RESEARCH ARTICLE

PHYSIOLOGICALLY DIVERSE MORPHOTYPES OF *BACOPA MONNIERI* L. PANNELL

Parmeshwar Lal Saran*, Hiteksha I. Damor and Kuldeep Singh A. Kalariya

ICAR-Directorate of Medicinal and Aromatic Plants Research, Boriavi 387310, Anand, Gujarat, India
Email: plsdehradun@gmail.com

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Abstract: The aim of the experiment was to evaluate morphological and physiological variability among different accessions of *Bacopa monnieri*. Variation in leaf colour was reported in DBM-13, which exhibited exceptionally light green colour leaves as well as purple flower colour with least total chlorophyll content among studied accessions. A maximum number of leaves per stolon were reported by DBM-10, having the least leaf size and leaf area. The highest basal leaf area was reported in DBM-2, which is economically important for higher biomass content. Information on the extent of morphological variability among yield-related traits is a prime requirement for selection, trait improvement, and to design of a suitable breeding line.

Keywords: Leaf diversity, Chlorophyll content, Flower colour, Jal Brahmi

INTRODUCTION

Jal brahmi (*B. monnieri* L.) is a creeping, succulent perennial herb belongs to family Scrophulariaceae (Albach et al., 2005). It comprises of 146 species of aquatic herbs distributed throughout the world. The native place is India, Bangladesh and Southern Asia. It is also distributed in Australia, Europe, Africa, Nepal, Sri Lanka, China, Taiwan and Vietnam, Florida etc. Brahmi is grown under varying soil and climatic conditions. The plant performs exceptionally well in poorly drained soils. Near-neutral, clayey loam to clayey soils is best suited for its growth (Baruah *et al*., 2014).

It is commonly found in marshy habitats throughout the country up to 1320 m height from sea level. The name *brahmi* is derived from the word 'Brahma', in the Hindu pantheon. It is basically precious as a revitalizing herb and used by Ayurvedic practitioners for nearly 3000 years ago (Gohil and Patel, 2010). The whole plant is used as a nerve tonic. It is also being used as diuretic and for treating rheumatism, asthma and hoarseness. This plant is considered among one of the 'celestial drugs' when consumed with milk for six months. In siddha system of medicine, the plant is useful against painful joints, swelling in joints, peripheral neuritis, constipation, and burning urination (Gohil and Patel, 2010). It is also used in convulsions, mental retardation, chest congestion, and laryngitis. This miracle herb has the inherent potential of enhancing memory and vitality, therefore, gaining attention for its commercial cultivation globally (Saran and Patel, 2019). Integration of such crops into low laying area existing rice-wheat farming systems was thought to be one of the viable options for stakeholders.

In North India, it can grow in a wide range of temperatures (15–40 °C) and soil pH (5–7.5). It becomes dormant during the winter months except when grown near running water. In south India, it can be grown throughout the year (Saran, 2020). The tolerance of plants under shade conditions sustained the growth due to an increase in leaf area, photosynthetic capacity per unit of light, and sugar content (Ginting *et al*., 2015). The leaves under shade conditions made efficient use of the less intense irradiation reaching up to them like rauvolfia, patchouli, turmeric, Shatavari and brahmi (Arnon, 1949 and Saran *et al*., 2019). It can even grow in slightly brackish conditions (Deshpande *et al*., 2014). Efforts to know the efficient elites for cultivation in the non-traditional area. Thus, identification of suitable accession was very much essential to ensure premium produce and its quality for sustainable utilization of natural resources in the era of changing global environment.

MATERIALS AND METHODS

The experiment was conducted during the year, 2019-20 at the ICAR-Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat (India). The soil type of experimental site was vertic ustochrepts fine loamy in texture supplied with 10 tha^{-1} farmyard manure (FYM). The crop was raised using standard agronomic practices (Saran, 2020). The four accessions were replicated five times using 3 × 2 m size individual plots and crop was harvested in seasons during June, October and March. The observations were recorded on full flowering stage. The leaf and flower parameters were observed in three subsequent seasons using RHS colour charts. The leaf area was observed using LAM (LAI 3000). The leaf pigment chlorophyll was extracted using 80% acetone and calculated as per standard methods.

