Research Article

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Variability studies in bael (*Aegle marmelos*) genotypes under semi-arid conditions

M.L. Choudhary[1], D.L. Bagdi[2]*, R.P. Ghasolya[3] and D.K. Bairwa[4]

[1]Department of Horticulture, SKN College of Agriculture (SKNAU), Jobner, Rajasthan
[2]Department of Plant Physiology, SKN College of Agriculture (SKNAU), Jobner, Rajasthan
[3]Department of Plant Pathology, SKN College of Agriculture (SKNAU), Jobner, Rajasthan
[4]College of Agriculture (SKNAU), Kotputli, Rajasthan

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ABSTRACT

A survey of bael genotypes was conducted in the districts of Ajmer, Churu, Jaipur, and Jhunjhunu in Rajasthan during 2021-22 and 2022-23.The collected genotypes exhibited significant variability in fruit morphology and physico-chemical characteristics. The number of fruits per tree ranged from 65 to 145, with fruit yield per tree varying between 22.79 kg and 176.6 kg. Fruit weight ranged from 0.33 kg to 2.85 kg across the genotypes. The important fruit traits, such as fruit length, ranged from 9.05 cm to 18.45 cm, shell weight per fruit varied from 115.25 g to 374.74 g, shell thickness ranged from 0.16 cm to 0.32 cm, and seed weight per fruit from 0.15 g to 0.32 g. The total soluble solids (TSS) ranged from 29.15 to 39.46 °Brix among the genotypes analyzed. Based on the overall assessment, the genotypes SKN-15 and SKN-2 were identified as the most promising.

Introduction

Indian bael (*Aegle marmelos* L. Correa) is one of the most ancient and common fruit indigenous to India. It belongs to family Rutaceae. It grows throughout subtropical and arid region and is a popular crop involving lower input with higher economic return even in the most fragile eco systems. The importance of bael fruits lies in its curative, pesticidal and nutritive properties. Ripe fruits are laxative and unripe fruits are prescribed for treatment of diarrhea and dysentery and have a great demand in Ayurvedic system of medicine. Every part of the plant such as fruit, seed, bark, leaf and root are important ingredients of several traditional formulations. Apart from medicinal value, it acts as a sink for chemical pollutants as it absorbs poisonous gases from atmosphere and makes them neutral. The tree is also considered under the category of 'Fragrant' species, whose flower and volatile vapours neutralize bad smell of putrefied organic matter or decaying refuge and thus save human life from bacterial attack by making them inert and deodorizing the bad odour of the air (Agarwal *et al.*,1997).

In India, it is found in wild form in sub-Himalayan tracts and dry deciduous forests of central and southern regions from prehistoric times and therefore a large number of ecotypes are available in different regions (Pandey *et al.*, 2008). A wide range of diversity of bael trees has been noticed in dry sub-tropical belts of north India. Plains of Uttar Pradesh have wide distribution of bael land races particularly in waste and

Corresponding author
Email: dlbagdi.2000@gmail.com (Dr. D.L. Bagdi)

degraded lands. Recently, few cultivars have been identified and found useful for commercial cultivation, i.e., NB-5 and NB-9 from NDUA&T, Faizabad (Pareek and Nath, 1996); Pant Aparna, Pant Shivani, Pant Sujata and Pant Urvashi from GBPUA&T, Pantnagar (Singh *et al*., 2000) and CISH-B-1 and CISH-B-2 from CISH, Lucknow (Pathak *et al*., 2002).

Some superior genotypes known to local people are on the verge of extinction and there is an urgent need to conserve them for use in posterity (Singh *et al.,* 2000). The western Rajasthan has high level of variability in bael land races. Therefore, a survey was conducted in high variability areas of western Rajasthan with a view to identify superior genotypes for various useful traits.

