

Diversity of Bael (*Aegle marmelos* Corr.) in East Central India

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The east and central India has rich genetic diversity of bael. To collect the existing genetic diversity, exploration programme was undertaken in parts of Jharkhand and Bihar during 2002. A total of 33 genotypes of bael having economically important horticultural traits have been identified from the diverse gene pool spread over six districts of Jharkhand and ten districts of Bihar. The genotypes showed variability with respect to tree morphological characters, intensity of bearing and fruit characters. The physico-chemical constituent in different genotypes also varied greatly. The fruit weight in different genotypes varied from 0.5-2.6 kg whereas the fruit length varied from 16.8-30.5 cm. The skull thickness which is a negative character for a quality bael fruit, varied from 0.17-0.4 cm in different genotypes collected during the exploration. On the basis of fruit characters and bearing behavior five promising genotypes has been identified.

Key Words: Bael, *Aegle marmelos*, Diversity

Introduction

Bael (*Aegle marmelos* Corr.) is one of the underutilized native fruits of Indo-Malaysian region (Anon., 1985). It is found in wild state in sub-Himalayan tract and dry deciduous forest of central and southern region (Anon., 1985); a large number of genotypes are available in different diversity regions. Bael has great mythological significance and medicinal value in which almost all parts of the plant are used in preparation of different medicines (Pathak *et al.*, 2002). The pulp contains marmelosin, which acts as laxative, diuretic and in strong doses a cardiac depressant. The plateau region of Jharkhand and plains of Bihar have wide distribution of bael particularly in degraded land. Although, there is no systematic plantation of bael, a fair quantity of fruits are made available from forests and grooves in marginal lands of Bihar, Jharkhand and Uttar Pradesh where it matures at different time. As a result, bael fruits are sold in market from March to July. Owing to seed propagation of the species no standard variety of bael is available. Recently a few genotypes of bael collected and evaluated by different research institutions have been found useful for commercial cultivation. NB-5 and NB-9 cultivars have been evolved at NDUAT Faizabad (Pareek and Vishal Nath, 1996) and CISH-B1 and CISH-B2 at CISH Lucknow (Pathak *et al.*, 2002). Bael gene pool growing in different ecological regions has enormous variability with respect to qualitative and quantitative characters (Singh and Roy, 1984). Some superior genotypes are at the verge of extinction (Roy, 1984) and need to be conserved (Rai *et al.*, 1991). East-Central India has high potential of bael diversity and therefore, an urgent need

for fine field survey and exploration was felt and thus, conducted in high variability region of Jharkhand and Bihar with a view to identify the superior genotype for various traits.

Material and Method

A joint exploration to identify and collect potential bael germplasm was undertaken by Horticulture and Agro Forestry Research Programme, Ranchi and Central Institute for Sub-tropical Horticulture, Lucknow in parts of Ranchi, Hazaribagh, Bokaro, Giridih, Deoghar and Koderma districts of Jharkhand and Jamui, Lakhisarai, Begusarai, Samastipur, Muzaffarpur, Vaishali, Motihari, Patna, Nalanda and Nawada districts of Bihar located between 83-87°E longitude and 23-26°N latitude during April, 2002. Five fruits were randomly collected in each genotypes to record the quantitative and qualitative characters. Tree height was estimated while spread and trunk girth was measured with the measuring tape. The information about age of the plant was gathered from local people whereas other vegetative characters were recorded visually. Yield of the tree was calculated on the basis of average weight of the fruit and total number of fruits on the tree. Population density was prepared by observing the plant population at a particular site. Range, mean and standard error for five characters were also calculated.

Results and Discussion

Bael is a drought hardy fruit plant, which grows in most degraded and marginal lands with varying soil types. In present exploration, it was observed that bael plants are widely growing in different parts of Jharkhand and Bihar.

Diversity in Plant Density

Population density of bael ranged low to high at different locations surveyed (Table 1). The highest densities of plants were observed at Khelari, Ranchi; Chitrapur, Bokaro; Sariya, Giridih; Chakai, Jamui; Dularpur, Begusarai; Bhikharia Mathia, Siwan and Jhumari-Tillaia, Koderma.

Diversity in Morphological Characters

Considerable variability was observed in the identified germplasms with respect to different morphological characters such as plant growth, leaf characters, thorniness on the stem and branches (Table 2). The tree height ranged from 6 m (IC 436503) to 22 m (IC 436475). Similarly, the trunk girth in these genotypes ranged from 0.5 m in IC 436503 to 1.5 m in IC 436505, IC 436492 and IC 436486. North-South canopy spread was the maximum (11.0 m) in genotype IC 436486 whereas the East-West canopy was highest (13.0 m) in case of IC 436507. Thorns on the branches also varied from less to very high in different genotypes as reported by Rai *et al.*, (1991).

