sub-surface planting method (15, 30 and 45cm) growth observations.

Introduction

Floriculture has a long history in India. The Rig-Veda, the Ramayana, and the Mahabharata are some of the great Sanskrit works that make mention to flowers and gardens. But it took a long time for the social and economic benefits of flower farming to be understood. In recent years, floriculture has achieved a distinct commercial standing and has become a significant agri-business due to changing lifestyles and rising urban prosperity.

Compared to other horticultural crops, floriculture has now become a career with a better potential for profits. With the rise in living standards, floriculture and ornamental horticulture have become more popular in contemporary India. His hunt for various plant species with lovely flower/foliage and generally pleasing appearance was sparked by the aesthetic sense that humans have. Flowers stand for innocence, splendor, harmony, love and passion. They serve a variety of functions in daily life, including worship, weddings, interior decorating, body adornment and celebrations.

A persistent environmental issue that has grown over time for sustainable agriculture is soil salinity

(Hossain *et al.,* 2012). About one-third of irrigated land is affected by salinity, which significantly lowers crop productivity (Ravindran *et al.,* 2007). According to (Flowers *et al.,* 2010), one of the most significant environmental factors limiting crop plant yield is salt stress. According to Brinkman (1980), there were 323 million hectares of salinized soil worldwide. By 2025, that number is predicted to reach 400 million hectares. Morris and Thomson (1983) and Schofield (1990) both emphasized the significance of tree planting for the recovery of salt-affected soils. However, the levels of salinity differ from one location to another, and different plant species have very different levels of salt tolerance (Tinus 1984, Toth 1981, Tomar and Yadav 1980). Heavy mortality has resulted from planting trees on such soils without taking into account their level of resistance to salinity (Singh *et al* 1991 and 1992). As a result, the salinity levels should be taken into account while choosing the tree species to plant at various locations.

One-third of all irrigated land is affected by soil salinity, which significantly reduces crop growth and yield (Ravindran *et al.,* 2007). Approximately 20% of the arable land is thought to be under salt stress. Saline and sodic soils make about 15% of the world's land area, according to the soil map. These were mostly spread in Australia (8%) and Europe (3.6%) throughout Asia and the Pacific. In India, 6.727 Mha, or 2.1% of the country's total (329 Mha), is impacted by salt stress, while in Punjab, 6.4% of the province's entire area is affected by salinity (Sharma *et al* 2011).

The five ornamental trees species chosen for this study were *Bauhinia purpurea* L. or *B. triandra* Roxb., which originated in India, is a member of the Leguminosae family, and is more popularly known as purple bauhinia. It works well for group planting and roadside plantations. African-born *Milletia ovalifolia* Roxb., a dwarf tree with tiny lilac flowers, is a member of the leguminosae family. It is appropriate for residential communities, parks, and open spaces (Randhawa and Mukhopadhyay, 1986). The Sapindaceae family includes the golden flowering plant known as *Koelreuteria paniculata* Laxm. (Golden Rain Tree). When the tree is covered in lilac blooms, it acts as a gorgeous and protecting hedge. *Putranjiva roxburghii* Wall., a member of the Putranjivaceae family, is also referred to as the "child life tree." Sub-tropical *Jacaranda mimosifolia* trees are native to south-central South America, although they have been widely introduced abroad due to their alluring and persistent violet blossoms. It is also referred to as a blue jacaranda. The goal of the current inquiry was to assess the relative salt susceptibility of five ornamental trees using various planting methods. Understanding how plants develop and survive in saline habitats is necessary for (i) Planting techniques of salinity susceptible trees in salinity affected lands.

Material and Methods

Experimental site

The field trials were carried out between 2021 and 2022 at the Punjab Agricultural University Regional Research Station in Bathinda, India (30° 9'36" North, 74° 55'28" East, and 211 meters above sea level), which is located in the extreme south-western region of Punjab. The location is a part of the Indo Gangetic alluvial plains and located in the north-western area of India. The site has a semi-arid, subtropical climate with an average annual rainfall of 436 mm, 80% of which falls during the first week of July and mid-September during the South-Western monsoon season. In June, the average maximum and minimum temperature ranged from 40 to 45^0 C and 4 to 5^0 C, respectively. Mid-December through mid-February is when frosty evenings and frigid breezes are most frequent. The texture of experimental soil was classified as a sandy loam with 75.0% sand, 16.8% silt and 8.2% clay.

