Middle-East Journal of Scientific Research 23 (4): 545-557, 2015
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2015.23.04.12583

Morphological and Anatomical Characteristics of Selected Dicot Xerophytes of District Karak, Khyber Pakhtunkhwa, Pakistan

[1]Hameeda Bibi, [1]Muhammad Afzal, [2]Mustafa Kamal, [1]Ihsan Ullah,
[1]Sohail, [1]Shujaul Mulk Khan, [1]Ayaz Ali Sher, [1]Irfan Ullah, [1]Ziaulhaq,
[1]Asghar Ali, [1]Sajjad Ali Khan and [1]Inayat Ur Rahman

[1]Department of Botany Hazara University, Mansehra, Pakistan
[2]Department of Botany Kohat University of Science & Technology, Kohat, Pakistan

Abstract: The present study reports the morphology and anatomy of the xerophytes (dicot) of district Karak. As a result of several surveys of the study area during 2011, nine (09) dicots plant species were collected belonging to 8 families. The plants were studied morphologically, as well as anatomically. The family *Cucurbitaceae* was dominant followed by the *Apocynaceae* and *Sapindaceae.* Similarly, the plant *Rhaziastricta (Apocynaceae*) was dominant followed by *Solanum surattense (Solanaceae*). The plants were found to be well adapted to the environment of district Karak. The morphological adaptations were presence of dense hair, as well as powder and cuticle layer on leaves and stem. The leaves were found to be leathery, needle like and elongated. Sometimes, the leaves were found to be modified into thorns and spines. Similarly, thick and short rhizome, sunken stomata, compact epidermis, wide cortex and many water storing tissues were observed during the study. During the study, it was also observed that xerophytes have numerous cortical cells to store large amount of water, as to compensate the harsh and dry environment. The xerophytes of study area were found to be well adapted in the extreme environmental factors of temperature, wind velocity, rainfall ratio, soil and humidity etc.

Key words: Xerophytes · Morphology · Anatomy · Dicot species · Karak · Pakistan

INTRODUCTION

Xerophytes are naturally grown in dry regions and are often structurally modified to withstand dry conditions and also adapted to live in conditions of extreme heat, drought and low humidity for long period of time. These plants are characteristics of desert and semi desert regions. Xerophytes are the plants which are able to survive in an environment with a limited supply of water as compared to hydrophytes and mesophytes. These plants develop certain structural, anatomical and physiological adaptations to absorb as much as water possible they can get from the surrounding and to retain water in their organs for long time by reducing the transpiration rate. These plants have deep root system with powdery leaves covered with small hair, with thick cortex and large vessels. The flowers of xerophytes usually develop in favorable conditions and they complete their reproduction in very short period of time. Fruits and seeds are protected by very hard coverings and they can remain dormant for a long period of time. Anatomically, xerophytic epidermal cells are small compact with thick cuticle. Wax, tannin, resin, cellulose etc. are deposited on the surface of epidermis. It is a protective measure against high intensity of light. Xerophytes show high stomatal resistance to reduce water loss. Many studies on xerophytes have been made by other scientists (Bahaji *et al.,* 2002; Colom *et al.,* 2002; Dawar and Vazzanna, 2010; Iqbal *et al.,* 2008). Hosseini *and Dorsa* 2007; Wahid, 2003; Hameed *et al.*, 2008; Arshad *et al.,* 2008; Islam *et al.,* 2008; Marwat *et al.,* 2009; Phillips and Comus 2009; Gostin2011; Kumar *et al.,* 2012; Nazir *et al.,* 2013; Tiwari *et al.,* 2013) [1-14]. There is no such information on the plants of District Karak. The main objectives of this paper were to study the morphological features of the xerophytes of district Karak and to study the anatomical characters in the xerophytes of the study area.

Corresponding Author: Muhammad Afzal and Sohail, Department of Botany Hazara University, Mansehra, Pakistan. Cel: +92 333 9486795.

MATERIALS AND METHODS

Karak is the district of the Khyber Pakhtunkhwa, Pakistan, at an altitude of 70.40°-70.30°N and the longitude of 32.48°-33.23°E. It is situated at 340m above the sea level. (Marwat *et al.,* 2009) [10].

The surveys of the studied area were conducted during the May-June 2011. All the important and frequent xerophytes were collected by folding them in newspapers and then put into plastic bags. They were properly sprayed with mercuric chloride, $CuSo_4$ and spirit to protect them from the decomposition. After complete dryness and poisoning, all the plants were mounted on standard herbarium sheets with proper taxonomical identification as Gostin (2011) [12] described anatomical and micromophological peculiarities of *Ranunculaceae.*

The study was comprised of three parts.

Taxonomical studies, morphological studies and anatomical studies.

Taxonomical Studies: The proper identification and taxonomy of each and every xerophyte was carried out with the help of available literature (Jafri, 1966; Qureshi and Khan, 1972) [15-16]. The identification was confirmed and authenticated by Dr. Abd- ur-Rehman, Professor of Botany, Govt Post Graduate College Bannu and Dr. Jan Alam, Assistant Professor, Department of Botany, Hazara University, Mansehra.

Morphological Studies: The general morphological descriptions of the characters like habit, root, stem, leaves and flowers were done according to method of Gostin (2011) [12]. Fresh material of the collected xerophytes was recorded along with their photographs.

Anatomical Studies: Study of the anatomy and histology of the collected species through preparing the safranine stained slides of transverse sections of leaves, stem and roots of the collected plants. The plant materials were examined under power microscope. Microphotographs of the prepared sections were made by using digital camera.

RESULTS

The plants of district Karak were collected, identified and studied for their morphological and anatomical features. The detailed description is given below:

Vaucher Number: 3625

Botanical Name: *Peganum harmala*
Local Name: Spelani
Distribution: Hamidan Banda, Bogara, Musakan, Takhte Nusrati, Chukara, Mita Khel, Sabir Abad, Soor Dag and Latamber.