*Corresponding Author

RESULTS AND DISCUSSION

A wide distinction within species is observed among the accessions of jal brahmi raised on their morphological and physiological diversity. Among all the accessions, DBM-2, DBM-10 and CIM Jagriti having an oblanceolate leaf shape, however, DBM-13 reported Obovate leaf shape. Obtuse type of leaf apex observed in accessions, DBM-2 and DBM- 10. In addition to this, DBM-13 and CIM-Jagriti reported Rounded leaf apex. All the accession reported an acuminate type of leaf base (Table 1). Different accessions of *B. monnieri* have been identified for variation in morphological characters *viz.*, light green leaf colour (Yellow Green 146B) and purplish white flower colour (Purple 76B petal with Violet 84C petal veins colour), while check has Green N137C (leaf) and Violet 85A (flower colors) using RHS colour chart in DBM-13 (Figure 1). Similar leaf colour variation was reported in different ornamental and landscape plants due to different environmental interaction and chlorophyll concentration (Sevik et al., 2014). The variation for flower colour among the DBM-13 and the check variety were confirmed by using the RHS colour chart. Based on that, DBM-13 exhibited purple colour (Purple group 76B), while CIM Jagriti (Check) has a violet colour (Violet group 85 A) (Figure 2).

For total chlorophyll content, accessions, DBM-13 showed the lowest estimation of total chlorophyll content among all the studied accessions (Figure 4A). Pigments provide colouring in plants and the most important pigment for colour is chlorophyll (Figure 4A). Chlorophyll is the pigment that imparts the plants their green colour. The change of chlorophyll amount in any plant affects colouring of plant leaves (Sevik, 2014; Saran *et al.*, 2019). Therefore, it can be concluded that the difference between the leaf colour in DBM-13 and CIM-Jagriti was maybe due to variation in total chlorophyll content.

The maximum average number of leaves per stolon at the full flowering stage in all three seasons was observed in DBM-13 among all the evaluated accession of *Bacopa moniieri* (Figure 4B). There might be a robust relationship between leaf development (Number of leaves) and leaf size. The basal leaf (Lateral leaves on the main stolon) reported maximum leaf area compared to normal leaves. However, maximum basal leaf area (1.65 cm^2; 0.99 cm^2)) was observed in DBM-2 compared to check variety (CIM- Jagriti) and evaluated accessions of *Bacopa monnieri* (Figure 3; Figure 4C). However, the least average leaf area was reported by DBM-10 among all the evaluated accession in open field conditions (Figure 4D).

Table 1. Different leaf morphological characters of Jal Brahmi.

Accession	Leaf shape	Leaf apex	Leaf base
DBM-2	Oblanceolate	Obtuse	Acuminate
DBM-10	Oblanceolate	Obtuse	Acuminate
DBM-13	Obovate	Rounded	Acuminate
CIM-Jagriti	Oblanceolate	Rounded	Acuminate