Material and Methods

Survey of bael trees was conducted in the districts of Ajmer, Churu, Jaipur and Jhunjhunu, of Rajasthan in the years 2021-22 and 2022-23. Both forested and farmed areas were covered throughout the survey using the technique recommended by Gupta and Rai (1996). The goal was to find only disease-free, pest-free, regularly bearing, dwarf trees with thin shells that contained less seed, fiber, and mucilage, had a pleasant scent, and produced uniformly shaped and sized fruits. A total of 15 genotypes having good fruit and tree characters were identified. Biased sampling after learning more about a certain genotype was done, in addition to random sample from the population. For each genotype, five fruits were randomly selected from every orientation in order to record the morphological and qualitative characteristics. It was noted how much the physical and qualitative characteristics of fruits from various places varied from one another. The physical attributes, viz., plant height, plant spread, stem girth, fruit weight, number of fruits per plant, number of seeds, seed weight, shell weight, shell thickness and pulp weight were calculated following standard procedures. Fruit yield per tree was calculated by counting the number of fruits per tree and multiplying by the average fruit weight. Total soluble solids were estimated in term of degrees Brix with the help of hand refractometer. The data were statistically analyzed as per method given by Gomez and Gomez (1984) using completely randomized block design.

Results and Discussion

The results of study on morphological characters and quality attributes of fruit revealed that the various germplasm of bael exhibited wide range of variation for all the characters studied under rainfed conditions of western India. The results of study on the vegetative characters of different bael germplasm revealed that the growth in terms of plant height, stem girth, plant spread, leaf and flower characters showed different variations under rainfed semi-arid environment.

Growth traits

The data on vegetative growth of different genotypes depicted in Table 1 exhibited significant differences. The differences in plant height, stem girth, plant spread ranged between 1.71-4.52m, 22.87-39.57cm, 1.39-3.57m, and 1.58-4.26m respectively. The plant height (4.52 m), stem girth (39.57 cm), plant spread (E-W-3.57 m and N-S-4.26m) were recorded the maximum in SKN-15, while the vegetative characters in terms of plant height (1.71 m), stem girth (22.87 cm) were measured minimum in SKN-9 and plant spread (E-W-1.39 m and N-S-1.58m) in SKN-3 respectively among the genotypes. The difference among SKN-1 to SKN-15do not differ at all in plant height, stem girth, plant spread (NS) but a significant difference was recorded among SKN-2 to SKN-13; SKN-13 to 14; and SKN-14 to SKN-7. The difference in vegetative growth among the genotypes may be due to inherent characters of individual genotype and their acclimatization to varied agro-climatic conditions. The dwarfness is the desirable characters for the high-density planting by accommodating a greater number of plants per unit area which ultimately enhance the productivity. Mishra *et al*. (1999) also reported that the different bael genotypes exhibited variations in their growth behavior under moist conditions of eastern India.

Table 1. Morphometrics of vegetative characters of bael germplasm under semi-arid region of Rajasthan

Genotypes	Vegetative growth				Terminal leaf size (cm)		Lateral leaf size (cm)	
	Plant height (m)	Stem girth (cm)	Plant spread (m) (NS and SW)		Length	Breadth	Length	Breadth
SKN-1	2.78	24.87	2.08	2.43	11.42	6.19	9.17	4.55
SKN-2	4.39	37.47	3.48	4.05	14.94	8.49	9.38	6.65
SKN-3	2.08	23.57	1.39	1.58	10.57	6.19	7.95	4.65
SKN-4	2.78	39.07	1.67	2.36	11.18	5.85	8.01	3.65

