

Performance of *bael* (*Aegle marmelos*) cultivars under hot arid ecosystem of Rajasthan*

PL SAROJ,¹ T A MORE² and U V SINGH³

Central Institute for Arid Horticulture, Bikaner, Rajasthan 334 006

Received: 30 May 2008

Key words: *Aegle marmelos*, Arid ecosystem, Fruit cracking, Fruit drop, Physico-chemical parameters

Though *bael* (*Aegle marmelos* Correa) is an important indigenous fruit of the country because its nutritional value, medicinal attributes, wider edapho-climatic adoptability, high production potential, better storage life, suitable for various processed products and least problem of pest and diseases but no sincere efforts have been made to popularize this fruit for commercial orcharding. In general, the fruits of *bael* are not consumed as dessert fruit because of its astringent taste, presence of numerous seeds embedded in mucilage and fibre content. However, the fruit pulp contains fair amount of vitamins A, carbohydrate, minerals and high amount of riboflavin. The fruit pulp contains marmelosin which is laxative, diuretic, astringent, digestive, stomachic and possesses anti-amoebic and hypoglycemic properties. Therefore, the *bael* fruit has great potential for pharmaceutical and processing industries. Vivid accounts with respect to genetic diversity, varietal wealth, nutritional value, agro-techniques and processing of *bael* have been documented by Saroj *et al.* (2006). So far, limited information is available about varietal suitability of *bael* for different ecological regions and particularly for hot arid ecosystem; no information is available based on field experimentation. Moreover, information available in this direction is for *tara* region (Misra *et al.* 2000) and sub-tropical regions (Singh *et al.* 2003). Therefore, present investigation was undertaken to assess the performance of new *bael* cultivars under hot arid ecosystem of Rajasthan.

The investigation to assess the performance of *bael* cultivars was carried at Central Institute for Arid Horticulture, Bikaner during 1998-2004. The budded plants of 7 *bael* cultivars, viz 'NB 5', 'NB 7', 'NB 9', 'Pant Aparna', 'Pant Urvashi', 'Pant Shivani' and 'Pant Sujata' were planted in the field in 1998 at 6 m apart. The planting materials of 'Narendra Bael' and Pant series were procured from NDUAT, Faizabad, Uttar Pradesh and GBPUAT, Pantnagar,

Uttarakhand, respectively. The uniform management practices with respect to nutrition and irrigation were adopted for all the cultivars. To assess the vigour of different cultivars, the growth parameters, like plant height, plant spread, trunk girth and canopy volume were recorded at the end of investigation in 2004. The yield-attributing parameters, like fruit length, breadth, weight and number of fruits/ tree, fruit yield/ plant and fruit yield/ ha were recorded when plants came to fruiting in 2000 to till the final observation in 2004. The fruit quality parameters like, fruit shape, fruit colour, flesh colour, pulp content, shell thickness, number of seeds, weight of seeds, TSS, acidity and ascorbic acid were analyzed based on pooled data of 3 years (2002-04), when all cultivars came in fruiting. The data on fruit drop was recorded from 5 randomly pre-tagged branches, whereas fruit cracking was recorded by the counting of cracked fruits after harvesting of fruits of all cultivars under investigation separately from 2002-04. The agro-ecological region comes under hot arid ecosystem where experimentation was done. The soil was sandy with low fertility status and poor water-holding capacity. Meteorological parameters, like temperature, rainfall and humidity were recorded during fruiting period from 2002 to 2004 for interpretation of experimental results. The data on various parameters were analyzed by INDOSTAT statistical package in randomized block design having 3 replications.

The data on vigour of different cultivars were recorded after 7 years of plantation to see the relative growth behaviour of these cultivars under uniform management conditions. The data presented in Table 1 indicate that maximum plant height was recorded in 'Pant Urvashi' (5.85 m), closely followed by 'NB 7' (5.82 m) and 'Pant Shivani' (5.70 m) and minimum in 'Pant Aparna' (3.60 m), followed by 'NB 5' (3.75 m) while the plant height of other cultivars were in between. The plant spread was maximum in 'NB 7' (4.61 m), followed by 'Pant Urvashi' (4.32 m), while minimum in 'Pant Aparna' (3.21 m). The trunk girth did not follow the same trend with respect to minimum value, as it was in 'Pant Sujata' (35.50 cm) while

*Short note

¹Senior Scientist (Horticulture), ²Director, ³Technical Officer

maximum was again in the same cultivars, i.e. 'Pant Urvashi' (44.25 cm), followed by 'Pant Shivani' (43.50 cm). The significant variations were recorded in canopy volume of different cultivars and maximum canopy volume was recorded in 'NB 7' (46.32 m³), followed by 'Pant Urvashi' (44.21 m³) and minimum in 'Pant Aparna' (23.08 m³). In general plant growth was less as compared to *tarai* or sub-tropical regions probably because of poor soil fertility and very low rainfall. Based on relative growth performance the cultivars 'Pant Aparna', 'NB 5', 'NB 9' and 'Pant Sujata' can be categorized as dwarf, whereas cultivars 'Pant Urvashi', 'NB 7' and 'Pant Shivani' as vigorous under hot arid ecosystem.

