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Research Article

Morphological characterization of Indian Sarsaparilla [*Hemidesmus indicus* (L.) R. Br. ex Schult.] – A potential medicinal plant

P. Yazhni[1], R. Chandirakala[1*], R. Gowthami[2], C. Vanniarajan[1], R. Renuka[3] and J. Suresh[4]

[1]Department of Plant Breeding and Genetics, Agricultural College and Research Institute, TNAU, Madurai, Tamil Nadu-625104, India
[2] Tissue Culture and Cryopreservation Unit, ICAR-National Bureau of Plant Genetic Resources (NBPGR), Pusa Campus, New Delhi-110012, India
[3] Department of Plant Biotechnology, Centre of Innovation, Agricultural College and Research Institute, Madurai, Tamil Nadu-625104, India
[4] Department of Medicinal and Aromatic Plants, Horticultural College and Research Institute, TNAU, Coimbatore, Tamil Nadu-641003, India
[*] **E-Mail:** chandirakala2009@gmail.com

Abstract
Hemidesmus indicus (L.) R. Br. ex. Schult, commonly called Indian Sarsaparilla, belongs to the family *Apocynaceae* and is one among the unexplored high valued medicinal plants endemic to the Indian subcontinent. In the recent past, the wild population of this valuable plant species is diminishing and being grouped in the list of endangered species. Environmental Information System (EIS) 2014 has reported *H. indicus* as a red listed medicinal plant which warrants an immediate need for the collection and conservation of this species. An exploration trip was undertaken to collect *H. indicus* germplasm from five different regions representing mountains and plains of Tamil Nadu and collected germplasm was successfully established and conserved in pot culture at the net house of Agricultural College and Research Institute, Madurai, Tamil Nadu. A detailed morphological characterization on twenty-two qualitative and thirteen quantitative traits of the germplasm collections was done and two morphotypes *viz.,* narrow-leaf and broad-leaf plant types. The morphological characterization of this species will be useful for germplasm collectors in the precise identification of the species and the development of an efficient set of descriptors. The collection and maintenance of different ecotypes will thus help to conserve this endangered medicinal plant.

Key words: Nannari, Crop descriptor list, Quantitative and Qualitative characters

INTRODUCTION

India with 2.4 per cent of the world's area possesses 8 per cent of global biodiversity and serves as one of the 12th mega diversity hotspot countries of the world (Bapat *et al.,* 2008). India with its rich diversity is endowed with four major hotspots (Himalaya, Indo-Burma, Sunderland and the Western Ghats and Sri Lanka and the Western Ghats) among the world's 35 hotspots (Jaisankar *et al*., 2018). India practices very strong traditional health care practices that are represented by the classical systems of medicine like Ayurveda, Siddha, Unani, Sowa-rigpa and several folk healthcare systems. About 80 per cent of the world population depends upon traditional herbal medicines as their foremost medicinal remedy. The domestic demand for medicinal plants has

been estimated as 1,95,000 Metric Tons (2014-2015) and export demand has been estimated as 1,34,500 Metric Tons (2014-2015). Total herbal raw drug consumption in the country is estimated to be 5,12,000 MT with a corresponding trade value of Rs. 5,500 crores for the year 2014-15. The tremendous increase in export value from 345.80 crores in 2005-06 to 3211 crores in 2014-15 has been observed in past one decade (Goraya and Ved, 2017). Among the total medicinal plants identified so far, many of them serve as the potential source of medicine whose medicinal properties remains unexploited and unutilized.