SKN-5	2.22	25.27	1.89	2.28	11.75	7.02	7.83	4.13
SKN-6	2.98	34.47	2.12	2.54	12.84	7.09	9.93	5.44
SKN-7	3.12	25.97	2.29	2.87	13.02	6.38	9.12	5.57
SKN-8	3.31	35.57	2.5	2.83	10.72	6.15	7.45	4.43
SKN-9	1.71	22.87	1.4	1.88	12.45	7.03	9.57	5.52
SKN-10	1.96	25.37	1.64	1.95	10.58	7.08	9.42	5.35
SKN-11	2.72	30.87	1.82	2.22	11.43	6.45	8.63	5.41
SKN-12	2.42	25.87	2.62	2.82	11.28	7.27	8.41	4.87
SKN-13	3.52	26.47	3.28	3.44	11.15	5.86	7.45	5.58
SKN-14	3.94	28.57	2.82	3.37	12.84	6.82	8.57	5.45
SKN-15	4.52	39.57	3.57	4.26	15.02	9.29	9.32	6.13
SEm±	0.16	1.67	0.16	0.13	0.47	0.21	0.54	0.33
CD at 5%	0.47	4.83	0.46	0.36	1.36	0.84	1.55	0.96

Leaf traits

It is evident from the data that the genotypes showed wide differences in their leaf characters under dry land conditions of western India (Table 1). It was noticed that the terminal leaflet size in terms of length (15.02) and breadth (9.29 cm) was found maximum in SKN-15 followed by SKN-2, SKN-7, SKN-14, SKN- 6 and SKN-9 for length andSKN-2, SKN-12, SKN-6, and SKN-5 with respect to leaflet width, while the minimum length (10.57 cm) was recorded in SKN-3 followed by SKN-9, SKN-10 and SKN-4, and minimum breadth (1.58 cm) was recorded in SKN-3 followed by SKN-10 and SKN-11. The lateral leaflet length (9.93 cm) and breadth (6.65 cm) was observed the maximum in SKN-6 and SKN-2, respectively, whereas the minimum lateral leaflet length (7.45cm) and breadth (3.65cm) was observed in SKN-8 and SKN-6 respectively followed by SKN-5 and SKN-3 for leaf length and genotypes SKN-5 and SKN-8 with respect to lateral leaflet breadth in all genotypes studied for the leaf morphological characters. The difference between lateral and terminal leaf size among genotypes do not differ at all but a significant difference was recorded among SKN-2 to SKN-12 in lateral leaf breadth and; SKN-2 to 7 in; and SKN-14 to SKN-7 in lateral leaf length. Differences in the leaf morphology in different germplasm are specific characters and adaptability to different agro-climatic conditions. More or less similar variations with respect to leaf characters in various bael genotypes have been reported by Mishra *et al.* (1999) and Singh (2000) in bael under different agro-climatic conditions.

Flower traits

The data on the morph metrics of flower of bael germplasm depicted in Table 2 and 3 showed considerable differences for all the floral characters studied. Flower characters with respect to flower length (12.39-19.84 mm), flower width (22.44-37.67 mm),bud size in terms of bud length (10.23-13.12 mm), bud width (7.17-9.24 mm), petal length (10.25-14.79 mm), petal width (7.43-9.16 mm), pedicel length (4.56-9.98 mm), pedicel width (2.02-2.88 mm), stamen length (6.7-8.5 mm), filament length (3.5-5.5 mm), width (0.40-0.80mm), anther length (40.45-45.25 mm), width (0.50-0.80 mm), pollen length (4.8-6.5mm), pollen width (1.5-2.5 mm), ovary length (1.1-1.5 mm), ovary width (1.50-2.5 mm), style length (2.4-3.5 mm), width (1.7-2.5 mm). The pollen viability was found to be significantly highest 95% in SKN-2 and SKN-15 followed by SKN-5 (94%), SKN-4 and SKN-1 (93%) and SKN-11 (92%) whereas rest of the germplasm have less than 92% pollen viability.

