



Morphological Variation among Four Species Belonging to Genus *Sida* L. (Family Malvaceae) from Western Uttar Pradesh, India

Dushyant K. Singh^{(1)#}, Parikshit K. Singh⁽²⁾, Rajesh K. Pandey⁽¹⁾, Rajneesh K. Agnihotri⁽³⁾

⁽¹⁾Department of Botany, Faculty of Sciences, Bundelkhand University, Jhansi, Uttar Pradesh-248128, India; ⁽²⁾Department of Botany, Digvijay Nath P. G. College, D. D. U. University, Gorakhpur, Uttar Pradesh-273001, India; ⁽³⁾Department of Botany, School of Life Sciences, Dr. B. R. Ambedkar University, Agra, Uttar Pradesh-282005, India.



STUDIES on the morphological features of four species of genus *Sida* L.; viz. *Sida acuta* Burm. f., *Sida cordata* Burm. f., *Sida cordifolia* L. and *Sida rhombifolia* L. belongs to family Malvaceae have been conducted in the present study. These species grow widely in the Agra city of western Uttar Pradesh; India. The present work focused on the determination of variations in the morphological attributes of the leaf, calyx, petal, staminal tube, stigma and trichomes, using compound microscopy to examine some minute morphological features. The overall study revealed that morphological characteristics in the four species of genus *Sida* exhibit considerable variation. *S. rhombifolia* leaf has a rhomboid-shaped lamina, while the rest of the studied species have cordate-ovate to suborbicular-cordate and linear shapes. *S. acuta* has large sized corolla (1.5cm in diameter), and calyx (10mm in diameter) followed by *S. cordifolia* (8mm), *S. cordata* and *S. rhombifolia* (7mm). Trichomes showed a wide variation from glandular to non-glandular, unicellular to multicellular, spiral, straight, stellate, branched and unbranched. Therefore, the study could be exploited as a baseline tool to characterize and identify the individual species of the genus *Sida*.

Keywords: Malvaceae, Morphology, *Sida*, Taxonomy, Trichomes, Variability.

Introduction

To identify several plant species, beside family features and characters, it is very important to carefully examine of the taxa for their identification. Characterization means to describe the character or quality of highly heritable anatomical and morphological features for classification, identification and evolutionary studies of plant species (Vicente et al., 2005). The relative studies of plant structure, morphology and anatomy have always the determination of plant systematics which endeavors to illuminate phylogeny, plant diversity and evolution (Endress, 2000). The study of morphological variation is very essential for taxonomic explanation and is generally used as an important tool in studying the systematic position of plants and population discernment (Vicente et al., 2005). The natural variation is generally easily seen in the leaves

of a plant, flowers, stems, and may show similar variation. Morphological characters of plant can be used to measure, compare, count, differences or similarities in plant taxa which are used for identification of plant, their descriptions and classification (Amitha & Joseph, 2019).

Leaf morphological characters proved to be helpful in taxonomic application especially in tropical species, especially in those species where reproductive part is absent (Hickey & Taylor, 1991). Leaf characters, especially venation patterns are acceptable taxonomic markers in the classification and identification of plant taxa (Larano & Buot, 2010). The leaf architecture which was first used for leaf structure, including venation pattern, gland position and marginal configuration are of use in taxonomical decisions (Hickey & Taylor, 1991). Plant trichomes are a hair-like structure which develops from the epidermis

#Corresponding author email: singh.dks1226@yahoo.com

Received 15/3/2021; Accepted 03/06/2021

DOI: 10.21608/ejbo.2021.68030.1653

Edited by: Prof. Dr. Ahmad K. Hegazy, Faculty of Science, Cairo University, Giza 12613, Egypt.

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tissue, varied in a single plant from glandular to non-glandular in the same individual (Huchelmann, 2017). Trichomes has differing organographic distributions in the same taxa. The morphology of trichomes can be helpful in identification of the plant species (Adedeji et al., 2007). The features of plant trichomes are broadly observed as useful for beginning the systematically relations within the family (Dorr, 1990). The main role of trichomes is plant protection against natural hazards and structural defence from small pathogen and insects (Xiao et al., 2017).

