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Research Article

Studies on macromorphological taxonomic variations in *Abutilon* species of Indian Thar Desert

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Abstract: *Abutilon* is an important medicinal plant. Its various plant parts such as leaves, flowers, fruits and seeds were used to treat various diseases and ailments from the ancient time. Present work deals with the investigation of three species of *Abutilon*viz. *Abutilon indicum*, *Abutilon pannosum*and *Abutilon ramosum* with a view to study macro morphological variations and to identify a set of diagnostic characters for individual *Abutilon* species. Distinct variations exist in stem surface and colour, leaf shape and size, flower diameter, fruit colour, shape and size, number of mericarps per fruit and seed structure. All these macromorphological variations were helpful in identification and delineation of the plant species.

Keywords: *Abutilon*, macromorphology, mericarps, schizocarpic fruit, subtrilobate leaf.

Introduction

The great Indian Thar desert lies between 24º to 28º N latitude and 68º to 71º E longitude. It covers approximately ten percent geographical area of India, extended upto four states -Punjab, Haryana, Gujarat and Rajasthan. Sixty percent area of Indian Thar desert lies within Rajasthan mainly along Jodhpur, Jaisalmer, Barmer, Bikaner and some parts of Jalore district. Thar desert has a unique natural ecosystem with extremely low and uncertain rainfall, seasonal and diurnal temperature variations, nutrient poor and saline soil, severe drought accompanied by high wind velocity and shifting sand dunes. Despite of so many adverse conditions, The Thar region is gifted with great and unique biodiversity in the world. Although Indira Gandhi canal brought tremendous variations in the vegetation of previously occurring flora of extremely hot arid region of Indian Thar desert. There are large number of shrubs, annual herbs and climbers recorded in this region, most of these were claimed useful economically and medicinally for welfare of human beings. The family Malvaceae is one of the largest family of flowering plants commonly known as Mallow family, estimated to contain 244 genera with 4225 known species distributed all over the world (Christenhusz, 2016). It can be easily distinguished from other related families by alternate leaves with well-developed stipules, actinomorphic flowers, petals united with staminal column, monoadelphous stamen, multicarpellary superior ovary and schizocarpic fruits. (Sivarajan & Pradeep, 1996). The genus *Abutilon* Mill. (Miller, 1754) is one of the most heterogeneous and large genera in the family Malvaceae with a need of critical revisionary treatment. (Fryxell, 1997).

Abutilon comprises about 200 recognized species distributed in tropical and subtropical regions of the earth. (Sivarajan & Pradeep, 1996). In India 18 species has been reported. (Sharma & Tiagi, 1979; Kumar 2001; Singh, 2002). From the great Indian Thar desert region mainly from Jodhpur, Jaisalmer, Bikaner and Barmer region of Rajasthan six species of *Abutilon*has been reported. (Bhandari, 1990). *Abutilon* is a perennial herb to shrub, rarely small tress, the plant grows a plenty along the road sides, in open field and in the waste places of gardens. The genus is distinguished from most other genera in Malvaceae by the lack of an epicalyx, wingless mericarps and having an endoglossum. (Esteves & Krapovickas, 2002). It was different from its closely related uniovulated genus *Sida* due to presence of more than one ovule in a locule, and opening of flower in *Abutilon* takes place in the evening while in *Sida* flower opens in the morning (Sweet, 1826).

Abutilon has been considered important economically because of its medicinal properties and the fibers obtained from the plant could be exploited as a substitute of jute. (Husain and Baquar, 1974). Furthermore, different plant parts such as root, leaves, flower, fruit, bark, seed and stem contain specific phytoconstituents responsible for their biological activity. (Patel, 2013). There were no identified toxins confirmed in the genus at large so in recent years there has been a renewed scientific interest in exploring the species (Khadabadi & bhajipale, 2010; Pingale & Virkar, 2011; Bano & Deora, 2017). There is much confusion exist in morphology among the species of the plant *Abutilon*. As the plant is important medicinally and economically, there is a need of proper identification and description of the species. Morphology has served largely for systematics. From ancient times morphological characters were the major criteria for plant classification and identification of species.

Present study was designed to revise and describe, macromorphological taxonomic variations of vegetative and reproductive structures in three *Abutilon* species namely *Abutilon indicum* (Linn.) Sweet, *Abutilon pannosum* (Forst. f.) Schlect. And *Abutilon ramosum* (Cav.) Guill. and Perr. found in Indian Thar desert mainly from Rajasthan region with reference to the earlier applied characters. Furthermore, a set of identification characters could be prepared for individual *Abutilon* species.

