Original Research Article

Performance of *Tecomella undulata* (Desert teak) stump planting over seedling for growth and straightness under arid condition.

Abstract

Tecomella undulata (Rohida) stump planting and seedling had shown 100 percent survival during the study period. Stump plants exhibited enhance growth parameters over seedling originated plants. Treatment T_4 showed best growth performance in terms of plant height, collar diameter, number of leaves and sprout density with 44% and 54 % higher growth in height and collar diameter than seedling after two years of planting. As per the modified visual method of assessing straightness higher stem straightness was obtained in T_4 (0.56 m) and T_3 (0.40 m) which had 77 and 66 % stem straightness percent, and score of 6 & 5 which plunge under A grade category. Whereas, T_2 and T_1 (0.33 m & 0.23 m) had 48 and 32 % stem straightness percent with a score of 4, 3 and 2 which comes under B & C grade. Form the study it is a clear that stump plantings treatment T_4-(>8-9 mm thickness (pen/pencil-sized), with 20-25 cm stump plant (2- 5 cm stem and 15-20 cm tap root) is found to achieving enhanced growth compared to seedling plant.

Keywords: *Tecomella undulata*, stump, seedling, stem straightness, sprout density.

Introduction

Tecomella undulata (Sm.) Seem (Rohida) is a medicinally and economically important plant that originated in India, Arabia (Randhawa and Mukhopadhyay, 1986), and now appears in the list of endangered plants of Punjab (Jerath *et al.,* 2012). *T. undulata* is a medium sized tree with height ranging from 8m to 15m. In India it is mostly distributed in the desert region of drier tract of Rajasthan, south-western parts of Punjab, Maharastra, Gujarat and Haryana. The plant grows under natural conditions in wild, unprotected and is highly exploited. It is very hardy and drought resistant plant and has potential application for afforestation and landscaping of dry tracts. The plant is used for its high quality timber. Its wood is soft, durable and takes a good polish and therefore is used in furniture, carving, and agricultural implements. The wood is prized equal to Teak and that's why it is also called as 'Marwar Teak of Rajasthan'. The plant parts are used for the cure of syphilis and eczema. Bark posses' mild, relaxant, cardio tonic and chloretic activities. Hot water extract of the plant is used to treat enlarged spleen, gonorrhea, leucoderma and liver diseases (Saxena 2000).

The main trunk of the plant branches very early, at lower level of the stem, in comparison to other timber yielding plants. Young plantlets growing in wild or unprotected areas are usually grazed upon by cattle, goats and sheep's which results in bushy habit of the plant. Consistent grazing by animal makes the plant bushy if kept unprotected in the younger age. This makes most of its trunk part unsuitable for timber production if the branches are left un-pruned and two species of imperfect fungi (*Phoma sp.* and *Botryodiplodia theobromae*) primarily responsible for canker-rots, which subsequently attract borers and heart rot pathogen (*Fomes* sp.) and damages the clear bole or death of trees leading this species to endangered status (Negi *et al.* 2011).

Overexploitation of plants for agriculture and other commercial, scientific and educational purposes and the other developmental activities of mankind have resulted in serious threat to plant species that have evolved over the course of millions of years (Khan, 1998). Natural regeneration of plants from seeds is very poor probably due to coincidence of seed maturity with onset of monsoon resulting in considerable damage to the seeds through fungal attack.

The growth behavior of rohida seedlings is of slow growing and branchy in nature and ascertains its superiority for its successful establishment either in any conservation, afforestation programmes on in agroforestry system with respect to its edaphic and climatic condition. For rapid early growth and development, adoptability and early establishment in the field, seedlings are either to be fertilized or new techniques are to be adopted to boost its growth and establishment. Among many planting technique stump planting is one method that can enhance the growth of the plant in the early establishment stage and it is practiced in many species of plants and most commonly in teak and is successful (Ghising et al., 2022). Keeping in view an attempt to standardize the stump planting technique and to evaluate the performance of stump plants over seedling was conducted in arid condition of Rajasthan, India.

Materials and methods

Study site

The experiment was conducted at Agricultural Research Station, Keshwana, Jalore, Rajasthan. The site is located at latitude $25^0 25' 58.86'' N$ and longitude of $72^0 29' 726'' E$, elevation 149.9 msl. Jalore comes under the lower transect in arid western Rajasthan.