Morphology:
Habit: A perennial herb (Fig. 1).
Leaves: Leaves simple, opposite and stipulate.
Stem: Herbaceous and branched.
Roots: Deep and tape roots.
Inflorescence: Spike.
Flower: The flowers white and bisexual, Fruit capsule. Seeds with irregular shape and small.

Anatomical Description: Transverse sections of leaf, stem and roots showed the following features (Fig. 58).

Leaf: Beneath the epidermis. Photosynthetic mesophyll tissues which consists of Palisade and spongy tissues clear. Vascular bundles in rings. Water conserving tissues arround the vascular bundles (Fig. 2) were presented behind the vascular bundles.

Stem: A cuticle layer around the epidermis. Beneath the epidermis, parenchymatous cortex. Endodermis clear. Vascular bundles numerous and radial (Fig. 3).

Roots: Epidermis enclosing thick cortex. Vascular bundles many and radial, in several circles from pith towards the periphery (Fig. 4).

Vaucher Number: 3626

Botanical Name: *Rhazia stricta*
Local Name: Gandarye
Distribution: Banda Daud Shah, Bahadur Khel, Ahmad Abad, Chukara, Hujaki.

Morphology

Habit: The plant is herb (Fig. 5).
Leaves: Leaves simple, alternate and exstipulate.
Stem: Herbaceous and hard.
Roots: Tape branched roots. Roots spreading over and under the soil surface extensively.

Table 1: Systematic Classification of *Peganum harmala* Linn.

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Sapindales
Family	Nitrariaceae
Genus	*Peganum*
Species	*Harmala*
Botanical Name	*P. harmala*

Table 2: Systematic Classification of *Rhazia stricta* Decne.

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Gentianales
Family	Apocynaceae
Genus	*Rhazia*
Species	*Stricta*
Binomial Name:	*R.stricta*

Fig. 1: *Peganum harmala*

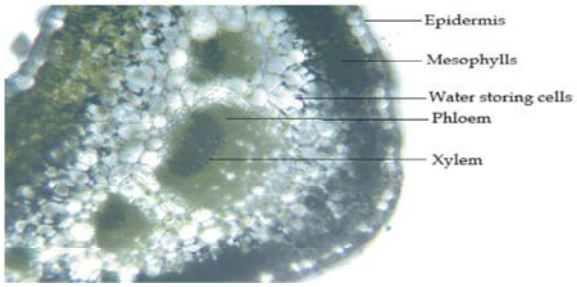

Fig. 2: Transverse section of leaf of *Peganum harmala*

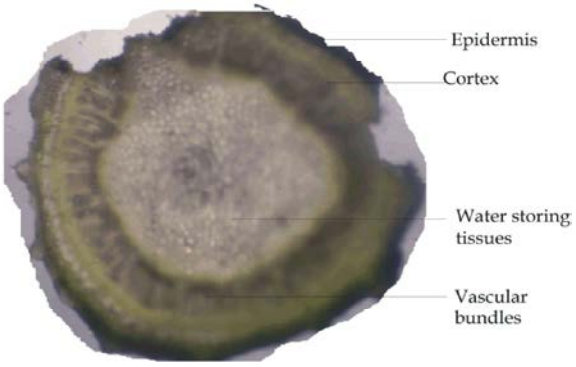

Fig. 3: Transverse section of stem of *Peganum harmala*

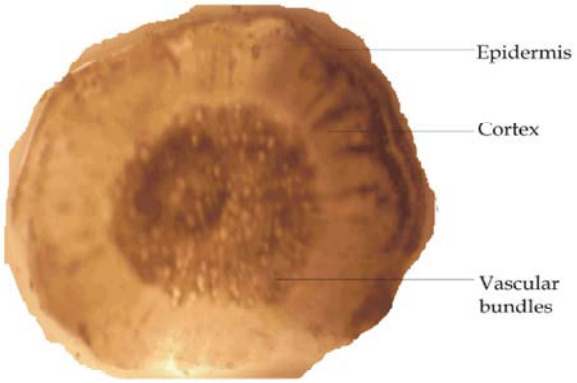

Fig. 4: Transverse section of root of *Peganum harmala*

Fig. 5: *Rhazia stricta*

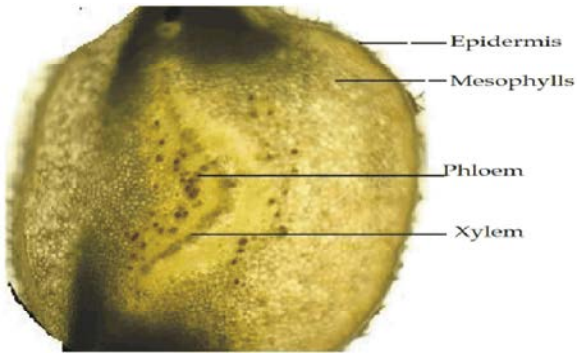

Fig. 6: Transverse section of leaves *Rhazia stricta*

Inflorescence: Cymose.
Flower: Regular, bisexual, white and actinomorphic. Fruit, small capsule. Seeds small and rounded.

Anatomical Description: Transverse sections of leaf, stem and roots show the following anatomical features.

Leaf: The outer layer epidermis,. Mesophyll tissues, clear. Xylems and phloems around each other. Arround the vascular tissues, water storing cells (Fig. 6).

Stem: A cuticle layer around the epidermis. Beneath the epidermis, collenchymatous cortex is found. The pericycle in zigzag shape due to intense dry environment (Fig. 7).

Table 3: Systematic Classification of *Ricinus communis* L.