Materials and Methods

Three species of *Abutilon*viz. *Abutilon indicum, Abutilon pannosum* and *Abutilon ramosum* were taken for macromorphological study. Fresh plant samples were collected from the field survey of different localities of Jodhpur, Jaisalmer and Bikaner. Plant growth characters, life form, plant height, colour of stem, flower colour period and opening period of flower were recorded during field visit. The plants were identified by BSI, Jodhpur and with the help of Flora of Indian desert (Bhandari, 1990). Herbarium specimen were prepared and voucher specimen were deposited in Jai Narain Vyas University Herbarium, Department of Botany, Centre for Advanced Study. Macromorphological characters like habit, leaf shape and size, stipule size, colour and size of flower, size of fruit,

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shape, size and number of mericarps and seeds were studied. Both qualitative and quantitative measurements were recorded from at least 5 individual populations of each species. Microscopic characters were studied using simple dissecting microscope and trinocular microscope. Both field photographs and photograph during workplan were taken with Sony digital camera Model number SAL-18552.

Results and Discussion

Macromorphological variations in vegetative and reproductive characters of three *Abutilon* species from Indian Thar desert were studied and presented in Table 1 to 4 and Figures 1, 2 and 3. The minimum and maximum measurements as well as mean of whole readings were listed in centimeter. Most important characteristics were discussed below under following headings.

Table 1. Macromorphological variations in vegetative characters of *Abutilon* species.

S.No.	Characters	*Abutilon indicum*	*Abutilon pannosum*	*Abutilon ramosum*
1.	Habit	Perennial shrub	Perennial shrub	Perennial shrub, small tree
2.	Life form	Erect, spreading	Erect, spreading	Erect
3.	Habitat	Open field, waste places	Open field along road side	Under shade of big trees
4.	Height	3-8 feet	5-10 feet	3-10 feet
5.	Colour of stem	Green with purple patches	Pale green	Dark Green
6.	Leaf shape	Deeply chordate	Broadly ovate	Chordate, subtrilobate
7.	Leaf surface	Upper and lower both velvety	Upper scabrous Lower wooly	Upper glabrous Lower hairy
8.	Leaf length Min (Mean) Max (cm)	2.3(5.71)7.5	4.0(7.7)12.0	8.5(11.31)20
9.	Leaf width Min(Mean)Max	2.5(5.75)7.5	5.5(8.58)12.5	9.0(11.1)19.8
10.	Leaf apex	acute	acute	acute
11.	Leaf Margins	serrate	Irregularly dentate	Serrate or crenulated
12.	Number of veins	7-9	7-9	7-9
13.	Petiole length Min(Mean)Max (cm)	0.8(2.71)6.5	4.0(7.8)9.0	10.5(14.47)22
14.	Stipule size Min(Mean)Max (cm)	0.5(0.6)).8	0.8(1.02)1.1	0.4(0.41)0.45

Table 2. Macromorphological variations in floral characters of *Abutilon* species.

S.No.	Characters	*Abutilon indicum*	*Abutilon pannosum*	*Abutilon ramosum*
1.	Position of flower	Axillary	Axillary	Axillary
2.	Colour of flower	Bright yellow	Orange yellow	Light yellow
3.	Opening of flower	3-5 pm.	5-6 pm.	3-5 pm.
4.	Pedicel lengthMin(Mean)Max(cm.)	1.6(2.39)6.0	1.0(1.36)1.6	2.3(3.72)5.6
5.	Bract length Min(Mean)Max(cm.)	0.2(0.2)0.22	0.40(0.42)0.5	0.2(0.22)0.3
6.	Floral diameter Min(Mean)Max(cm.)	3.5(3.3)3.8	1.9(2.24)2.6	1.5(1.6)1.8
7.	Calyx length Min(Mean)Max (cm.)	0.9(1.06)1.2	0.9(0.99)1.1	1.0(1.1)1.0
8.	Calyx width Min(Mean)Max (cm.)	0.4(0.52)0.7	0.3(0.3)0.3	0.4(0.4)0.4
9.	Corolla colour	Bright yellow	Orange yellow	Light yellow
10.	Corolla length Min(Mean)Max(cm.)	1.1(1.2)1.5	0.9(1.1)1.4	0.6(0.82)1.0
11.	Corolla width Min(Mean)Max (cm.)	1.2(1.3)1.4	0.8(0.88)0.95	0.7(0.74)0.8

Vegetative Characters:

Stem: The stem of all the three species were commonly erect, rounded, hairy and solid. Stem colour of *Abutilon indicum* was generally green sometimes purplish pigmentation was noticed from younger stem, branches and petioles (Fig.1b), which was absent in *Abutilon pannosum* and *Abutilon ramosum*. In *Abutilon pannosum* stem was pale green and densely covered with simple and glandular trichomes (Fig.2b) while it was dark green and intermixed with long spreading simple, glandular and stellate trichomes in *Abutilon ramosum*. (Fig.3b).