A significant difference was recorded between SKN-15 to SKN-3, SKN-4 to SKN-9 in stamen length; SKN-15 to SKN-1, SKN-1 to SKN-4, SKN-4 to SKN-5, SKN-6 to SKN-13 and SKN-11 to SKN-7 in stamen breadth. A significant difference was recorded between SKN-10 to SKN-13 and SKN-13 to SKN-11 in filament length; SKN-15 to SKN-10, SKN-10 to SKN-1, SKN-11 to SKN-4 and SKN-13 to SKN-3 in filament breadth. A significant difference was recorded between SKN-15 to SKN-2 and SKN-13 to SKN-4 and SKN-11 to SKN-8 in pollen length. A significant difference was recorded between SKN-12 to SKN-4, SKN-13 to SKN-3, SKN-15 to SKN-2, SKN-9 to SKN-1 in ovary length; SKN-15 to SKN-3, SKN-3 to SKN-1, SKN-11 to SKN-8, SKN-10 to SKN-12, SKN-13 to SKN-14, SKN-14 to SKN-7, and SKN-7 to SKN-5 in ovary breadth.

Variations in floral traits in different bael genotypes have been reported by Singh (1989), Srivastava and Singh (2000), Lal (2002) and Singh and Mishra (2004) under different climatic conditions of India.

Table 2. Floral biology of bael germplasm under semi-arid region of Rajasthan

Genotypes	Flower size (mm)		Bud size (mm)		Petal size (mm)		Pedicel size (mm)	
	Length	Width	Length	Width	Length	Width	Length	Width
SKN-1	14.34	28.18	10.85	7.23	10.25	7.55	7.56	2.02
SKN-2	19.32	35.56	12.39	9.18	14.23	8.93	9.58	2.88
SKN-3	14.38	27.48	10.64	8.65	12.28	7.45	8.06	2.15
SKN-4	18.74	36.22	11.23	8.55	12.59	7.46	5.57	2.19
SKN-5	12.39	23.44	10.52	8.36	10.41	6.99	4.56	2.47
SKN-6	14.4	27.64	11.46	8.11	12.22	6.87	4.59	2.09
SKN-7	14.44	29.16	10.23	7.17	13.08	8.08	5.45	2.14
SKN-8	16.84	32.11	10.96	7.22	13.28	7.76	8.88	2.08
SKN-9	15.38	31.02	12.51	8.29	10.47	7.51	7.96	2.07
SKN-10	15.46	29.13	11.58	7.59	13.25	7.43	7.66	2.03
SKN-11	15.34	30.63	11.52	8.59	12.86	7.65	7.46	2.11
SKN-12	12.65	25.43	12.33	7.89	13.45	8.11	6.56	2.12
SKN-13	14.4	28.32	11.37	8.11	12.87	7.34	7.84	2.43
SKN-14	16.44	32.43	10.54	8.39	11.65	6.65	7.64	2.13
SKN-15	19.84	37.67	13.12	9.24	14.79	9.16	9.98	2.87
SEm±	0.72	0.94	0.78	0.37	0.70	0.37	0.35	0.15
CD at 5%	2.08	2.73	2.25	1.08	2.03	1.06	1.01	0.44

Table 3. Floral biology of bael germplasm under semi-arid region of Rajasthan

Geno-types	Flower size (mm)		Filament size (mm)		Anther size (mm)		Pollen size (mm)		Ovary size (mm)		Style size (mm)		Pollen viability (%)
	Length	Breath	Width	Length	Width	Diameter	Length	Width	Length	Width	Length	Width	
SKN-1	7.5	5.1	0.6	3.5	0.8	41.25	6.1	3.1	1.1	2.1	2.5	2.1	93
SKN-2	8.5	5.5	0.8	4.5	0.7	45.25	6.5	4.2	1.2	2.5	3.5	2.5	95
SKN-3	8.2	4.4	0.4	4.5	0.8	44.35	5.5	3.2	1.3	2.2	2.5	2.5	91
SKN-4	8.1	4.8	0.5	3.5	0.6	42.45	5.9	3.3	1.4	2.1	2.8	2.2	93
SKN-5	7.5	4.5	0.6	3.5	0.8	41.25	5.4	3.5	1.5	1.5	2.7	2.1	94
SKN-6	7.5	4.3	0.6	3.5	0.8	40.25	5.6	3.5	1.5	2.1	2.5	2.1	90
SKN-7	6.7	2.7	0.5	4.5	0.7	41.25	4.9	3.2	1.2	1.6	2.4	2.3	93
SKN-8	7.4	3.5	0.4	3.5	0.5	41.25	4.8	2.5	1.3	1.9	2.9	2.2	91
SKN-9	7.7	3.7	0.6	4.5	0.7	42.55	6.1	3.6	1.2	1.5	2.8	1.9	89
SKN-10	7.5	4.5	0.7	3.5	0.7	43.57	6.5	2.5	1.5	1.9	2.5	1.8	91