The Malvaceae is the largest flowering plant family represented 80 genera and over 1000 species widely distributed in the world (Erarslan & Kocyigit, 2019). The *Sida* genus is the largest group of herbs, shrubs, and small trees with about 200 species distributed in temperate regions and 20 species listed in India (Paul & Nayar, 1988; Shivranjan & Pradeep, 1996). *S. acuta* Burm. f., *S. cordata* Burm. f., *S. cordifolia* L. and *S. rhombifolia* L. are annual or perennial wildly distributed herbs of the family Malvaceae. These species have big medicinal and economic value in India, as they used as traditional medicine since last 2000 years (Pradhan et al., 2013).

These four herbs wild species of genus *Sida* are found in abundance in Agra city of western Uttar Pradesh and used as traditional medicine at the local level. Therefore these plants were selected for the present investigation. The present work was done to study the morphological attributes of four species of genus *Sida* from the Malvaceae family to facilitate their morphological identification.

Materials and Methods

Plant specimens of the four *Sida* species; *Sida acuta*, *Sida cordata*, *Sida cordifolia* and *Sida rhombifolia* were collected from various locations (damage garden, shady places and road sides) of Agra city of Braj region of western Uttar Pradesh. About 40 individuals were subjected to this study. These individuals were deposited as voucher specimens and identified at Regional Ayurveda Research Institute, Jhansi (AYUSH, Govt. of India) with the help of authentic taxonomic literature. The fresh samples including leaves, calyx, pistil, staminal tube and trichomes were studied morphologically and measured with the help of graph paper during the flowering

period. Trichomes features (when present) viz: types, shape and structure were observed using the compound microscope at the Department of Botany, Khandari Campus, Dr. Bhim Rao Ambedkar University, Agra and electron microscope at SAIF, AIIMS-New Delhi. Then schematic illustrations of trichomes were drawn by hand sketching on white plain paper.

Results

Morphology of leaves

S. acuta

It is a perennial small herb (Fig. 1, Photo A). Leaves are simple, sword-shaped, hairy, yellowish-green, acute at the apex with a sharply pointed tip, narrowly lanceolate, rounded or blunt base. Arranged alternately along the stems and on short, hairy stalks. Leaves size was observed around 3-6cm long and 1-1.8cm width with toothed margins, prominent veins under surface, margin regularly serrate, pubescent (Fig. 1, Photo E).

S. cordata

It is an ascending herb known as heartleaf fan petals (Fig. 1, Photo B). Leaves are simple, alternate, green, heart-shaped with cordate base, one at each node, around 5 cm long and 4.8cm broad, orbicular to ovate, margins crenate serrate, short teeth, glabrate, stellate hairy present on both surface, 4-6 veined, petioles 3 cm long (Fig. 1, Photo F).

S. cordifolia

It is about 20cm to 1.2m across in height known as Indian ephedra (Fig. 1, Photo C). Leaves of *S. cordifolia* are simple, alternate spiral, green in colour, leaf base obtuse to shallow cordate broadly ovate to orbicular oblong, leaf margin crenate serrate around up to 5 cm long and 3.5 cm broad, 7 nerved from the base, 3-5 veined, long hairs present on both surface (Fig. 1, Photo G).

S. rhombifolia

It is known as Arrow leaf *Sida* (Fig. 1, Photo D). Leaves are green, simple, alternate, jelly, across 3-7cm long and 1-3cm wide, highly variable in shape and size, margins serrate (irregularly toothed), apex acute, base is rounded or wedge-shaped, small spines, glabrate or stellate hairy (tiny star-like hair) present on both side, lamina rhomboid (diamond-shaped) which is different from *S. acuta* (Fig. 1, Photo Q).