The mean data of 3 consecutive years presented in Table 1 reveal that more than 95.55 % fruits were dropped in all the cultivars and hardly 4 % fruits retained up to maturity. In spite of that, good yield was recorded in some cultivars. Though, fruit drop is a natural phenomenon but it is influenced by various internal and external factors. The fruit cracking was observed in all cultivars and was maximum in 'NB 9' (44.47 %), closely followed by 'Pant Sujata' (43.40 %) and minimum under 'NB 7' (15.63 %). Fruit cracking in other cultivars were in between 32.25 and 39.47%. The problem of *bael* fruit cracking was also reported by Misra *et al.* (2000), Saini *et al.* (2004) in *tarai* and arid region of Haryana respectively. In fact, high fluctuation in temperature

Table 1 Plant growth, fruit drop and fruit cracking of *bael* cultivars under hot arid ecosystem

Cultivar	Growth parameters				Fruit drop (%)				Fruit cracking (%)			
	Plant height (m)	Plant spread (m)	Trunk girth (cm)	Canopy volume (m ³)	2002	2003	2004	Mean	2002	2003	2004	Mean
'NB 5'	3.75	3.79	40.50	27.16	94.60	96.20	97.45	96.08	34.50	35.60	38.80	36.30
'NB 7'	5.82	4.61	42.20	46.32	97.50	98.00	98.20	97.57	15.25	13.15	18.50	15.63
'NB 9'	3.90	3.70	41.20	28.24	94.20	95.20	97.25	95.55	47.50	40.40	45.50	44.47
'Pant Aparna'	3.60	3.21	36.28	23.08	97.50	98.20	98.02	97.91	34.50	38.20	45.70	39.47
'Pant Urvashi'	5.85	4.32	44.25	44.21	96.00	95.90	97.55	96.48	33.75	32.80	35.60	34.05
'Pant Shivani'	5.70	3.68	43.50	40.41	96.00	98.25	97.50	97.25	30.00	30.50	36.25	32.25
'Pant Sujata'	4.02	3.51	35.50	26.92	98.00	97.20	98.30	97.83	40.20	43.50	46.50	43.40
SEm±	0.07	0.16	0.06	0.36				0.22				0.38
CD (P=0.05)	0.21	0.49	0.18	1.08				0.68		1.20		

Table 2 Yield and yield attributing characters of different *bael* cultivars (2000-04)

Parameter	Cultivars							SEm±	CD (P=0.05)
	'NB 5'	'NB 7'	'NB 9'	'Pant ' Aparna	'Pant ' Urvashi	'Pant ' Shivani	'Pant ' Sujata'		
Fruit length (cm)	12.76	17.52	15.80	11.50	14.81	14.90	12.15	0.03	0.08
Fruit breadth (cm)	12.66	16.85	14.75	11.60	13.20	14.78	12.20	0.03	0.10
Fruit weight (kg)	0.98	1.80	1.65	0.58	0.95	1.45	0.79	0.02	0.08
Number of fruits/tree	28.02	4.35	16.92	21.55	26.19	13.76	11.84	0.07	0.24
Fruit yield (kg/ tree)									
2000			15.20						
2001	20.50		14.50		15.50	8.00	2.67		
2002	16.00	6.50	18.00	8.00	16.00	7.50	5.00		
2003	30.50	4.00	25.50	9.50	26.01	15.00	10.50		
2004	35.00	8.25	42.00	18.25	20.00	21.50	15.00		
Mean*	25.50	6.25	22.94	11.83	19.38	12.88	8.29	0.18	0.54
Fruit yield (tonnes/ha)									
2000			4.23						
2001	5.69		4.52		4.29	2.22	0.74		
2002	4.43	1.73	4.43	2.22	4.43	2.08	1.39		
2003	8.45	1.11	6.68	2.63	7.20	4.16	2.91		
2004	9.70	2.29	11.63	5.00	5.54	5.83	4.16		
Mean*	7.06	1.71	6.30	3.28	5.37	3.57	2.30	0.16	0.50

*Based on fruiting years

and low atmospheric humidity during active fruit growth period was the main reasons of premature fruit cracking.