SKN-11	7.3	3.5	0.6	4.6	0.6	42.55	5.5	3.5	1.5	2.1	3.1	1.7	92
SKN-12	7.5	4.5	0.5	3.5	0.7	43.45	6.5	3.6	1.5	1.8	2.5	1.9	88
SKN-13	6.9	3.8	0.5	4.8	0.7	40.46	6.4	3.5	1.4	1.8	2.4	2.1	89
SKN-14	7.4	4.5	0.4	4.6	0.8	41.48	6.5	3.7	1.3	1.7	2.9	2.3	89
SKN-15	8.5	5.5	0.8	5.5	0.8	44.27	6.5	4.5	1.3	2.5	3.5	2.5	95
SEm±	0.10	0.07	0.01	0.07	0.01	0.52	0.08	0.05	0.02	0.03	0.04	0.02	1.41
CD at 5%	0.29	0.19	0.03	0.20	0.03	1.50	0.23	0.15	0.05	0.09	0.101	0.06	4.07

Fruit characters

It is evident from the data (Table 4) that the values of quantitative characters also varied significantly in different germplasm. The maximum yield per plant was recorded in SKN-15 (535.76 kg) followed by SKN-2 (138.58 kg), SKN-1 (55.87 kg), SKN-12 (54.02 kg),SKN-7 (52.94 kg) and they were found at par for fruit yield, whereas fruit yield was recorded minimum in SKN-4 (40.52 kg) followed by SKN-9 (41.06 kg), SKN-5 (45.39 kg), SKN-13 (46.45 kg) in the genotypes studied for yield. Fruit weight was recorded the highest in SKB-15 (2.85 kg) followed by SKN-2 (0.96 kg), SKN-7 (0.67 kg) and SKN-4 (0.65 kg), whereas the lowest fruit weight was recorded in SKN-13 (0.33 kg) followed by SKN-8 (0.37 kg). The fruit length (18.45 cm) was found to be highest in SKN-15 followed by SKN-2 and SKN-11, whereas the same was recorded the lowest in SKN-10 (9.05 cm) followed by SKN-6 (9.03 cm) and SKN-5 (9.45 cm).The maximum fruit girth (67.88 cm) was exhibited by SKN-15 followed by SKN-5 (48.62 cm) and SKN-11 (12.12 cm), while the minimum fruit girth was observed in SKN-8 (29.39 cm) followed by SKN-4 (29.81 cm), SKN-13 (32.42 cm), SKN-1 (32.53 cm), SKN-10 (33.24cm), SKN-14 (35.34 cm) and SKN-3 (36.44 cm). A significant difference was recorded between SKN-15 to SKN-2 and SKN-2 to SKN-1 in number of fruits and fruit yield per plant; SKN-4 to SKN-1in fruit weight; SKN-15 to SKN-2 and SKN-2 to SKN-12 in fruit length; SKN-15 to SKN-5 in fruit girth among genotypes of bael. Variations in the physical parameters among the germplasm may be owing to individual varietal characters. However, difference in floral traits in various genotypes of bael are as just reported by earlier workers (Mazumdar, 1975; Rai *et al.,* 1991; Pathak *et al.,* 2002; Ram and Singh, 2003; Pandey *et al.,* 2005) under different agro-climatic conditions.