Field experiment

On the basis of morpho-physiological, biochemical and anatomical parameters during the 1st year and 2nd year of experiment, plants will be classified as salt stress-tolerant and susceptible. From these plants highly susceptible tree species will be planted by subsurface method (15, 30, and 45 cm) and ridge methods (15, 30 and 45 cm) the soil will be treated with FYM (5kg), DAP (10g) and urea (15g) per tree. From these plants salt susceptible tree species were planted at PAU regional research station, Bathinda. The field experiments were conducted in a randomized block design with 30 treatments replicated three times. The treatments were comprised of two planting techniques (ridge and sub-surface) and five ornamental tree species.

Irrigation water quality treatments

The irrigation water qualities used in this study is described in Table 1

Table 1: Composition of saline water qualities used in the experiment.

Variable	Saline Water
pH	8.99
EC (dS	3.650
Ca^2+ (me/ L)	2.69
Mg^2+ (me/ L)	5.70
Na+(me/L)	24.48

K+(me/L)	0.26
CO_3^{2-}(me/ L)	0.62
HCO_3^- (me/ L)	6.80
Cl^- (me/L)	9.35
SO_4^{2-} (me/ L)	9.21

Result and Discussion

Morphological Parameters

Plant height (cm)

Effect of different planting techniques on salinity susceptible ornamental tree species. From these plants highly susceptible tree species were be planted by subsurface method (15, 30 and 45 cm) and ride method (15, 30 and 45 cm) in salt affected soil.

The plant height was significantly for the tree species, planting methods and interaction of tree species x planting methods (Table 2). The maximum plant height was observed (130cm) *in J. mimosifolia* followed by *K. paniculata* (95.83cm), *B. purpurea* (86.83cm), *M. ovalifolia* (78.17cm) and minimum plant height was observed in *P. roxburghii* as compared to other tree species. Maximum plat height (95.93cm) was observed in ridge planting method (15cm) and minimum plant height (69.00cm) in subsurface planting method (30cm) and in (45cm) furrow planting method all tree species were died.

The interaction of tree species & planting method had the maximum plant height (133.33cm) was observed in subsurface planting method (15cm) x *J. mimosifolia* and followed by (130cm) in ridge planting method (30cm) x *J. mimosifolia* and minimum plant height (36cm) observed in ridge (45cm) planting method x *M. ovalifolia* compare to other planting methods and tree species. In subsurface planting method (45cm) all salt sensitive tree species were drying.

When treated with modest concentrations of salt, salt bush *Atriplex nummularia* also showed an increase in plant height (Araujo *et al.,* 2006), probably as a result of enhanced water intake (Munns and Tester 2008). These plants may engage in osmotic adjustment activity in response to low salt concentrations, which may enhance plant development. In *Azadirachta indica*, similar outcomes were also observed by (Kumari *et al* 2012). Under waterlogged conditions, *T. indica, S. cuminii, A. auriculiformis, T. arjuna*, and *E. tereticornis* are among the species that failed over time, despite the fact that several of them are known to withstand irrigation with saline water up to 17 dS/m (Arar 1975, Bangash 1977). *A. auriculiformis, A. nilotica,* and *T. arjuna* could survive salinity up to ECe = 26 dS/m" for their establishment, but these species did not fare well in terms of further growth under these unfavorable conditions, according to earlier pot studies by Tomar and Gupta (1985). However, if salinity was not associated with waterlogging, these species did not fare well. Due to the extreme salinity of the subsurface, *L. leucocephala* was unable to live. High levels of tolerance to salinity and aeration stress are seen in *P. juliflora, A. tortilis, A. nilotica,* and *C. equisetifolia.* Although growth (height and diameter) was better during subsurface planting, *P. juliflora* behaved admirably under both types of planting. Under subterranean conditions, *A. tortilis* and *A. nilotica* clearly grew better.

