International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating: 5.29
IJABR 2025; 9(5): 959-968
www.biochemjournal.com
Received: 13-03-2025
Accepted: 18-04-2025

Yogesh Kumar Chandrakar
Ph.D. Scholar, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Hemant Kumar Panigrahi
Asst. Professor, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Deepanjali Kashyap
M.Sc. Scholar, Department of Entomology, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Kajal Sahu
Ph.D. Scholar, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Varsha Minz
Ph.D. Scholar, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Tarun Sonkar
M.Sc. Scholar, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Yogesh Kumar Chandrakar
Ph.D. Scholar, Department of Fruit Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Variability studies on morphological characteristics of indigenous Bael (*Aegle marmelos* Correa) genotypes at Mahasamund district of Chhattisgarh, India

Yogesh Kumar Chandrakar, Hemant Kumar Panigrahi, Deepanjali Kashyap, Kajal Sahu, Varsha Minz and Tarun Sonkar

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i5l.4449

Abstract
Bael (*Aegle marmelos* Correa) is one of the important indigenous fruits of India with high nutraceutical significance. The present investigation was conducted during the year 2022-23 and 2023-24 on already existed in-situ Bael genotypes located at different villages of five blocks in Mahasamund district of Chhattisgarh, India. This study was conducted with the main objectives to characterize the available genotypes and genetic variability of Bael. Forty different Bael genotypes has arranged in Randomized Block Design consisting replications of four in each genotype along with check variety (Goma Yashi). The findings of the present study include the morphological characterization of forty-one Bael genotypes as per the key descriptor of *Aegle marmelos* Correa, CIAH, Godhra, Gujrat, 2015.
Under the present research, it was found that extreme variability found in terms of morphological characters of Bael genotypes. The tree parameters like growth habit was found upright in 20 genotypes, spreading type in 8 genotypes, drooping type in 5 genotypes and semi-spreading in 8 genotypes, trunk colour was greyish yellow in 13 genotypes, grey in 7 genotypes, yellowish grey in 12 genotypes and yellow in 9 genotypes, bark splitting pattern was rectangular in 12 genotypes, irregular in 15 genotypes and cylindric in 14 genotypes, thorniness at basal portion of primary branches was thorny in 26 genotypes and thorn less in 15 genotypes and foliage or branching habit was dense in 23 genotypes and sparse in 18 genotypes. Likewise, the leaf characteristics *viz.* leaf colour was green in 13 genotypes, light green in 12 genotypes and dark green in 16 genotypes, leaf margin was crenate in 22 genotypes and crenulate in 19 genotypes, leaf size was small in 10 genotypes, medium in 16 genotypes and large in 15 genotypes, leaf shape was ovate in 16 genotypes, lanceolate to ovate in 7 genotypes, broadly ovate in 8 genotypes and lanceolate in 10 genotypes, leaf apex was acute in 16 genotypes, aristate in 9 genotypes and acuminate in 16 genotypes, leaf base was cuneate in 13 genotypes, round in 12 genotypes, attenuate in 10 genotypes and tapering in 6 genotypes and leaf surface was smooth in 25 genotypes and rough in 16 genotypes were recorded under the present trial.

Keywords: Goma Yashi, MB, Mahasamund Bael, Bael, morphological, variability, genotypes, trees, growth habit, leaf apex, leaf base, drooping, spreading and Lanceolate

Introduction
Bael (*Aegle marmelos* Correa.) also known as Bengal quince, Bilva, Bilpatre, Maredu, Shul, Vilvam and Shaiphal, etc., belongs to the family Rutaceae. In Garo language, Bael is called as Selfree. It is a subtropical plant which can grow up to an altitude of 1200 m from the sea level. The generic name Aegle is of Greek origin and the species marmelos is of Portuguese origin. Aegle belong to one of the three monotypic genera of orange sub family Aurantioideae, tribe Clauseneae and sub-tribe Balsamocitrinea (Nair and Barche, 2016) [7]. The chromosome number 2n=36. Bael can adapt a wide range of habitat and can be cultivated worldwide. It is native to India and has its origin from Eastern Ghats and Central India. It is a sub-tropical and deciduous tree, which is very hardy and can thrive well under diverse agro-climatic conditions. The tree generally reaches a height of 6 to 8 metres with trifoliate, aromatic leaves, while the terminal leaflet is 5.7 cm long and 2.8 cm broad with a long petiole. Moreover, two lateral leaflets are 4.1 cm long and 2.2 cm wide, almost sessile (Allen, 1969) [1]. It can easily be grown on eroded soil and adverse climatic conditions where most of the other fruits cannot be grown. It is grown in various parts of Southeast Asia including India, Sri Lanka, Pakistan, Burma, Bangladesh, Thailand etc.

In India, Bael is being grown throughout the country but concentrated area under Bael is in eastern parts of the Gangetic plains and nearby areas particularly in Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh, Jharkhand and it can also be seen growing in West Bengal, Punjab and Odisha (Singh *et al*., 2008) [15].

India is one of the countries where, Bael are grown on area 8.43 thousand hectares, with an annual production 81.88 thousand tonnes. Odisha is the leading producing Indian state, with a cultivated area of 7.28 thousand ha, an annual production of 45.29 thousand tonnes. In Chhattisgarh, Bael are grown on an area of 0.06 thousand hectares, with an annual production of 0.43 thousand tonnes. Mahasamund district is the leading in area and production of Bael in Chhattisgarh state with an area of 0.04 thousand ha and production of 0.33 thousand tonnes.

It is a nutritious and medicinal fruit plant, which is most suitable to grow in water scarce areas of the country. Its fruit is rich in riboflavin, vitamin A, carbohydrate etc. Various chemical constituents *viz*., alkaloids, coumarins and steroids have been isolated from different parts of Bael plants. Bael is known as the panacea of the stomach ailments and marmelosin is probably the therapeutically bioactive compound of Bael fruit (0.03-0.37%) which vary according to variety and locality (Dixit and Dutt, 1932) [6]. All parts of the tree, whether stem, bark, root, leaves, flower and fruit at different maturity stages has some use or the other. It is also used in the preparation of several Ayurvedic medicines since ancient times (Sharma *et al*., 2007) [12].