Hemidesmus indicus (L.) R. Br. ex. Schult, commonly called Indian Sarsaparilla, is one among the unexplored high value medicinal plant endemic to the Indian subcontinent and belongs to the family *Apocynaceae.* Indian Sarsaparilla commonly named as Nannari has been in use in Indian medicinal systems such as Ayurveda, Siddha and Unani medicines for centuries (Panchal *et al.,* 2009). *H. indicus* is commonly found in deciduous forests, uncultivated lands and moist hedges. Its origin is India which then got distributed in subtropical Asian countries including Sri Lanka, Pakistan, Iran and Bangladesh. It has many medicinal properties such as hepatoprotectant, anticancer, antidiabetic, antioxidant, neuroprotectant, anti-ophidian, cardioprotectant, nephroprotectant, anti-ulcerogenic, blood purifier, body coolant and diuretic (Nandy *et al.,* 2020 a). Apart from the therapeutic uses, the “Nannari” root extracts have cooling properties which are used in many other forms, as the majority use it as refreshing syrup with lemon sherbet in South India. As a result of its immense medicinal value, the National Medicinal Plant Board (NMPB) of India identified it as a “highly traded (500-1000 million tonnes/year) medicinal plant” (NMPB, 2020; Gowthami *et al.,* 2021). The seeds act as poor propagules due to short seed viability and vegetative propagation by the stem is a slow process that further hinders the spread of this species. Thus, the conventional method of propagation is inadequate to meet the demand for raw material. Thus, for the constant supply of raw materials and reduction of pressure on the natural/wild population, the development of an efficient and reliable *in vitro* plant regeneration protocol for this wonderful medicinal herb is essential. Few reports on *in vitro* plant regeneration using different explants including nodal segments of *H. indicus* are available (Sharma *et al.,* 2020) and this method of propagation may overcome the inadequacy and extinction of the raw material from natural sources. Due to its colossal medicinal properties and meagre cultivation in the country, the shrub is collected from its natural habitat indiscriminately making the species more vulnerable to extinction (Malar *et al.,* 2019). Hence, there is an immediate need to collect and conserve the existing genetic diversity of the species without being lost. Moreover, the diversity in the available germplasm can be evaluated in future to identify superior genotypes for large scale cultivation in near future (Kanagarasu *et al.,* 2014). With this background, an exploration was carried out to collect, conserve and characterize *Hemidesmus indicus* germplasm from in and around Madurai district of Tamil Nadu, India.

MATERIALS AND METHODS

An Exploration trip was conducted to collect the *Hemidesmus indicus* germplasm from different locations of Madurai district, Tamil Nadu, India (**Fig. 1**). The details of the germplasm collection sites are listed in **Table 1**. The matured rooted plants of each germplasm sample were collected separately and properly labelled. Each sample was planted separately in different pots and conserved in pots at the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai, Tamil Nadu, India (**Fig. 2**). The identity of the germplasm collections were verified using the online herbarium catalogue of Kew Royal Botanical Garden (accessible through https://apps.kew.org- Narrow-leaf plant type herbarium nos.: K001125017, K001125018, K001125019, K001125023, Broad-leaf plant type herbarium nos.: K001125016, K001125021, K001125025, K000894567, and K000894568). The collected germplasm was classified based on their morphology as broad-leaved and narrow-leaved plant types. The two year old germplasms were subjected to morphological characterization using twenty-two qualitative and thirteen quantitative traits. Each quantitative trait of both the types was recorded in five plants and the mean and the range was calculated.

Table 1. Details on the different locations chosen for exploration

S.No	Location	Latitude	Longitude	Altitude (mts)
1.	Peraiyur	9.7350° N	77.7932° E	150
2.	Mooparmadam	9.7305° N	77.7614° E	150
3.	Yanamalai hills, AC & RI, Madurai	9.9699° N	78.2040° E	166
4.	Chitankulam	9.9653° N	78.2017° E	166
5.	Vellaripatti	9.9968° N	78.2541° E	121

RESULT AND DISCUSSION

The plant collections were distinguished into two types based on morphological variations, namely narrow-leaved and broad-leaved plant types. The broad-leaved plant types were observed only in places where the human interventions were less and the narrow-leaved plant types were observed in all the collection sites. The qualitative characters that were recorded for the two morpho-types are tabulated in **Table 2 and Fig. 3A**. Both the plant types share similar qualitative characters like climbing growth habit, propagation by rootstock cuttings, cylindrical stem shape, opposite leaf arrangement, secretion of lactiferous substance, tap root, brown color pods, and slightly glabrous fruit with hooked fruit beak. In both ecotypes, seed shape is elliptical with tapering ends on both sides