Leaf: leaves of all three species were simple, broadly ovate to deeply chordate, 7-9 nerved, serrate or crenate margins with alternate phyllotaxy. However, leaf of *Abutilon indicum* was comparatively thicker and velvety in texture on both surfaces (Fig.1c). Upper surface of *Abutilon pannosum* leaf was somewhat scabrous while its lower surface was densely hairy or wooly in appearance (Fig.2c). Leaf of *Abutilon ramosum* was thinner, shallowly subtrilobate at apex, its upper surface was somewhat glabrous and lower surface was hairy. (Fig.3c). The length and width of leaf lamina was greater in *Abutilon ramosum* than the other two species (Table.1). During rainy season leaf lamina of *Abutilon ramosum* reaches up to 20 centimeters in length with almost equal length of petioles. Stipules were long and linear in all the three species. In *Abutilon ramosum* these were subulate while deflexed in other two species.

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Reproductive characters:

Floral characters: Floral and fruit characters are the most important features used in identification and delineation of *Abutilon* species. Generally, inflorescence of the three species was axillary solitary. In *Abutilon pannosum* it appears in panicle or raceme due to reduction of leaves at terminal branches. These observations were in line of previous study (Abedin, 1979). Flowers were complete, actinomorphic, bracteate,

pedicellate, hermaphrodite, pentamerous, hypogynous and cyclic. *Abutilon indicum* flower were larger in size ranging from 3.5-3.8 cm in diameter (Figure.1d) which is almost double to *Abutilon pannosum* (Fig.2d) and *Abutilon ramosum.* (Fig.3d) (Table.2).

Calyx and Corolla: Calyx were with 5sepals, valvate, persistent and green. (Fig.1e, 2e, 3e). Corolla of *Abutilon indicum* were larger and dark yellow coloured (Figure.1f) whereas in *Abutilon pannosum* corolla colour was orange yellow (Fig.2f) and in *Abutilon ramosum* light yellow colour of corolla were observed (Fig.3f). Other important features of flower and quantitative measurements were depicted (Table.2). In previous study on Saudian specimen of *Abutilon pannosum*, big size of flower with a diameter of 5.0-8.0 centimeter was reported (Taia, 2012) while in present study flower size was measured up to 1.5-1.8 centimeter in diameter (Table.2).

Table 3. Macromorphological variations in reproductive characters of *Abutilon* species

S.No.	Characters	*Abutilon indicum*	*Abutilon pannosum*	*Abutilon ramosum*
1.	Length of staminal tube Min (Mean) Max (cm.)	0.5(0.56)0.6	0.2(0.34)0.5	0.2(0.25)0.3
2.	Length of free filament Min(Mean)Max (cm.)	0.3(0.34)0.3	0.10(0.17)0.19	0.15(0.18)0.2
3.	Pollen grain shape	Spheroidal	Spheroidal	Spheroidal
4.	Pollen grain diameter Min (Mean) Max (µm.)	54.6(73.32)80.6	70.2(72.02)74.1	54.6(55.9)59.9
5.	Ovary diameter Min (Mean) Max (cm.)	0.5(0.5)0.5	0.3(0.3)0.3	0.29(0.29)0.3
6.	Ovary surface	Hairy	Hairy	Hairy
7.	Style length Min(Mean)Max (cm.)	0.8(0.84)0.9	0.3(0.6)0.8	0.2(0.25)0.3
8.	Stigma type	Capitate	Capitate	Capitate

Table 4. Macromorphological variations in Fruit and seed characters of *Abutilon*species.

