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Standardization of Spacing Treatments in Bare Root Seedling Nursery for Raising Qualitative and Quantitative Growth Stock of "Honey locust" (*Gleditsia* SPP.)

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Abstract
Honey locust an important fast growing introduced multipurpose tree species of Kashmir. The tree can be adapted to environmental extremes such as drought, air pollutants and high light intensities. The propagation of this species not only ensure availability of fuelwood, fodder and timber supply but at the same time results in optimum use of degraded sites. Since under valley conditions, there was no documented information with respect to its status and propagation despite its immense potential for which the species is reputed throughout the temperate world. The investigations conducted on "Honey locust (*Gleditsia* spp.) : its distribution, nursery raising and uses in Kashmir" were carried out in the Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar during the year 2009 and 2010. The present study was carried out for the consecutive years 2009 and 2010 in order to examining the same growth parameters under the multi spacing treatments *Viz*; T_0 (control), T_1 (5cmx5cm), T_2 (10cmx10cm) and T_3 (15cmx15cm) raising nursery in open beds. Under the spacing treatments in the open beds T_3 (15cmx15cm) emerged out the best treatment with respect to gain maximum mean values of growth parameters *Viz*; collar diameter, shoot weight and root weight in the nursery stage. Seeds sown in open beds at different spacings revealed that 15 cm x 15 cm spacing is ideal for raising better plantable seedlings as most of the parameters showed higher values at this spacing

Keywords: Nursery raising in open beds, seedling growth parameters, standardization of nursery technique, honey locust

Introduction
The total forest area of Jammu and Kashmir is 2.023 million hectare (Anonymous, 2011) [1, 2], which contribute 19.95 per cent of total geographical area. Of the geographical area of 10.138 million hectares inside LOC, 62.70 per cent (6.358 million hectare) is under permanent snow cover, glaciers and cold deserts. Potential land resources of Jammu and Kashmir have thus been constricted to 3.781 million hectare only. Dense forest tree cover of Kashmir valley is 0.3296 million hectares (21.03 % of its geographical area). Degraded forest have engulfed over 0.4774 million hectare. In Ladakh region, forest cover is 0.21 per cent only. Similarly in Jammu division, dense forest cover exist on 0.576 million hectare (23.24 % of its geographical area). In whole state 1.0765 million hectare of demarcated forests are degraded. Waste lands in Jammu and Kashmir are spread over an area of 0.946 million hectare which include 0.262 million hectare in vale of Kashmir, 0.557 million hectare in Jammu division and 0.127 million hectare in Ladakh region (Anonymous, 2011) [1, 2]. The Kashmir Himalaya, known for its indigenous and endemic flora, also provides home to a large number of exotic plants, which exhibit a wide taxonomical and distributional stretch. The inventorization and documentation of its exotic ornamentals has received a little or negligible attention. There is a lot of scope for these exotic ornamentals in the Floriculture and Forestry industry of Kashmir, but lack of authentic identification has been as big hurdle in their scientific management. Exotic ornamentals grown in Kashmir show better performance in both quality and quantity attributes as compared to other regions of India (John *et al*., 2007) [3].

The valley of Kashmir is witnessing continuous introduction of exotic plant and animal species. The high-tech cross border transport and migration of humans has provided easy pathway to plant species to witness a wide spread on the world map. Kashmir valley grows 317 exotic ornamental plant species, which belong to 209 genera and 85 families. Dicotyledons are the largest group, represented by 252 species in 163 genera and 67 families. Monocotyledons comprise 52 species in 37 genera and 13families. Gymnosperms are the smallest group, with 13 species distributed in 9 genera and 5 families. Asteraceae is the largest

family containing 33 exotic ornamental species (Shabana *et al*., 2010) [4]. *Gleditsia* spp. (Honey locust) is a valuable legume tree is well suited for cooler climates. It is very tolerant to lower temperatures ranging from 15 to 24 ºC. The honey locust has deep tap roots and can survive on all but the driest soil, good growth occurs with 500 – 1500 mm of rainfall. It can be successfully grown to elevations of 1,500 meters in temperate areas and has survived at 2,500 metres in subtropical highlands. In addition to fuelwood, this species produces pods with a sweet tasting pulp that are edible by people. The pods can also be used to make high quality feed for animals (Anonymous, 2005) [5]. Honey locust is a shade intolerant tree, and will only become established in openings. It has a strong taproot and profusely branched root system. Its best growth in the United States is found on deep soils (pH 6.0 to 8.0) in moist, alluvial flood-plains between 35 and 40ºN latitude (Blair, 1990) [6]. *Gleditsia* spp. family Leguminosae (subfamily – Caesalpinioideae), attains a normal height of 15-25 m and 0.51 m diameter (maximum height 50 m, diameter 1.8 m). Trees have a short bole and open, narrow or spreading crown with reddish brown to black scaly ridged bark, often covered in clusters of large, branched thorns (Harlow *et al.*, 1996) [7].