Soil characters

The soil of the experimental site has been classified as sandy loam. Soil information on pH, OC, N, P and K is given in Table 1. Data shows that surface soil is loamy in texture, overall, the pH 8.1indicating that soil is slightly alkaline in nature, with 0.67 EC. Carbon content in the soil is poor having 0.52 %. Low in available nitrogen 156.3 kg ha^{-1}, medium in phosphorus (11.4 kg ha^{-1}) and low in potassium (30.29 kg ha^{-1}).

Table 1. Soil physico-chemical characteristics of the study site.

Parameters	Value
pH	8.1
EC (mS/cm)	0.67
OC (%)	0.52
Available Nitrogen (kg ha^{-1})	156.3
Phosphorus (kg ha^{-1})	11.4
Potassium (kg ha^{-1})	30.29

Stump plant preparation

In the present study *T. undulata* stump plant or stump plants are prepared by the seedlings that are maintained in the nursery for about one year, seedling are raised and harden for one year in a polybag with proper potting mixture (sand: soil: FYM in the ratio of 1:1:1, v/v). One year old hardy seedling with 4- 9 mm (pencil/pen thickness) collar diameter seedlings are selected and uprooted, all the leaves and secondary roots are trimmed or removed with a clean secateurs and stumps with 2 to 5 cm shoot height and 15 to 20 cm tap root portion is retained. The stem portion receives an oblique cut and the root portion a horizontal cut (Fig 1.).

Fig 1. a. Stump plant **b. Stump planting methodology** **c. Pencil/pen thickness Stump plant**

Treatments

The experiment was laid in a randomized block design with five replication and four treatments (Table 2). A total of 20 stumps per treatment having four stumps in each replication were taken for study. Weeding and irrigation was done as and when required.

Table 2. Treatment details

Treatments	Details
T_1	Seedling (1 yr).
T_2	<6 mm Stump Planting
T_3	7-8 mm Stump Planting
T_4	>8-9 mm Stump Planting

Data on growth attributes of seedlings and stump plant i.e. survival percent, collar diameter, shoot height, number of branches, leaves, percent increase in growth, sprout density and stem straightness was documented using following procedure.

Survival Percentage, plant height (m), collar diameter (mm) and number of branches Plant^{-1}

Plant survival percentage was calculated as:

$$\text{Survival Percentage} = \frac{\text{Number of stumps planted} - \text{Number of stumps wilted}}{\text{Total number of stumps planted}} \times 100$$

Plant height data of randomly selected plants in each replication was recorded from ground level to the top of the plant with the help of measuring tape and then its averaged. Collar diameter was measured near the ground level with the help of digital caliper and expressed in mm. Number of branches and leaves were counted and then its average was worked out.

Percent increase in growth

Percent increase in growth of stump plant versus seedling parameter is calculated using following formula;

$$\text{Percent increase} = \frac{\text{Stump growth} - \text{Seedling growth}}{\text{Seedling growth}} \times 100$$

Sprout density

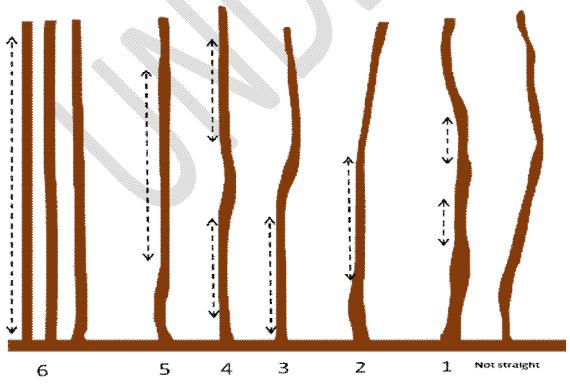
Sprout density (the number of sprouts per stump) was examined at the beginning and the end of growing season for two growing seasons. Sprouts were considered alive when at least one green tissue was present on the stump (Obrien *et al.* 2014).

Stem straightness.

Stem straightness for the rohida plantation was done in the second year plantation and adopted visual assessment method. Data of randomly selected plants in each replication was recorded at the places where ever the stem exhibited the straightness with the help of meter scale and summed to get the total straightness of the plant and further used for calculation of straightness percentage.

Visual assessment

The Forestry Commission's method for visual assessment of stem straightness was adopted and applied with some modification for rohida seedlings. Individual stem straightness is based on an estimate of straightness of sapling lengths and adopted scoring system from 0 (not straight) to 6 (straightest) and accordingly allotted the grade from A to E (Fig. 2) (Macdonald *et al.* 2009, Price *et al.* 2017).