A wide range of genetic variability with respect to plant morphology have been observed in different Bael accessions. Considerable variations with respect to shape, margin, base and apex of leaf have been reported by (Singh *et al*., 2012) [13]. Leaves alternate, compound, trifoliate with one pair of shortly stalked opposite showing pulvinus leaflet, ovate or ovate lanceolate, crenate, acuminate and membranous, and midrib prominent beneath. It has also been observed that in place of the leaflets (trifoliate), 4-8 leaflets are also found rarely in Bael plant. Similarly, bark morphology of different varieties/genotypes also varied to some extent. The bark is furrowed and corky yellowish-brown in colour in different varieties, variation in bark colour (light yellow, grey and dark grey) and bark splitting pattern (rectangular, cylindrical, triangular and irregular) was also observed by Singh *et al.*, 2012 [13]. Bael tree armed with straight, sharp, axillary thorns, 2-5 cm long. Considerable variation in thorn orientation, its number, size, shape is found in different genotypes. In some genotype's thorns are small and stout, whereas in few genotypes, three thorns can be seen at a node. It can also be observed that the thorn converts into spines in pairs. Generally, two thorns at a node are common.

Keeping in view of the above consequences the present study was undertaken to assess the performance and find out the suitable variety for hot semi-arid region, so that unproductive land of such region could be made productive by growing such a hardy fruit tree like Bael, which holds promise for nutritional security and also helpful in curing the various ailments.

Materials and Methods

The experimental site is geographically located at Mahasamund district of Chhattisgarh state. Mahasamund district is situated in the Eastern part of the Chhattisgarh state. It falls in the Survey of India's Degree Sheet No. 64 K, O, L and G between the Latitude 20º49'30"-21º33'07" N and Longitude 81º59'56"-83º16'10" E and an altitude of 318 meters above from mean sea level. The district is bounded by Raipur district in the North-West and South-West, Raigarh district in the North-East, Kalahandi and Sambalpur district of Orissa state in the South-East, South and East. From the exploration of Mahasamund district of Chhattisgarh about 18 to 40 years old Forty Bael genotypes from 5 different block were randomly marked or chosen for study with the help of local villagers. The blocks were Mahasamund, Baghbahra, Basna, Pithoura and Saraipali. Two villages were nominated for each block *viz*. Machewa & Paraskol from Mahasamund block, Khamariya & Bakma from Baghbahra block, Bansula & Baraspur from Basna block, Kisanpur & Kotapara from Pithoura block and Sagarpali & Sajapali from Saraipali block. Four different Bael genotypes were selected from each village for further investigation and all the genotypes were compared with check variety (Goma Yashi). All the chosen or assigned genotypes were found growing as wild plants on forest land, bund, farmer's land, backyard, roadside and near pond etc. and the morphological observation were recorded as per the key descriptor of *Aegle marmelos* Correa, CIAH, Godhra, Gujarat, 2015.

Result and Discussion

Morphological variability in tree characteristics

The tree characteristics of Bael genotypes were recorded for the following variables *i.e.* growth habit, trunk colour, bark splitting pattern, thorniness at basal portion of primary branches and foliage or branching habit, respectively, based on Bael key descriptor, which are presented in Table 1 and graphically depicted from Fig. 1 to 5.

Growth habit

The growth habit of trees for forty-one genotypes of Bael was divided into four groups *viz*. drooping, spreading, semi spreading and upright. Out of the 41 genotypes, 20 genotypes namely MB-1, MB-2, MB-7, MB-8, MB-13, MB-14, MB-15, MB-17, MB-18, MB-19, MB-25, MB-26, MB-29, MB-30, MB-31, MB-32, MB-37, MB-38, MB-39 and MB-40 had upright whereas, 8 genotypes *i.e.* MB-3, MB-4, MB-5, MB-6, MB-9, MB-10, MB-20 and MB-21 had spreading, similarly 8 genotypes *viz*. MB-16, MB-22, MB-23, MB-24, MB-27, MB-28, MB-35 and Goma Yashi had semi spreading and remaining 5 genotypes have drooping growth habit. So, the highest frequency of tree growth habit was observed in upright category with 48.78% followed by spreading and semi spreading with 19.51 and 19.51% respectively, while lowest was noted in drooping with 12.20%.

Trunk colour

Trunk colour of all forty-one genotypes of Bael was categorized into four groups *viz.* grey, yellow, greyish yellow and yellowish grey. Out of the 41 genotypes, 13 genotypes namely MB-4, MB-14, MB-15, MB-16, MB-17, MB-18, MB-31, MB-32, MB-33, MB-34, MB-35, MB-36 and Goma Yashi had greyish yellow, 12 genotypes *viz.* MB-1, MB-2, MB-6, MB-7, MB-8, MB-9, MB-25, MB-26, MB-27, MB-28, MB-29 and MB-30 had yellowish grey. Moreover 9 genotypes *i.e.* MB-3, MB-10, MB-11, MB-12, MB-13, MB-37, MB-38, MB-39 and MB-40 had yellow and remaining 7 genotypes have grey trunk colour. The maximum frequency of trunk colour of Bael trees were recorded in greyish yellow (31.71%), followed by yellowish grey (29.27%) and yellow (21.95%), whereas minimum frequency was observed in grey trunk colour having percentage of 17.07 under the present experiment.

Bark splitting pattern

The bark splitting pattern of all forty-one Bael genotypes was classified into three distinct groups *viz*. rectangular, cylindric and irregular. From the 41 genotypes, 15 genotypes namely MB-12, MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-28, MB-29, MB-30, MB-31, MB-32, MB-33 and Goma Yashi had irregular bark splitting pattern while, 14 genotypes *viz.* MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-20, MB-21, MB-22, MB-23, MB-24, MB-25, MB-26 and MB-27 had cylindric bark splitting pattern and 12 genotypes *i.e.* MB-1, MB-2, MB-3, MB-4, MB-5, MB-34, MB-35, MB-36, MB-37, MB-38, MB-39 and MB-40 had rectangular bark splitting pattern. Therefore, the maximum frequency for bark splitting pattern was documented in irregular category with 36.59%, which was closely followed by cylindric pattern having 34.14% and minimum was recorded in rectangular type with the percentage of 29.27%.

Thorniness at basal portion of primary branches

Thorniness at basal portion of primary branches of all forty-one genotypes of Bael was categorized into thornless and thorny. It was observed that the 26 genotypes *viz.* MB-1, MB-2, MB-3, MB-4, MB-5, MB-7, MB-8, MB-9, MB-10, MB-12, MB-13, MB-14, MB-16, MB-17, MB-18, MB-19, MB-20, MB-21, MB-22, MB-23, MB-24, MB-29, MB-33, MB-38, MB-39 and MB-40 had thorn at basal portion of primary branches. Moreover, the remaining 15 genotypes. *i.e.* MB-6, MB-11, MB-15, MB-25, MB-26, MB-27, MB-28, MB-30, MB-31, MB-32, MB-34, MB-35, MB-36, MB-37 and Goma Yashi had thornless at basal portion of primary branches. The maximum frequency of thorniness at basal portion of primary branches was observed in thorny category with 63.41% whereas, minimum was perceived in thornless group having 36.59% under the present investigation.