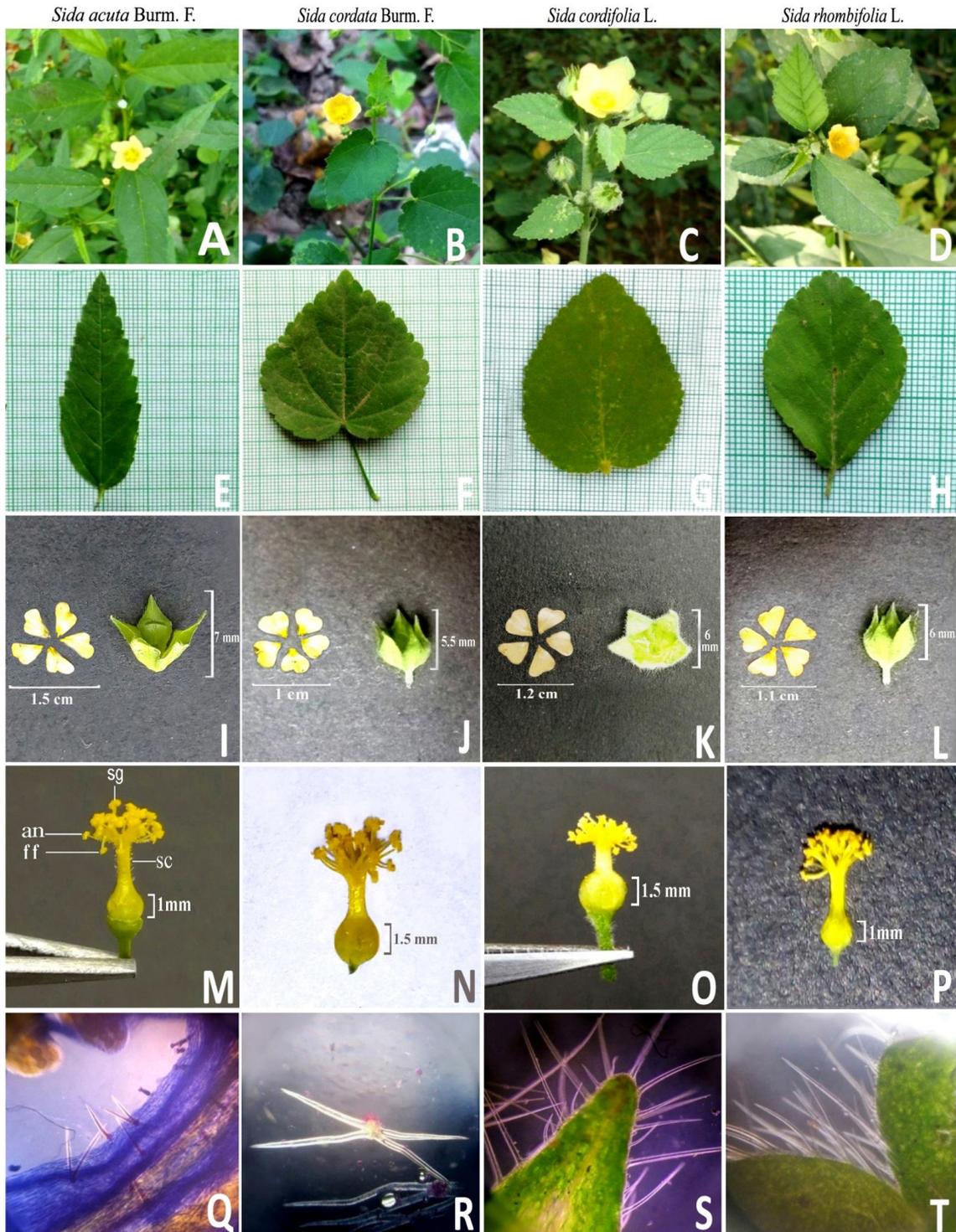


Fig. 1. Morphological variability of leaves, corolla and calyx, staminal tube & stigma head and trichomes of *Sida* genus: *S. acuta* (Photo A-Q), *S. cordata* (Photo B-R), *S. cordifolia* (Photo C-S) and *S. rhombifolia* (Photo D-T)

Morphology of corolla and calyx

S. acuta

Corolla of *S. acuta* is light yellow, around 1.5cm in diameter consists of 5 free petals,

fused and having a long lobe on one side. Calyx is yellowish-green in colour, large, consists of 5 sepals, free at the tips, hairy, gamosepalous, around 7mm long with 6mm width and 10mm

in diameter, campanulate, slightly crescent, persistent, valvate aestivation (Fig. 1, Photo I).

S. cordata

Corolla consists 5 free petals, broadly, light yellow, about 1cm in diameter and apex rounded with twisted aestivation. Calyx is shallow, cup-shaped, compose of 5 green sepals, gamosepalous, persistent, across 5.5mm long with 5mm width and 7mm in diameter, deep hairs present on both surface, lobes triangular and free at the tips, base connate till middle (Fig. 1, Photo J).