Figure legends

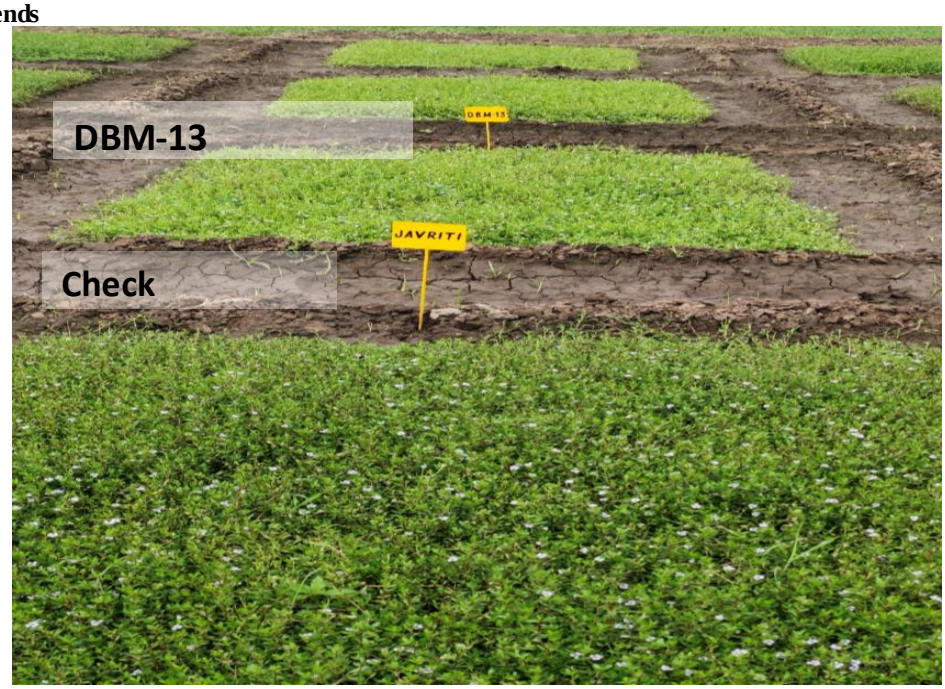


Figure 1: Morphological diversity of *B. monnieri* for leaf parameters.