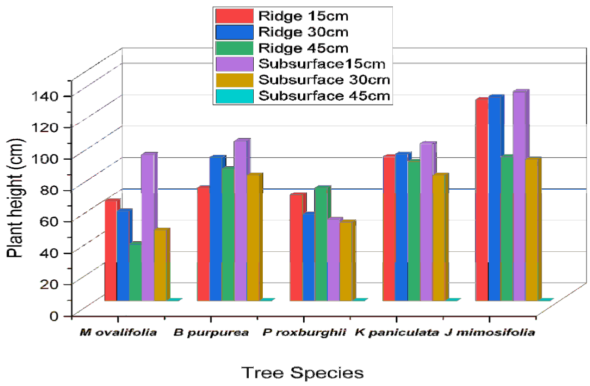

Fig. 1 : Effect of different planting techniques on plant height (cm) of salinity susceptible ornamental tree species.

Stem girth (mm)

Salt susceptible ornamental tree species were be planted by subsurface method (15, 30 and 45 cm) and ride method (15, 30 and 45 cm) in salt affected soil. The stem girth was significantly for the tree species, planting methods and interaction of tree species x planting methods (Table 2). The maximum stem girth was observed (13.43mm) in *J. mimosifolia* followed by *B. purpurea* (10.60mm), *M. ovalifolia* (9.42mm), *K. paniculate* (9.06mm), and minimum stem girth was observed in *P. roxburghii* (6.58mm) as compared to other tree species. Maximum stem girth (10.96mm) was observed in ridge planting method (15cm) and minimum (6.69mm) in furrow planting method (30cm) and in (45cm) furrow planting method all tree species were dry.

The interaction of tree species & planting method had the maximum stem girth (15.98mm) was observed in furrow planting method (15cm) x *J. mimosifolia* and followed by (13.20mm) in ridge planting method (45cm) x *B. purpurea* and minimum stem girth (4.92mm) observed in ridge (45cm) planting method x *M. ovalifolia* compare to other planting methods and tree species. In furrow planting method (45cm) all salt sensitive tree species were drying.

According to Tomar and Gupta (1985), *Acacia auriculiformis, Acacia nilotica,* and *Terminalia arjuna* could survive salinity up to ECe = 26 dS m"1 for their establishment but did poorly for subsequent growth in these unfavorable conditions. However, if salinity was not associated with waterlogging, these species could. Due to the excessive salinity, *Leucaena leucocephala* could not thrive below ground. Both salinity and aeration stress are stresses that *Prosopis juliflora, Acacia tortilis, A. nilotica,* and *Casuarina equisetifolia* are shown to be very resistant. The growth (height and diameter) was better under subsurface planting, *Prosopis juliflora* thrived admirably under both types of planting. Under subterranean conditions, *Acacia tortilis* and *A. nilotica* clearly flourished better. Those plants that were nearer to the storage channel performed well because of diffusion of moisture and also because of leaching of salts, hence the low salinity within the root zone.

In the country's dry and semi-arid regions, secondary salinization caused by waterlogging has rendered large tracts of agricultural land unusable. A shallow water table and a large rise in root zone salinity due to greater capillary salinization are caused by water seepage from canals and poor on-farm water management practices combined (Chhabra & Thakur, 1998). Saline areas that are flooded traditionally undergo reclamation by the installation of sub-surface drainage systems, which are costly, challenging to maintain, and problematic for the disposal of saline drainage effluents (Chhabra & Thakur 1998, Ram *et al.,* 2011). Due to these operational challenges, interest in various workable solutions, such as bio drainage for maximizing the productivity of flooded soils, has grown (Ram *et al* 2011).

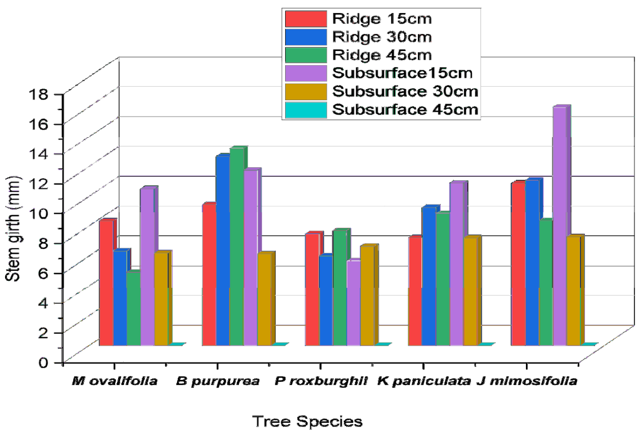

Fig. 2 : Effect of different planting techniques on Stem girth (mm) of salinity susceptible ornamental tree species.

