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GENETIC DIVERSITY OF WILD LANDRACES OF BAEL FOR ROOTSTOCK PURPOSE IN SOUTH EASTERN RAJASTHAN

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ABSTRACT : The present investigations were carried out in Department of Fruit Science, College of Horticulture and Forestry, Jhalawar during 2010-2011 to assess morphometric variations and genetic variability in bael fruits grown in Hadoti region to explore the possibility for using them as rootstock under high rainfall conditions of Hadoti region. Morphometric studies revealed that fruit weight ranged from minimum from 57.95g in T_6 landrace to maximum 1068.66g in T_3 landrace; fruit length ranged from minimum (4.64 cm) in T_6 landrace to maximum (12.35 cm) in T_3 landrace; fruit width ranged from minimum (5.06 cm) in T_6 landrace to maximum (12.19 cm) in T_3 landrace; number of seeds/fruit varied from minimum (62.66) in T_6 landrace to maximum 305.33 in T_{14} landrace; skull thickness ranged from minimum (2.83 mm) in T_{15} landrace to maximum (6.32 mm) in T_3 landrace; Based on fruit shape, six landraces T_1, T_2, T_3, T_5, T_8, T_9 and T_{11} showed obovate shape; T_4 landrace exhibited elliptical shape; six landraces T_6, T_7, T_{12}, T_{13}, T_{14} and T_{15} showed round shape and T_{10} landrace exhibited oblong fruit shape. Pulp weight ranged from minimum (16.34 g) in T_6 landrace to maximum (469.52 g) in T_3 landrace; however pulp percentage ranged from minimum (22.41%) in T_8 landrace to maximum (49.23%) in T_2 landrace. Data on biochemical analysis revealed significant diversity among all landraces studied. TSS content was found maximum in T_7 landrace; ascorbic acid content was estimated maximum in T_3 landrace. The fruits of T_7 landrace exhibited lowest acidity value.

Keywords : *Bael, landrace, Aegle marmelos, fruit weight,*

Bael fruit (*Aegle marmelos* Correa.) is a tropical fruit native to Southeast Asia and belongs to the Rutaceae family. It is an important indigenous fruit of India. Aegle, the genus of bael is monotypic. It is a midsized, slender, aromatic, armed, gum-bearing tree growing up to 18 meters tall. It has a compound leaf with three leaflets. It has been known in India from prehistoric times and is more prized for its medicinal virtues than its edible quality. In Hinduism the tree is considered sacred. It is used for worship of Lord Shiva. The trifoliate leaves symbolize the trident that Shiva holds in his right hand. The fruits were used in place of coconuts before large-scale rail transportation became available. The fruit is said to resemble a skull with a white, bone-like outer shell and a soft inner part. The tree grows wild in dry forests on hills and plains of central and southern India, Burma, Pakistan, Bangladesh, Sri Lanka, Northern Malaya, Java, and Philippine Islands. Jhalawar district is blessed with plethora of natural forest and horticulture diversity comprising vast forest cover with abundant rainfall and Jhalawar is known as Cherrapunji of Rajasthan. Genetic diversity is the variability in the genetic composition of individuals within or amongst species and it is the inherent ability of organisms to acclimatize in agro-climatic condition with acclimatization as a result of gene-environment interaction. Crop genetic variability is not only a tool for searching diversity in natural habitat but it forms a basis to utilize the untapped potential so that it can be utilized by farmers for their subsistence and socio-economic upliftment according to their needs and edaphic-climatic conditions. Since bael is a crop for arid region and sensitive to water logging conditions but staggered plantation in the forest plateau hills, periphery of farms makes an interesting genetic acclimation of this crop in heavy black cotton soils of Jhalawar district. The survival of introduction of bael plants from arid zones particularly Faizabad district of Uttar Pradesh into Jhalawar become very difficult in vertisols of Jhalawar district because of continuous rainy season from July to September during South West monsoon as there is heavy mortality of plants in black clayey soils due to anoxia.

The estimation and characterization of wild germplasm and relationship between genetic variability forms the basis for estimation of genetic diversity of any crop prevailing and surviving naturally in ecological niche. The selection of good quality rootstock is a must for better survival and to start any breeding programme

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as nature has gifted to mankind an immense opportunities to explore and select from the natural habitat. As bael fruit crop grows successfully in hot arid wastelands, present study was done with intent to explore identification of rootstocks for bael under high rainfall ecological niche of Hadoti region.