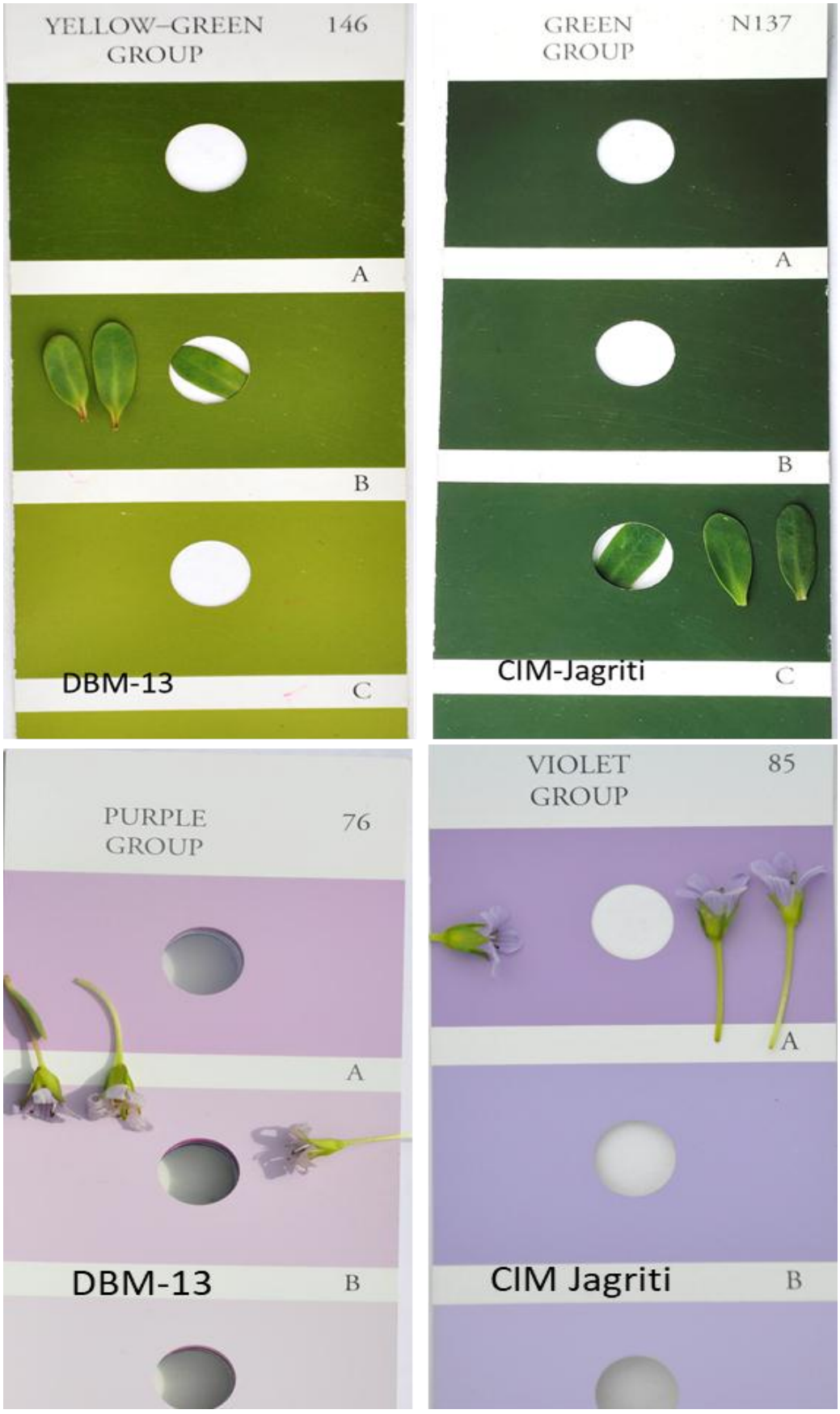


Figure 2: Leaf and flower colour of DBM-13 as compared to check.

Figure 3: Basal leaf size in DBM-2 as compared to check.

Figure 4A: Average total chlorophyll content in leaves of different accessions in three seasons (2020-21).

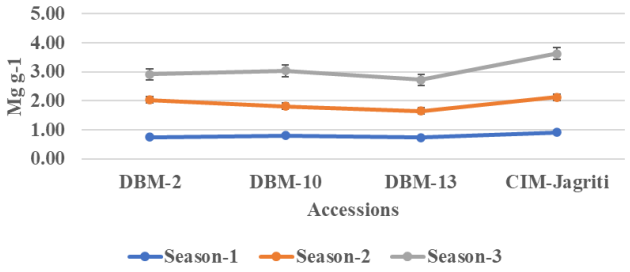


Figure 4B: Average number of leaves per stolon at full flowering stage (2021-22).

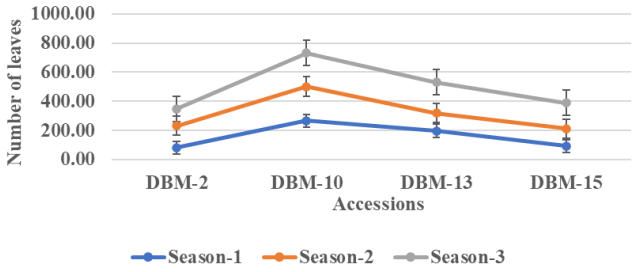


Figure 4C: Average leaf area of basal leaves of different accessions in three seasons (2020-21).

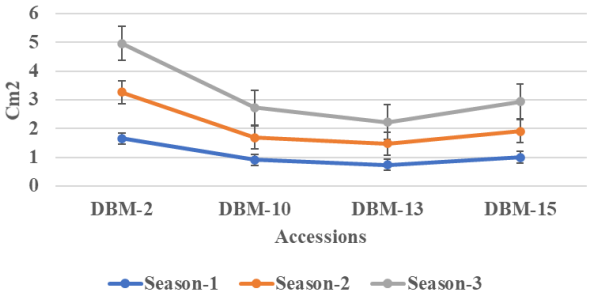
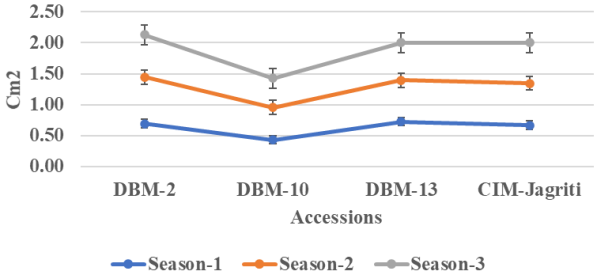


Figure 4D: Average leaf area of different accessions at full flowering stage (2021-22).



CONCLUSION

The present study revealed the presence of considerable variation among *Bacopa monnieri* accessions for all the parameters which permit an opportunity to plant scientists for the improvement of the traits. The study confirms the co-dependency of plant colour and chlorophyll content. The linear relationship between the number of leaves and leaf size suggests a common physiological basis among the traits. Maximum average basal leaf area in DBM-2 and number of leaves in DBM-10 furnish an economic benefit to a grower.

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