Among different cultivars, 'NB 9' started bearing just after third year of planting, while 'NB 5', 'Pant Urvashi', 'Pant Shivani', 'Pant Sujata' came in bearing in fourth year, though the cultivar 'NB 7' and 'Pant Aparna' came in bearing comparatively late, i.e. fifth year of planting, thus 'NB 9' showed precocity in bearing. The data given in Table 2 indicate that maximum fruit length (17.52 cm) and breadth (16.85 cm) were recorded in 'NB 7' while minimum fruit length (11.50 cm) and breadth (11.60 cm) in 'Pant Aparna'. Similarly, the fruit weight was also maximum in 'NB 7' (1.8 kg) followed by 'NB 9' (1.65 kg) and minimum in 'Pant Aparna' (0.58 kg). However the maximum fruits/ tree was recorded in 'NB 5' (28.02), closely followed by 'Pant Urvashi' (26.19) and minimum in 'NB 7' (4.35). The observations indicate that there was almost inverse relationship between fruit size and number of fruits/ tree, thus fruit size only may not be a real criterion of yield, attributing parameters of *Bael*. Therefore, for better yield of *bael*, optimum fruit size and crop load both are essential. The fruit yield/ tree was increased with the increasing age of the tree but did not follow any trend. This was probably due to difference in cropping load of 2 consecutive years as well as fruit dropping behaviour of an individual cultivar. The data (Table 2) indicated that mean maximum fruit yield was recorded in 'NB 5' (25.50 kg/tree), followed by 'NB 9' (22.94 kg/ tree) and 'Pant Urvashi' (19.38 kg/ tree), whereas minimum in 'NB 7' (6.25 kg/ tree). Similarly, fruit yield/ ha basis was also maximum in 'NB 5' (7.06 tonnes/ha), followed by 'NB 9' (6.30 tonnes/ha) and 'Pant Urvashi' (5.37 tonnes/ha) and minimum in 'NB 7' (1.71 tonnes/ha). The variations in yield and yield-attributing characters of *bael* recorded by

Misra *et al.* (2000), Gupta and Misra (2002) and Singh *et al.* (2003) were in close proximity.

The fruit shape affects the marketing while natural flesh colour has better impact on processing quality. It is obvious from the data given in Table 3 that the pulp content was maximum in 'NB 9' (70.50 %) followed by 'Pant Sujata' (70.24 %) and 'NB 7' (68.16 %), though the differences were non-significant. The minimum pulp content was obtained in 'Pant Aparna' (54.50 %), which is a small-fruited variety. The thickness of fruit shell did not vary significantly among different cultivars, which ranged from 2.20 mm to 2.85 mm. There were wide variations in number of seeds/ fruit as it varied from 30.51 (Pant Aparna) to 75.20 (NB 9). In general, 'NB 9', 'NB 7', 'Pant Urvashi' and 'Pant Shivani' having more seeds than small-fruited cultivars 'NB 5', 'Pant Sujata' and 'Pant Aparna'. The weight of seeds/ fruit showed similar trend. The maximum value of TSS (36.25 %) was recorded in 'NB 9' while minimum under 'NB 7' (30.00 %). There was marginal difference in other cultivars with respect to TSS. Moreover, slightly higher TSS values were recorded in all the cultivars as compared to *tarai* or sub-tropical regions. This is mainly because of arid climate having sharp fluctuations in day and night temperature coupled with low atmospheric humidity during fruit ripening (Dhandar and Saroj 2004). The highest acidity was recorded in 'Pant Shivani' (0.90 %), closely followed by 'Pant Urvashi' (0.80 %) and minimum in 'NB 5' and 'NB 9' (0.30 %). The ascorbic acid content also varied significantly and recorded maximum in 'NB 5' (18.50 mg/ 100 g), while minimum in 'Pant Urvashi' (12.90 mg/ 100g). The results of quality parameters are almost in conformity with those of Ram and Singh (2003).

Thus it can be concluded that *bael* cultivars 'NB 5', 'NB 9', 'Pant Urvashi' and 'Pant Shivani' can be recommended.