Table 4. Physical attributes of fruits of bael germplasm under semi-arid region of Rajasthan

Genotypes	Number of fruit/ tree	Fruit yield/ tree (kg)	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Shell weight (g)	Shell thick-ness (cm)	Pulp weight (g)
SKN-1	98	55.87	0.57	11.15	32.53	141.69	0.18	418.31
SKN-2	145	138.58	0.96	15.59	48.12	241.65	0.27	708.35
SKN-3	91	43.68	0.48	10.28	36.44	146.09	0.16	323.91
SKN-4	65	42.25	0.65	9.61	29.81	115.25	0.16	525.75
SKN-5	71	38.82	0.55	9.45	48.62	212.92	0.22	327.08
SKN-6	86	33.56	0.39	9.03	43.27	146.47	0.17	235.53
SKN-7	79	52.94	0.67	10.54	37.88	260.05	0.21	400.95
SKN-8	77	28.49	0.37	10.51	29.39	227.31	0.21	140.32
SKN-9	67	23.50	0.35	11.15	43.39	240.22	0.22	100.67
SKN-10	79	37.84	0.48	9.05	33.24	374.74	0.23	100.26
SKN-11	88	50.33	0.57	12.12	41.25	190.63	0.32	369.37
SKN-12	73	54.02	0.74	13.2	41.75	210.75	0.23	519.25
SKN-13	69	22.79	0.33	9.45	32.42	216.45	0.24	110.51
SKN-14	82	34.37	0.42	10.35	35.34	231.46	0.24	184.54
SKN-15	62	176.70	2.85	18.45	67.88	587.5	0.32	2096.40
SEm±	5.38	4.39	0.02	0.53	2.14	11.85	0.01	28.81
CD at 5%	15.57	12.73	0.07	1.53	6.20	34.33	0.02	83.45

Physical composition of fruits

It is evident from the data that the fruit attributes vary greatly in different germplasm (Table 4 and 5). Shell weight (374.74 g) was measured conspicuously very high in SKN-15 and the lowest in SKN-4 (115.25 g) followed by SKN-1 (141.69 g) and SKN-3 (146.09 g). Shell thickness (0.32 cm) was recorded maximum in SKN-15 & SKN-11 and the least thickness was observed in SKN-3 & SKN-4 (0.16 cm) followed by SKN-6 (0.17 cm) and SKN-1 (0.18 cm). The pulp content was maximum in SKN-15 (2096.40 g) followed by SKN-2 (708.35 g), SKN-4 (525.75 g) and the minimum pulp content was obtained in SKN-10 (100.26 g). Total number of seeds/fruits (122) was recorded maximum in SKN-11 followed by SKN-12 (113), SKN-9 (101), SKN-6 & SKN-13 (97) and the minimum numbers of seeds/fruit was observed in SKN-2 (65). Seed weight was maximum in SKN-15 (0.32 g) followed by SKN-13 (0.29 g), SKN-3 (0.28 g) and the minimum seed weight was obtained in SKN-8 (0.25 g). Total seed weight /fruit (13.5 g) was measured conspicuously very high in SKN-14 and SKN-11 and the lowest in SKN-2 (7.2 g) followed by SKN-15 (7.5 g), SKN-7 (8.6 g) and SKN-5 (8.7 g). Fiber weight/ fruit was maximum in SKN-15 (109.79 g) followed by SKN-2 (67.0 g), SKN-12 (52.46 g) and the minimum fiber weight was obtained in SKN-10 (22.7 g). A significant difference was recorded between SKN-10 to SKN-15, SKN-15 to SKN-7, SKN-11 to SKN-6 in shell weight; SKN-15 to SKN-2, SKN-2 to SKN-13 and SKN-8 to SKN-1 in shell thickness; SKN-15 to SKN-2, SKN-2 to SKN-4, SKN-12 to SKN-1 and SKN-3 to SKN-6 in pulp weight; SKN-15 to SKN-13, SKN-11 to SKN-1, SKN-9 to SKN-8 in total seed weight/fruit; SKN-15 to SKN-2, SKN-2 to SKN-12 in fiber weight among these genotypes of bael whereas a non-significant variation were recorded in number of seeds/ fruit among these genotypes of bael.