Survival (%)

Salt susceptible tree species were be planted by subsurface method (15, 30 and 45 cm) and ride method (15, 30 and 45 cm) in salt affected soil. The plant survive was significantly for the tree species, planting methods and interaction of tree species x planting methods (Table 2). The maximum survival% was observed (100%) in *J. mimosifolia* and *K. paniculata* followed by *B. purpurea* (83.33) and minimum survival % was observed in *M. ovalifolia* and *B. purpura* (50%) compared to other tree species. Maximum survival % (100%) was observed in ridge planting method (30cm) and minimum plant height (60%) in furrow planting method (30cm) and in (45cm) furrow planting method all tree species were drying.

The interaction of tree species & planting method had the maximum survival % (100%) was observed in ridge planting method (30 and 45cm) x all salt sensitive tree species and minimum survival % (33.33%) observed in furrow (30cm) planting method x *M. ovalifolia* and *B. purpura* as compare to other planting methods and tree species. In furrow (45cm) planting method all salt sensitive tree species were drying.

According to Tomar and Gupta (1985), *Acacia auriculiformis, Acacia nilotica,* and *Terminalia arjuna* could survive salinity up to ECe = 26 dS m"1 for their establishment but did poorly for subsequent growth in these unfavorable conditions. However, if salinity was not associated with waterlogging, these species could. Due to the excessive salinity, *Leucaena leucocephala* could not thrive below ground. *Acacia tortilis, Acacia nilotica, Prosopis juliflora,* and *Casuarina equisetifolia* are reported to be extremely resilient to salinity and aeration stress. Although growth (height and diameter) was better under subsurface planting, *Prosopis juliflora* thrived admirably under both types of planting. Under subterranean conditions, *Acacia tortilis* and *A. nilotica* clearly flourished better. Because of moisture diffusion and salt leaching, which resulted in low salinity inside the root zone, those plants that were closer to the storage channel performed well under all salinity levels. *T. arjuna* died, whereas *A. nilotica* and *E. camaldulensis* survived to 50% and 90%, respectively, for subsurface and furrow planting, and *T. arjuna* only survived to a maximum of 20% for the furrow planting method when the groundwater salinity was exposed to higher levels after irrigation was stopped after three years of planting (Table 2).

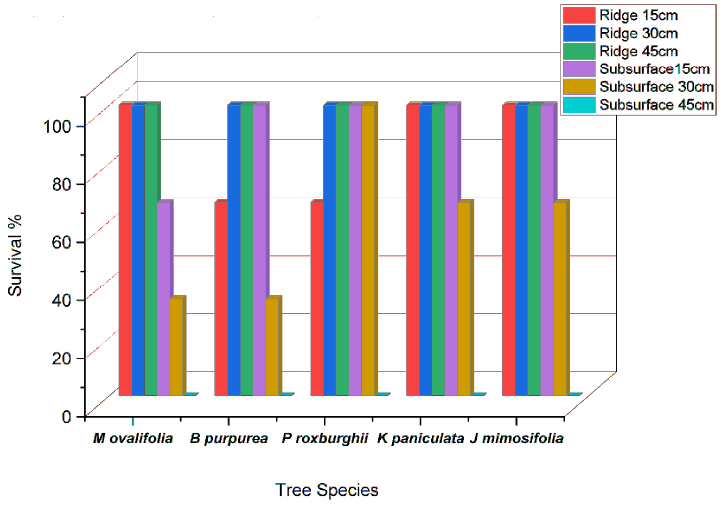

Fig. 3 : Effect of different planting techniques on Survival (%) of salinity susceptible ornamental tree species.

Table 2: Effect of different planting techniques on plant height (cm), stem girth (mm) and survival (%) of tree species in salinity affected land.