MATERIALS AND METHODS

Fruit samples of bael were collected randomly from fifteen locations in Hadoti region during May 2010 and May 2011. A total of 225 bael fruit samples were collected from 15 different locations in Hadoti region and three replications comprising five fruits per unit replication was undertaken to evaluate the fruit samples. Collected samples were brought to the laboratory of Department of Fruit Science, College of Horticulture and Forestry, Jhalawar for analysis. The weight of fruit was taken with the help of electronic weighing machine and average weight of fruit was calculated. Numbers of seeds per fruit were counted and then average to obtain the mean number of seeds per fruit. The length of the fruits (Polar diameter) was measured from stem end to calyx end in centimeter with the help of Vernier calipers. The width (Transverse diameter) of the fruits was measured from the cut pieces in center of fruits with the help of Vernier calipers. Number of seeds per fruits was found out by counting seeds in the whole pulp of individual fruit. The thickness of skull was measured with the help of Vernier calipers in mm. Pulp weight: The pulp of individual fruit was weighed separately in digital balance to determine the pulp content per fruit. The pulp content percentage was also calculated from the whole fruit weight. T.S.S of filtered juice was measured by hand refractometer of 0 to 32 Brix range. Few drops of juice were put on prism of refractometer with the help of clean glass rods. The cover of refractometer was folded lightly and looked through eye piece with projector inlet facing towards light. The point where the boundary line of shaded area interacts with the unshaded area on the scale was noted. The specimen chamber was cleaned with muslin cloth after every use. The reading was taken at room temperature. Acidity was estimated by simple acid alkaline titration method as described in AOAC (1). Ascorbic acid In order to estimate the ascorbic acid, first a dye solution was prepared by addition of 42mg sodium bicarbonate (dissolved in distilled water) and 52mg 2,6-dichlorophenol indophenols and the volume was made up to 200 ml by adding distilled water. Then stock solution and working standard solution were prepared. Then 5ml of standard solution was taken in a 100 ml volumetric flask and 10 ml of 4% oxalic acid was added to it. The sample was titrated against the dye until an end point of pink colour persisting for a few minutes was observed.

RESULTS AND DISCUSSION

The data presented in table 1 indicates that there was considerable variation observed in fruit weight among different bael landraces. Fruit weight varied from 57.95g in T_6 landrace to 1068.66g in T_3 landrace. The predominance of low fruit weight recorded in majority of landraces at different locations in Hadoti region might be attributed to their inherent genetic character and modification of these wild genotypes in due course of time to survive in heavy clay soils and high rainfall conditions otherwise bael fruit crop is highly susceptible to water logging conditions and these wild landraces can be utilized as potential rootstocks to introduce improved varieties under these high rainfall districts of South Eastern districts of Rajasthan state where bael trees are only found as scattered trees either in forest areas and local people only utilize them for religious purpose. The present results are in agreement with the findings of Mitra *et al.* (4) and Pandey *et al.* (7). Number of seeds/fruit under the present study on bael landraces ranged from minimum value of 62.66 in T_6 landrace to maximum 305.33 in T_{14} landrace. The lowest number of seeds/fruit found in T_6 landrace was found at par with T_1 landrace and was statistically lower than all other treatments. The high number of seeds present in majority of surveyed bael land races could be utilized to raise water logging resistant rootstocks in order to introduce cultivars of arid region in sub humid climate of Hadoti region under shallow gravelly soil conditions. The findings are in agreement with findings of Pandey *et al.* (5), Mitra *et al.* (4), Singh and Mishra (10) and Pandey *et al.* (7).

Fruit length variation ranged from minimum 4.64 cm in T_6 landrace at Borda Village, Jhalawar to maximum 12.35 cm in T_6 landrace at Asnawer village. The maximum fruit length found in T_3 landrace was found statistically significant over all other landraces. Fruit width variation ranged from minimum (5.06 cm) in T_6 landrace at Borda village to maximum (12.19 cm) in T_3 landrace at Asnawer village. The highest fruit width estimated in T_3 landrace was found significantly higher over other treatments. Variation in fruit length and fruit width of bael landraces could be attributed to inherent genetic makeup of genotype which may influenced this morphological expression through the activity of endogenous growth regulators. The findings are also in agreement with the findings of Rai and Mishra (8), Pandey *et al.* (6), Pandey *et al.* (5), Singh and Mishra

Table 1 : Physical analysis of wild landraces of bael in Hadoti region of South-Eastern Rajasthan.

