

Morphogenetic diversity in DBM-4 accession of jal brahmi

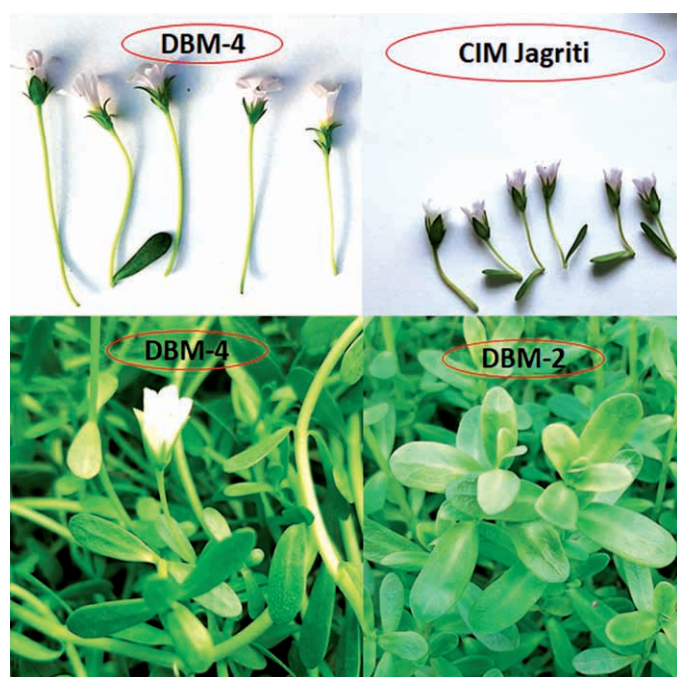
Successful restoration of overexploited species depends upon variability, conservation and cultivation. Elite accessions were characterized for quantitative and qualitative traits for sustainable cultivation and industrial uses. The evaluated accessions were having sufficient variability in morphology, herbage yield and chemical content. The accession DBM-5 was showing maximum dry herbage yield ($19.88 \pm 1.5 \text{ t ha}^{-1} \text{ y}^{-1}$) and DBM-4 rich in bacoside-A3 and bacoside-II. Overall, economic and/or industrial yield was found maximum in accessions DBM-4, therefore, they may be further used in crop improvement program as valuable selection.

MORPHOLOGICAL variation in vegetative traits is a key determinant in unraveling phenotypic diversity of any plant population. Diversity in plant genetic resource provides opportunity for breeders to develop new and improved cultivars with desirable characteristics, which include both farmer-preferred traits (yield potential), and very important consumer preferred traits (superior quality). In addition to this, characterization of herbage morphology is a classical approach which is well suited for analysis of genetic diversity in regards of plant resources conservation and utilization. Herbal medications are receiving widespread acclaim globally in more than 80% of the world population, due to their

higher biosafety profile over the allopathic or synthetic medications. Medicinal plant like jal brahmi utilization and conservation have allured global attention due to their overexploitation these days. The increasing demand has placed *B. monnieri* as the second most priority species among the most important Indian medicinal plants and is identified among the seven important medicinal plants recommended for immediate attention and included in the list of highly endangered medicinal plants of India by NMPB and Technology Information Forecasting and Assessment Council (TIFSAC), Department of Science and Technology, GOI, India.

Bacopa monnieri (L.) Penn. commonly known as 'Neera-Brahmi' of family *Scrophulariaceae* is a perennial, prostrate and creeping herb which is identified in habitat including wetlands and muddy shores. Jal brahmi, a nootropic herb being used as a promising agent in modern Ayurveda system owing to its antioxidant, cholinergic, anti-beta amyloid property; also, has been used as a traditional Ayurvedic medicine to enhance memory and to prepare popular ayurvedic preparations like 'Brahmirasayanam' and 'Brahmighritam'. Bacoside A is the major active compounds of jal brahmi.