Kingdom	Plantae
Division	Angiospermsae
Class	Dicotyledoneae
Order	Malpighiales
Family	Euphorbiaceae
Genus	*Ricinus*
Species	*Communis*
Binomial Name	*R. communis*

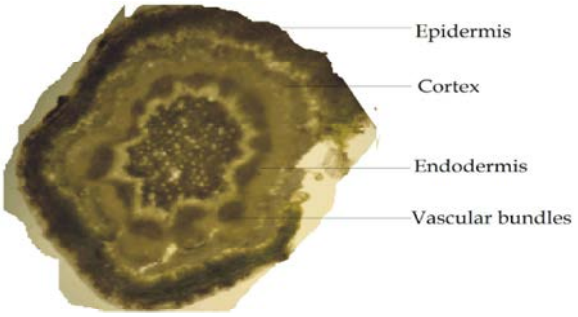

Fig. 7: Transverse section of stem of *Rhazia stricta*

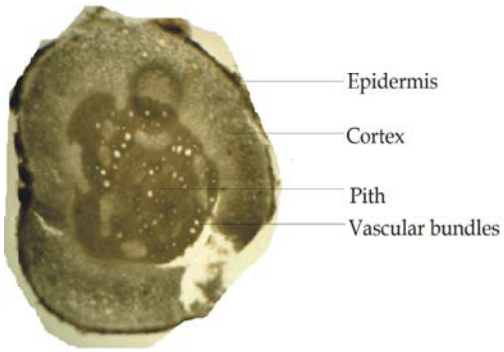

Fig. 8: Transverse section of root of *Rhazia stritca*.

Roots: Thick epidermis enclosing the cortex. Cortex with dense parenchymatous tissues. Vascular bundles radially arranged in the central zone. Protoxylems and metaxylems clear (Fig. 8).

Vaucher Number: 3627

Botanical Name: *Ricinus communis*
Local Name: Rand.
Distribution: Common throughout the area.

Morphology

Habit: *R.communis* is a shrub. (Fig. 9)
Roots: Tape roots, branched and deep.
Stem: Stems succulent and herbaceous.
Leaves: Leaves alternate, palmately compound and lobed at margins.

Fig. 9: *Ricinus communis*

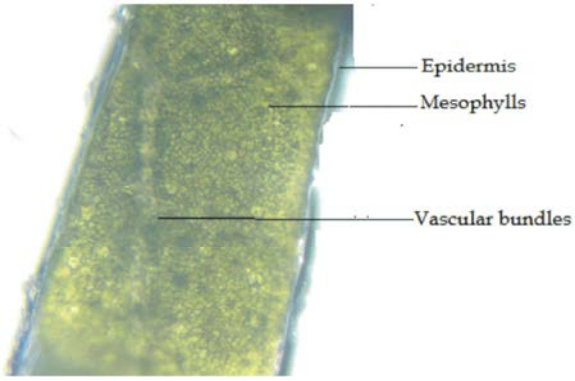

Fig. 10: Transverse section of leaf of *Ricinus communis*

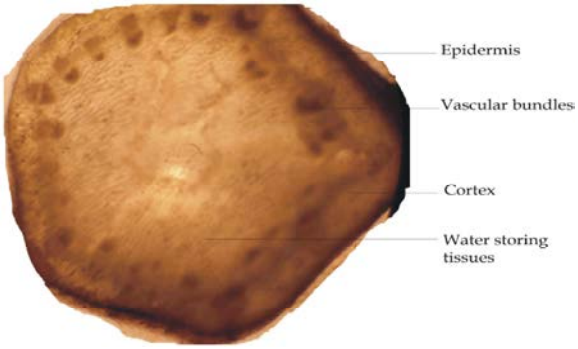

Fig. 11: Transverse section of stem of *Ricinus communis*

Flower and Inflorescence: Flowers monoecious, numerous in long inflorescences. Male flowers at the base and female flowers at the top. Flower colour red. Fruit, globose capsule. Seeds, oval.

Anatomical Description: Transverse sections of leaf, stem and root show the following anatomical features.

Leaf: First row of cells, epidermis below which paranchymatous mesophyll tissues are found. Vascular bundles clear (Fig. 10).

Stem: A cuticle layer around the epidermis. Beneath the epidermis, parenchymatous cortex. Endodermis and vascular tissues clear. Large pith in the center (Fig. 11).

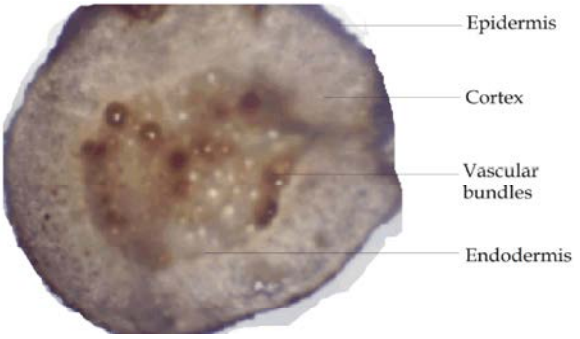

Fig. 12: Transverse section of root of *Ricinus communis*

Table 4: c Classification of *Salvadora oleiodes* Decne

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Brassicales
Family	*Salvadoraceae*
Genus	*Oleoids*
Botanical Name	*S.oleoids*

Roots: Cuticle layer enclosing the epidermis. Cortex compact and parenchymatous. Radial vascular bundles.Large parenchymatous pith retaining moisture (Fig. 12).

Vaucher Number: 3628

Botanical Name: *Salvadora oleoides*
Local Name: Plamu
Distribution: Ahmad Abad, Chukara, AmberiKela, Hamidan Banda, BahadurKhel, Banda Daud Shah, Soor Dag and Latamber.

Morphology

Habit: A small tree with drooping branches (Fig. 13).
Leaves: Leaves linear or ovate, fleshy, simple and opposite.
Stem: Short woody trunk with numerous branches.
Roots: The roots are branched and deep in soil.
Inflorescence: Spike.
Flower: Flowers sessile, greenish-white, minute often clustered. Fruit berry. Seeds rounded.

Anatomical Description: Transverse sections of leaf, stem and roots showed the following anatomical features.

Leaf: Outer layer epidermis.. Mesophyll tissues performing function of photosynthesis. Vascular bundles are in rings (Fig. 14).

