Devendra Pandey[1]*,
Shiv Poojan and Devanand Giri

CISH Bael-2: New Cultivar for High Pulp Content

***Aegle marmelos* Correa, commonly known as Bael, stands as a significant indigenous fruit within the Rutaceae family, boasting considerable prominence in Indian tradition and culture. The plant's widespread adaptability, coupled with its pronounced medicinal and nutritional attributes, as well as its religious significance, renders it a revered entity in Indian mythology. The botanically trifoliate compound leaves of Bael, reminiscent of the *trishool* associated with Lord Shiva, hold particular importance in temple rituals, being employed for ceremoniously adorning the deity during worship. This article delves into the attributes of CISH-Bael-2, a recently developed bael variety characterized by its elevated pulp content, thus contributing to the scientific understanding and advancement of this culturally and economically significant plant species.**

BAEL (*Aegle marmelos*) is culturally and medicinally significant fruit in India, revered for its adaptability, health benefits, and religious symbolism. This article introduces CISH-Bael-2, a newly developed variety notable for its high pulp content and superior quality. The variety offers promising potential for farmers, processors, and researchers, contributing to both economic value and scientific advancement.

Chief characteristic of CISH-Bael-2

CISH-B-2 represents a cultivar derived from open-pollinated seedlings, distinguished for its notable pulp content. Exhibiting a mid-season maturity pattern, the fruits of this selection reach maturation in the months of April to May. The trees, characterized by a dwarf stature and a dense canopy with a moderately spreading habit, are precocious and prolific bearers. Virtually devoid of thorns, the oblong to round fruits feature an average length of 14.80 cm, a circumference of 52.64 cm, and a mean weight of 2.25 kg per fruit. Upon ripening, the fruit transforms into an attractive yellow hue.

The thin-shelled fruits, with a thickness ranging from 0.24 to 0.26 cm, facilitate easy removal, revealing an orange-yellow pulp with a pleasing flavour, low mucilage, and seed content. The seed and fiber contents are minimal, with an average of 50.12 seeds per fruit and a seed-to-pulp ratio of 1:270. The pulp content, constituting approximately 61.32%, makes it a preferred choice for juice and other processed products within the processing industry. CISH-B-2 is distinguished by its excellent taste and flavour, further enhancing its suitability for the processing sector. The fruit pulp recovery is high, boasting a 61.32% pulp content with a total soluble solids (TSS) of 31.98 °B, total carotenoids at 0.99 mg/100g pulp, total sugar content of 16.33%, tannin content of 2.45%, marmelosin concentration of 170.08 µg/g, psoralen at 9.20 µg/g, aurapten at 9.16 µg/g, ascorbic acid at 93.0 µg/g, riboflavin at 182.0 µg/g, thiamine at 165.00 µg/g, and niacin at 717.00 µg/g. These nutritional and therapeutic attributes contribute to the high value of this variety. Yield from mature trees (10–12 years) of CISH-B-2 ranges from 60–90 kg per tree.

Crop management

Bael exhibits extensive adaptability to various soil and climatic conditions, thriving particularly well in subtropical regions characterized by hot summer and mild winter. It can be cultivated at elevations of up to 1,200 m and is resilient to both low temperatures (down to 7 °C) and high temperatures (up to 48 °C). However, susceptibility to severe frost is observed during the early stages of its growth. Although Bael can be cultivated in various soil types, sandy loam soil with effective drainage is deemed optimal. The plant demonstrates a tolerance of up to 30 ESP sodicity, salinity levels up to 9 dS m^{-1}, and an EC and pH range of 6.0–8.5. Due to its xerophytic characteristics, Bael exhibits significant potential for cultivation in marginal and wasteland areas, as well as in other challenging soil and climatic conditions.

Plant propagation is commonly achieved through seeds, which are sown in 15–20 cm raised beds measuring 1 × 5 meters at a depth of 1–2 cm immediately following extraction, typically in June. Germination occurs within three weeks, and after seven weeks of sowing, the seedlings are transplanted into the field. Grafting or budding of these seedlings is typically undertaken after one year, although on occasion, Bael can also be propagated through root suckers. Among various

propagation methods, patch budding yields a success rate of 80–90% when performed between June and July. Bael propagation can be conducted year-round under poly/net house conditions, with optimal success achieved by maintaining a polyhouse temperature of approximately 28 ± 2 °C and a humidity level of 70–80%.

Tree of CISH-B-2

In-situ orchard establishment

For various types of wastelands and areas facing water scarcity, the recommendation is the in-situ establishment of orchards. According to the layout plan, two bael seeds can be sown in each pit, or alternatively, seedlings cultivated in polythene bags can be planted during the months of June and July. In the subsequent year, the preferred cultivar is then budded onto these seedlings during the same June–July timeframe.

Pits of one cubic meter in size are excavated at a spacing of 8 × 8 m, a prerequisite undertaken two months prior to planting, typically in April–May. Each pit is enriched by incorporating 30–40 kg of Farm Yard Manure (FYM) and either one kilogram of neem cake or 0.5 kg of bone meal into the upper 50% of the soil. The pit is initially filled with the unmixed soil, followed by the introduction of the soil-fertilizer mixture. In cases where the soil exhibits sodicity, an additional incorporation of 5–8 kg of gypsum or pyrite, along with 20 kg of sand, is carried out. Prior to filling, rainwater is allowed to accumulate in the pit, subsequently flushed two or three times to eliminate detrimental salts, thereby optimizing conditions for plant establishment. Subsequently, the filled pit is promptly irrigated, and planting is scheduled 20–25 days after the pit-filling process. This timeframe facilitates the completion of soil reactions with the pre-treated gypsum/pyrite. Once the soil attains a workable consistency, grafted/budded plants are strategically planted at the center of each pit using a planting board, typically during the months of July–August.