Table 3 Quality parameters of *bael* cultivars under arid ecosystem (pooled data of 2004-04*)

Parameter/year	Cultivars							SEm±	CD (P=0.05)
	'NB 5'	'NB 7'	'NB 9'	'Pant ' Aparna	'Pant ' Urvashi	'Pant ' Shivani	'Pant ' Sujata'		
Fruit shape	Spheroid	Flattened round.	Oblong	Ellipsoid	Ovoid-oblong	Spheroid	Globose		
Fruit colour	Greenish-yellow	Light green	Greenish-yellow	Bright-yellow	Yellow	Yellow	Bright-yellow		
Flesh colour	Creamy - yellow	Yellow	Orange-yellow	Light-yellow	Yellow	Lemon-yellow	Creamy-yellow		
Pulp content (%)	62.25	68.16	70.50	54.50	65.00	68.52	70.24	0.76	2.34
Shell thickness (mm)	2.49	2.85	2.65	2.20	2.75	2.36	2.31	0.60	1.81
Number of seeds/ fruit	47.52	71.20	75.20	30.51	69.50	70.04	45.30	0.38	1.18
Weight of seeds/ fruit (g)	5.40	8.72	9.80	3.41	6.52	7.50	6.25	0.21	0.64
TSS (%)	35.20	30.00	36.25	35.03	34.13	34.10	32.04	0.33	1.03
Acidity (%)	0.30	0.40	0.30	0.50	0.80	0.90	0.50	0.01	0.03
Ascorbic acid (mg/100 g pulp)	18.50	14.02	17.50	14.00	12.90	14.13	16.28	0.11	0.34

for cultivation in arid region. However the problem of fruit cracking needs to be tackled properly.

SUMMARY

The study was conducted during 1998–2004 to assess performance of *bael* (*Aegle marmelos* Correa) cultivars under hot arid ecosystem of north-western Rajasthan. The budded plants of 07 *bael* cultivars, viz 'NB 5', 'NB 7', 'NB 9', 'Pant Aparna', 'Pant Urvashi', 'Pant Shivani' and 'Pant Sujata' were planted in low fertile sandy soil at 6 m apart. The observations on growth parameters revealed that the cultivars 'Pant Aparna', 'NB 5', 'NB 9' and 'Pant Sujata' can be categorized as dwarf type, whereas cultivars 'Pant Urvashi', 'NB 7' and 'Pant Shivani' as vigorous types. Among different cultivars, big fruit size (> 1.45 kg) was obtained in 'NB 7', 'NB 9' and 'Pant Shivani', while in cultivars 'NB 5', 'Pant Urvashi', 'Pant Sujata' and 'Pant Aparna' medium size (< 1.0 kg) fruits were obtained. The highest yield/plant was recorded in 'NB 5' (25.50 kg), followed by 'NB 9' (22.94 kg) and 'Pant Urvashi' (19.38 kg). Variable quality attributes were recorded among different cultivars but in general, better quality fruits with respect to high TSS and low acidity were obtained. There were also heavy fruit drop in all the cultivars and <4% fruits were retained up to maturity. Fruit cracking which ranged from 15.63 to 44.47 % emerged as serious problem of *bael* cultivation in this region. The cultivars 'NB 5', 'NB 9', 'Pant Urvashi' and 'Pant Shivani' can be

recommended for cultivation in hot arid ecosystem but with proper management of moisture, nutrient and problem of fruit cracking.

REFERENCES

- Dhandar D G and Saroj P L. 2004. Changing scenario in arid horticulture. (in) *Advances in Arid Horticulture*, Vol I, pp 1–27. International Book Distributing Co., Lucknow.
- Gupta N K and Misra K K. 2002. Growth, yield and photosynthetic efficiency of *bael* (*Aegle marmelos*) genotypes in foot-hills region of Uttaranchal. *The Indian Journal of Agricultural Science* 72 (4): 220–2.
- Misra K K, Singi R and Jaiswal H R. 2000. Performance of *bael* (*Aegle marmelos*) genotypes under foot-hill regions of Uttar Pradesh. *The Indian Journal of Agricultural Sciences* 70 (10): 682–3.
- Ram D and Singh I S. 2003. Physico-chemical studies on *bael* (*Aegle marmelos* Correa) fruits. *Progressive Horticulture* 35 (2): 199–01.
- Saini R S, Singh S and Deswal R P S. 2004. Effect of micronutrients, plant growth regulators, and soil amendments on fruit drop, cracking, yield and quality of *bael* (*Aegle marmelos* Correa) under rainfed conditions. *Indian Journal of Horticulture* 61 (2): 175–6.
- Saroj P L, Singh R S and Singh A K. 2006. *Bael* (*Aegle marmelos*). (in) *Advances in Arid Horticulture*, Vol II pp 21–38. International Book Distributing Co., Lucknow.
- Singh H K, Srivastava A K and Prasad J. 2003. The catalogue on *bael* (*Aegle marmelos* Correa). *Bulletin of Narendra Deva University of Agriculture and Technology*, Faizabad.