Fig. 13: *Salvadora oleoides*

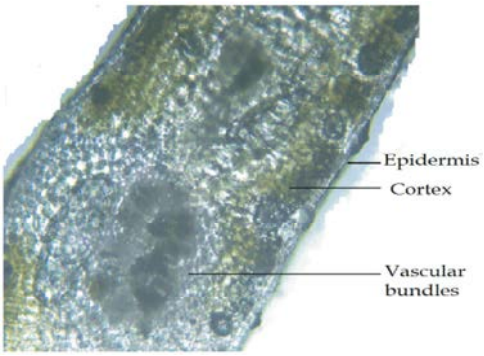

Fig. 14: Transverse section of leaf of *Salvadora oloides*

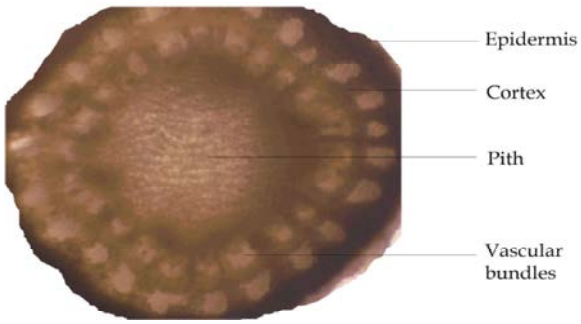

Fig. 15: Transverse section of stem of *Salvadora oleoides*

Stem: In the stem of *S. oleoides,* cuticle layer around the epidermis. Beneath the epidermis, parenchymatous cortex is found. Vascular bundles in two rows. Large pith performing the function of storage (Fig. 15).

Roots: Cuticle layer enclosing the epidermis. The cortex with compactly arranged parenchymatous cells. Vascular bundles clear. Large parenchymatous pith is present (Fig. 16).

Vaucher Number: 3629

Botanical Name: *Solanum surattense*
Local Names: Maragonye
Distribution: Commen throughout the area.

Table 5: Classification of *Solanum surattense* Burm. F

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Cucurbitales
Family	Solanaceae
Genus	*Solanum*
Species	*Surattense*
Botanical Name	*S. surattense*

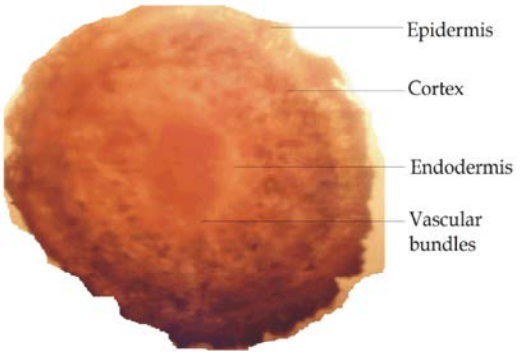

Fig. 16: Transverse section of root of *Salvadora oleoides*

Fig. 17: *Solanum surattense*

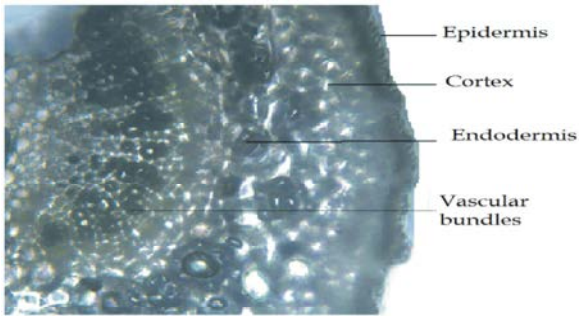

Fig. 18: Transverse section of leaf of *Solanum surattense*

Morphology

Habit: A spiny herb (Fig. 17).
Leaves: Alternate, simple, exstipulate and hairy.
Stem: Herbaceous, spiny and hairy.
Roots: Tape roots and branched.
Inflorescence: Auxiliary cyme.
Flower: Purple, bisexual and regular. Fruit, small achene. Seeds, small and rounded.

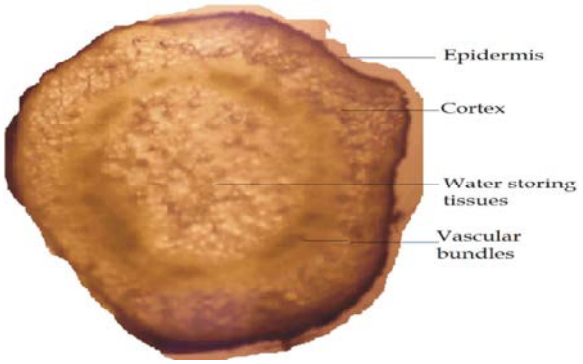

Fig. 19: Transverse section of stem of *Solanum surattense*

Anatomical Description: Transverse sections of leaf, stem and roots showed the following features.

Leaf: The first row of cells epidermis, below which wide cortex is found. Endodermis occuring after the cortex. Radial vascular bundles clear. Water retention and conservation, tissues are many in number (Fig. 18).

Stem: Epidermis the first layer of cells. The paranchymatuos cortex store large amount of water. Vascular bundles radially arranged. Pith large and parenchymatous (Fig. 19).

Roots: Epidermal layer with closely elongated cells. Thick parenchymatous cortex stores profound amount of water. Vascular bundles radial, protoxylems towards the centre and metaxylems towards the cortex (Fig. 20).

Vaucher Number: 3634

Botanical Name: *Solanum xanthocarpum*
Local Names: Tharhamara.
Distribution: Common in the area.

Morphology

Habit: A perennial herb (Fig. 21).
Leaves: Leaves rough, simple and lobed at margins.
Stem: Stems branched, rough and angular.
Roots: Fleshy, tape roots, long and branched.
Flower: Flowers monoecious, solitary. Colour creamy. Fruit achene. Seeds, rounded, many and small.

Anatomical Description: Transverse sections of leaf, stem and roots showed the following features.

Table 6: Systematic Classification of *Solanum xanthocarpum* L.