Score	Straightness %	Grade	Condition
6	>75 % Straight	A	Excellent
5	>60 % & <75 %		
4	>50 % &<60 %	B	Very good
3	>40 % & <50 %		
2	>30 % & <40 %	C	Good
1	>20 % & <30 %	D	Moderate
0	<20 % Not straight	E	Poor

Fig 2. Adopted stem straightness score and grading.

Stem straightness percentage

Stem straightness percentage was calculated using the following formula

$$\text{Stem straightness } \% = \frac{\text{Straight stem (m)}}{\text{Total height}} \times 100$$

Statistical analysis

The mean values of each replication were calculated and ANOVA was worked out for level of significance among different treatment combinations. Significant differences of treatment means were tested at $P \leq 0.05$ significance level.

Result and discussion:

There is no information cited regarding preparation and development of stump planting technique and its performance evaluation in *Tecomella undulata***,** stump planting are widely employed in raising teak plantations, but there are reports of stump planting in *Eucalyptus tereticornis, Grewia tiliifolia, Bombax ceiba*. *Pterocarpus marsupium* etc. (Joshi 1981, 1983, and Chacko *et al.* 1990).

Growth performance of *T. undulata* stump planting over seedling.

Survival (%) did not show marked variation between the plantations established by stump and seedling. The rohida stump and seedling had shown 100 percent survival during the study period. However, the success of stump planting varies considerably with species. Based on the data presented in table 1 it can be inferred that the stump plants showed enhance growth parameters over seedling originated plants, growth data was significant among treatments throughout the study period. Mean tree height was higher in the stump grown plants than seedling grown plants. Treatment T_4 showed best growth performance in terms of plant height, collar diameter, number of leaves and sprout density followed by T_3, T_2 and T_1 for 2022 and for collar diameter, number of leaves and sprout density in the year 2021; Whereas, other parameters found to be non-significant i.e. height and number of branches in 2021 and number of branches during 2022 (Table.3). It also exhibited 44% and 54 % higher growth in height and collar diameter in T_4 fallowed by T_2 (26 & 39) and T_3 (14 & 24) as compare to seedling after two years of planting (Fig. 3). The results suggested that the differences in average height and collar diameter was more in stump than in seedling is due to marked adoptability which attributed for better root growth by utilization of stored food material and absorption of required nutrients from the soil. There is significant height increment in stump planted pine over regular planted pine was noted by Shaw et al. 1897 and

height to diameter ratio was higher than those regular planted pine which indicates that trees are putting on height in order to get more light (Koot, 2005). In *Faraxinus angustifolia* it was advantageous that stumpling significantly increased the growth of highly damaged seedling by providing good survival of the species (Cieck and Tilki 2007). In another study it is found that there is lack of significant difference between height and collar diameter among stump and regular planted seedling of Dougles-fir (Koot, 2005). In contrary the root trainer grown stands showed good growth performance than stump plants in teak (Gorge et al. 2019). Similar findings were documented by many scientists in teak (Khedkar, 1999 and Rao *et al*., 2001, Khedkar and Subramanian, 1997). Many reports suggest such variation in growth parameters owing due to differences in planting materials (Gyi *et al*., 1983; Rao *et al*., 2001).

Stem straightness (m), stem straightness percentage, score and grading stump and seedlings.

Stem straightness is important for timber, pole and pulpwood species. It is better to assess the stem straightness in the early stage that can be helpful for proper management and also to determining tree and log value. This measurement makes a forest or plantation manager to effectively assess the production before harvesting and is useful to improve forecasting, planning, marketing and resource use. Very less or no information is available on the stem straightness characteristics of stumpling and seedling of rohida. However, available reports on different species suggest considerable differences in seedling grown plant as compared to clonal or vegetative origin (Mitarini and Harahap, 1994). For *T. undulata* it is important to study the stem straightness in the early stage because the main trunk of the plant branches very early at lower level of the stem and results in bushy habit of the plant which makes most of its trunk part unsuitable for timber production if the branches are left un-pruned. Stem straightness was significantly differed among treatments, higher stem straightness was obtained in T_4 (0.56 m) and T_3 (0.40 m) which had 77 and 66 % stem straightness percent , scored 6 & 5 considered A grade. Whereas, T_2 and T_1 (0.33 m & 0.23 m) had 48 and 32 % stem straightness percent with a score of 4, 3 and 2 which comes under B & C grade (Fig 4) as per the modified visual method of assessing straightness (Price et al. 2017).

