

EFFECT OF DIFFERENT SOIL ENVIRONMENTS ON THE BRACT ANATOMY OF CYPERUS SPECIES FROM DIFFERENT AREAS OF PUNJAB PAKISTAN

¹AAMIR MUMTAZ, ²AISHA TASEEN AND ²AMINA AMEER

¹ Government Post Graduate College Mianwali

² Department of Botany University of Agriculture Faisalabad
Corresponding Author email: aamirkazmi038@gmail.com

خلاصہ

پودوں میں پائی جانے والی تبدیلیوں کا انحصار اندرونی و بیرونی عوامل پر پایا جاتا ہے۔ مندرجہ ذیل تحقیق سائبرس کی بریکٹ پر کی گئی۔ پنجاب میں پائے جانے والے اس پودے کی بریکٹ کے مختلف حصوں کا بغور جائزہ لیا گیا۔ مقامی حالات سے جڑے بریکٹ اندرونی حصوں میں جو تبدیلیاں رونما کی گئی تھیں ان کی تفصیل اکٹھی کی گئی۔ اور یہ بات نوٹ کی گئی کہ بریکٹ کی نشوونما کا انحصار زیادہ تر مقامی حالات پر ہوتا ہے۔

Abstract

Sedges, in the family Cyperaceae, are ranked as a third leading family of monocots after Poaceae and Orchidaceae. They are annuals, generally perennial, stoloniferous or rhizomatous herbs. Family members of Cyperaceae can adapt different habitats like extreme aridity, high altitude, extreme salinity, swamps, moist areas, marshes, and steep slopes. *Cyperus* is the largest genus of this family and is distributed throughout the world including desert or semi-desert regions. The most common species of this genus are abundantly found in the Northern hemisphere, in the temperate region. In Pakistan, Family Cyperaceae has different species distributed in different habitats all over Punjab including sub-mountainous scrub forests, desert and semi-deserts, Indus plains, and riverine/bela forests. Modifications in anatomical characteristics were studied in each population which showed its adaptability for different environmental situations. In this study, we have investigated the bract anatomy of various species of *Cyperus* collected from different regions of Punjab and different parameters of the bract were measured for this purpose. Our observations showed various anatomical modifications in the bract of *Cyperus* species growing in different soil conditions of Punjab.

Introduction

Cyperaceae is a widely distributed family of angiosperms and plays a dominant role in wetland vegetation. It contains 70 genera and 4000 species, found all over the world. The members of the family Cyperaceae have so many reductions and convergences in the inflorescences that result in inhibition of evolutionary reconstruction and classification (Archer & Balkwill, 2012). Sedges grow in different types of habitats like hyper-saline waters, soil with lot of unhealthy material dry land salinities; however, many are associated with moist areas, or with poor soils. They are herbs in nature and can be used for various agricultural purposes. Sedges are aquatic plants, annual or perennial, and grow in water to about 0.2 cm in length (Barrett, 2013). Cyperaceae is commonly called the sedge family and plants of this family are herbs giving a significant environmental variation from sea level to high altitude. Sedges can play an important role in the food web, and also help in recycling nutrients and produce food by consuming energy for the consumers similar to the animals that are dependent on other higher animals and decomposers (Nagels *et al.*, 2009). Among them, there are very useful natural herbs, also used as food additives, fibers, animal poison foods, drinks, and some also play a role in the manufacture of medicines, paper, mats, boats, perfumes, ropes, roofing, clothing, and shoes. Mostly animals and wildlife feed on the foliage from tubers and seeds of sedges (Bryson & Carter, 2008).

At the tropics and subtropics level, *Cyperus* belongs to the largest genus in the family Cyperaceae. Based on their anatomical modifications, *Cyperus* is divided into two sub genera, one that contains kranz anatomy with C₄ photosynthesis while another genus possesses C₃ type of photosynthesis and without Kranz anatomy. The distinct feature of *Cyperus* is spike lets. In this genera, the morphological characters such as the spiral arrangement of glumes, pleiomorphic trimerous and laterally and dorsoventrally flattened dimerous gynoeceum, etc. have already been analyzed using anatomical and ontogenetical techniques (Reutemann *et al.*, 2012).