S.No.	Characters	*Abutilon indicum*	*Abutilon pannosum*	*Abutilon ramosum*
1.	Type of Fruit	Shizocarpic	Shizocarpic	Shizocarpic
2.	Colour of fruit	Light brown	Greyish Brown	Blackish brown
3.	Fruit diameter Min (Mean) Max (cm.)	1.7(1.9)2.1	0.8(0.92)1.0	0.8(0.90)1.0
4.	Length of fruit stalk Min(Mean)Max (cm.)	3.3(4.1)5.1	1.4(1.5)1.6	4.0(4.43)0.5
5.	Number of mericarp per fruit	16-20	28-36	10-13
6.	Length of mericarp Min (Mean) Max (cm.)	1.3(1.34)1.3	0.8(0.86)0.9	0.9(0.96)0.9
7.	Width of mericarp Min(Mean)Max (cm.)	0.7(0.84)0.9	0.5(0.5)0.5	0.4(0.4)0.4
8.	Awn sizeMean (cm)	Absent/if present .1	Absent -	Present 0.2
9.	Number of seeds per mericarp	3	2 or 3	3
10.	Colour of seed	Brown	Blackish brown	Black
11.	Shape of seed	Reniform	Heart shape	Reniform
12.	Seed surface	Hairy, dotted	Hairy	Hairy
13.	Seed length Min (Mean) Max (cm)	0.22 (0.26) 0.31	0.2 (0.2) 0.2	0.2 (0.2) 0.2
14.	Seed width Min (Mean) Max (cm.)	0.21 (0.24) 0.21	0.25 (0.25) 0.25	0.2 (0.23) 0.3

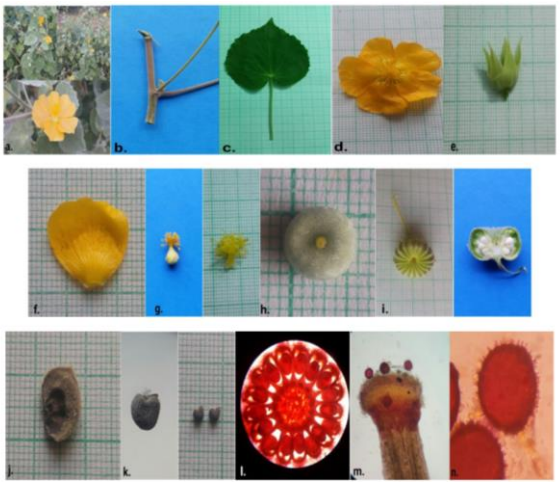

Figure 1. ***Abutilon indicum:*** a; Field photograph. b; Stem twig. c; Chordate leaf d; Flower.e; Calyx. f; Corolla. g; Androecium. h; Gynoecium. i; Schizocarpic fruit. j; Mericarp. k; Seed. l; T.S. of ovary showing axile placentation. m; Capitate stigman; Pollen grain.

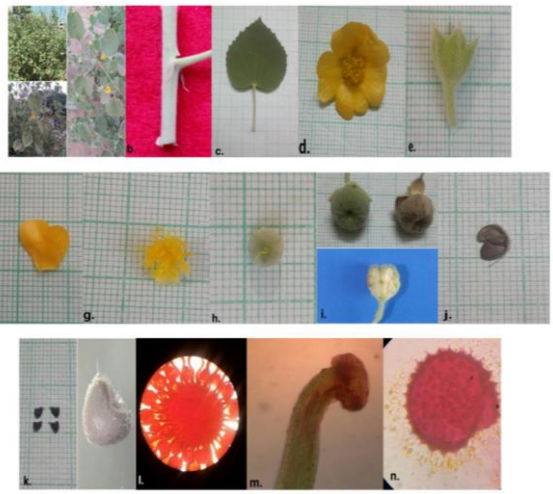

Figure 2. ***Abutilon pannosum*****:** a; Field photograph. b; Stem twig. c; Obovate Leaf.d; Flower.e; Calyx. f; Corolla. g; Androecium. h; Gynoecium. i; Schizocarpic fruit.j; Mericarp k; Seeds. l; T.S.of ovary. m; Capitate stigma. n; Pollen grain

Androecium: In all the three species and roecium consists of indefinite stamens. These were monoadelphous and forms a staminal tube around style which was united with petals at the base. Upper part of staminal tube consists of monothecous and extrose anthers. Length of staminal tube and free anther filament varied among three species, as it was larger in size in *Abutilon indicum* ranging from 0.5-0.6 cm. (Fig.1g) followed by *Abutilon pannosum* 0.2-0.5 cm. (Fig.2g) and *Abutilon ramosum* 0.2-0.3 cm. (Fig.3g).