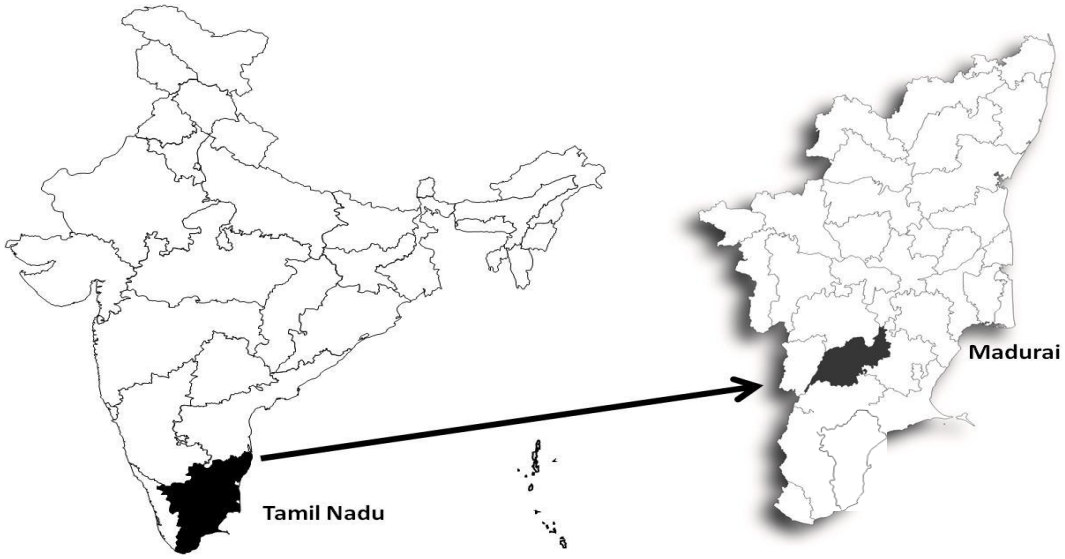

Fig. 1. Collection sites of *Hemidesmus indicus* germplasm

Fig. 2. Collection and conservation *of H. indicus* germplasm. (A-B) Collection of *H. indicus* from its natural habitat (C) Establishment and *ex-situ* conservation of collected germplasm at AC & RI, Madurai

Table 2. Morphological characterization of *H. indicus* germplasm

S.No.	Plant Characters	Narrow leaf type	Broad leaf type
1.	Growth habit	Climber	Climber
2.	Propagation	Rootstock cutting	Rootstock cutting
3.	Stem shape	Cylindrical	Cylindrical
4.	Stem color	Dark green, Purplish green	Light green, Dull brown
5.	Stem pubescence	Absent	Very sparse to moderately dense
6.	Leaf arrangement	Opposite	Opposite
7.	Leaf shape	Linear, Lanceolate	Elliptical, Obovate, Ovate
8.	Leaf margin	Entire	Entire, Slightly undulating
9.	Dorsal leaf pubescence	Absent	Absent, Low
10.	Ventral leaf pubescence	Absent	Absent, Low
11.	Leaf color	Dark green	Dark green, Light green
12.	Midrib color	White	White, Light green, Dark green
13.	Lactiferous secretion	Present	Present
14.	Flower color	Yellowish green, Purple	Yellowish green, Purple
15.	Fruit color	Brown	Brown
16.	Fruit pubescence	Glabrous	Glabrous
17.	Fruit curvature	Slightly curved	Slightly curved
18.	Fruit beak	Hooked	Hooked
19.	Seed shape	Elliptical with tapering ends	Elliptical with tapering ends
20.	Seed surface	Smooth on one side and wrinkled on the other side	Smooth on one side and wrinkled on the other side
21.	Seed appendages	Present	Present
22.	Root type	Tap root	Tap root

Table 3. Mean and Range of quantitative characters for narrow-leaf and broad-leaf plant type germplasm of *H. indicus*

S.No.	Plant Characters	Narrow-leaf		Broad-leaf	
		Range	Mean	Range	Mean
1.	Stem thickness (cm)	0.7 – 1.2	0.90	0.8 – 1.2	0.98
2.	Internode length (10^{th} to 15^{th} node)	5 – 7.8	6.43	8.2 – 13.0	11.3
3.	Length of leaf (cm)	5.2 – 7.1	6.40	7 – 9.5	8.20
4.	Breadth of leaf (cm)	0.9 – 1.3	1.03	2.6 – 3.9	3.13
5.	Petiole length (cm)	0.4 – 0.5	0.43	0.6 – 0.7	0.63
6.	Fruit length (cm)	15.5 – 20.2	18.27	15.1 – 22.5	19.37
7.	Fruit width (cm)	1.9 – 2.7	2.30	2.2 – 2.9	2.57
8.	No. of seeds/ fruit	60 – 69	64	72 - 81	75
9.	Seed length (cm)	0.65 – 0.72	0.69	0.68 – 0.78	0.72
10.	Seed width (cm)	0.12 – 0.15	0.13	0.14 – 0.20	0.15
11.	100 seed weight (g)	0.55 – 0.57	0.56	0.62 – 0.66	0.65
12.	Root length (cm)	54.0 – 62.3	58.2	65.0 – 71.6	67.8
13.	Primary root diameter (cm)	2.4 – 3.00	2.6	2.8 – 3.5	3.2