The Cyperaceae family has a diverse nature and is widely distributed all over Pakistan ranging from plains to sandy mountainous areas of Sindh, Punjab, Baluchistan, Gilgit Baltistan, Kashmir, and Khyber Pakhtunkhwa. In Pakistan, 22 genera and 179 species of this family have been studied. Among these, most of the species are weedy. In this paper, we have collected *Cyperus* species from various regions of the Punjab province that lies 69°18' to 75°23' east longitudes and 27°42' to 34°02' north latitude and is bordered by Sindh on the South and Khyber Pakhtunkhwa on the west and Baluchistan on the North. Geographically it covers around 20.63 million hectares and spreads 1078 km in length from north to south and 616 km in width from east to west (Khalid & Siddiqui, 2014).

The growth and anatomy of various parts of plants can be affected by soil structure. In plants, the comparison of the anatomical structure has significant role in determining their axonomy, ecology, and diversity of species. Modification in the anatomy of various plant organs is considered an adaptation to the habitat of certain species. So, it was an assumption that native members of family Cyperaceae must have adopted specific bract anatomical characteristics, which allow them to survive under adverse climatic conditions like salinity and drought in different soil regions of Punjab, Pakistan. The present investigation revealed the specified nature of bracts tissues and ecological diversity among other species.

Materials and Methods

Different surveys were conducted throughout the Punjab region including Faisalabad, Sahianwala, Rawalpindi, Sargodha, Murree, the Salt Range Nowshera, Khushab, Mianwali, Lahore, Jhang, and some other districts for the different types of Soils of Punjab. Anatomical features were measured by using an ocular micrometer under a compound microscope, which was calibrated with the help of a stage micrometer. During the investigation, anatomical characteristics of the bract anatomy, for example epidermis thickness and cell area, cortical cell area, the thickness of chlorenchyma and sclerenchyma, cell area of aerenchyma, vascular bundle, meta xylem and bulliform cell area, and cell area of phloem were studied.

FAA (formalin Acetic Acid) solution was used for material fixation containing 10% Acetic acid, 5% formalin, 50% ethyl alcohol, and 35 % distilled water. It can be used as a long-term preservative by adding acetic alcohol solution (25% acetic acid and 75% ethyl alcohol).

During the preparation of slides (transverse) double-stained standard technique was used. The following formula was used to evaluate the area of different cells and tissues (It was modified from the area of a circle, πr^2):

$$\text{Area} = \frac{\text{Maximum length} \times \text{Maximum width}}{28} \times 22$$

Statistical analysis

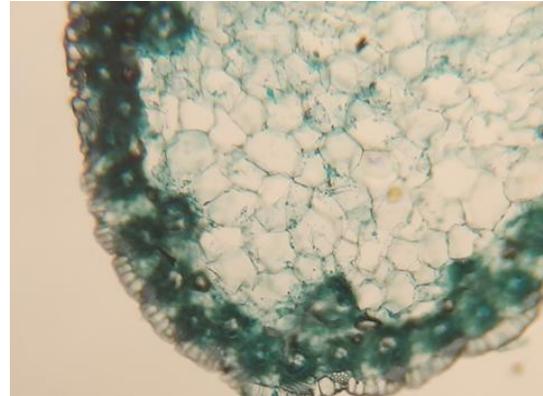
The data collected was analyzed statistically by using analysis of variance (ANOVA) technique.