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Cucurbitales
Family	Solanaceae
Genus	*Solanum*
Species	*xanthocarpum*
Botanical Name	*S. xanthocarpum*

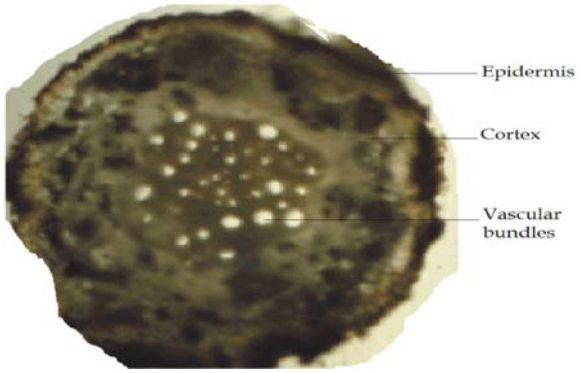

Fig. 20: Transverse section of root of *Solanum surratens*

Fig. 21: *Solanum xanthocarpum*

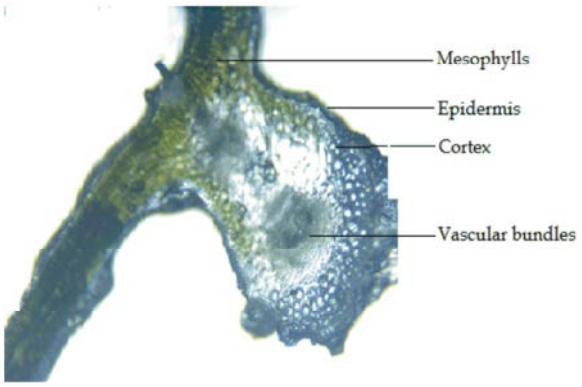

Fig. 22: Transverse section of leaf of *Solanum xanthocarpum*

Leaf: Epidermis, consist of closely elongated cells. Thick collenchymatous layer. Beneath the collenchymatous layer, vascular bundles are found (Fig. 22).

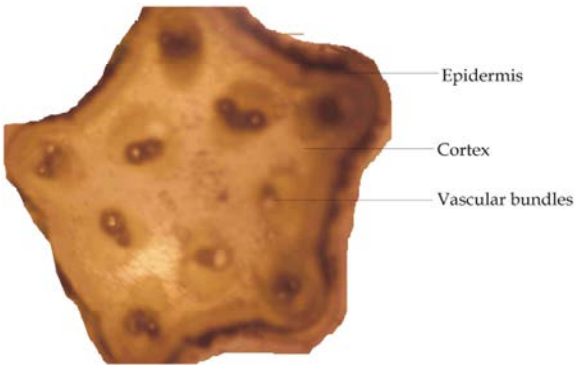

Fig. 23: Transverse section of stem of *Solanum xanthocarpum*

Fig. 24: Transverse section of root of *Solanum xanthocarpum*

Stem: The epidermal layer covering the cortex. The paranchymatuos cortex stores large amount of water. Vascular bundles arranged in rings (Fig. 23).

Roots: Epidermis around the cortex. Vascular bundles in circles showing high capacity of water conduction (Fig. 24).

Vaucher Number: 3630

Botanical Name: *Tamarsix aphylla*
Local Name: Ghaz.
Distribution: Ahmad Abad, Chukara, Hamidan Banda, Bogara, Musakan Banda, TakhteNusrati, Chukara, MitaKhel, Sabir Abad, Soor Dag and Latamber.

Morphology

Habit: A branched tree (Fig. 25).
Leaves: Leaves simple, elongated, needle like, alternate and ensheathing.
Stem: Erect trunk, with many spreading branches. Bark thick and deeply furrowed into long, narrow and hard ridges.

Table 7: Systematic Classification of *Tamarix aphylla* (Linn.) Karst

Kingdom	Plantae
Division	Angiospermae
Class	Monocotyledoneae
Order	Caryophllales
Family	Tamaricaseae
Genus	*Tamarix*
Species	*Aphylla*
Botanical Name	*T.aphylla*

Fig. 25: *Tamarix aphylla*

Roots: Roots deep and branched.
Inflorescence: Racemose.
Flower: Flowers many, stalkless, whitish-pink. Fruit, a small capsule. Seeds, many and rounded.

Anatomical Description: Transvers sections of leaf, stem and root of *T. aphylla* are shown as under.

Leaf: Epidermis composed of elongated cells. It covering the cortex composed of mesophyll tissues. Water storing tissues are many in number. Vascular bundles, in rings (Fig. 26).

Stem: Thick epidermis. Cortex, thick and composed of parenchymatous cells. Vascular bundles, radially arranged from centre towards the periphery. Pith large and clear (Fig. 27).

Roots: Epidermal layer consist of closely elongated cells. Thickparenchymatous cortex. Vascular bundles arranged radially, protoxylem towards the centre while metaxylem towards the cortex. Pith, clear (Fig. 28).

Vaucher Number: 3631

Botanical Name: *Tribulus terrestris*
Local Names: Malkondye
Distribution: Ahmad Abad, Chukara, AmberiKela, Musakan, Hamidan Banda, MitaKhel, Musakan, Hujaki, Tatar Khel, Mambati and Gardi Banda.