Foliage or branching habit

The foliage or branching habit of all forty-one genotypes of Bael was grouped into sparse and dense. Out of the 41 genotypes, 23 genotypes namely MB-1, MB-2, MB-3, MB-5, MB-6, MB-10, MB-11, MB-12, MB-13, MB-15, MB-16, MB-17, MB-23, MB-24, MB-25, MB-26, MB-27, MB-32, MB-33, MB-34, MB-35, MB-36 and Goma Yashi showed dense type of foliage or branching habit and remaining 18 genotypes *i.e.* MB-4, MB-7, MB-8, MB-9, MB-14, MB-18, MB-19, MB-20, MB-21, MB-22, MB-28, MB-29, MB-30, MB-31, MB-37, MB-38, MB-39 and MB-40 had found sparse type of foliage or branching habit under the present experiment. The maximum frequency of foliage or branching habit was noted in dense category with 56.10% and minimum was confined in the sparse type of foliage or branching habit having 43.90%.

Discussion

The wide variation in the tree characteristics might be due to the differences in the age of genotypes, training or punning, their agronomic practices, different growing habitats and differences in environmental and edaphic factors. Difference in tree characteristics is also might be associated with the variation in root distribution pattern of various seedling origin Bael genotypes, which have influenced the absorption of water and nutrients from the soil. The results are in close agreements with the findings of Parihar (2015), Singh *et al*. (2015), Pavani *et al*. (2017), Amulya (2019), Pale *et al*. (2019) and Singh *et al*. (2020) [9, 14, 11, 2, 8, 18] in Bael genotypes.

Table 1: Morphological variability in tree characteristics of forty-one different Bael genotypes

Bael Genotypes	Growth Habit	Trunk Colour	Bark Splitting Pattern	Thorniness at basal portion of primary branches	Foliage or branching habit
MB-1	Upright	Yellowish Grey	Rectangular	Thorny	Dense
MB-2	Upright	Yellowish Grey	Rectangular	Thorny	Dense
MB-3	Spreading	Yellow	Rectangular	Thorny	Dense
MB-4	Spreading	Greyish Yellow	Rectangular	Thorny	Sparse
MB-5	Spreading	Grey	Rectangular	Thorny	Dense
MB-6	Spreading	Yellowish Grey	Cylindric	Thornless	Dense
MB-7	Upright	Yellowish Grey	Cylindric	Thorny	Sparse
MB-8	Upright	Yellowish Grey	Cylindric	Thorny	Sparse
MB-9	Spreading	Yellowish Grey	Cylindric	Thorny	Sparse
MB-10	Spreading	Yellow	Cylindric	Thorny	Dense
MB-11	Drooping	Yellow	Cylindric	Thornless	Dense
MB-12	Drooping	Yellow	Irregular	Thorny	Dense
MB-13	Upright	Yellow	Irregular	Thorny	Dense
MB-14	Upright	Greyish Yellow	Irregular	Thorny	Sparse
MB-15	Upright	Greyish Yellow	Irregular	Thornless	Dense
MB-16	Semi-Spreading	Greyish Yellow	Irregular	Thorny	Dense
MB-17	Upright	Greyish Yellow	Irregular	Thorny	Dense
MB-18	Upright	Greyish Yellow	Irregular	Thorny	Sparse
MB-19	Upright	Grey	Irregular	Thorny	Sparse
MB-20	Spreading	Grey	Cylindric	Thorny	Sparse
MB-21	Spreading	Grey	Cylindric	Thorny	Sparse
MB-22	Semi-Spreading	Grey	Cylindric	Thorny	Sparse
MB-23	Semi-Spreading	Grey	Cylindric	Thorny	Dense
MB-24	Semi-Spreading	Grey	Cylindric	Thorny	Dense

MB-25	Upright	Yellowish Grey	Cylindric	Thornless	Dense
MB-26	Upright	Yellowish Grey	Cylindric	Thornless	Dense
MB-27	Semi-Spreading	Yellowish Grey	Cylindric	Thornless	Dense
MB-28	Semi-Spreading	Yellowish Grey	Irregular	Thornless	Sparse
MB-29	Upright	Yellowish Grey	Irregular	Thorny	Sparse
MB-30	Upright	Yellowish Grey	Irregular	Thornless	Sparse
MB-31	Upright	Greyish Yellow	Irregular	Thornless	Sparse
MB-32	Upright	Greyish Yellow	Irregular	Thornless	Dense
MB-33	Drooping	Greyish Yellow	Irregular	Thorny	Dense
MB-34	Drooping	Greyish Yellow	Rectangular	Thornless	Dense
MB-35	Semi-Spreading	Greyish Yellow	Rectangular	Thornless	Dense
MB-36	Drooping	Greyish Yellow	Rectangular	Thornless	Dense
MB-37	Upright	Yellow	Rectangular	Thornless	Sparse
MB-38	Upright	Yellow	Rectangular	Thorny	Sparse
MB-39	Upright	Yellow	Rectangular	Thorny	Sparse
MB-40	Upright	Yellow	Rectangular	Thorny	Sparse
Goma Yashi	Semi-Spreading	Greyish Yellow	Irregular	Thornless	Dense