Diversity in Fruit Yield

The identified genotypes had wide diversity with respect to number of fruits per plant. During the exploration it was observed that the plants in backyard or at religious places had more number of fruits than those of disturbed and barren lands. In different genotypes, the yield ranged from 30 fruits/plant (IC 436494) to 500 fruits/plant (IC 436489). Rai *et al.* (1991) had earlier reported 60-3000 fruits per plant in different genotypes of bael.

Table 1. Population density of bael in parts of Jharkhand and Bihar

Location	Population Density	Location	Population density
Khijri, Ranchi	+	Musri Gharai, Samastipur	+
Ratu, Ranchi	+	Chak Salem, Samastipur	++
Khellari, Ranchi	+++	Kamalpur, Vaishali	+
Ramgarh, Hazaribagh	++	Meenapur, Muzaffarpur	++
Sandi, Hazaribagh	++	Phatuha, Patna	+
Chitrapur, Bokaro	+++	Biharsharif, Nalanda	-
Vishnugarh, Hazaribagh	+	Nawadah	+
Sariya, Giridih	+++	Jamui Tillaia, Koderma	+++
Mahua, Giridih	++	Barhi, Hazaribagh	+
Lataki, Giridih	++	Chakai, Jammui	+++
Jasidih, Deoghar	++	Deoghar Local	++
Jhajha, Jamui	++	Dularpur, Begusarai	+++

+ low, ++medium, +++ high

Variation in Fruit Characters/Fruit Size

Fruits of different genotypes varied in different physico-chemical characters (Table 3). The maximum fruit weight (2.6 kg/fruit) was recorded in genotype IC 436485, whereas the minimum (0.41 kg/fruit) was in IC 436476. Fruit length and breadth in different bael genotypes varied from 16.75 cm (IC 436476) to 30.50 cm (IC 436485) and 13.50 cm (IC 43694) to 29.00 cm (IC 436483), respectively. Botanically, bael is an Amphisarca. The outer hard skin, called skull, contains mini sacs. The number of sacs in different genotypes varied from 8-17 (Table 3). The skull weight in different genotypes varied from 28.1 g (IC 436476) to 480 g (IC 436499), whereas the skull thickness varied from 0.17 cm (IC 436486) to 0.50 cm (IC 436481). Pareek and Vishal Nath (1996) noted 0.26 cm to 0.32 cm skull thickness in different cultivars of bael whereas Pathak *et al.* (2002) and Rai *et al.* (1991) mentioned that papery skull in bael is a desirable horticultural trait. Fibre content in bael is considered to be negative character particularly with respect to pulp quality, whereas for medicinal point of view, fibre and mucilage content is desirable trait. The bael genotypes collected also varied with respect to fibre content. The maximum values of fibre (935.2g/fruit) was recorded in genotypes IC 436477. Data presented in Table 3 reveal that the number of seeds per fruit in different genotypes varied from 20 (IC 436488) to 165 (IC 436503). Pareek and Vishal Nath (1996) reported 46-108 seeds per fruit in different bael genotypes whereas Rai *et al.* (1991) noticed 46-120 seeds in different genotypes of bael from Eastern Uttar Pradesh.

On the basis of different desirable traits, following five elite genotypes have been identified.

IC 436483: Plant medium in height (8.0 m), medium spreading (7.8 x 8.5 m), leaves vigorous, healthy green, which persist up to end of April. Grown up plant bears 150-175 fruits weighing 2.0-2.5 kg fruit. Fruit round (29.0 cm diameter) with flat styler end. Skull thin (0.26 cm) pulp has less seeds (40) and fibre and has pleasant aroma.

IC 436486: Plant tall (20.0 m) with thick trunk (1.5 m girth), more spreading (11.0 x 10.5 m), leaves healthy green, which persist up to mid of May. Well grown plant (50-60 years) has thorns and bears 300-400 fruits weighing 0.6 - 1.0 kg fruit. Bright yellow fruits are oblong in shape with 19.5 cm length and 18.5 cm diameter. Skull papery (0.17 cm) pulp has less seeds (52) and fibre content and has pleasant aroma.