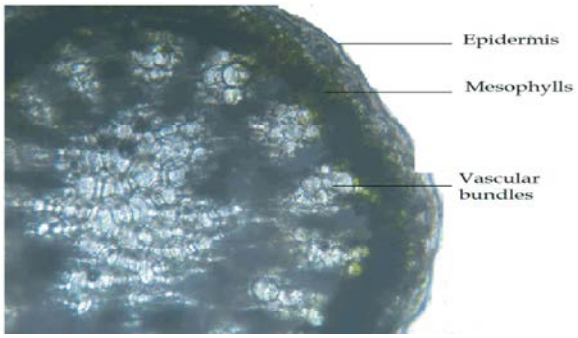

Fig. 26: Transverse section of leaf of *Tamarix aphylla*

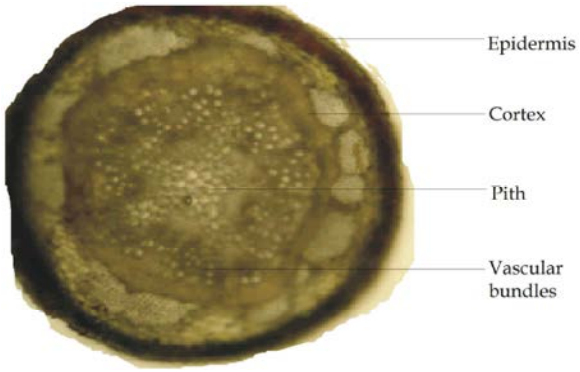

Fig. 27: Transverse section of stem of *Tamarix aphylla*

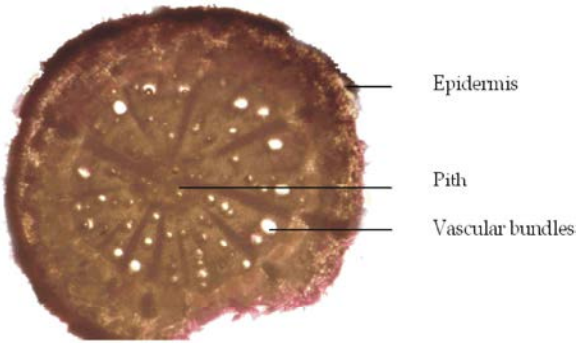

Fig. 28: Transverse section of root of *Tamarix aphylla.*

Morphology

Habit: An herbaceous perennial plant (Fig. 29).
Roots: Fibrous and adventitious.
Stem: The stem prostrate and branched.
Leaves: Leavespinnately compound.
Inflorescence and Flower: Recemose. Flowers yellow. Seeds, rounded and small.Four or five single-seedednutlets.

Anatomical Description: Transverse sections of leaf, stem and roots showed the following features.

Fig. 29: *Tribulus terrestris*

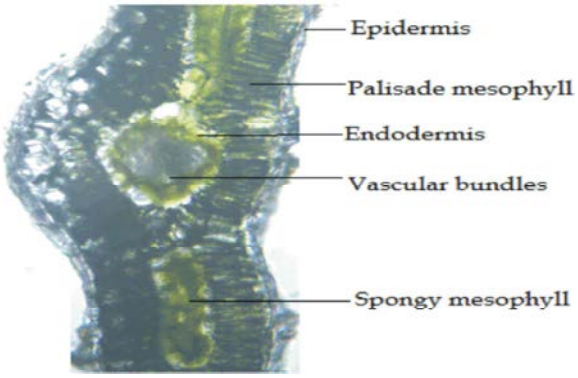

Fig. 30: Transverse section of leaf of *Tribulus terrestris*

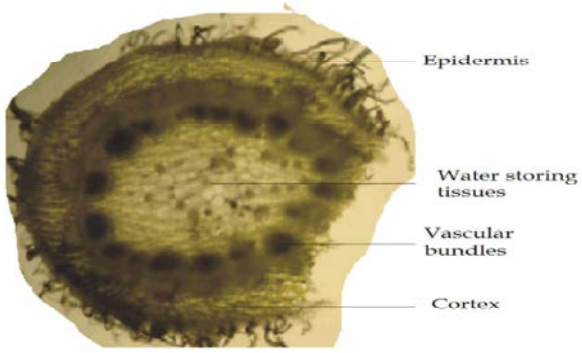

Fig. 31: Transverse section of stem of *Tribulus terrestris*

Leaf: The outer layer epidermis composed of rectangular cells. Below the epidermis, mesophyll tissues are found. Firstly, the elongated palisad mesophyll cells are found and then spongy mesophyll cells. These tissues performing the function of photosynthesis.Endodermis enclosing the vascular bundles (Fig. 30).

Stem: A cuticle layer around the epidermis. Beneath the epidermis, parenchymatous cortex. Endodermis clear. Vascular bundles numerous and in the form of ring (Fig. 31).

Fig. 32: Transverse section of root of *Tribulusterrestris*

Fig. 33: *Withania coagulans*

Roots: Epidermis around the cortex. Compact cortical zone. Vascular bundles arranged radially (Fig. 32).

Vaucher Number: 3632

Botanical Name: *Withania coagulans*
Local Names: Shapianga.
Distribution: Found in the hilly parts of the area.

Morphology

Habit: Branched shrub (Fig. 33).
Leaves: Leaves ovate, leathery and petiolate.
Stem: Branched and shrubby.
Roots: Brenched and deep in the siol.
Flower and Inflorescence: Bisexual and yellowish. Female flowers anthers smaller than in male flowers. Fruit, berry globose. Seeds, brown and irregular shaped.

Anatomical Description: Transverse sections of leaf, stem and roots show the following features.

Table 8: Systematic Classification of *Tribulus terrestris* L.

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Order	Zygophyllales
Family	Zygophyllaceae
Genus:	*Tribulus*
Species	*Terrestris*
Botanical Name	*T. terrestris*

Table 9: Systematic Classificatrion of *Withania coagulans* Dunal

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledoneae
Family	Solanaceae
Genus	*Withania*
Species	*Coagulans*
Botanical Name	*W.coagulans*

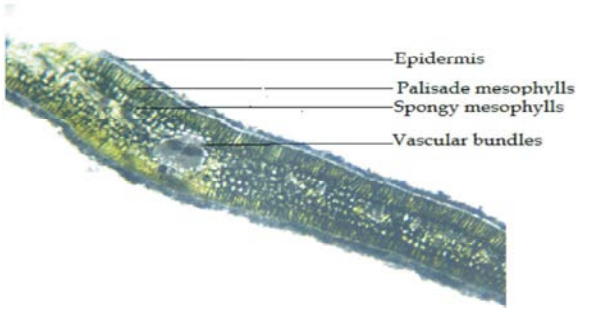

Fig. 34: Transverse section of leaf of *Withania coagulans*

Fig. 35: Transverse section of stem of *Withania coagulans*

Fig. 36: Transverse section of root of *Withania coagulans*

Leaf: Beneath the cuticle, epidermis. Parenchymatous and mesophyll tissues clear. The elongated tissues palisade mesophylls while the rounded and irregular tissues, spongy mesophylls. These tissues, performing the function of photosynthesis. Vascular bundles in the form of ring (Fig. 34).

Stem: A cuticle layer around the epidermis. Epidermal cells compact and rectangular. Beneath the epidermis, wide parenchymatous cortex. Endodermis clear. Vascular bundles many in number and in the form of rings (Fig. 35).