with a white silky hairy appendage at one end which aids in the seed dispersal mechanism of the plant. On one side of the seed, the seed coat is smooth and the other side is wrinkled and pitted.

The two morphological plant types expressed variation for some of the characters. The stem color is dark green to purplish green in narrow-leaf type whereas in broadleaf type it is light green to dull green in color (**Fig. 3-B, C**). Stem pubescence is almost absent to very sparse in narrow-leaf type, but in broad leaf type, the stem pubescence is moderately dense (**Fig. 3D**). The unicellular non-glandular trichomes observed in Indian sarsaparilla protects the plant from desiccation during adverse conditions (Patel *et al.,* 2020) which makes it hardy in appearance. The easily noticeable morphological variation, *i.e.*, the leaf shape is linear lanceolate in narrow leaf type and obovate elliptical in broad leaf type which has not been documented so far (**Fig 3- J to Q**). The leaf margin is entire in narrow-leaf variant and entire to slightly undulating in broad-leaf type (**Fig 3- E to G**). The leaf has no pubescent hairs in narrow leaf type, whereas it is glabrous to slightly pubescent in broad leaf type (**Fig 3-H, I**). The midrib color is silvery white in narrow leaf type, but the silvery white midrib was not common in the available collections. The flower color is yellowish green to purple and was observed in both the plant types (**Fig 3-R, S**) (George *et al.,* 2008, Chakrabortty and Choudhary, 2014). The mean value and range of the quantitative characters for both the plant types are represented in **Table 3**. The petiole length varied from 0.4-0.7 cm and the flowers are sessile. The internode length of the narrow-leaved type is much shorter than the broad-leaved type which renders the faster growth of the broad-leaved type. The length of the fruit of the narrow-leaf variant (15.5-20.2 cm) was greater than the broad-leaf variant (15.1-22.5 cm). The root length and diameter of the narrow leaf type was comparatively lesser than the broad leaf type. The broad leaf type plants were collected from the areas less intervened by human activities and this might be the reason for the hardy nature of the plants with massive and longer roots. The fruit of the crop is termed as follicle (Tabassum *et al.,* 2015) and fruit length varied from 15.5 – 20.2 cm for narrow-leaf type and 15.1 – 22.5 for broad leaf type. According to Nandy e*t al.* (2020b), the length of the follicle is 10-15 cm which is comparatively less than the observed values.

Hemidesmus indicus is a highly valued medicinal plant that has a greater potential in the herbal medicine industry. The morphological characters such as root length, diameter and regeneration capacity from cut ends of *H. indicus* is greater and more vigorous in its natural habitat compared to the plants maintained in the potted condition. Due to the increasing demand for the plant and the rapid diminishing availability of the plant and roots, the plant is over-exploited in its habitat which could force it to become an endangered plant. In order to avoid this, collection and *ex-situ* conservation of the genetic diversity of this species is essential. Germplasm collections from different regions of Madurai were morphologically characterized and experiments were initiated for *in vitro* conservation of the pathogen free genetic stocks (Shankar *et al.,* 2018) of *H. indicus* germplasm. Till date morphological descriptors are not available for *Hemidesmus indicus*. The present investigation initiated on morphological characterization would serve as a base for developing standard descriptors in this species.