Table 2. Diversity in morphological characters of bael land races in parts of Jharkhand and Bihar

Genotype (IC Number)	Tree height (m)	Trunk Girth (m)	Canopy spread (m)		Leaf Characters	Spines on Tree	General Health	Age of tree (years)	Plant Location	Yield (No. of Fruits)	Remarks
			(N-S)	(E-W)							
IC 436475	22	1.3	10.5	10.5	Early leaf fall	Medium	Medium	70-75	Barren land	100	-
IC 436476	13	0.9	8.5	7.3	Vigorous	Less	Medium	50-55	Threshing flour	300	Die back of twigs
IC 436477	10	0.7	6	5.5	Early leaf fall	Medium	Medium	30-35	Closed backyard	150	Less branches
IC 436478	12	1.1	-	-	Vigorous, healthy	Less	Good	50-60	Barren land near house	150	Disease free
IC 436479	12	0.9	9.5	9.5	Early leaf fall	Very less	Very good	30-35	Closed backyard	350	Heavy yield
IC 436480	8	0.6	5.5	4.5	Early leaf fall	More	Good	10.15	Closed fencing boundary	60	Disease free
IC 436481	12	0.9	7.5	7	Healthy, Vigorous	Very less	Very good	25-30	Open backyard	150	Heavy bearing of uniform
IC 436482	15	1.2	8	8.5	Smaller leaf	Less	Good	60-70	Closed backyard	250	Disease free pest free
IC 436483	8	0.8	7.8	8.5	Vigorous, healthy leaf	Very less	Very good	35-40	Bund of field	175	Disease free pest free
IC 436484	11	1.3	9	8.3	Early leaf fall	Very less	Very good	80-90	Field boundary	225	Heavy bearing disease free
IC 436485	7	0.6	5.5	6	Early leaf fall	Medium	Good	20-22	Field boundary	100	Heavy yield disease free
IC 436486	20	1.5	11	10.5	Healthy green leaf	Less	Very good	50-60	Open backyard	400	Heavy fruiting disease free
IC 436487	18	1.1	8	7	Early leaf fall	More	Medium	40-45	Closed backyard	250	Heavy bearing pest free
IC 436488	10	0.9	6.5	7	Early leaf fall	Very Less	Medium	20-25	Field boundary	250	Heavy bearing pest free
IC 436489	12	1.2	8	7.9	Healthy vigorous leaf	Less	Good	60-70	Community place	500	Heavy bearing
IC 436490	10	1	7.5	7.9	Healthy vigorous leaf	Less	Very good	30-35	In front of house	300	Heavy fruiting disease free
IC 436491	8	0.8	6	6.4	Early leaf fall	More	Good	25-27	In front of house	200	Disease pest free
IC 436492	11	1.5	8	8.5	Early leaf fall	Very less	Poor	100-125	Closed backyard	400	Old age symptom
IC 436493	15	1.3	9	8.5	Healthy green leaf	Less	Very good	90-100	Community land	350	Disease free
IC 436494	7	0.7	-	-	Early leaf fall	Less	Medium	100-150	Uncared backyard groove	30	Affected with black mould
IC 436495	13	1.1	8.5	9.5	Healthy green	Less	Good	60-65	Closed backyard	200	Disease free
IC 436496	10	Multi-stem	6.5	7.5	Early leaf fall	Very less	Poor	75-80	Single plant in mango orchard	400	Old age symptom
IC 436497	9	0.8	6.7	6	Healthy leaf	Less	Medium	25-30	In front of office near bamboo clamp	100	Dieback symptom
IC 436498	7	0.8	6.8	-	Early leaf fall	Less	Medium	30-40	Community land	100	Dieback symptom
IC 436499	10	0.9	5	5.5	Early leaf fall	Less	Poor	40-45	Closed backyard	75	Dieback symptom
IC 436500	7	0.7	6	6.5	Healthy green leaf	Less	Very good	20-25	In front of house	150	Orange flavour type fruit
IC 436501	9	1	5.5	6	Green, vigorous leaf	Less	Poor	40-50	Field boundary	75	Attack of pest and dieback symptom
IC 436502	7	0.6	5	5.5	Early leaf fall	Medium	Medium	10-15	Single plant in banana orchard	35	Pest and disease free
IC 436503	6	0.5	6	5.5	Healthy green vigorous leaf	Less	Very good	20-25	Closed boundary in front of house	125	Dwarf type
IC 436504	8	0.7	7.5	7.8	Early leaf fall	Less	Good	15-20	Open backyard	200	Disease and pest free
IC 436505	13	1.5	9.5	7.5	Healthy green vigorous leaf	Less	Very good	25-30	Open backyard	175	Disease and pest free
IC 436506	8	0.8	8	6.5	Vigorous, early leaf drop	Very less	Good	32	Open backyard	150	Large fruits with shining skull disease free
IC 436507	15	1	12	13	Healthy green	Less	Very good	30	Open backyard	250	Medium size, shining fruit

IC 436488: Plant medium tall (10.0 m), medium spreading (6.5 x 7.0 cm) leaves broader but falls by mid of April. Grown up plant has very few thorns and bears 250-275 fruits weighing 0.9-1.2 kg fruit. Pale yellow oblong fruits have 22.0 cm length and 19.5 cm diameter. Fruit has very thin papery skull (0.19 cm) and less seed, mucilage and fibre in its pulp. It also possesses very good aroma.