Roots: Thick epidermis enclosing the cortex. Cortex comprising of dense parenchymatous cells. The cortical parenchyma stores large quantity of water. Vascular bundles arranged in the central zone (Fig. 36).

DISCUSSION

During the present study, xerophytes of district Karak were studied for their morphological and anatomical features.

Among all the plants studied, *Solvadora oleoides* showed special features morphologically and anatomically.

S. oleoides was observed as a small erect tree with drooping branches, exceeding a height of 6-9m, short trunk, stiff and swollen at the nodes. Bark grey, stem branched and roots long. Leave simple, opposite, linear, or ovate. Flowers complete and white. Seeds rounded and small. The epidermis of stem and leaf enclosed by cuticle layer, compact parenchymatous cortex, radial vascular bundles and large pith. All the characters were, as in the case of previous studies. However, the present study do not concide with the previous work of Qureshiand khan (1972) [16], who reported that the fruit of *S.oloides* in white colour. Fruit colour was white perhaps due to genetic variation.

Anatomically of the *S.oloides* and plant has trichome and salt storing tissues because of salty habitat. In leaf, there were certain appendages which help the plant to secrete excess quantity of salt from the main body and are called as trichomes (Marcum and Murdoch, 1994) [17].

Ricinus communis, a branched shrub up to 5 feet. tape roots, tetrarch condition, stem succulent, leaves alternate, palmately compound, male and female flowers, red, seeds, ovate. Cuticle on epidermis, pericycle in ring, wide cortex, radial vascular bundles, tetrarch and many in number. Wahid (2003) [6] worked on the ecomorphology

of the *R. communis* and stated that *R. communis* present in dry regions has less calcium, potassium and proteins than the species of other regions due to soil composition and some other factors.

*Peganum harmala*a perennial herb with deep tape roots. Stem herbaceous and branched.Leaves simple, opposite and stipulates. Inflorescence spike.flowers white and bisexual. Seeds with irregular shape.A layer of cuticle on epidermis. Parenchymatous and sclernchymatous cortex. Radial and numerous vascular tissues. Koyuncu *et al.,* (2008) [18] reported the presence of thick cuticle on the leaves surface of *P. harmala* but in the present study, the cuticle was thin as district Karak is dry and sandy area but not a typical desert. There is a more humidity and variable rainfall ratio than the aforementioned studied area.

Anatomically, results of the present study are agreement with the report of other workers Koyuncu*et al.,* (2008) [18] stated that sclerenchyma cells are present in lower cortex which provides resistance in the dry condition.Vascular bundles were radially arranged in several circles from pith towards the periphery. Whole of the root section was covered by vascular bundles.

Rhazia stricta is an erect branched shrub. Roots long branched, leaves, leathery, simple, peteolated. Stem, smooth. Inflorescence cymose. Flowers white, regular, bisexual and actinomorphic. Seeds rounded. Thick cuticle on epidermis, wideparenchymatous cortex, pericycle in zigzag shape, numerous radially vascular bundles. Protoxylems and metaxylems, clear. The results of the present study are agreement with Jafri (1966) [15]. He reported that *R. stricta* is an erect shrub with leathery, sessile leaves and white flowers. *R. stricta* has semi erect branches and central smooth stem. Wide cortical region and numerous vascular tissues are present. These findings supports our study.

Tamarix aphylla is a tree with deep and extensive roots. Stem erect and spreading. Bark grey-brown and rough. Leaves green, alternate, reduced to tiny scales. Flowers many, stalkless and whitish-pink. Seeds many and rounded. Anatomically, epidermal layer is found. Thick cortex composed of parenchymatous cells. Vascular bundles, radial. Pith present.

Wahid (2003) [6] reported that *T. aphylla* has smaller leaves, thick cuticle and waxes. These are all important adaptations of *T. aphylla*to conserve water and to reduce loss of water. Hameed *et al.,* 2010 [7] stated that salt glands are present in the leaves epidermal layer. Hameed *et al.,* [7] discussed that the salt glands are present in the *T. aphylla* due to environmental conditions of saline habits of halophytes. The salt glands store the salt and secrete it through trichomes.

Solanum surattense spiny herb, tape roots, long and branched. Stem runner herbaceous, spiny and hairy. Leaves alternate, simple, extipulate and hairy. Flowers purple colored. Inflorescence cyme. Seeds rounded. Epidermis, the outermost layer. Leaves have amphistomata. Paranchymatuos cortex.Radial vascular bundles.Pith, parenchymatous.

The results of present studies are supported by Wahid (2003) [6]. Who discussed the morphological characters of *S. surattense.* Who, added that *S. surattense* is a prostrate herb having spines on stem and leaves. Spines are thought to be reduced leaves. It is an adaptation to xeric environment in order to minimize water loss and protect the plant from drying. Its flowers are white in colour. The results of present studies are similar with Hameed *et al.* 2011 [19], who reported the morphology of leaves, stem and roots of *S.surattense*. According to their study, amphistomatal types is found. They are present at both surfaces of leaves. Vascular bundles are many in number.

Tribulus terrestris a perennial prostrate herb, roots fibrous and adventitious.Leaves, pinnately compound. Flowers, yellow coloured, seeds rounded. Cuticle, above epidermis. Stomata, anomocytic. Wide parenchymates cortex. Pericycle, found.

The results of the present studies have similarity with the results of Arshad *et al.,* [8] who studied the morphology of *T. terrestri* and stated that it has compound leaves, prostrate branches and yellow flowers. Prostrate branches creep at the surface of the ground to prevent the lower parts of the plant from direct intense sun light. Similarly, compound leaves reduce the leaf surface area to decrease the more loss of water. These are the adaptations to dry environment. The present studies have similarties with the results of Perveen *et al.,* (2007) [20] who reported that the stomata of *T. terrestris*as anomocytic.