Table 5. Physical attributes and TSS content of fruits of bael germplasm under semi-arid region of Rajasthan

Genotypes	Total number of seed/ fruits	Seed weight (g)	Total seed weight/ fruit (g)	Fiber weight/ fruit (g)	TSS (°Brix)
SKN-1	90	0.22	10.2	22.70	31.20
SKN-2	65	0.20	7.2	67.00	36.45
SKN-3	81	0.28	9.6	28.50	30.16
SKN-4	92	0.25	10.2	25.91	32.23
SKN-5	79	0.27	8.7	36.50	29.15
SKN-6	97	0.21	10.7	35.24	33.17
SKN-7	78	0.27	8.6	49.30	30.57
SKN-8	90	0.15	10.4	43.80	33.46
SKN-9	101	0.18	11.2	35.60	31.49
SKN-10	94	0.19	10.4	41.50	34.56
SKN-11	122	0.25	13.5	30.77	33.25
SKN-12	113	0.22	12.2	52.46	33.98
SKN-13	97	0.29	10.6	43.21	34.23
SKN-14	122	0.21	13.5	39.46	33.18
SKN-15	71	0.32	7.5	109.79	39.46
SEm±	4.32	0.01	0.22	4.14	1.58
CD at 5%	12.52	0.03	0.64	11.98	4.58

Qualitative traits

It is quite obvious from the data (Table 5) that the different genotypes manifested considerable variation in qualitative attribute. The total soluble solids in pulp were recorded highest in SKN-15 (39.46° brix) followed by SKN-2 (36.45° brix), SKN-13 (34.23° brix) and SKN-10 (34.56° brix) and the lowest TSS of pulp was recorded in SKN-5 (29.15 brix) followed by SKN-3 (30.16° brix) and SKN-7 (30.57° brix), whereas a non-significant variation in the total soluble solids was recorded in among these genotypes of bael. Based on the observations, it may be inferred from the study that the bael can successfully be grown commercially with and without irrigation under rainfed conditions of western India. Among the genotypes the SKN-15 and SKN-9 for plant height and stem girth; SKN-15 and SKN-3 for plant spread and leaf length; SKN-15 and SKN-4 for leaf breadth; SKN-13 followed by SKN-8 and SKN-6 for lateral leaf length; SKN-4 and SKN-6 for lateral leaf breadth, SKN-15 ranked first for floral biology attributes followed by SKN-5 for flower size, SKN-7 for flower bud, SKN-1 for petal length, SKN-10 for petal breadth, SKN-5 for pedicel length and SKN-1

for pedicel breadth, SKN-7 for stamen size, SKN-14, 3, 2 for filament width, SKN-6, 2 for anther diameter, SKN-10 for pollen width, SKN-2 for ovary width, style size and pollen viability percent. The genotype SKN-15 ranked first for yield attributes, yield and quality (except SKN-14, in which total seed weight / fruit was recorded higher) followed by SKN-4 for number of fruit/ tree and yield / tree; SKN-13 for fruit weight; SKN-6 for fruit length; SKN-8 for fruit girth; SKN-4 for shell weight; SKN-3, 4 for shell thickness and SKN-10 for pulp weight; SKN-11 for total number of seed/ fruits; SKN-8 for seed weight; SKN-2 for total seed weight / fruit (g); SKN-1 for fiber weight/ fruit (g) and SKN-5 for TSS pulp ((°Brix).

Conclusion

Based on the overall performance in both qualitative and quantitative traits, including vegetative growth, fruit characteristics, and yield, the genotypes SKN-15 and SKN-2 demonstrated superior adaptability and productivity under the rainfed semi-arid conditions of western India.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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