The diversity of different *B. monnieri* accessions collected from different parts of country were evaluated for horticultural traits. The leaves of herb are oblanceolate, relatively thick, succulent and arranged oppositely on the stem/stolon. At the same time larger leaf size or leaf area (ranging from $0.57\text{--}0.81 \text{ cm}^2$) was observed in DBM-5 and DBM-2. However, DBM-10 had a very tiny leaf size ($0.39\text{--}0.46 \text{ cm}^2$). Small, actinomorphic flowers are borne in leaf axils, which are whitish, blue to medium purple in colour with various sizes of flower-stalk length. At the same time elite accession DBM-9 exhibited maximum stolon length ($95\text{--}122 \text{ cm}$). Variation was observed in flower pedicel length and pedicle diameter. Higher pedicel length (1.57 cm) and pedicel diameter ($0.52\text{--}0.91 \text{ m}$) was exhibited by



Variation in leaf shape/twisting and pedicel length of jal brahmi accessions



Representative variation in leaf shape and size in different jal brahmi accessions.

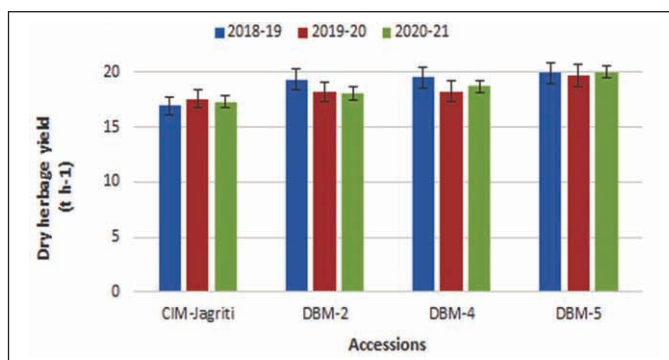
DBM-4. Flower colour was purple to purplish white in most of the genotype but whitish purple flower colour was also observed.

Table 1. Jal brahmi accessions with distinct morphological characters

Accession	Distinct characters
DBM-2	Maximum stolen leaf length, light green colour and twisty top leaves
DBM-4	Maximum pedicel length and high total bacoside content especially bacoside-A ₃ and bacopaside-II
DBM-5	Maximum herbage yields, leaf size and number of leaves
DBM-9	Maximum inter nodal length and stolon thickness
DBM-10	Smaller leaf size/area



Fresh herbage yield under field conditions



Dry herbage yield of different elites under field trials

Crop exhibited very good plant growth round the year even under polyhouse conditions and harvested three to four times in a year. Maximum dry herbage yield was observed under open field condition as compared to polyhouse. The morphometric traits like stolon length, thickness and leaf size might be helpful for contribution in higher herbage yield. The highest fresh herbage yielding accession was DBM-5 (13.5 kg m²) followed by DBM-9 (10.1 kg m²) and DBM-4 (7.9 kg m²). On an average dry herbage yield was observed maximum in DBM-5 (19.88 t h⁻¹y⁻¹) followed by DBM-4 (18.84 t h⁻¹y⁻¹) as compared to check (17.29 t h⁻¹y⁻¹).

The whole plant is used in indigenous system of medicine as a nerve tonic and for epilepsy and insanity due to richness in Bacosides which are a class of chemical compounds, that are dammarane-type triterpenoid saponins. Elite DBM-4 observed for having maximum average bacoside-A₃ (1.13 % W/W) and bacopaside-II (2.52 % W/W) content on dry weight basis. It developed through selection and is a trait specific elite accession which produce quality herbage rich in saponins. Among the evaluated accessions, DBM-5, DBM-9, DBM-2 exhibited high herbage yield whereas DBM-4 was also containing maximum bacoside-A₃ and bacopaside-II. The accession DBM-4 and DBM-5 is rich in quality as well as herbage yield, respectively. Therefore, it can be used further in crop improvement and commercial cultivation as a new selection.

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