Materials and Methods

Experimental site

The experimental site Forest Nursery of Faculty of Forestry Shalimar is located between 74.89ºE longitude and 34.08ºN latitude at an altitude of about 1587 m above mean sea level. It is roughly 15 km north of the Srinagar city. The nursery is well drained having silty loam soil.

The climate in general is temperate; with severe winter extending from November to February. The region faces a wide temperature range from a minimum of -4ºC in winter to a maximum of 33ºC in the summers. Winter frost is common and medium to heavy snowfall is also witnessed. The annual precipitation of the area is about 676 mm and most of the precipitation is received in the form of snow during winter months. The seedling nursery of *Gleditsia triacauthos* variety inermis was raised from bold and filled seeds in nursery at Forest Nursery, SKUAST-Kashmir, Shalimar. Open beds of size of 1 m x 1 m were prepared. Seeds were sown in beds in the ending February, 2009. The trial was harvested for both the years (2009 and 2010) after 32 weeks (8 months). Best pre-sowing treatment was given to the seeds before sowing in the beds. Beds were well prepared before sowing. The same process was repeated again in year 2010 during the same period. The growing medium used was garden soil in all the treatments. The details of the experiment/treatments are given below:

T_0 = Control (broadcast)
T_1 = 5.0 x 5.0 cm spacing
T_2 = 10 x 10 cm spacing
T_3 = 15 x 15 cm spacing
Design = RBD

The seedlings raised at these spacing were replicated four times in Randomised Block Design (RBD). Observations with respect to following parameters were recorded:

i)	Survival percentage	ii)	Plant height (cm)
iii)	Collar diameter (mm)	iv)	Fresh shoot weight (g/plant)
v)	Fresh root weight (g/plant)	vi)	Dry shoot weight (g/plant)
vii)	Dry root weight (g/plant)	viii)	Root shoot ratio
ix)	Number of secondary roots		

Results and Discussion

The mean values of growth parameters of both the years were recorded in Table -1 and Table -2.Whileas, the results were discussed on the pooling of mean values of the years 2009 and 2010 is presented in Table-3.The data revealed that maximum survival percentage of 75 per cent was recorded at two spacings *viz*. T_2 (10 cm x 10 cm) and T_3 (15 cm x 15 cm). However, it was significantly higher than T_0 (control) and T_1 (5 cm x 5 cm). With respect to seedling height, the data reveal that maximum height (15.06 cm) was recorded under the spacing of T_0 which was significantly higher than all other spacings used in the experiment. The minimum height (12.78 cm) was recorded under spacing T_3 (15 cm x 15 cm) which was found statistically at par with T1 (5 cm x 5 cm) and T_2 (10 cm x 10 cm) with values (13.60 cm and 12.80 cm) respectively. The maximum collar diameter (3.98 mm) was recorded under the spacing T_3 (15 cm x 15 cm) which was significantly higher than the spacings i.e. T_1 (5 cm x 5 cm) and T_2 (10 cm x 10 cm). However, the minimum collar diameter (3.64 mm) was exhibited under T_0 (control). Whereas the values recorded with T_1 and T_0 remained at par.Fresh shoot weight was recorded maximum (4.93 g) under the spacing T_3 (15 cm x 15 cm) which was significantly higher than all other spacings used. However, the minimum value (3.10 g) was recorded under the spacing T_0 (control) which was statistically at par with spacing T_1 (5 cm x 5 cm) with value (3.44 g) and T_2 (3.53 g).The maximum fresh root weight (3.29 g) was recorded at T_3 (15 cm x 15 cm) which was significantly higher than all other spacings used. However, minimum fresh root weight (2.59 g) was recorded under the spacing T_0 (control). With respect to dry shoot weight, the maximum weight (1.91 g) was observed at the spacing of T_3 (15 cm x 15 cm) which was significantly higher than all other spacings used. The dry shoot weight of T_0 and T_1 observed at par values. The maximum dry root weight (1.55 g) recorded at the spacing of T_3 (15 cm x 15 cm) which was significantly higher than all other spacings used. However, the minimum dry root weight (1.10 g) was recorded under spacing T_0 (control). The *Gleditsia triacanthos* var. inermis seedlings raised at T_3 (15 cm x 15 cm) spacing gained maximum total seedling dry weight (3.46 g), however, the treatments T_1 and T_2 raised seedlings recorded at par values of total seedling dry weight. Seedling raised with spacing T_0 (control) registered minimum total seedling dry weight (2.72 g) which remained at par with T_1 and T_2. The root:shoot ratio showed significant response of spacing and maximum root:shoot ratio (0.81) was recorded in seedling raised under T_3 (15 x 15 cm), whereas the broadcast method of sowing seeds registered minimum value of root: shoot ratio (0.67). The values of root:shoot ratio under T_0 and T_1 remained at par. The results obtained (Table-3; Plate-1 and Fig. 1) revealed that with respect to most of the characters recorded under the spacing of 15 cm x 15 cm (T_3) proved to be the best among all other spacings including control (broad cost). Spacing has the significant influence on plant growth parameters *viz*., collar diameter, shoot weight, root weight upto certain limit at the nursery stage. Increase in space between plants caused increase in most of the growth parameters as per the observations recorded except height, which increases with density particularly in light demanders. Similar observations were made by Singh (2001) [8] in *Populus deltoides*. Increase in collar diameter, and other growth parameters like shoot and root biomass with increase in spacing have been attributed to availability of more space and nutrients upto certain limit to each plant in *Abies pindrow* by Singh and Sharma (1984) [9].