S. cordifolia

Corolla of *S. cordifolia* having 5 free petals, around 1.2cm in diameter. Calyx consists of 5 free sepals, gamosepalous, lobes triangular, persistent, around 6mm long and 5 mm width with 8 mm in diameter, free at tip, hairy, green in colour with twisted aestivation (Fig. 1, Photo K).

S. rhombifolia

Corolla is 1.1cm in diameter in size consists of 5 petals, yellow to pale orange, fused at base, small and cup shaped. Calyx compose five free hairy petals, gamosepalous, persistent, hairy yellowish-green and about 6 mm long with 5 mm width and 7 mm in diameter, lobes triangular, free at the tip and apices acute (Fig. 1, Photo L).

Morphology of stigma and staminal tube

S. acuta

Pistil is yellowish in colour, about 6 mm long, differentiated into stigma, style and ovary. Stigma is capitate, 5-6, globular, stamens are indefinite in numbers and united by their filaments, filament sparsely hirsute, the tube being united with the petals (epipetalous) and arrange on staminal column, staminal column around 2mm long, filaments 1.5mm long but bunches is not clear, around 6-10 anther per bunch. Style is single and solid. Ovary is superior, multicarpellary and 1mm long (Fig. 1, Photo M).

S. cordata

Ovoid staminal tube on to base and tubular ovoid onto apex, Stigma is papillate and capitate, branched, across 4-6 anthers per bunch, arrange on staminal column, antheriferous filaments confined at the apex of the staminal tube and densely sphere arranged. Style is single, terminal and solid. The ovary is superior, axil, around 1.5 mm long and multicarpellary (Fig. 1, Photo N).

S. cordifolia

Pistil is yellowish, 5mm long, differentiated into stigma, style and ovary. Number of Stigma is 6, capitate and wet type, staminal column 3mm long, anther monothealous, number of anthers per bunch is 6-10, filament tube glabrous. Style is single, solid, terminal passes through the staminal tube. Ovary is syncarpous, multicarpellary, 1.5mm long and 1.8 mm width (Fig. 1, Photo O).

S. rhombifolia

Pistil length is about 5mm long, tubular staminal tube present at the apex and slightly swollen at base. Stigma is capitate, united and around 4-6, number of anthers per bunch is about 6. antheriferous filaments confined to the apex of the staminal tube and in form 5-6 bunches. Style is one, solid and terminal through passes in the staminal tube. Ovary is axil and superior, about 1mm long and 1mm width in size (Fig. 1, Photo P).

Morphology of trichomes

S. acuta

Non-glandular stellate trichomes present on the upper surface of calyx and leaf (Fig. 2, Photo A). Simple, unicellular, pointed conical trichomes located on calyx and style (Fig. 1, Photo Q & Fig. 2, Photo B), branched tetra radiates present on the stem (Fig. 2, Photo C), spiral circuitous flattened with a conical tip present at the style surface (Fig. 2, Photo D).

S. cordata

Capitate stalked, non-glandular, branched, tetra-radiate, stellate or H shaped trichomes present on the calyx and leaf surface (Fig. 1, Photo R & Fig 2, Photo E), unicellular sword-shaped on calyx surface (Fig. 2F), circuitous flattened on pedicle (Fig. 2, Photo G) and spiral, long, circuitous trichomes present on the pedicle and calyx surface (Fig. 2, Photo H).

S. cordifolia

Non-glandular simple and spiral trichomes located on pedicle, stem and leaves (Fig. 2, Photo I), they are simple, unicellular, or bicellular and branched at calyx and pedicle (Fig. 1, Photo S & Fig 2, Photo J), while they are simple circuitous flattened at style surface (Fig. 2, Photo K), or branched, tri-radiate on stem and leaves surface (Fig. 2, Photo L) and stellate trichomes found on leaves and calyx surface (Fig. 2, Photo M).

