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Effect of spacing on growth and biomass production in *bael* (*Aegle marmelos* Correa.) under hot arid conditions

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ABSTRACT

Bael (*Aegle marmelos* Correa.) is a suitable tree for growing different parts of the country for fruits as well as for its medicinal uses. All plant parts are used in ayurvedic formulations. *Bael* saplings were planted at a distance of 1 m x 1 m, 1.5 m x 1.5 m and 2 m x 2 m under drip irrigation system to assess the plant and root growth and biomass yield. The finding of the study revealed that close planting at 1 x 1 m was suitable for better growth and high biomass production (leaves/shoot/roots) under arid conditions. However, for root growth and development the planting of saplings at 2 x 2 m spacing gave better results.

KEY WORDS: *Bael*, *Aegle marmelos*, medicinal value, spacing, biomass yield, arid region

Bael (*Aegle marmelos* Correa.) also known as *Shri phal*, *Baelpatra*, Bengal quince and beel is highly suitable tree for water scarce areas of the country. *Bael* fruit is highly nutritive and rich in riboflavin, vitamin A, carbohydrate, etc. All the part of tree, whether stem, bark, root, leaves or fruit at different maturity stages has some use or the other. It is also used in the preparation of several ayurvedic medicines since ancient times (Rai and Dwivedi, 1992). It is a main part of "*Dashmool*" and it is mainly procured from forest sources. Marmelosin is the therapeutically active factor of *bael* fruit and is known as the panacea of the stomach ailments. Psorolen content is high in roots than in fruit .The pulp of fresh ripe fruits is eaten and used for preparation of value added products sherbet, nector, powder, candy, jam, squash, etc (Singh and Roy,1984). It is grown naturally in forests, degraded lands and also planted on boundary of field and orchards (Singh *et al.*, 2011). In India, there is no systematic cultivation of *bael* hence, its area and production data is also not available. There is no systematic work has been done for its planting density, spacing and biomass production point of view since, plant part is required through out the year for ayurvedic medicines. The present study was under taken with objective to find out the shoot and root growth patterns and biomass production at different planting distance in saplings of *bael* under arid conditions.

MATERIALS AND METHODS

The study on the high density planting of *bael* was carried out at CIAH, Bikaner during the year 2008-09 – 2010-11. The soil of experimental field is poor in fertility, organic matter and light textured. The water holding capacity of soil is also poor. Soils are generally rich in total potassium and boron but are low in nitrogen, phosphorus and micronutrients such as copper, zinc and iron. The soils of the region are having salinity. The ground water resource is not only limited owing to poor surface and sub-surface drainage but is also saline in quality. The annual average rainfall is about 240 mm and erratic in nature. The saplings of *bael* were raised in nursery in poly bags and one year old was transplanted in the field at a distance of 1 m x 1 m, 1.5 m x 1.5 m and 2 m x 2 m in three replications during 2008 to see the survival, growth pattern and biomass production. The plants were maintained under drip irrigation system. The intercultural operation was carried out as and when required. The survival of plants was recorded after a year of planting. However, plant growth was recorded after three years of planting. Plants were affected by frost/low temperature during winter under arid environment. However; they recovered during spring season after employing hoeing and irrigation. Plant growth *viz.* height and number of branches were observed to note the growth pattern and

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roots production. Plants were uprooted carefully at the end of experiment to study root growth and root biomass production. Observations on plant characters were recorded and the plant samples were kept in oven for drying to record dry weight. The data was statistically analyzed to find out the effect of different spacing treatment on growth of plant and biomass production.

RESULTS AND DISCUSSION

Survival of plants

The survival of plants was cent per cent in all treatments during first year of planting. The upper top portions of young plants were affected by low temperature / frost during winter season which recovered after giving irrigations to the plants during the month of February. The survival rate of plant was also good during second and third year in all spacing treatments.

Height of plant

The data presented in Table 1 revealed that the maximum plant height (124.20 cm) was recorded under 1 x 1 m spacing followed by 2.0 x 2.0 m (95.66 cm height) of spacing which differed significantly. However, slow growth in plant was noticed in all planting distance during initial stage of establishment which may be due to genetic make of plant as well as environmental conditions. Similar growth in *bael* plants has also been recorded by Shukla and Singh (1996) and Singh and Nath (1999). The thicker main shoot (1.22 cm.) was observed under 1x1m followed by 1.04 cm in 2x2 m spacing which may possibly be due to better plant vigour.

