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Evaluation of Bael (*Aegle marmelos* Corr.) Germplasms for Seed and Qualitative Characters under Semi-Arid Conditions of Haryana

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ABSTRACT

The experiment was conducted at CCS Haryana Agricultural University, Hisar, RRS, Bawal to evaluate genetic variability in bael genotypes grown in experimental orchard. A total of twelve genotypes (NB-5, NB-9, NB-17, CISH B-1, CISH B-2, NB-16, Pant Aparna, Pant Sujata, Samastipur Selection, Seedling-1, Seedling-2 and Seedling-3.) having wide range of variability in fruit characteristics studied. Number of seed sacks/fruit, number of seeds/sack, number of seeds/fruit, seed weight/fruit and test weight varied as (10.33-23.0), (5.0-8.66), (71.10-161.0), (5.45 g-26.45 g) and (6.63 g- 17.50 g), respectively. TSS (%), total sugars (%), reducing sugars (%) and non-reducing sugars (%) were recorded maximum in NB-5. Acidity was minimum in NB-9 (0.30 %) and ascorbic acid was recorded maximum in Samsastipur Selection (13.31 mg/100g). Sugar-acid ratio, TSS-acid ratio and tannin content were observed maximum in NB-17.

Key words: *Bael germplasms, seed & quality characters, semi-arid conditions, Haryana.*

INTRODUCTION

Bael (*Aegle marmelos* Corr.) is one of the important underutilized medicinal, indigenous fruit crop of India. It belongs to family Rutaceae. It is a native of South East Asia and is widely distributed throughout the subtropics and tropics. In India, it is found in wild state in sub-Himalayan tract and dry deciduous forest of central and southern region from pre-historic times and therefore, a large number of landraces are available in different diversity regions[10].

Aegle marmelos grows well in the dry forests of hilly and plain areas. It can adapt a wide range of habitat and can be cultivated worldwide. This tree is mentioned in the pre-historic writings dating back to 800 B.C. The Chinese Buddhist pilgrim, Hiuen Tsiang also noticed the presence of this tree during his visit to India in 1629 A.D. [14]. The fruits of bael are rich in vitamins, minerals, anti-oxidants and with importance in medicinal remedies for rural folks.

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All the parts of bael tree (roots, bark, leaves, branches, fruits) are consumed in the form of 'Panchang' for curing various diseases like ulcer, dysentery and diarrhoea, etc. It has 'marmelosin' constituent in fruits which protects our stomach from various stomach diseases.

It is found almost in all the states of India but no much organized and systematic orcharding of this fruit crop has been taken in India. It is cultivated throughout India and due to mythological importance; it is mainly grown near the temples. It is cultivated on a small scale covering an area of 750 ha with production 1830 MT [17]. Owing to its hardy nature, bael tree has a wide adaptability to adverse soil and climatic conditions even where other crops cannot survive well. However, well drained, sandy loam soils are ideal for its growth. It requires subtropical climate where summer is hot and dry; winter is mild. Its plants can be grown even up to an altitude of 1200 m. The plants are not damaged by temperature as low as -7°C [2].

It can ensure food and nutritional security by supplying quality fruits for human consumption and feed for animals resulting stability in total biomass production. Ripe bael fruit has a demand for therapeutic use. Drinks are prepared during summer for its soothing and cooling effect. The bael fruit pulp contains many functional and bio-active compounds such as carotenoids, phenolics, alkaloids, coumarins, flavonoids, terpenoids and other antioxidants which may protect us against chronic diseases. In addition, it also contains many vitamins and minerals including vitamin C, vitamin A, thiamine, riboflavin, niacin, calcium and phosphorus[13]. The gum enveloping the seeds is most abundant in wild fruits especially when they are unripe. It is commonly used as adhesive glue, soap-substitute, waterproofing and mixed with lime plaster[6].