Note: MB stand for Mahasamund Bael

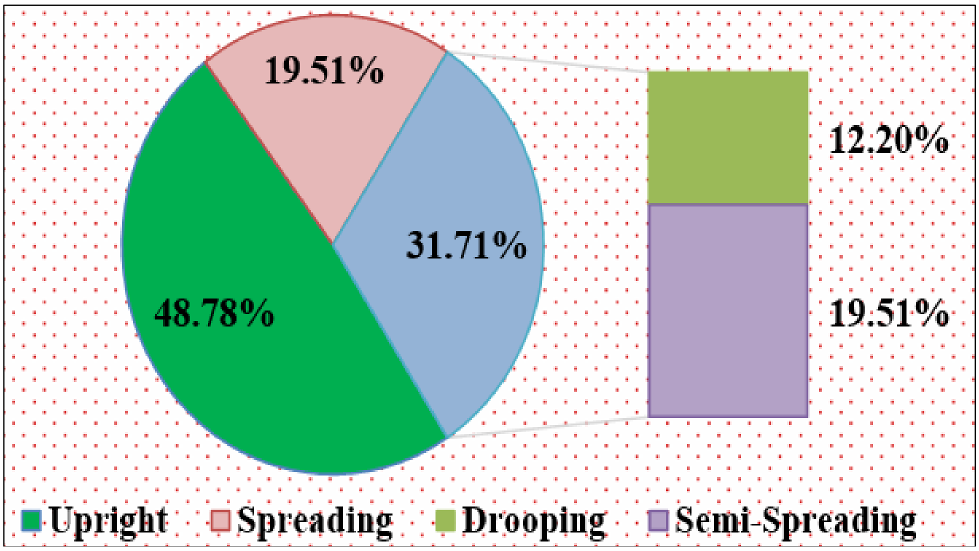

Fig 1: Growth habit percentage of forty-one different Bael genotypes

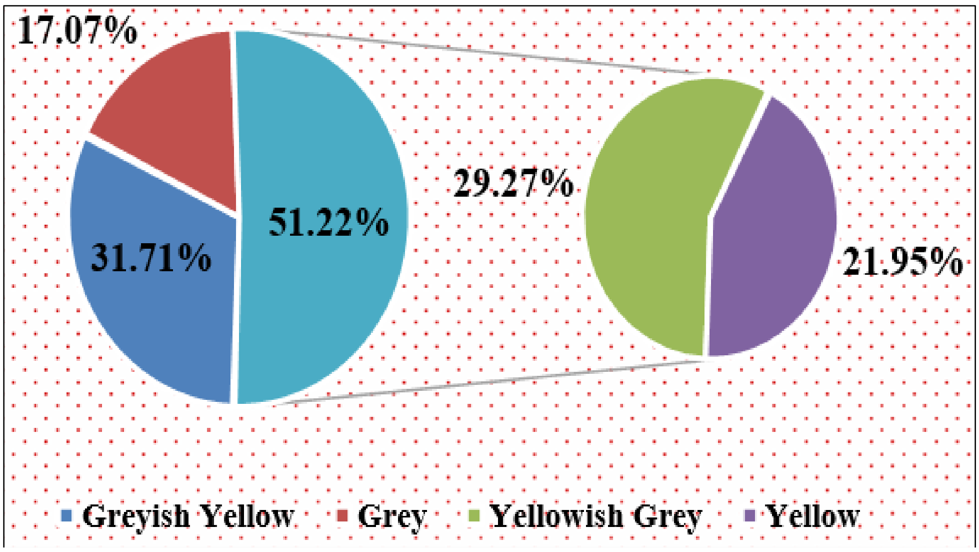

Fig 2: Trunk colour percentage of forty-one different Bael genotypes

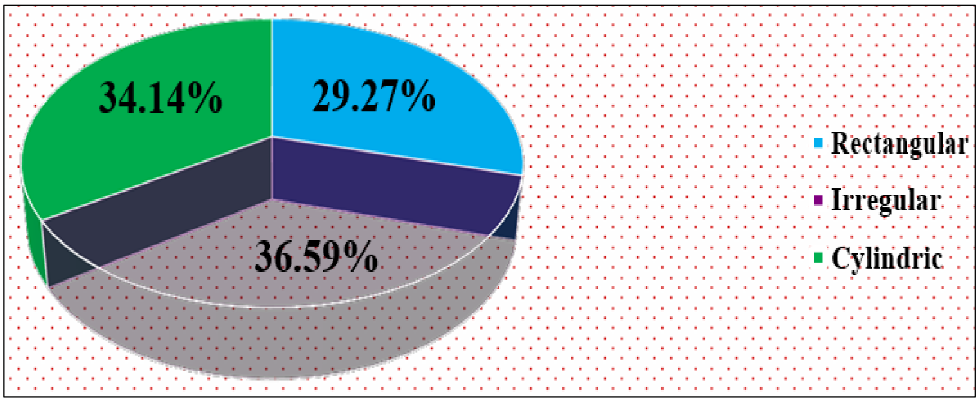

Fig 3: Bark splitting pattern percentage of 41 different Bael genotypes

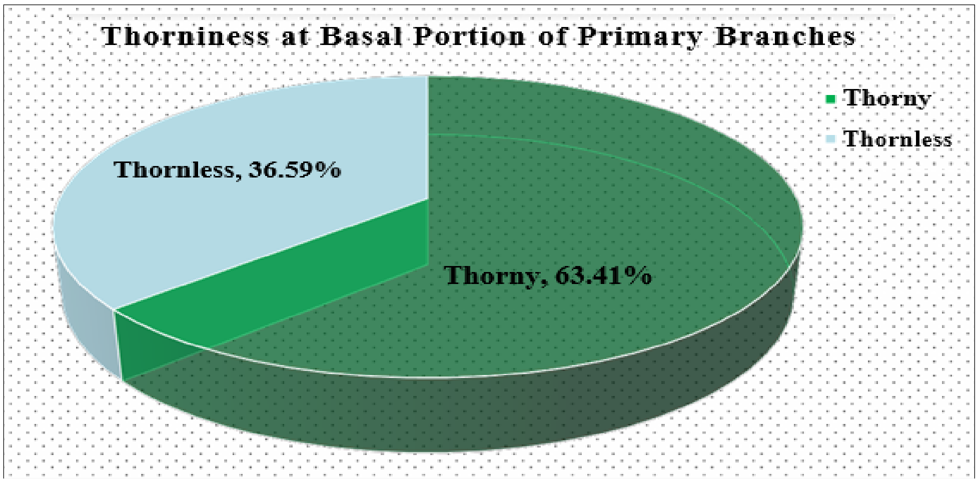

Fig 4: Thorniness at basal portion of primary branches percentage of forty-one different Bael genotypes