Shoot growth

Data presented in Table 1 indicated that the number of branches/plant was significantly higher under 1 x 1 m of spacing at final stage of study *i.e.* after three years of planting. The maximum number of branches per plant (12.97) was observed under 1x1m spacing followed by 2x2m. The minimum number of branches (5.95) was recorded under 1.5x1.5 m spacing. However, all the characters studied were significantly superior under 1x1m distance of planting in comparison to other planting distance. The variation in number of shoots varies from place to place and genotypes. Variation in shoot growth pattern in *bael* genotypes has also reported by Mishra *et. al.* (1999).

Leaves production

The number of leaves per plant was significantly higher under 1x1m spacing than 2x2 m and 1.5x1.5 m spacing during experimentation. Leaves are also important for different uses besides required for growth of plants. Good foliage was also observed under 1x1 m planting followed by 2x2 m distance of planting. The fresh weight of leaves was higher under 2x2 m (119.5 g per plant) followed by 1x1m spacing. The lowest leaves production was under 1.5x1.5 m. The trend of leaves production in plants was also similar to other characters.

Table 1: Effect of spacing on plant growth and biomass production in *bael* seedlings

Characters / Spacing (m)	1 x 1	1.5 x 1.5	2 x 2 m	CD at 5%
Plant height (cm)	124.200±0.721	74.730±1.123	95.667±0.289	1.575
No. of branches/plant	12.967±0.473	5.953±0.561	8.767±0.492	1.018
Diameter of main shoot (cm)	1.223±0.025	0.837±0.015	1.043±0.006	0.034
No. of leaves/plant	143.993±3.233	46.033±0.907	119.503±0.746	3.967
Fresh wt. of plant (g)	547.700±0.848	120.250±0.564	379.983±1.001	1.650
Dry wt. of plant (g)	180.290±0.356	43.433±0.289	134.750±0.219	0.584
Fresh wt. of shoot (g)	114.963±0.763	16.233±0.975	62.200±0.693	1.636
Dry wt. of shoot (g)	47.537±0.975	9.953±0.569	25.153±0.136	1.311
Fresh wt. of leaves (g)	108.633±1.644	34.163±1.071	119.520±0.417	2.313
Dry wt. of leaves (g)	55.400±0.529	18.600±0.458	63.310±0.165	0.829
Length of root (cm)	113.767±4.423	80.133±1.026	127.773±0.836	5.325
No. of roots/ plant	18.317±0.076	13.000±1.519	25.867±0.231	1.774
Fresh wt. of root (g)	270.767±55.23	57.303±19.79	238.793±23.61	1.862
Dry wt. of root (g)	114.000±27.78	38.600±14.21	94.707±4.26	5.177

Root growth

Perusal of data in Table1 showed that number of roots/plant (25.86) and longest root (127.77 cm) was significantly better in 2x2 m planting than that of other treatments. It was observed that root growth was faster than shoot length during first year establishment of plants. The growth of roots was spreading type and deep tap root system was observed in sandy soils of arid region. The fresh and dry weight of root/plant was significantly higher under 2x2 m distance than other treatment. It was interesting to note that vigorous root growth was observed under 2x2 m of spacing possibly be due to availability of more area of growth and development of plants. Better root growth has also been reported by Singh and Mishra (2000) while studying root distribution in *bael* in tarai belt.

Biomass production

Biomass production depends on good foliage and vigorous growth of plants. Three plants from each treatment were uprooted carefully for root and biomass study. For biomass, fresh weight of plant was observed and after proper drying, weight of dry sample was noted. The significantly higher biomass production (leaves, shoot and root) was observed under 1x1 m spacing after three years of planting under hot arid conditions followed by 2x2 m spacing. Thus, the study indicates that planting of seedlings at 1x1 m in *bael* was suitable for high biomass production under hot arid conditions. However, planting at 2x2 m distance was found better for plant growth and for the root production which can supplement the requirement of raw material for ayurvedic preparations throughout the year.

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