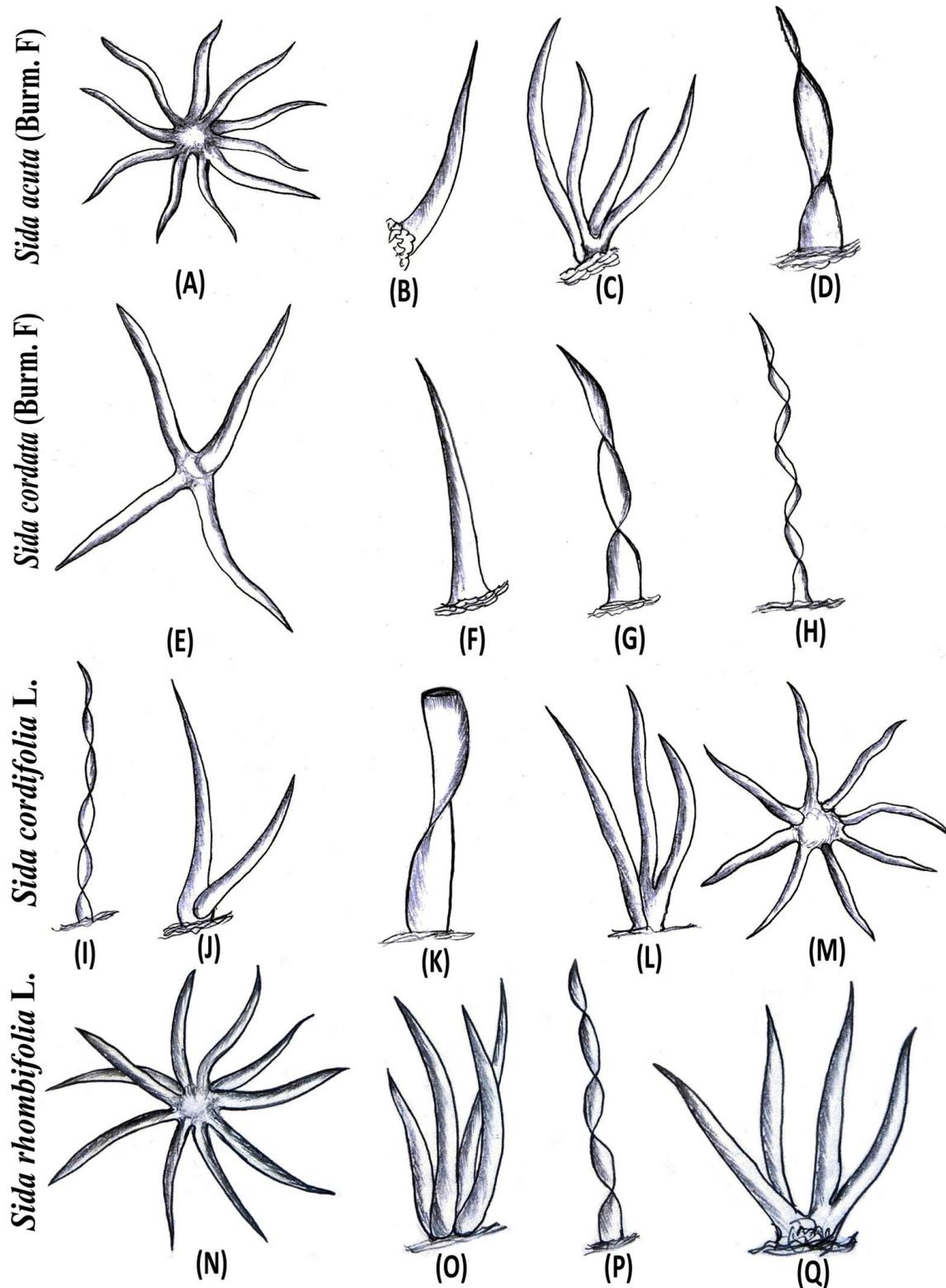


Fig. 2. Trichomes morphology (schematic illustration) of *Sida* genus. *S. acuta* (Photo A-D), *S. cordata* (Photo E-H), *S. cordifolia* (Photo I-M) and *S. rhombifolia* (Photo N-Q)

S. rhombifolia
Branched non-glandular, multiradiate and

stellate trichomes beside simple, branched, sward shaped and tetra radiate observed at leaves and

calyx surface (Fig. 1, Photo T & Fig. 2, Photo O), while unicellular spiral trichomes observed on the pedicel (Fig. 2, Photo P), and branched tetra radiate trichomes present on both stem and pedicel surface (Fig. 2, Photo Q).