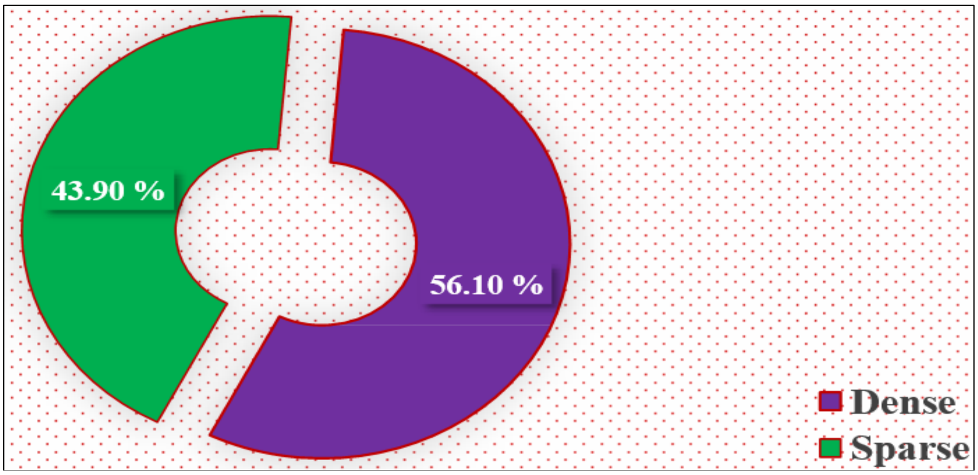

Fig 5: Foliage or branching habit percentage of 41 different Bael genotypes

Morphological variability in leaf characteristics

The leaves characteristics of Bael genotypes were recorded for the following variables *i.e.* leaf colour, leaf margin, leaf size, leaf shape, leaf apex, leaf base and leaf surface, based on Bael key descriptor, which are offered in Table 2 and graphically shown from Figure 6 to 12.

Leaf colour

The leaf colour of forty-one genotypes of Bael was divided into three groups *viz*. green, light green and dark green. Out of the 41 genotypes, 16 genotypes namely MB-25, MB-26, MB-27, MB-28, MB-29, MB-30, MB-31, MB-32, MB-33, MB-34, MB-35, MB-36, MB-37, MB-38, MB-39 and MB-40 had dark green colour leaves whereas, 13 genotypes *i.e.*, MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-20, MB-21, MB-22, MB-23, MB-24 and Goma Yashi showed green leaves and remaining 12 genotypes have light green colour leaves, which was MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11 and MB-12, respectively. The highest frequency of leaf colour was observed in dark green category with 39.02% followed by green colour 31.71%, while lowest was noted in light green colour having 29.27% under the present investigation.

Leaf margin

Leaf margin of all forty-one genotypes of Bael was categorized into crenate and crenulate. From the 41 genotypes, 22 genotypes namely MB-1, MB-2, MB-3, MB-

4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-21, MB-22, MB-23, MB-24, MB-25, MB-26, MB-27, MB-28, MB-29, MB-30, MB-31 and Goma Yashi were found crenate type of leaf margin and remaining 19 Bael genotypes *viz.* MB-11, MB-12, MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-20, MB-32, MB-33, MB-34, MB-35, MB-36, MB-37, MB-38, MB-39 and MB-40 showed leaf margin of crenulate type. The maximum frequency of leaf margin of Bael trees were recorded in crenate type (53.66%), whereas minimum frequency was observed in crenulate type of leaf margin having percentage of 46.34 under the present experiment.

Leaf size

The leaf size of all forty-one Bael genotypes was classified into three distinct groups *viz*. small, medium and large. From the 41 genotypes, 16 genotypes namely MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-37, MB-38, MB-39, MB-40 and Goma Yashi was verified medium size leaves while, 15 genotypes *viz.* MB-12, MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-20, MB-21, MB-22, MB-23, MB-24, MB-25 and MB-26 was found large size and 10 genotypes *i.e.* MB-27, MB-28, MB-29, MB-30, MB-31, MB-32, MB-33, MB-34, MB-35 and MB-36 had small size leaves. The maximum frequency for leaf size was documented in medium size category with 39.02%, which was followed by large size having 36.59% and minimum was recorded in small size with the percentage of 24.39%.

Leaf shape

The leaf shape of all forty-one genotypes of Bael was categorized into four distinct group *viz.* ovate, broadly ovate, lanceolate and lanceolate to ovate. It was observed that the 16 genotypes *viz.* MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-12, MB-13, MB-38, MB-39 and MB-40 was found ovate type of leaf shape. Moreover, the 10 genotypes *i.e.* MB-29, MB-30, MB-31, MB-32, MB-33, MB-34, MB-35, MB-36, MB-37 and Goma Yashi was recorded lanceolate type of leaf shape, 8 genotypes *viz.* MB-21, MB-22, MB-23, MB-24, MB-25, MB-26, MB-27 and MB-28 possess broadly ovate and remaining 7 genotypes were observed as lanceolate to ovate type of leaf shape, which was MB-14, MB-15, MB-16, MB-17, MB-18, MB-19 and MB-20 respectively, under the present exploration. The maximum frequency for leaf shape was observed in ovate category with 39.02%, which was followed by lanceolate and broadly ovate having 24.39 and 19.51% respectively, whereas, minimum was perceived in lanceolate to ovate group having percentage of 17.08%.

Leaf apex

The leaf apex of all forty-one genotypes of Bael was grouped into acute, aristate and acuminate. Out of the 41 genotypes, 16 genotypes namely MB-17, MB-18, MB-19, MB-20, MB-21, MB-22, MB-23, MB-24, MB-25, MB-26, MB-27, MB-28, MB-29, MB-30, MB-31 and MB-32 showed acute type of leaf apex. Similarly, the 16 genotypes *i.e*. MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-12, MB-13, MB-14, MB-15 and MB-16 was recorded as acuminate type of leaf apex and remaining 9 genotypes *viz.* MB-33, MB-34, MB-35, MB-36, MB-37, MB-38, MB-39, MB-40 and Goma Yashi had found aristate type of leaf apex under the present experiment. The maximum frequency of leaf apex was noted in acute and acuminate category with 39.02 and 39.02% respectively, besides, minimum was confined in the aristate type of leaf apex having 21.96% under the present exploration.

Leaf base

The leaf base of all forty-one Bael genotypes was classified into four distinct groups *viz*. attenuate, cuneate, round and tapering. From the 41 genotypes, 13 genotypes namely MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-12 and Goma Yashi was observed cuneate type of leaf base while, 12 genotypes *viz.* MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-20, MB-21, MB-22, MB-23 and MB-24 found round type of leaf base and 10 genotypes *i.e.* MB-25, MB-26, MB-27, MB-28, MB-29, MB-30, MB-31, MB-32, MB-33 and MB-34 was grouped in attenuate type of leaf base. Moreover, remaining 6 genotypes was documented as tapering type of leaf base, which was MB-35, MB-36, MB-37, MB-38, MB-39 and MB-40 respectively, under the present experiment. The maximum frequency for leaf base was documented in cuneate type of leaf base category with 31.71%, which was closely followed by round and attenuate type having 29.27 and 24.39% respectively, while minimum was recorded in tapering type of leaf base with the percentage of 14.63 under the present research.