Gynoecium: Gynoecium was multicarpellary, syncarpous, hairy, axile placentation with long style and capitate and papillous stigma. Number of styles and stigmas were as many as carpels in all the three species. Number of carpels were greater in *Abutilon pannosum* ranging from 25-30 while in *Abutilon indicum* and *Abutilon ramosum* these were 18-20 and 10-13 respectively (Table 3). Ovary size and hairiness varied among all three species. (Fig.1h, 2h, 3h)

Fruit: Although fruits of all *Abutilon* species were schizocarpic, the species can be distinguished from each other mainly with the help of fruit morphology especially on basis of shape and size of fruit, number of mericarps and presence or absence of awn in mericarp.

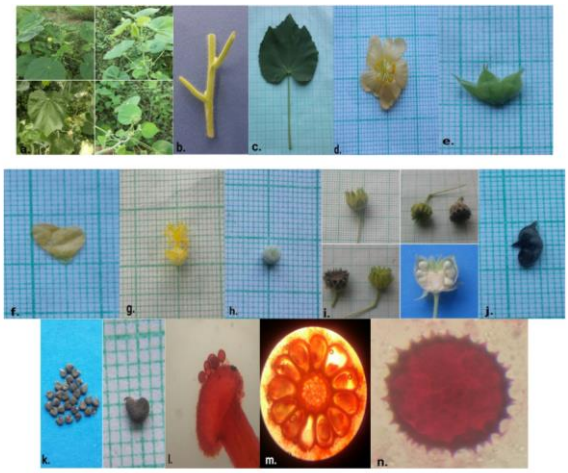

Figure 3. *Abutilon ramosum*: a; Field photograph. b; Stem twig. c; Subtrilobate Leaf.d; Flower. e; Calyx. f; Corolla. g; Androecium. h; Gynoecium. I; Schizocarpic fruit. j; Mericarp. k; Seeds. l; Capitate stigma. m; T.S. of ovary. n; Pollen grain

In *Abutilon indicum* fruits were leathery brown or blackish brown in colour, larger, truncate or with a very short mucro. Number of mericarps were16-20 with mean size of mericarps1.34×0.84 cm. Usually mericarp with round tips were observed but sometimes a short mucro persist at tip of mericarp. (Fig.1h) However, fruit of *Abutilon pannosum* was totally different as it was globose, truncate, densely hairy, greyish brown in colour, number of mericarp ranging from 28-30-35 (Fig.2i). These reports were in line of previous study. (Bhandari, 1990) However, in the plant from Saudi Arabia region number of mericarp per schizocarp was reported up to 7-10 (Taia, 2009) which was totally different from species occurring in Indian Thar desert.

In *Abutilon ramosum* fruit diameter was lesser from other two species (Table.4). Mericarps of *Abutilon ramosum* were quite distinct from the other two species by having very few in number ranging from 10-13, with a prominent awn, splitting dorsally when fully mature (Fig.3i). Previously 8-10 mericarps were reported from Indian Thar desert. (Bhandari, 1990; Singh, 1987; Abedin, 1979). In some studies, 6-8 mericarps with 7 most common were also recorded from different regions of India. (Thulin, 1999; Kunnur & Kotresha, 2011; Gill & Kaur, 2015). Seed morphology of three plant species showed certain variations from each other. As *Abutilon indicum* having bigger size seed which was brown in colour. Seeds of all the three species were reniform, hairy, warty at surface and black to brownish black in colour with tuft of stellate hairs visible at hilum. (Fig.1k, 2k, 3k.) (Table.4). Despite of some minor variations the present study on three species of *Abutilon* supported the previous reports. (Bhandari, 1990; Singh, 1987).

Conclusion

From study of different sites belonging to Indian Thar desert region, it was concluded that *Abutilon* species belonging to this region showed some noticeable variations. Furthermore, the complete illustrated account (both qualitative and quantitative) on all the macromorphological parameters can help in identification and delineation of species.

Identification key:

1. Stem ……..Green and hairy
(1) Purplish pigmentation…*Abutilon indicum.*
(2) Pale green, densely wooly…*Abutilon pannosum.*
(3) Dark green with long spreading hairs…*Abutilon ramosum*

2. Leaf……Chordate, hairy
(1) Leaf velvety……..*A.indicum.*
(2) Leaf deeply chordate, obovate, densely wooly on abaxial surface…….*Abutilon pannosum.*
(3) Leaf subtrilobate, glabrous…..*Abutilon ramosum.*

3. Mericarps 10-13……*Abutilon ramosum.*
(1) Mericarps more than 15……. (2).
(2) Mericarps 16-20……..*Abutilon indicum.*
(3) Mericarps 28-36……..….*Abutilon pannosum*

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