Key characters of genus *Sida*

Prostrate, ascending.....*S. cordata*

Erect, branched.....*S. acuta*, *S. cordifolia*,
S. rhombifolia

Epicalyx absent.....*S. acuta*, *S. cordata*, *S. cordifolia*, *S. rhombifolia*

Stellate trichomes..... *S. acuta*, *S. cordata*, *S. cordifolia*, *S. rhombifolia*

Larger corolla, calyx (1.5, 10mm in diameter).....
.....*S. acuta*

Acute leaf apex and linear.....*S. acuta*

Rhomboid lamina..... *S. rhombifolia*

Cordate (hearts-shaped) leaves.....*S. cordata*,
S. cordifolia

Stigma capitates, branched at apex.....*S. acuta*,
S. cordata, *S. cordifolia*, *S. rhombifolia*

Discussion

From the above mentioned results it is absolutely clear that the studied *Sida* species have simple and alternate leaves. Stellate hair is common in all plant leaves. *S. acuta* leaves differ compared to the other three species as shown in the results. This variation coordinate with Arul & Jespin (2017) who reported similar results in five *Sida* species.

Larano & Buot (2010) classified forty species of the family Malvaceae and characterized by using leaf morphology characters as margin and vein patterns. Baroga & Buot (2014) reported similar result of leaf architectural characters of 10 species of *Terminalia* (Combretaceae) on the basis of leaf attachment, laminar shape, petiole features, base and apex shape. Silva et al. (2018) characterized eight species of zingibers leaves with the help of their anatomy and morphological study.

The calyx and corolla of *S. acuta* were observed larger in measurements than the rest of the species (7mm long and 10mm in diameter, 1.5cm in diameter) and count maximum number of anther compared to the three *Sida* species. Calyx size of *S. rhombifolia* and *S. cordifolia* is similar. The pistil of all investigated *Sida* species is more similar in structure and size. Similarly result has also been reported by Nasker & Mandal (2014) who characterized fourteen taxa on the basis of the morphology of epicalyx, staminal tube and stigmatic head. The morphological similarities of staminal tube of both *Sida* and *Abutilon* have their close affinities.

Data obtained from the trichomes characters showed a great morphological variation within the studied species. Types of trichomes, number of cells and their branching were noticed within the studied taxa. Stellate trichomes were commonly recognized in all *Sida* species. The stellate trichomes are a key attribute of the family Malvaceae (Fryxell, 1988). Nasker & Mandal (2014) studied the morphology of non-glandular trichome and used to identify the fourteen taxa of Malvaceae. Similarly, stellate trichome of *S. cordata* distinguishing it from *S. acuta* and *S. rhombifolia*. Chavan et al. (2014) have also been identification of 19 medicinal plants of family Malvaceae on the basis of micromorphological characters. Celka et al. (2006) reported the morphological variation of trichomes in *Malva alcea* L. Arabameri et al. (2020) recently reported morphology of glandular and non-glandular trichomes and their application of 26 species of *Alcea* genus (Malvaceae).

Conclusion

Morphological information are necessary for taxonomic descriptions and comparisons within the species. The present study is aimed to provide detailed comparative morphological information of four genus of *Sida* L. which are currently found in abundance in different place of Agra city of western Uttar Pradesh. This basic morphological information will help to add new information about the inter-specific relationships within species and is crucial for understanding the biodiversity conservation by scientific analysis and may serve as a great supportive tool for identifying plant species.

Acknowledgements: Authors are thankful to the

Director and team, Regional Ayurveda Research Institute, Jhansi (Ministry of AYUSH, Govt. of India) for identify of plant specimens, and Head, Department of Botany, Dr. Bhim Rao Ambedkar University, Agra for provided necessary research facilities.

Funding source: The author received no financial support for the research, authorship of this article.

Conflict of interest: The authors declare that they have no conflict of interest.

Authors' contributions: All the authors have contributed the manuscript. Author DKS performed all the experiment, field survey, photography, collection and write the manuscript. PKS supervised the research work. RKP designing the experiments and RKA analysis of data, suggestion and coordination for carrying out the present work. All authors read and approved the final manuscript.

Ethical approval: Not applicable

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