Leaf surface

Leaf surface of all forty-one genotypes of Bael was categorized into smooth and rough. Out of the 41 genotypes, 25 genotypes *viz.* MB-1, MB-2, MB-3, MB-4, MB-5, MB-6, MB-7, MB-8, MB-9, MB-10, MB-11, MB-12, MB-13, MB-14, MB-15, MB-16, MB-17, MB-18, MB-19, MB-36, MB-37, MB-38, MB-39, MB-40 and Goma Yashi was observed as smooth leaf surface. Moreover 16 genotypes *i.e.* MB-20, MB-21, MB-22, MB-23, MB-24, MB-25, MB-26, MB-27, MB-28, MB-29, MB-30, MB-31, MB-32, MB-33, MB-34 and MB-35 was seen as rough leaf surface under the present study. The maximum frequency for leaf surface of Bael genotypes were recorded in smooth type of leaf surface category (60.98%), followed by rough type of leaf surface (39.02%) under the present experiment.

Discussion

Variability in leaves characteristics in different genotypes might be due to genetic composition of a particular genotypes along with environmental, nutritional and edaphic factors. These results are in close agreement with the earlier findings by Singh (2007), Bhawna and Mishra (2011) and Singh *et al*. (2014) [17, 5, 16] in Bael genotypes.

Table 2: Morphological variability in leaves characteristics of forty-one different Bael genotypes

Genotypes	Leaf colour	Leaf margin	Leaf size	Leaf shape	Leaf apex	Leaf base	Leaf surface
MB-1	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-2	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-3	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-4	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-5	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-6	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-7	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-8	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-9	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-10	Light Green	Crenate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-11	Light Green	Crenulate	Medium	Ovate	Acuminate	Cuneate	Smooth
MB-12	Light Green	Crenulate	Large	Ovate	Acuminate	Cuneate	Smooth
MB-13	Green	Crenulate	Large	Ovate	Acuminate	Round	Smooth
MB-14	Green	Crenulate	Large	Lanceolate to Ovate	Acuminate	Round	Smooth
MB-15	Green	Crenulate	Large	Lanceolate to Ovate	Acuminate	Round	Smooth
MB-16	Green	Crenulate	Large	Lanceolate to Ovate	Acuminate	Round	Smooth
MB-17	Green	Crenulate	Large	Lanceolate to Ovate	Acute	Round	Smooth
MB-18	Green	Crenulate	Large	Lanceolate to Ovate	Acute	Round	Smooth
MB-19	Green	Crenulate	Large	Lanceolate to Ovate	Acute	Round	Smooth
MB-20	Green	Crenulate	Large	Lanceolate to Ovate	Acute	Round	Rough
MB-21	Green	Crenate	Large	Broadly Ovate	Acute	Round	Rough
MB-22	Green	Crenate	Large	Broadly Ovate	Acute	Round	Rough
MB-23	Green	Crenate	Large	Broadly Ovate	Acute	Round	Rough
MB-24	Green	Crenate	Large	Broadly Ovate	Acute	Round	Rough
MB-25	Dark Green	Crenate	Large	Broadly Ovate	Acute	Attenuate	Rough
MB-26	Dark Green	Crenate	Large	Broadly Ovate	Acute	Attenuate	Rough
MB-27	Dark Green	Crenate	Small	Broadly Ovate	Acute	Attenuate	Rough
MB-28	Dark Green	Crenate	Small	Broadly Ovate	Acute	Attenuate	Rough
MB-29	Dark Green	Crenate	Small	Lanceolate	Acute	Attenuate	Rough
MB-30	Dark Green	Crenate	Small	Lanceolate	Acute	Attenuate	Rough
MB-31	Dark Green	Crenate	Small	Lanceolate	Acute	Attenuate	Rough
MB-32	Dark Green	Crenulate	Small	Lanceolate	Acute	Attenuate	Rough
MB-33	Dark Green	Crenulate	Small	Lanceolate	Aristate	Attenuate	Rough
MB-34	Dark Green	Crenulate	Small	Lanceolate	Aristate	Attenuate	Rough
MB-35	Dark Green	Crenulate	Small	Lanceolate	Aristate	Tapering	Rough
MB-36	Dark Green	Crenulate	Small	Lanceolate	Aristate	Tapering	Smooth
MB-37	Dark Green	Crenulate	Medium	Lanceolate	Aristate	Tapering	Smooth
MB-38	Dark Green	Crenulate	Medium	Ovate	Aristate	Tapering	Smooth
MB-39	Dark Green	Crenulate	Medium	Ovate	Aristate	Tapering	Smooth
MB-40	Dark Green	Crenulate	Medium	Ovate	Aristate	Tapering	Smooth
Goma Yashi	Green	Crenate	Medium	Lanceolate	Aristate	Cuneate	Smooth