In the initial stages of plantation, young bael trees necessitate regular irrigation, typically every 10–15 days in summer and once a month during winter. Conversely, well-established orchards generally do not require irrigation. During the summer, bael sheds all its leaves, a natural adaptation that shields the plant from the adverse effects of hot, dry winds. In regions with water scarcity, pitcher or drip irrigation has proven successful for establishing new orchards. Additionally, basin maintenance involves weeding and hoeing to ensure a clean environment around the tree. Mulching with organic waste, especially materials such as paddy straw or sugarcane trash, has demonstrated effectiveness in establishing new bael orchards in sodic and barren wastelands.

In the early stages of growth, newly planted bael trees are trained with stakes to achieve an upright form. A well-structured framework is encouraged by prohibiting lateral branches within 75 cm from the ground level on the trunk, allowing the emergence of 4–6 branches in different directions. The modified leader system is employed during the initial 4–5 years for optimal tree development. While bael generally does not require extensive pruning, the removal of dead, crisscross branches, diseased, weak, and broken twigs is advisable. To ensure robust growth, high yield, and quality production, a fertilizer regimen of 5 kg FYM, 50 g N, 25 g P, and 50 g K per plant is recommended for one-year-old plants.

This dosage is progressively increased each year, reaching its peak in the tenth year or beyond, where mature plants should receive 50 kg FYM, 500 g N, 250 g P, and 500 g K. All fertilizer applications should be carried out in July. In sodic soil conditions, zinc deficiency symptoms can be rectified through basal application of

Newly developed flower bud

Fruit attached on twig

Ripe fruit

Dark yellow pulp colour

250 g zinc sulfate per tree alongside regular fertilizer. For orchards facing fruit cracking issues, the application of 100–150 g borax, combined with regular fertilizer, is advocated. In the interspaces of young plantations, crops such as peas, cowpeas, mung beans, guar, and vegetables like brinjal, tomato, spinach, coriander, chili, and garlic, or oilseed crops like mustard can be cultivated. These crops require frequent irrigation, and heavy fertilization should be avoided.

The harvest-ready stage for CISH-B-2 fruit occurs in April–May, characterized by the outer shell transitioning from green to yellowish-green (colour break stage). Harvesting is recommended individually, including the stalk (approximately 2 cm), not only for ease of handling but also as a ripening indicator. The separation of the stalk signals the ripe stage of the fruit. Bearing in budded/grafted CISH-B-2 plants commences 4–5 years post-planting. The number of fruits per tree increases with the age of the tree. A fully grown CISH-B-2 tree, aged 10–15 years, can yield between 60–80 fruits per tree.

Table 1. Comparative nutraceutical contents of CISH-B-2 with other commercial cultivars.

Nutraceutical	CISH-B-2	NB-9	NB-16
Marmelosin (µg g-1)	170.08	84.79	86.70
Psoralen (µg g-1)	9.20	62.83	130.32
Pulp (%)	61.32	60.25	59.68
Aurapten (µg g-1)	9.16	19.32	25.95
Polyphenols (%)	2.55	2.89	2.93
Ascorbic acid(µg g-1)	93	81	74
Riboflavin(µg g-1)	182	99	54
Thiamine(µg g-1)	165	59	260
Niacin(µg g-1)	717	471	351

CONCLUSION

CISH-B-2 exhibits resistance to many diseases and pests, with canker and gummosis being occasional concerns. Gummosis is effectively addressed through the application of copper fungicide, either by pasting or spraying. Canker, on the other hand, can be cured by spraying the tree with streptomycin (200 ppm). Noteworthy insect pests impacting tree growth include leaf weevil and leaf-eating caterpillar, both of which can be controlled by applying Rogor (0.5%) twice or thrice at fortnightly intervals. Fruit cracking in bael typically occurs during December–January. Proper moisture management in the root zone is essential to mitigate this issue. Mulching the tree basin with materials such as paddy straw or dry leaves, coupled with the implementation of windbreaks in the orchard, helps reduce fruit cracking. In instances of boron deficiency-induced fruit cracking, the application of 100–150 g of borax per tree, along with fertilizer in the tree basin, serves as an effective corrective measure.

Based on the overall performance in terms of pulp percent, quality and stability, CISH-B-2 demonstrates superior attributes compared to NB-9 and NB-16. It exhibits higher concentrations of marmelosin, ascorbic acid, riboflavin, thiamine, and niacin, making it a more nutritionally valuable and stable variety. It offers significant advantages across multiple sectors. For farmers, CISH-B-2 presents an opportunity for higher-value cultivation due to its superior pulp percent and nutritional content. Researchers and scientists can explore its potential for further genetic improvements and health benefits. The industry, especially in food processing and nutraceuticals sectors, CISH-B-2 provides an opportunity for product development targeting health-conscious consumers, given its enriched nutrient content. Thus, CISH-B-2 stands out as a promising variety with wide-ranging benefits.

For further interaction, please write to:
[1]*Principal Scientist, ICAR-Central Institute for Subtropical Horticulture, Lucknow, Uttar Pradesh, India 226101 *Corresponding author email: devendracish@gmail.com