Bael gene pool is spread over different parts of the country and has enormous variability with respect to qualitative as well as quantitative characters. Apart from the tree morphological characters, wide variability exists in fruit size and shape, bearing habit, flesh colour, texture, sugar content, mucilage content, number of seeds per fruit, gum locules and pericarp thickness[5]; ascorbic acid content, fruit weight, fruit length, number and seed weight per fruit, fibre content, petiole length[11]; bark, leaves and fruits[14].

Recently, few land races have been developed for commercial cultivation from NDUA&T, Faizabad; GBPUAT, Pantnagar; CISH, Lucknow; Pusa, Samastipur but their adaptability has not been studied for south westen Haryana. Farmers are experiencing the challenges of identifying the cultivars as they are unfamiliar with the characteristics of many varieties of bael. In order to identify distinct characters of various bael cultivars for seed and qualitative character are very important for germplasm evaluation. In the absence of suitable genotype, desirable growth, flowering and fruit set has not been accomplished. Identification of suitable genotype for the region is necessary for promoting its productivity, production and quality of the fruits under semi-arid conditions. On the basis of performance of different cultivars in south-westrn Haryana the suitable cultivar (s) can be selected. It will also help the orchardist in selection of appropriate cultivar (s) of this neglected crop for large scale cultivation to get high yield with good quality fruits. Unproductive land of this region could be utilized properly by growing such a hardy fruit crop, which holds promise for nutritional security and also helpful in curing the various ailments. Considering the above mentioned facts the present study entitled, "Evaluation of different bael (*Aegle marmelos* Corr.) germplasm under semi-arid conditions of Haryana" was planned with the following objective: "To study the seed and qualitative characteristics of bael germplasm."

MATERIALS AND METHODS

The present investigations entitled, "Evaluation of different bael (*Aegle marmelos* Corr.) germplasm under semi-arid conditions of Haryana" were carried out at experimental

orchard of Regional Research Station, Bawal (Rewari) CCS Haryana Agricultural University, Hisar during the year 2015-16. Bawal has a typical semi-arid climate with hot and dry summer and extremely cold winter. A maximum temperature of around 44ºC during summer months from May to June and minimum temperature as low as freezing point accompanied by frost in winter months of December and January are common in this region. About 65-70 per cent of the annual rainfall (about 271 mm) is received during July to September with 20- 30 per cent annual and 30- 50 per cent seasonal variations.

The experiment was laid out in a randomized block design with three replications of all twelve germplasms *viz.* Pant Aparna, Pant Sujata, NB-16, NB-17, NB-9, NB-5, CISH B-1, CISH B-2, Samastipur, Seedling-1, Seedling-2 and Seedling-3. Nine year old, uniformly grown trees were selected randomly and maintained under uniform condition of orchard management during the study period where all the cultural practices were carried out as per recommended package of practices. Uniform fruits of each germplasm free from any injury, disease or bruising were harvested from the orchard of CCS HAU, Regional Research Station, Bawal (Rewari) for physico-chemical characteristics.

The fruit was cracked horizontally and the numbers of seed sacks were counted manually. The average value was calculated and expressed in numbers. The numbers of seeds from each seed sack were counted manually and the average value was calculated and expressed in numbers. Total number of seeds per fruit were counted manually. The average value was calculated and expressed in numbers**.** According to ISTA, 2010 the dried hundred seeds weight of each replication weighed on digital electric balance and the average value was calculated and expressed in grams. Total numbers of dried seeds from each replication were weighed on digital electric balance and the average value was calculated and expressed in grams.

The total soluble solids of fruit pulp was determined at room temperature by using hand refractometer. The refractrometer was calibrated with distilled water after every use and the values of total soluble solids was expressed in °Brix. Titratable acidity was determined as per the method suggested by AOAC[1]. The ascorbic acid was estimated by using the procedure given in AOAC[1]. Sugars were estimated by using the method of Hulme and Narain[3]. Sugar- acid ratio was calculated by dividing the average value of total sugars with the average value of titrable acidity. TSS-acid ratio was calculated by dividing the average value of total soluble solids with the average value of titrable acidity.