Note: MB stand for Mahasamund Bael

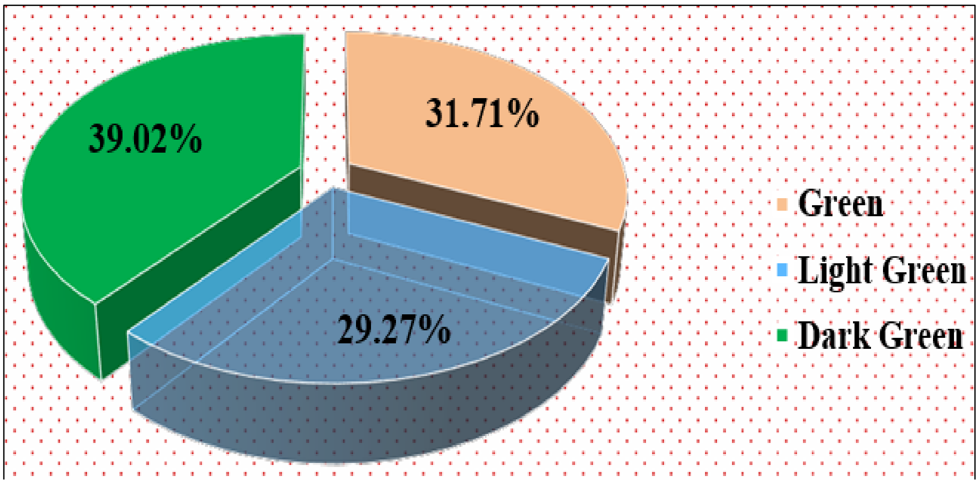

Fig 6: Leaf colour percentage of forty-one different Bael genotypes

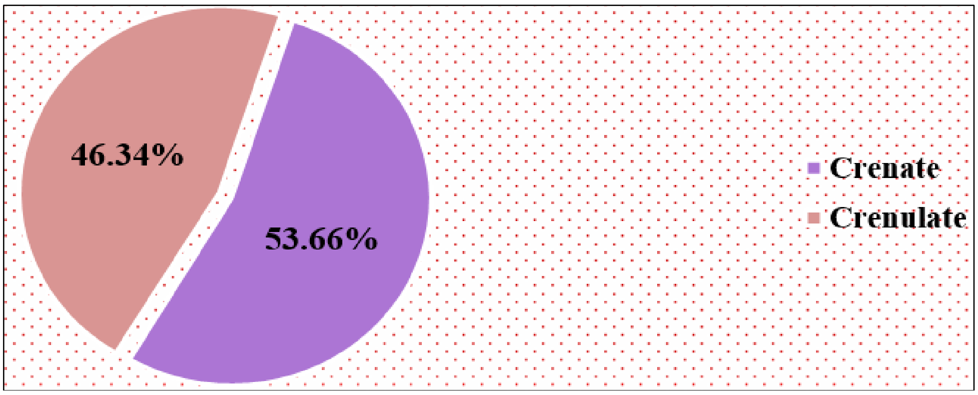

Fig 7: Leaf margin percentage of forty-one different Bael genotypes

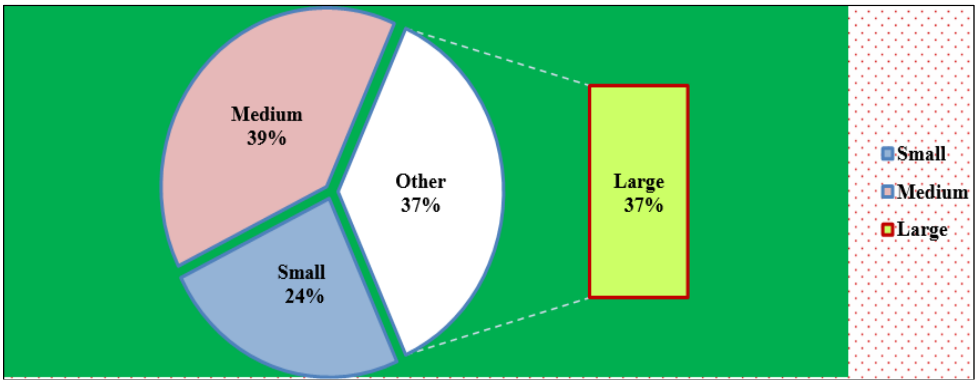

Fig 8: Leaf size percentage of forty-one different Bael genotypes

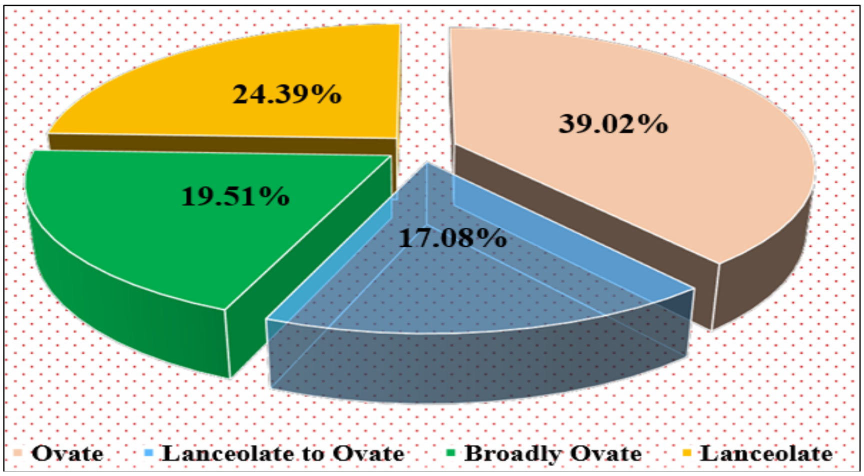

Fig 9: Leaf shape percentage of forty-one different Bael genotypes

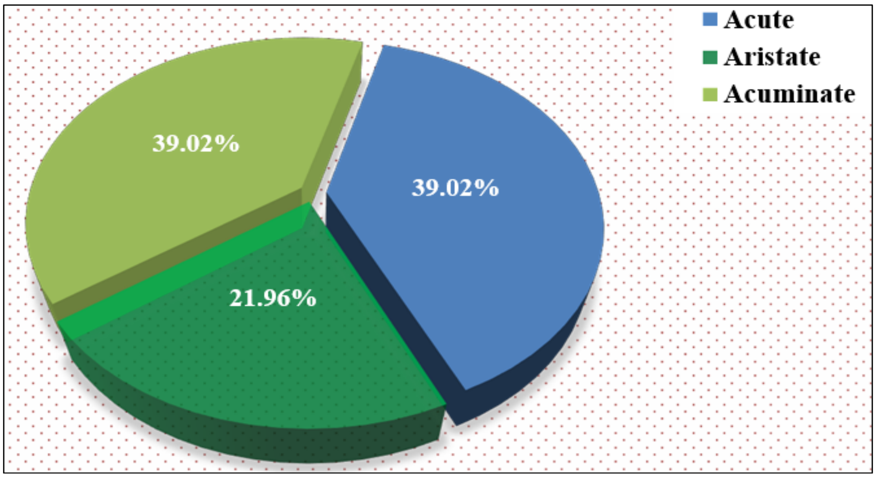

Fig 10: Leaf apex percentage of forty-one different Bael genotypes

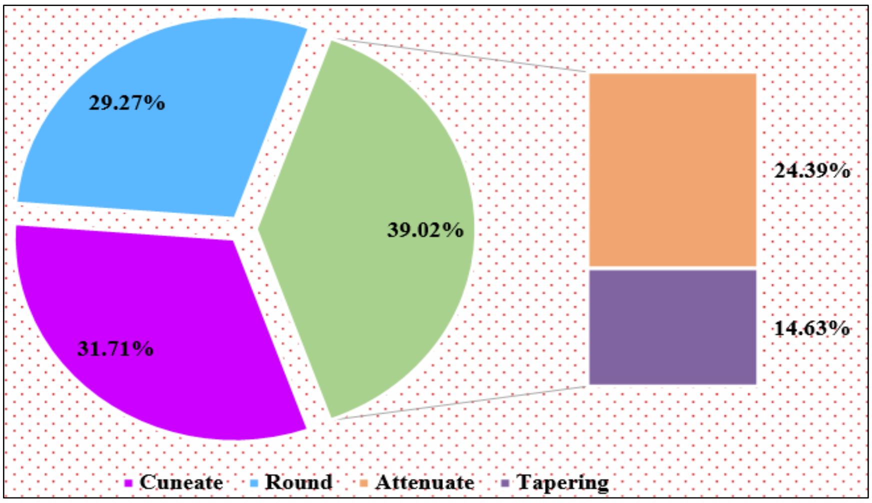

Fig 11: Leaf base percentage of forty-one different Bael genotypes

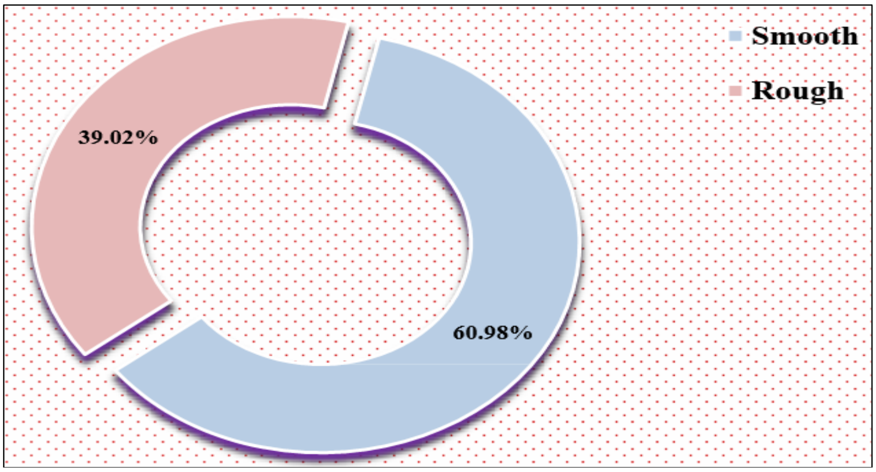

Fig 12: Leaf surface percentage of forty-one different Bael genotypes

Conclusion

The basic requirement of the breeding program is the measurement of existing variability of genetic material. The outcome of the present research showed existing of wide range of diversity for nearly of all the morphological characters suggesting the existence of sufficient variability among the genotype. Identification and characterization of genotypes gave an idea for horticultural and crop morphology characters of Bael genotypes which is required in providing the helpful information of gene bank management.

Suggestions for future research work

- Since the results of present study was based on two years of research. To achieve any definite conclusion, it needs to be repeated during successive seasons.
- Since the results of present exploration was from one geographical region of Chhattisgarh. To achieve any definite conclusion, it needs to be repeated more than one geographical region because variability vary according to the geographical region.

References

1. Allen BM. *Malayan* Fruits: An Introduction to the Cultivated Species. Singapore: Donald Moore Press Ltd., 1969, p. 245.
2. Amulya RN. Variability studies on Bael (*Aegle marmelos* Correa) genotypes of Sakharayapattana (Chickamagalur District) [M.Sc. thesis]. Shivamogga: University of Agricultural and Horticultural Sciences, 2019.
3. Anonymous. Indian Horticultural Database. Gurgaon: National Horticulture Board, 2021(a).
4. Anonymous. Directorate Horticulture and Farm Forestry, Indravati Bhavan, Atal Nagar, Nava Raipur, Chhattisgarh, 2021(b).