S. No.	Landraces	Legends	Fruit wt.(g)	No. of seeds/fruit	Fruit length (cm)	Fruit width (cm)	Skull thickness (mm)	Pulp wt. (g.)	Pulp %	Fibre content	Mucilage	Fruit Shape
1	Durbar Residence, Jhalawar	T_1	106.80	69.33	5.93	5.73	5.56	43.27	40.79	Medium	Medium	Obovate
2	Chaudhary Krishi Farm, Jhalawar	T_2	91.17	128.00	5.76	5.30	5.38	44.88	49.23	Less	Less	Obovate
3	Asnawer village	T_3	1068.66**	123.33	12.35	12.19	6.32	469.52	46.43	Less	Medium	Obovate
4	Chouhan Farm House, Jhalawar	T_4	185.66	135.33	5.98	7.13	5.83	46.75	25.37	High	High	Elliptical
5	Bilwari,village, Jhalawar	T_5	114.42	153.66	5.82	6.09	4.56	54.45	47.35	Medium	Less	Obovate
6	Borda village, Jhalawar	T_6	57.95*	62.66*	4.64*	5.06	4.50	16.34	27.78	High	Medium	Round
7	Jhalawar road station	T_7	143.40	100.00	6.41	6.93	3.60	59.75	40.01	High	High	Round
8	Dahikhera Village, Jhalawar	T_8	70.55	70.55	4.97	5.15	5.12	16.70	22.41	High	High	Obovate
9	Golana Village, Jhalawar	T_9	195.70	195.70	7.09	7.52	5.06	115.86	58.91	Medium	Medium	Obovate
10	Kishanganj village, Baran	T_{10}	145.85	145.85	7.30	6.68	3.87	73.16	50.27	Medium	High	Oblong
11	Doondi village, Jhalawar	T_{11}	148.50	148.50	6.71	6.72	5.37	64.02	42.61	Medium	High	Obovate
12	Khanpuriya village, Jhalawar	T_{12}	81.48	81.48	5.83	5.98	6.03	40.65	49.93	Medium	High	Round
13	Dediya village, Jhalawar	T_{13}	122.61	122.61	5.63	6.36	4.54	68.95	56.62	High	High	Round
14	Rathore farm house, Khanpur, Jhalawar	T_{14}	305.33	305.33**	7.57	8.70	3.98	207.66	67.77	High	High	Round
15	Mahuakhera village, Ataru, Baran	T_{15}	194.00	194.00	6.34	7.52	2.83	118.11	60.84	High	High	Round
	CD (P=0.05)		8.15	3.64	0.31	0.28	0.26	2.52	3.97			
	CV (%)		11.94	18.84	5.27	3.72	16.75	11.69	9.47			

(10) and Pandey *et al.* (7). Skull thickness ranged from minimum (2.83 mm) in T_{15} landrace to maximum (6.32 mm) in T_3 landrace. In consonance with Kumar *et al.,* (2 & 3), wide variation observed in fifteen bael landraces could be attributed to inherent genetic makeup and difference in skull composition with respect to Ca content as the hardness of skull thickness is the result of lignifications processes of fruit in terms of maturity indices. The findings are also in agreement with the findings of Shrivastava and Singh (11), Pandey *et al.* (6), Pandey *et al.* (5), Mitra *et al.* (4) and Pandey *et al.* (7) and Srivastava and Kumar (11).. Pulp weight ranged from minimum (16.34 g) in T_6 landrace to maximum (469.52 g) in T_3 landrace. The maximum pulp weight estimated in T_3 landrace was found statistically significant and superior over all other treatments. Pulp percentage ranged from minimum (22.41%) in T_8 landrace to maximum (49.23%) in T_2 landrace. The variation in pulp weight and pulp percentage of different bael landraces could be attributed to differences in soil nutritional status and differences in source: sink ratio to translocate assimilates from the site of synthesis to utilization site (fruits). Based on fibre content of these bael genotypes, they were categorized under three categories *viz.* less, medium and high. Out of fifteen bael landraces, landrace T_2 and T_3 comes under less fibre content category; six landraces *viz.* T_1, T_5, T_9, T_{10}, T_{11} and T_{12} exhibited under medium fibre content category and seven landraces T_4, T_6, T_7, T_8, T_{13}, T_{14} and T_{15} comes under high fibre category. Based on mucilage content of these bael genotypes, they were categorized under three categories *viz.* less, medium and high. Out of fifteen bael landraces, two landraces T_2 and T_5 comes under less mucilage content category; four landraces T_1, T_3, T_6 and T_9 exhibited under medium mucilage content category and nine landraces T_4, T_7, T_8, T_{10}, T_{11}, T_{12}, T_{13}, T_{14} and T_{15} comes under high mucilage content category. Based on fruit shape, landraces were categorized into four categories viz. obovate, elliptical, oblong and round. Six landraces T_1, T_2, T_3, T_5, T_8, T_9 and T_{11} showed obovate shape; T_4 landrace exhibited elliptical shape; six landraces T_6, T_7, T_{12}, T_{13}, T_{14} and T_{15} showed round shape and T_{10} landrace exhibited oblong fruit shape.