RESULTS AND DISCUSSION

Seed variability of fruits: The results pertaining to seed variability such as number of seed sacks per fruit, number of seeds per sack, number of seeds per fruit, seed weight per fruit and test weight of seed (100 seed weight) in respect of various germplasm are presented in Table 1. All these parameters recorded significant variation in respect of different germplasm, but there is no clear trend when compared to seedlings. There was significant variation in number of seed sacks per fruit in all the genotypes. Significantly lower numbers of seed sacks per fruit were found in Seedling-3 (10.33), while higher numbers of seed sacks (23) per fruit were found in Samastipur Selection. Pandey *et al.*[7]conducted the study to find out variation in number of seed sacks per fruit and observed a significant variation in number of seed sacks per fruit, ranged from eight to fifteen in different genotypes. The variations in number of seed sacks per fruit were also reported by Pandey *et al.*[8] They revealed from the study that the number of seed sacks per fruit were maximum in genotype T_5 and minimum in T_{22}.

There was significant variation in number of seeds per sack in all the genotypes. Number of seeds per sack varied from 5.0 to 8.66. Number of seeds per sack were significantly lower in CISH B-1 (5.0), it was statistically at par with NB-16 (5.33) and CISH B-2 (5.66), however, higher number of seeds per sack (8.66) were recorded in NB-17,

it was statistically at par with Seedling-2 (8.0). The variation in number of seeds per seed sack varied from 4-7 under Karnataka, Tamil Nadu and Andhra Pradesh conditions reported by Raju *et al.*[12].

Number of seeds per fruit were observed significantly lower in NB-16 (71.10) followed by CISH B-1 (73.33), CISH B-2 (75.55) and Seedling-3 (75.77), while number of seeds per fruit were observed significantly higher in Samastipur Selection (161). Seed weight per fruit among all the genotypes studied ranged from 5.45 g to 26.45 g. Pandey *et al.*,[10] found higher number of seeds per fruit (>100) in collections T_1, T_9, T_{17},T_{23}, T_{24}, T_{26}, T_{27}, T_{29}, T_{32}, T_{34}, T_{36} and T_{46} among the different bael genotypes evaluated.

There was significant variation in seed weight per fruit among all the genotypes. Significantly lower seed weight per fruit was recorded in NB-16 (5.45 g), while it was at par with CISHB-2 (5.65 g), CISHB-1 (5.87 g) and Seedling-2 (6.91 g and higher seed weight per fruit (26.45 g) was found in Samastipur Selection. Pandey *et al.*, [8] reported the seed weight per fruit varies from 4.01 g to 12.78 g among different accessions. Further, Pandey *et al.*, [10] reported seed weight per fruit in different genotypes varied greatly from 2.7 g (T_4) to 18.0 g (T_{46}).

Test weight of seed was observed significantly higher (17.50 g) in NB-5, it was statistically at par with Samastipur Selection (16.43 g) and minimum test weight of seed was found in Seedling-2 (6.63 g), it was statistically at par with Pant Aparna (7.16 g), Pant Sujata (7.39 g), CISH B-2 (7.48) and NB-16 (7.66 g). The test weight of seeds varied with the size of the seed and the variation in size of the seed may be due to its genotypic characters. Similarly, variation in test weight of seed was mentioned in the findings of Raju *et al.*, [12] who reported that test weight of seed ranged from 21.70 g per 100 seeds to 22.80 g per 100 seeds under Andhra Pradesh conditions.

Biochemical characteristics of fruits:

The results pertaining to variation in biochemical characteristics such as TSS, total sugars, reducing sugars, non-reducing sugars, acidity, ascorbic acid, sugar-acid ratio, TSS-acid ratio and tannin content in respect of various germplasm are presented in Table 2. Biochemical traits with respect to different parameters varies significantly in all the germplasms. TSS values of all the genotypes ranged from 26.33 °B to 40.66 °B. Significantly higher TSS (40.66 °B) was recorded in NB-5, followed by NB-17 (40.33 °B) and Pant Aparna (39.66 °B), whereas lower TSS were recorded in Samastipur Selection (26.33 °B) and Seedling-1 (26.33 °B). Jana *et al.*[4] recorded variation in TSS of genotype; HABL-1 recorded maximum of TSS as 37.00 °B and 39.00 ºB in 2008 and 2009, respectively under Ranchi condition. More TSS in a fruit is more useful in medicinal as well as processing industry.