5. Bhawna, Misra KK. Variability in growth, yield and photosynthetic parameters in clones of Bael (*Aegle marmelos* Correa). Environment and Ecology. 2011;29(1A):254-262.
6. Dixit BBL, Dutt S. The constitution of marmelosin. J Indian Chem Soc. 1932;9(2):271-279.
7. Nair R, Barche S. Medicinal value of Bael (*Aegle marmelos* Correa). Int J Farm Sci. 2016;6(1):307-320.
8. Pale JPL, Chetri S, Suresh CP, Singh YS, Chaurasiya A, Barman A. Morphological and bio-chemical characterization of Bael (*Aegle marmelos* Correa) in West Garo Hills, Meghalaya, India. Int J Curr Microbiol Appl Sci. 2019;8(10):2414-2420.
9. Parihar N. Variability studies in Bael (*Aegle marmelos* Correa) gene pool of Kymore Plateau and Satpura Hill Region [M.Sc. Thesis]. Jabalpur: Jawaharlal Nehru Krishi Vishwa Vidyalaya, 2015.
10. Patel A, Singh PK, Singh AK, Singh S, Pandey D, Acharya S, *et al*. Descriptor of Bael (*Aegle marmelos* Correa). Godhra: CIAH, 2015, p. 8-16.

11. Pavani P, Kiranmayi P, Dash SN. Evaluation of Beal (*Aegle marmelos* Correa) genotypes for morphological, quality and yield related characters. Int J Basic Appl Biol. 2017;4(3):164-167.
12. Sharma PC, Bhatia V, Bansal N, Sharma A. A review on Bael tree. Nat Prod Radiance. 2007;6(2):171-178.
13. Singh AK, Singh S, Joshi HK. Genetic diversity in Bael. Rashtriya Krishi. 2012;7(1):59-61.
14. Singh AK, Singh S, Makwana P. Inter-varietal morphological variability in Bael (*Aegle marmelos* Correa) under rainfed semi-arid hot ecosystem of western India. Curr Hortic. 2015;3(2):3-9.
15. Singh AK, Singh S, Joshi HK, Bagle BG, More TA. Evaluation of Bael genotypes for growth behavior and floral traits under semi-arid ecosystem of western India. Hort J. 2008;21(30):140-142.
16. Singh AK, Singh S, Singh RS, Joshi HK, Sharma SK. Characterization of Bael (*Aegle marmelos*) varieties under rainfed hot semi-arid environment of western India. Indian J Agric Sci. 2014;84(10):1236-1242.
17. Singh DR. Under-utilized fruits crops of Andaman and Nicobar Islands. In: Peter KV, editor. Under-utilized and Under-exploited Horticultural Crops. Vol. 2. New Delhi: New India Publishing Agency, 2007, p. 11-54.
18. Singh S, Sharma JR, Sehrawat SK, Jitarwal OP, Gavri A. Studies on the collection and evaluation of Bael cultivars. Int J Chem Stud. 2020;8(6):212-214.