Solanum xanthocarpum a perennial prickly herb,stem angular and rough. Roots fleshy. Leaves simple and rough. Flowers creamy, monoecious and solitary. Seeds rounded or irregular. Epidermis the outermost layer, thick cortex, xylems around the pith. Rita and Animesh (2011) [21] reported the morphological characters of *S. xanthocarpum.* They stated that it is a prickly, perennial herb, stem profusely branched. However, the results of present studies do not agree with Rita and

Animesh (2011) [21] with respect to profuse branching of *S. xanthocarpum*. Profusely branched body is another type of adaptation to xeric condition. Extensive branches make a net to store water and prevent the plant from drying.

Withania coagulance a branched shrub, stem rigid, tape roots long and branched. Leaves ovate, acute and leathery. Flowers, cream coloured and bisexual. Seeds, rounded or irregular. Anatomically, first layer epidermis, cuticle present on the epidermis. Wide parenchymatous cortex. Endodermis found. Ringed pericycle.

Hameed *et al.*, [19]. The cortex was wide. Morphologically the present studies are agreement with Anderson *et al.,* [22]. They reported the morphological characters of *W. coagulance.* They stated that it has branched roots system, ovate leaves and stem with furrows. Branched roots are an adaptation to dry environment. They grow deep and can absorb water to prevent the plant from drying.

In short, the findings of present study are agreement with the previous reports. However, some differences in adaptations and modifications were also observed in few cases. Overall the plants were found well adapted to harsh climatic condition of the study area.

REFERENCES

1. Bahaji, A., I. Mateu, A. Sanz and M.J. Cornejo, 2002. Common and distinctive responses of rice seedlings to saline- and osmotically-generated stress. Plant Growth Regul., 38: 83-94.
2. Colom, M.R. and C. Vazzana, 2002. Water stress effects on three cultivars of *Eragrostis curvula*. Ital. J. Agron., 6(2): 127-132.
3. Dawar, S., S. Khaliq and M. Tariq, 2010. Comparative effect of plant extract of *Datura alba* for the control of root rots disease of Cow Pea and Okra. Pak. J. Bot., 42(2): 1273-1279.
4. Iqbal, M. and A.K.M. Ghouse, 2008. Anatomy of the vascular cambium of *Acacia nilotica* (L.) Del. var. teliatroup (Mimosaceae) in relation to age and season. Botanical Journal of the Linnean Society, 94(3): 385-397.
5. Hosseini, R. and M. Parsa, 2007. Micropropagation of *Aloe vera* L. grown in South Iran. Pak. J. Biol Sci., 10: 113-47.
6. Wahid, A., 2003. Physiological significance of morpho-anatomical features of xerophytes. Journal of Biological Sciences, 2: 207-212.
7. Hameed, M., M. Ashraf, M.S.A. Ahmad and N. Naz, 2010. Structural and functional adaptations in plants for salinity tolerance. In Plant Adaptation and Phytoremediation, pp: 151-170. Springer Netherlands.
8. Arshad, M., A. Hussn, M. Yasin, S. Ashraf Noureen and M. Moazzam, 2008. Factors and distribution of vegetation in the Cholistan desert, Pakistan. Pak. J. Bot., 40(5): 1923-1931.
9. Islam, S., M. Rubina, P. Abid and M. Qaiser, 2008. Anther types of dicots within flora of Karachi. Pak. J. Bot., 40: 33-41.
10. Marwat, S.K., M.A. Khan, M. Ahmad, M. Zafar, A. Farooq and A. Nazir, 2009. Taxonomic studies of nodulated leguminous weeds from the flora of Northwestern part (Dera Ismail Khan) of Pakistan. African Journal of Biotechnology, 8: 2163-2168.
11. Phillips, S.J. and P.W. Comus, (Eds.) 2009. A Natural History of the Sonoran Desert. Arizona-Sonora Desert Museum Press, Tucson and University of California Press, Berkeley.
12. Gostin, I.N., 2011. Anatomical and micromophological peculiarities of Ranunculaceae. Pak. J. Bot., 43: 811-820.
13. Nazir, A., A.M. Khan, F. Ahmad, K. Ullah and A. Sha, 2013. Foliar epidermal studies as an aid to the identification of grasses of tribe Andropogoneae (Poaceae) from Potohar region of Pakistan. Pak. J. Bot., 45(SI): 235-241.
14. Tiwari, S., P. Kumar, P. Yadav and D.M. Chauhan, 2013. Comparative morphological, epidermal and anatomical studies of *Pinus roxburghii* needles at different altitudes in the North-West Indian Himalayas, Turk. J. Bot., 37: 65-73.
15. Jafri, S.K.H., 1966. The Flora of Karachi.The Book Corporation Karachi, pp: 246-247.
16. Qureshi, S. Khan, 1972. Flora of West Pakistan ABS, Corporation, university of Karachi, 29: 1-4.
17. Marcum, K.B. and C.L. Murdoch, 1994. Salinity tolerance mechanisms of six C4 turfgrasses. Journal of the American Society for Horticultural Science, 119(4): 779-784.
18. Koyuncu, O., D. Ozturk, D.P. Erkara and A. Kaplan, 2008. Anatomical and palynological studies on economically important *Peganum harmala* L., (Zygophyllaceae). Biology Diver Conservation Bio Diversity, 20: 108-115.
19. Hameed, I., F. Hussain and G. Dastagir, 2008. Stomatal studies of some selected medicenal plants of Polygonaceae. Pakistan Journal of Botany, 40(6): 2273-2280.

20. Perveen, A., A. Rubina and F. Rabab, 2007. Stomatal types of some dicots within flora of Karachi, Pakistan. Pakistan Journal of Botany, 39(4): 1017-1023.
21. Rita, P. and D.K. Animesh, 2011. An updated overview on Solanum xanthocarpum schrad and wendl. International Journal of Research in Ayurveda and Pharmacy, 2(3): 730-735.
22. Anderson, G.J., G. Bernardello, M.R. Opel, A. Santos-Guerra and M. Anderson, 2006. Reproductive biology of the dioecious Canary Islands endemic *Withania aristata* (Solanaceae). American Journal of Botany, 93(9): 1295-1305.