Table 1: Effect of spacings on growth parameters of *Gleditsia triacanthos* variety inermis seedlings in open beds for the year 2009 (8 months)

Parameters→ / Treatments (spacings)↓	Survival (%)	Height (cm)	Collar diameter (mm)	Fresh shoot weight (g/p)	Fresh root weight (g/p)	Dry shoot weight (g/p)	Dry root weight (g/p)	Total seedling dry weight (g/p)	Root shoot ratio	No. of secondary roots
T_0 Broadcast) [Control]	64.45	15.04	3.60	3.05	2.58	1.60	1.09	2.70	0.65	6.41
T_1 (5 x 5 cm)	68.30	13.58	3.65	3.40	2.80	1.65	1.17	2.80	0.68	6.67
T_2 (10 x 10 cm)	75.00	12.75	3.75	3.50	2.90	1.70	1.30	2.90	0.74	7.10
T_3 (15 x 15 cm)	75.00	12.70	3.97	4.90	3.20	1.89	1.53	3.44	0.79	7.15
CD(0.05)	2.63	1.11	0.09	1.33	0.10	0.10	0.11	0.46	0.07	NS
SEm±	0.81	0.34	0.03	0.41	0.03	0.03	0.03	0.14	0.02	0.33

NS = Non-significant

Table 2: Effect of spacings on growth parameters of *Gleditsia triacanthos* variety inermis seedlings in open beds for the year 2010 (8 months)

Parameters→ / Treatments (spacings)↓	Survival (%)	Height (cm)	Collar diameter (mm)	Fresh shoot weight (g/p)	Fresh root weight (g/p)	Dry shoot weight (g/p)	Dry root weight (g/p)	Total seedling dry weight (g/p)	Root shoot ratio	No. of secondary roots
T_0 Broadcast) [Control]	64.55	15.08	3.68	3.15	2.60	1.64	1.11	2.74	0.69	6.51
T_1 (5 x 5 cm)	68.36	13.62	3.67	3.48	2.88	1.67	1.21	2.90	0.74	6.69
T_2 (10 x 10 cm)	75.00	12.85	3.79	3.56	2.92	1.72	1.32	2.94	0.78	7.14
T_3 (15 x 15 cm)	75.00	12.86	3.99	4.96	3.38	1.93	1.57	3.48	0.83	7.21
CD(0.05)	1.28	NS	0.10	0.67	0.03	0.06	0.06	0.05	0.01	NS
SEm±	0.39	0.53	0.03	0.28	0.01	0.02	0.01	0.01	0.004	0.39

NS = Non-significant

Table 3: Effect of spacings on growth parameters of *Gleditsia triacanthos* variety inermis seedlings in open beds (mean of two years data *viz*., 2009 and 2010) [8 months]