IC 436501: Plant medium tall (9.0 m), less spreading (5.5 x 6.0 m) with healthy green leaves. Well grown up plant bears 50-75 fruits weighing 1.4-1.8 kg fruits. Oblong fruits having 23.0 cm length and 22.0 diameter. Fruit contains papery skull (0.20 cm), less seeds (26) and mucilage.

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IC 436507: Plant tall (15.0) with well spreading canopy (12.0 x 13.0 m) healthy green leaves. Grown up plants bears 200-250 fruits weighing 1-1.4 kg fruit. Round fruit with flat styler end has 20.8 cm length and 23.2 cm diameter. At ripening fruit becomes yellow. It contain less seeds, and mucilage has good aroma.

Conclusion

The available variability for various traits in bael genotypes can be utilized for improvement of this underutilized fruit. Five genotypes described with desirable characters can be directly selected for commercial cultivation. Genotypes having less seeds and mucilage content, papery

Table 3. Diversity in fruit characters of bael genotypes

Genotype (IC Number)	Fruit weight (kg)	Fruit length (cm)	Fruit breadth (cm)	No. of Sacs in fruits	Weight of skull (g)	TSS (°brix)	No. of seeds per fruit	Weight of seed per fruit (g)	Thickness of skull (cm)	Weight of fibre (g)
IC 436475	0.50	19.50	16.57	10	175.2	36.5	48	7.5	0.32	3.6
IC 436476	0.41	16.75	16.10	12	098.1	30.0	45	7.9	0.34	9.7
IC 436477	0.96	23.25	20.60	12	265.3	34.5	69	39.5	0.31	35.2
IC 436478	0.96	23.25	20.60	12	265.3	34.5	69	39.5	0.31	35.2
IC 436479	1.30	25.00	23.75	12	204.3	36.0	40	12.0	0.26	10.0
IC 436480	0.95	20.25	17.85	10	228.7	34.0	140	20.0	0.28	20.0
IC 436481	1.00	21.00	23.00	10	218.5	35.0	80	20.0	0.50	10.0
IC 436482	0.90	18.00	18.65	10	158.6	37.0	70	10.0	0.33	7.5
IC 436483	2.50	29.00	29.00	14	410.5	35.0	54	10.0	0.37	25.0
IC 436484	2.05	28.50	27.50	12	478.9	36.0	70	10.0	0.35	20.0
IC 436485	2.60	30.50	28.00	12	448.2	36.0	71	10.0	0.30	10.0
IC 436486	0.60	19.50	18.50	12	208.7	37.0	53	10.0	0.17	10.0
IC 436487	1.40	25.75	25.50	12	200.1	32.0	50	20.0	0.35	15.0
IC 436488	0.90	22.00	19.50	12	209.8	36.0	20	5.0	0.24	30.0
IC 436489	1.25	22.30	26.50	11.5	289.9	34.0	60	13.8	1.90	20.0
IC 436490	1.90	25.00	26.50	13	318.7	39.0	73	15.0	0.25	25.0
IC 436491	1.10	24.50	19.25	11	219.5	35.0	70	5.0	0.33	15.0
IC 436492	1.00	22.25	19.00	12	249.1	36.0	63	110	0.30	20.0
IC 436493	1.70	23.50	27.50	12	417.5	35.0	120	20.0	0.40	10.0
IC 436494	0.60	18.50	13.50	8	130.2	30.0	100	15.0	0.25	15.0
IC 436495	1.25	21.00	21.50	12	304.1	29.0	51	15.0	0.34	10.0
IC 436496	1.85	27.00	25.00	12	430.0	35.0	64	10.0	0.35	10.0
IC 436497	1.15	22.50	24.00	14	380.0	34.0	112	15.0	0.36	20.0
IC 436498	2.50	30.00	28.50	14	2480.0	34.0	49	20.0	0.36	30.0
IC 436499	2.50	30.00	28.50	14	480.0	34.0	49	20.0	0.36	30.0
IC 436500	1.15	21.20	22.50	12	175.0	35.0	110	17.5	0.28	11.0
IC 436501	1.40	23.00	22.00	17	180.0	36.0	26	5.0	0.20	10.0
IC 436502	2.50	26.30	28.00	12	450.0	39.0	112	15.0	0.30	30.0
IC 436503	0.80	17.80	18.50	12	180.0	35.0	165	20.0	0.20	30.0
IC 436504	1.05	20.50	18.50	11	160.0	38.0	40	10.0	0.32	10.0
IC 436505	1.40	24.50	23.50	15	210.0	35.0	90	15.5	0.20	26.2
IC 436506	2.25	26.50	27.90	15	450.0	31.0	85	20.0	0.30	60.0
IC 436507	1.10	20.75	23.15	13	180.0	28.0	140	30.0	0.20	20.0

skull pulp content, less fibre in pulp and better aroma can be used for improvement of this native fruit.

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