Fig. 3A. Climbing growth habit of *H. indicus*

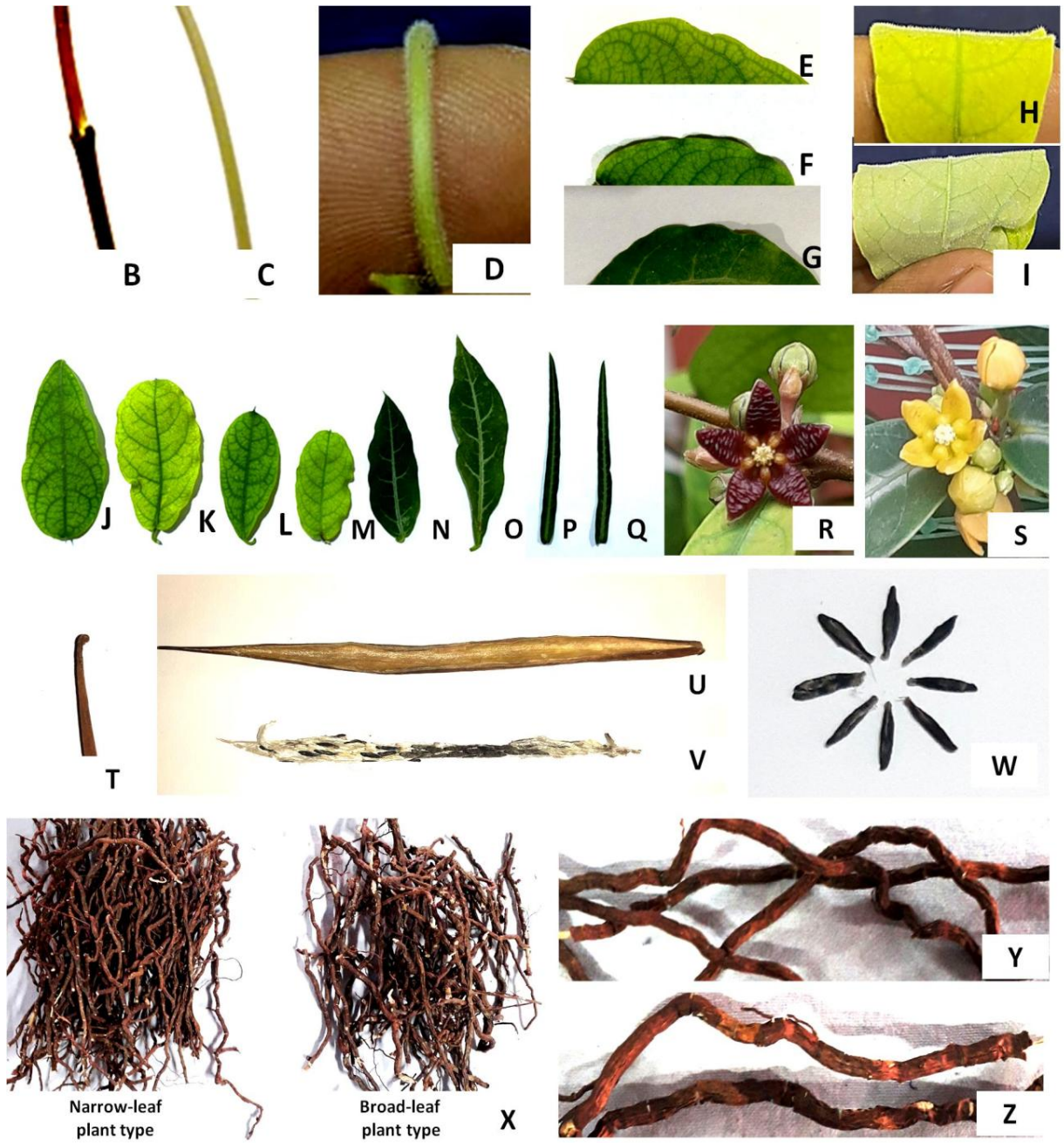

Fig. 3 B-Z. Morphological characterization of *H. indicus*

(B) Stem color-purple (narrow-leaf type)
(C) Stem color - light green (broad-leaf type)
(D) Sem pubescence of broad-leaf type
(E-G) Undulating leaf margin of broad-leaf type
(H, I) Leaf pubescence of broad-leaf type - dorsal side & ventral side
(J-O) Leaf shape variation- broad-leaf type
(P-Q) Leaf shape variation- narrow-leaf type
(R-S) Flower color variation observed in both the types
(T) Beak shape tip of pod observed in both the types
(U) Pod
(V) Seed with seed appendages
(W) Seeds
(X-Z) Roots
(Y) Roots of narrow-leaf plant type
(Z) Roots of broad leaf plant type.

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