Parameters→ / Treatments (spacings)↓	Survival (%)	Height (cm)	Collar diameter (mm)	Fresh shoot weight (g/p)	Fresh root weight (g/p)	Dry shoot weight (g/p)	Dry root weight (g/p)	Total seedling dry weight (g/p)	Root shoot ratio	No. of secondary roots
T_0 Broadcast) [Control]	64.50	15.06	3.64	3.10	2.59	1.62	1.10	2.72	0.67	6.46
T_1 (5 x 5 cm)	68.33	13.60	3.66	3.44	2.84	1.66	1.19	2.85	0.71	6.68
T_2 (10 x 10 cm)	75.00	12.80	3.77	3.53	2.91	1.71	1.31	2.92	0.76	7.12
T_3 (15 x 15 cm)	75.00	12.78	3.98	4.93	3.29	1.91	1.55	3.46	0.81	7.18
CD(0.05)	1.89	1.15	0.04	0.67	0.06	0.06	0.06	0.22	0.04	NS
SEm±	0.58	0.35	0.01	0.21	0.02	0.02	0.02	0.07	0.01	0.31

NS = Non-significant

Plate 1: Bare root nursery raising of *Gleditsia triacanthos* variety inermis at different spacings with bed size 1 m x 1 m

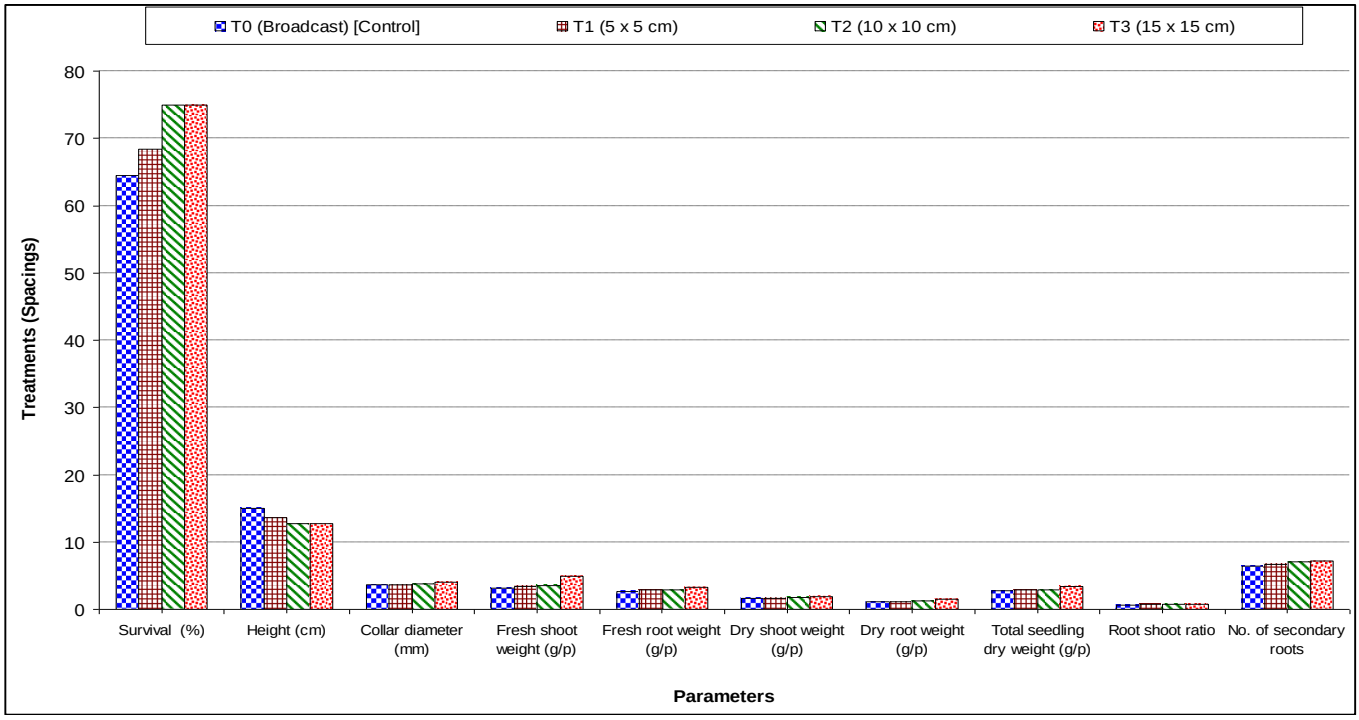

Fig 1: Effect of spacing on growth parameters of *Gleditsia triacanthos* variety inermis sseedlings in open beds

Conclusion

For raising bare root nursery, three spacing *viz*., 5 cm x 5 cm, 10 cm x 10 cm, 15 cm x 15 cm along with control (broadcasting) were tried and nursery spacing 15 cm x 15 cm have been standardized for raising best bare root nursery stock of honey locust for most of the parameters with respect to collar diameter and biomass of the seedlings.

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