The results presented in Table 2 indicates that wild landraces of bael exhibited considerable variation in terms of biochemical variation present in the fruit samples of bael collected from different locations in Hadoti region. The data on total soluble solids content among bael landraces indicate variation range from minimum (9.50° brix) in T_{13} landrace to maximum (27.00°brix) in T_7 landrace. The reason for overall low TSS content estimated in these wild bael genotypes

Table 2 : Biochemical analysis of bael landraces in Hadoti region.

Landraces	Legends	TSS (°brix)	Acidity %	Ascorbic Acid (mg/100g pulp)
Durbar residence	T_1	26.83	0.20	14.36
Chaudhary Krishi Farm, Jhalawar	T_2	17.33	0.09	29.66
Asnawer village	T_3	25.50	0.08	31.16
Chouhan farm house, Jhalawar	T_4	21.66	0.10	26.53
Bilwari village, Jhalawar	T_5	21.16	0.11	19.50
Borda village, Jhalawar	T_6	17.66	0.09	19.33
Jhalawar road station	T_7	27.00	0.07	28.83
Dahikhera Village, Jhalawar	T_8	18.83	0.14	15.33
Golana Village, Jhalawar	T_9	14.10	0.08	24.63
Kishanganj village, Baran	T_{10}	13.80	0.17	17.52
Doondi village, Jhalawar	T_{11}	9.83	0.19	15.23
Khanpuriya village, Jhalawar	T_{12}	15.00	0.13	12.93
Dediya village, Jhalawar	T_{13}	9.50	0.11	22.32
Rathore farm house, Khanpur, Jhalawar	T_{14}	11.66	0.09	25.33
Mahuakhera village, Ataru, Baran	T_{15}	16.23	0.15	20.73
	CD (P=0.05)	1.35	0.10	1.05
	CV (%)	1.35	7.29	3.12

might be attributed to the fact that these bael trees are found grown under natural conditions and have not received any due attention from fruit point of view so far from the tribal people inhabiting in Hadoti region. Ascorbic acid content variation in bael landraces in Hadoti region ranged from minimum (12.93 mg/100g pulp) in T_{12} treatment to maximum (31.16mg/100g pulp) in T_3 landrace. The presence of sufficient amount of ascorbic acid in most of the landraces indicates the medicinal value of bael fruit. Acidity percentage variation ranged from minimum (0.08%) in T_3 landrace to maximum (0.20%) in T_1 landrace. Results are in line of Kumar *et al.* (2 and 3) and Rao *et al.* (9). The lower

acidity percentage in these wild landraces indicates that if improved cultivars are being tried by vegetative propagation on these locally grown cultivars, acceptable fruit quality can be harnessed on these wild landraces which are by nature growing successfully in black clayey soils of Hadoti region. Fig. 1 depicts the genetic variability of bael landraces in Hadoti region.

CONCLUSION

There is no regular orcharding of bael in sub humid climate of Hadoti region encompassing Jhalawar, Baran, Bundi and Kota districts. The natural variability existing in the form of wild landraces of bael indicates that they can be utilized as potential rootstocks for improved cultivars under heavy black clayey soils and typically high rainfall conditions during South West monsoon under South Eastern districts comprising Hadoti region of Rajasthan State.

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