Results and Discussion

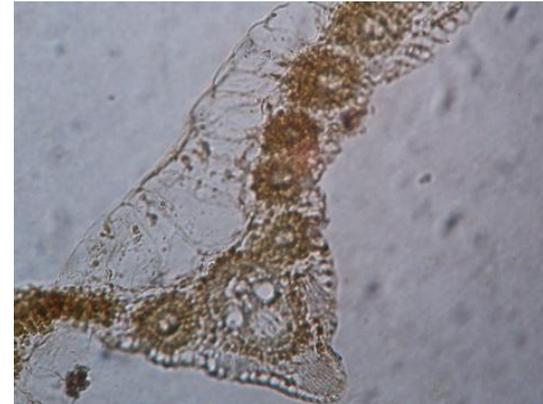
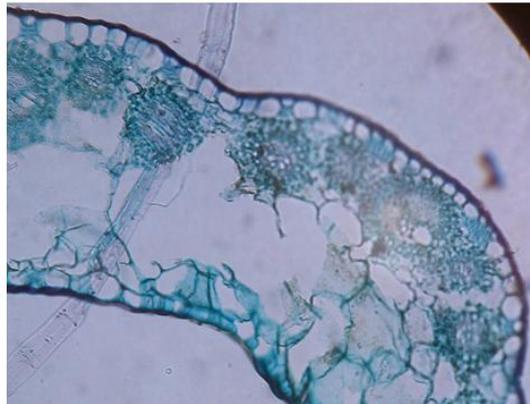
The *Cyperus* family covers a wide range of habitats from temperate forests, damp marshes, arctic tundra, old fields, and steep slopes (Stock *et al.*, 2004). Cyperaceae is a eudicot group that has morphological diversity, to the point of being “in definable. However, anatomical structures are of great significance in plant taxonomy, ecology, and other related branches of botany. Mostly, in the members of the family Cyperaceae, epidermal cells of adaxial side are much larger than those of abaxial side. The leaf and bract mid-region contains bulliform cells that are very well developed in most taxa (Hameed *et al.*, 2012). Vascular bundles seem to be of collateral type and bundle sheath is two layered structure. The first layer contains parenchymatous cells and the second layer is highly sclerified as well as fibrous. Most of the species of Cyperaceae contain Silica bodies (phytoliths) in the epidermal cells, whereas stomata are paracytic with two subsidiary cells lying parallel to the stomatal pore. Family Cyperaceae commonly have both C3 and C4 photosynthetic forms (Rocha & Martins, 2011). In C4 sedges, two different types of photosynthetic cells have been studied, the primary carbon assimilation cells (PCA), which are the basic counterpart of mesophyll tissues, and the photosynthetic carbon reduction cells (PCR), and also the basic twin to bundle sheath cells. Based on exceptional internal features, C4 sedges have been further divided into 4 types, which are based on the presence of parenchymatous bundle sheath layer or absence of them and the position of PCR tissue in leaves (Bidarlord *et al.*, 2018).

During the survey, we recorded maximum epidermal thickness in *Cyperus difformis* (38.82) collected from Jarhanwala which is followed by *Cyperus squarrossus* (33.28) collected from the head Rasool. However, *C.esculentus* (5.54) collected from Pakkaanna showed minimum epidermal thickness while other species were