Acidity was noticed significantly lower in NB-9 (0.30 %), being at par with NB-17 (0.32 %), CISH B-1 (0.34 %), NB-16 (0.34 %) and CISH B-2 (0.35 %), however, higher value of acidity (0.52 %) was recorded in Samastipur Selection, statistically at par with Seedling-1 (0.48 %) and Seedling-3 (0.47 %). Pandey *et al.*[10] observed minimum acidity (0.30 %) in T_{16} genotype and maximum (0.56 %) in T_{46} genotype. The variation in acidity among different bael germplasm was also reported by Raju *et. al.*[12]

Total sugars were significantly higher (29.65 %) in NB-5, it was statistically at par with NB-17 (28.23 %), NB-16 (28.64 %) and Pant Aparna (29.21 %), however, minimum total sugars (18.43 %) were recorded in Samastipur Selection and it was at par with Seedling-1 (18.68 %). Pandey *et al.* (2006) recorded variation in total sugars content from 17.85 to 25.72 per cent in different bael cultivars under different locations of UP and Bihar. Maximum reducing sugars were recorded in NB-5 (13.34 %), Pant Aparna (13.14 %) and NB-16 (12.89 %), however, minimum reducing sugars were found in Seedling-1 (8.58%), being at par with Samastipur Selection (8.75%). Pandey *et. al.*[8] recorded the variation in reducing sugars content from 8.38 per cent to 11.38 per cent in

different bael cultivars. These findings regarding variation in reducing sugars are in agreement with those of Pandey *et al.*[10]

Significantly higher value of non-reducing sugars (16.31 %) were observed in NB-5, being at par with Pant Aparna (16.07 %) and NB-16 (15.75 %) and minimum non-reducing sugars was found in Samastipur Selection (9.68 %), it was statistically at par with Seedling-1 (10.10 %). Singh *et al.*[15] recorded maximum non-reducing sugars in NB-9 followed by Goma Yashi and it was recorded minimum in NB-7.

There was significant variation in ascorbic acid content among all the genotypes. Ascorbic acid was found significantly higher in Samastipur Selection (13.31 mg/100g), being at par with Pant Aparna (12.75 mg/100g) and minimum ascorbic acid was recorded in Seedling-2 (7.60 mg/100g). Significantly less ascorbic acid was recorded in seedlings as compared to improved varieties. The results regarding variation in ascorbic acid among diffrernt germplasm are in line with the findings of Pandey *et al.*[8] and Pandey *et al.*[10]. Singh *et al.*[15] studied ascorbic acid content in different bael genotypes and reported maximum ascorbic acid in Goma Yashi followed by NB-5 and NB-7 and minimum in Pant Sujata.

Maximum sugar-acid ratio (88.22) was recorded in NB-17, however, minimum sugar-acid ratio was recorded in Samastipur Selection (35.44). The results regarding variation in sugar-acid ratio are in consonance with those of Pandey *et al.*[10] who reported maximum sugar- acid ratio in T_{39} genotype while lowest ratio was observed in genotype T_{28}.

Maximum TSS-acid ratio (126.03) was recorded in NB-17 the minimum in Samastipur Selection (50.65), being at par with Seedling-1 (54.85). These findings of variability in TSS-acid ratio have also been supported by earlier findings of Pandey *et al.*[10] However, maximum TSS-acid ratio was in Goma Yashi; followed by NB-5 and NB-17 while, minimum in Pant Uravashi followed by NB-16 and Pant Sujata (Singh *et al.*,[15]).