F1	PH_ 15 cm	PH_ 30 cm	PH_ 45 cm	SG_ 15 cm	SG_ 30 cm	SG_ 45 cm	Survival_ 15 cm	Survival _ 30 cm	Survival _ 45 cm
Ridge	95.93	85.33	74.46	10.96	9.07	8.60	100	100.00	93.33
Subsurface	84.56	69.00	0.00	8.67	6.69	0.00	86.66	60.00	0.00
SEM	0.41	0.66	0.36	0.08	0.04	0.03	0.16	0.06	0.00
C.D. (5%) Ai-Aj	1.21	1.96	1.08	0.22	0.13	0.10	0.47	0.18	0.00
F2									
M. ovalifolia	78.17	51.00	18.00	9.42	6.27	2.46	83.33	66.67	50.00
B. purpurea	86.83	85.67	42.00	10.60	9.41	6.60	83.33	66.67	50.00
P. roxburghii	59.58	52.50	36.00	6.58	6.33	3.85	83.33	100.00	50.00
K. paniculata	95.83	86.67	44.33	9.06	8.24	4.43	100.00	83.33	50.00
J. mimosifolia	130.83	110.00	45.83	13.43	9.18	4.18	100.00	83.33	50.00
SEM	0.65	1.04	0.57	0.12	0.07	0.05	0.25	0.10	0.00
C.D. (5%)	1.92	3.10	1.70	0.35	0.20	0.15	0.74	0.29	NS
Interaction									
Method 1 X SP 1	63.33	57.00	36.00	8.33	6.34	4.92	100.00	100.00	100.00
Method 1 X SP 2	72.00	91.33	84.00	9.45	12.67	13.20	66.66	100.00	100.00
Method 1 X SP 3	67.50	55.00	72.00	7.48	6.01	7.69	66.66	100.00	100.00
Method 1 X SP 4	91.66	93.33	88.66	7.22	9.27	8.85	100.00	100.00	100.00
Method 1 X SP 5	128.33	130.00	91.66	10.88	11.08	8.35	100.00	100.00	100.00
Method 2 X SP 1	93.00	45.00	0.00	10.50	6.20	0.00	66.66	33.33	0.00
Method 2 X SP 2	101.66	80.00	0.00	11.75	6.15	0.00	100.00	33.33	0.00
Method 2 X SP 3	51.66	50.00	0.00	5.68	6.65	0.00	100.00	100.00	0.00
Method 2 X SP 4	100.00	80.00	0.00	10.89	7.20	0.00	100.00	66.66	0.00
Method:2 X SP 5	133.33	90.00	0.00	15.98	7.27	0.00	100.00	66.66	0.00
SEM	0.91	1.47	0.81	0.17	0.10	0.07	0.35	0.14	0.00
CD 5%	2.71	4.38	2.41	0.50	0.29	0.22	1.04	0.41	NS
C.V. %	1.75	3.31	3.77	2.96	2.12	2.91	0.67	0.30	0.00

(PH- Plant height (cm) and SG- stem Girth (mm)
Method1- Ridge and Method 2- Subsurface)
SP1- *Millettia ovalifolia*, SP2- *Bauhinia purpurea*, SP3- *Putranjiva roxburgahii*, SP4- *Koelreutraria paniculata* and SP5- *Jacaranda mimosifolia*

Conclusions

This study investigated the Effect of different planting techniques on salinity susceptible ornamental tree species in the semi-arid region of Bathinda, Punjab. The findings underscore the critical role of appropriate planting methods and soil management in enhancing the resilience of these species to saline conditions. The results demonstrate that the planting techniques such as ridge planting and the use of soil amendments significantly improve plant growth and vitality compared to traditional planting methods. Notably, species tolerance to salinity varies, highlighting the necessity for selecting appropriate tree species based on their specific salinity tolerance levels. This study demonstrates the significant impact of planting techniques on the growth and survival of salinity-susceptible ornamental tree species. Raised bed planting emerged as the most effective method, highlighting the need for its adoption in urban greening initiatives in saline environments.

Future scope

Further research is needed to explore long-term impacts of these planting techniques, the performance of additional species, and the integration of innovative irrigation practices. Engaging local communities in these efforts will be essential for promoting sustainable urban green belts.

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No Conflict of interest

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