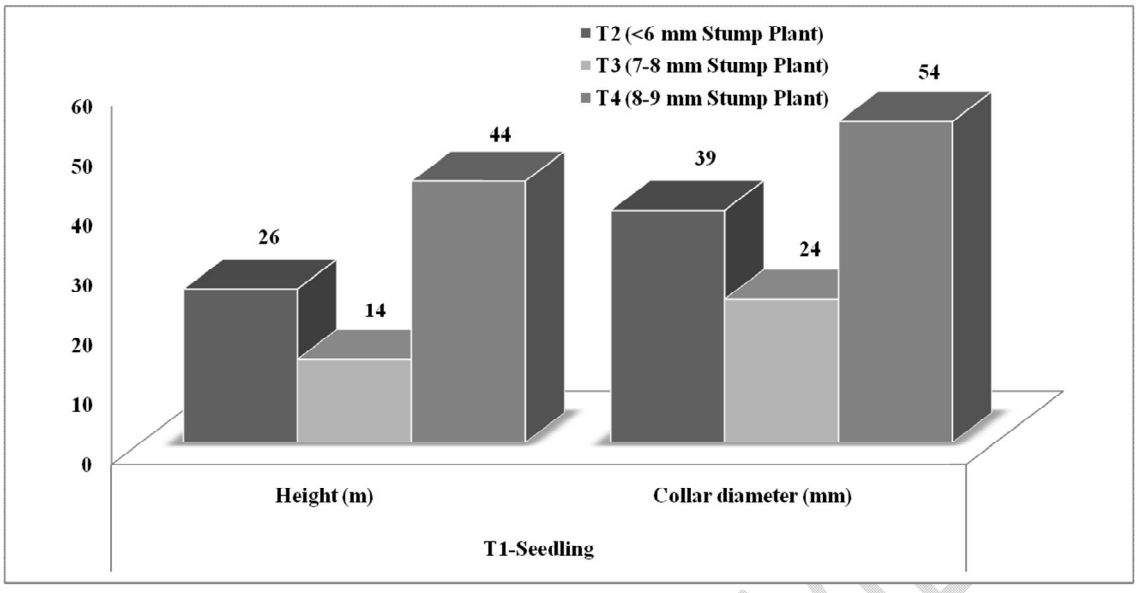


Fig. 3. Percent increase in growth of stump plant over seedling of *T. undulata*.

A grade **B grade** **C grade** **D grade**

Fig. 4. Photograph showing grades (A,B,C & D) of stem straightness in *T. undulata*

Conclusion

The present study showed that growth and productivity can be enhanced by stump planting technique. Hence stump plantings of 8-9 mm thickness (pen/pencil-sized), with 20-25 cm stump plant (2- 5 cm stem and 15-20 cm tap root) is found to achieving enhanced growth and stem straightness in *T. undulata*. This finding is helpful in producing quality planting stock of *T. undulata* for establishment of plantation and afforestation programmes.

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Conflict of interest.

Authors declare there is no conflict of interests.

Table 3: Growth performance *T. undulata* stumpling and seedling.

Treatments	2021					2022				
	Height (m)	Collar diameter (mm)	No. of branches	No. of leaves	Sprout density	Height (m)	Collar diameter (mm)	No. of branches	No. of leaves	Sprout density
T_1	0.28	9.12	5.98	37.00	6.17	0.91	18.01	7.20	42.90	7.15
T_2	0.29	9.44	5.51	32.40	5.40	1.11	22.16	8.20	49.30	8.22
T_3	0.32	9.48	5.58	32.3	5.38	1.14	20.881	9.30	51.90	8.65
T_4	0.34	11.06	5.97	42.00	7.00	1.44	27.563	10.30	64.50	10.75
Mean	0.31	9.78	5.76	35.93	5.99	1.19	20.48	8.75	52.15	8.69
CD	NS	0.939	NS	4.908	0.799	0.242	5.846	NS	12.473	2.082
SE(m)	0.018	0.301	0.339	1.575	0.257	0.078	1.876	0.721	4.004	0.668

Table 4: Stem straightness (m), stem straightness percentage, score and grade for *T. undulata*.

Treatments	Height (m)	Stem straightness (m)	Stem straightness %	Score	Grade
T_1	0.91	0.23	32	2	C
T_2	1.11	0.33	48	3 & 4	B
T_3	1.14	0.40	66	5 & 6	A
T_4	1.44	0.56	77	6	A
Mean	1.19	0.37	56		
CD	0.242	0.231	12.075		
SE(m)	0.078	0.074	3.876		

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