Maximum tannin content (7.23%) was recorded in NB-17, however, minimum tannin content in CISHB-1 (1.22%) followed by Samastipur Selection (1.39%). Pandey *et al.*[10] reported tannin content varied from 2.01 per cent to 4.53 per cent among the different genotypes evaluated under different locations of eastern UP. These findings were also in agreement to the investigations of Pandey *et al.*[8] and Raju *et al.*[12]

Variations in the qualitative attributes of different germplasm at different locations might be due to adaptability to varied agro-climatic conditions, root distribution pattern of individual variety, availability of nutrient to individual plant, management practices of the crop and genetic make-up of the germplasm. Singh *et al.*[16] and Pandey *et al.*[9] reported differences in chemical composition in fruits of bael genotypes under different locations.

Table 1: Seed variability of fruits of bael germplasm under semi–arid conditions of Haryana

Germplasm	Number of seed sacks/ fruit	Number of seeds /sack	Number of seeds/ fruit	Seed weight/ fruit (g)	Test weight of seed (g)
NB-5	14.33	7.66	109.89	19.23	17.50
NB-9	15.66	7.33	114.88	10.80	9.40
NB-17	11.66	8.66	101.11	9.94	9.83
CISH B-1	14.66	5.00	73.33	5.87	8.01
CISH B-2	13.33	5.66	75.55	5.65	7.48
NB-16	13.33	5.33	71.10	5.45	7.66
Pant Aparna	14.66	7.33	107.55	7.70	7.16
Pant Sujata	14.33	6.00	85.99	6.35	7.39
Samastipur Selection	23.00	7.00	161.00	26.45	16.43
Seedling-1	13.66	6.66	91.11	11.69	12.83
Seedling-2	13.00	8.00	104.00	6.91	6.63
Seedling-3	10.33	7.33	75.77	10.22	13.49
CD at 5%	1.04	0.95	9.76	2.33	1.36

Table 2: Biochemical characteristics of fruits of bael germplasm under semi–arid conditions of Haryana

Germplasm	TSS (%)	Total sugars (%)	Reducing sugars (%)	Non reducing sugars (%)	Acidity (%)	Ascorbic acid (mg/100g)	Sugar : Acid ratio	TSS: Acid ratio	Tannin (%)
NB-5	40.66	29.65	13.34	16.31	0.37	10.90	80.14	109.90	2.19
NB-9	33.66	23.56	10.60	12.96	0.30	9.68	78.53	112.23	4.24
NB-17	40.33	28.23	12.70	15.53	0.32	8.65	88.22	126.03	7.23
CISH B-1	34.33	24.03	10.81	13.22	0.34	10.70	70.68	100.97	1.22
CISH B-2	31.66	22.12	9.95	12.17	0.35	10.30	63.20	90.48	2.98
NB-16	38.66	28.64	12.89	15.75	0.34	11.72	84.24	113.70	3.95
Pant Aparna	39.66	29.21	13.14	16.07	0.39	12.75	74.90	101.71	2.96
Pant Sujata	28.66	20.06	9.38	10.68	0.40	12.11	50.15	71.67	4.61
Samastipur Selection	26.33	18.43	8.75	9.68	0.52	13.31	35.44	50.65	1.39
Seedling-1	26.33	18.68	8.58	10.10	0.48	8.00	38.92	54.85	3.43
Seedling2	30.66	21.46	10.26	11.20	0.43	7.60	49.91	71.32	2.25
Seedling3	35.33	24.73	11.13	13.60	0.47	8.10	52.62	75.17	4.16
CD at 5%	1.41	0.95	0.59	0.61	0.05	0.73	2.14	5.54	0.48

CONCLUSION

The results indicate that, there was an significant variation in all the genotypes evaluated for seed and qualitative characters under semi-arid conditions of Haryana. Total soluble solids and sugars were recorded highest in NB-5 with moderate acidity and ascorbic acid. Therefore, it can be concluded from the present study that, NB-5 performed better for seed and qualitative characters than other germplasms evaluated under semi-arid conditions of Haryana. The present study also revealed that, the presence of great amount of genetic variability which offers bright prospects for its improvement in near future.

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