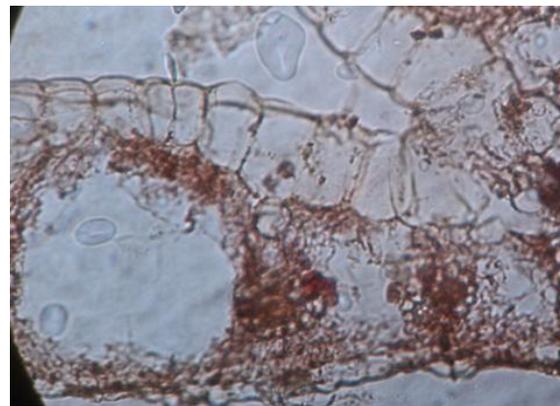
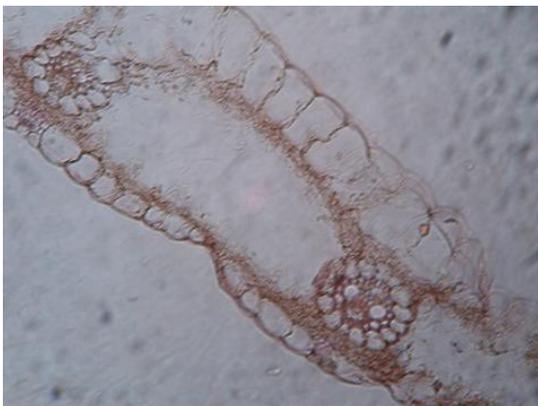
moderate in the thickness of their epidermis. Similarly, *Cyperus difformis* (1590.87) also showed a wide epidermal cell area. On the other hand, *Scirpus maritimus* (20.39) species collected from Khabeki lake showed minimum epidermal cell area. The rest of the collected species had a moderate epidermal cell area. *Cyperus glaber* (9939.59) collected from Head Rasool possesses maximum cortical areas while *C.haspans* (498.560) from Chiniot covered minimum cortical areas. *C.nutans* (90.13) collected from Chiniot demonstrated maximum chlorenchyma thickness followed by *Scirpus maritimus* (81.12) collected from Khabeki lake while *C. compressus* collected from Kalar kahaar showed minimum Chlorenchyma thickness (24.96). Here, *Cyperus glaber* (30299.22) collected from Head Rasool also possessed maximum aerenchymatous cell area. On the other hand, *C.longus* and *C.rotundus* showed minimum aerenchyma cell area (2266.21). *Cyperus squarossus* species (55.46) managed from Head Rasool recorded a maximum range of sclerenchyma thickness.



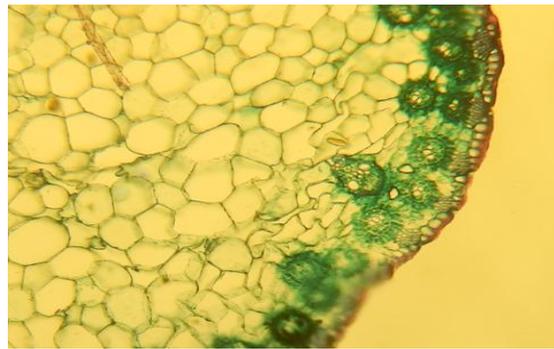
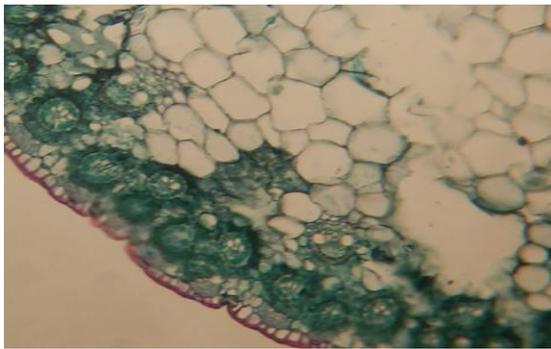
Cyperus alternifolius and *Cyperus laevigatus* (highly saline soil)



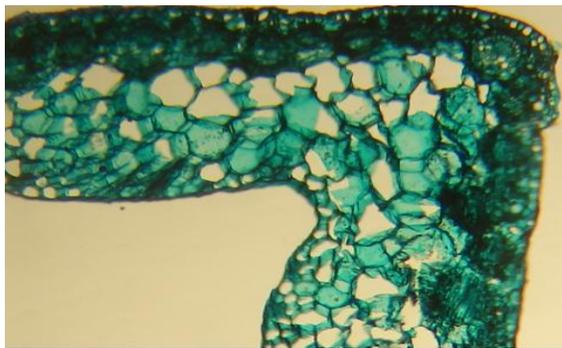
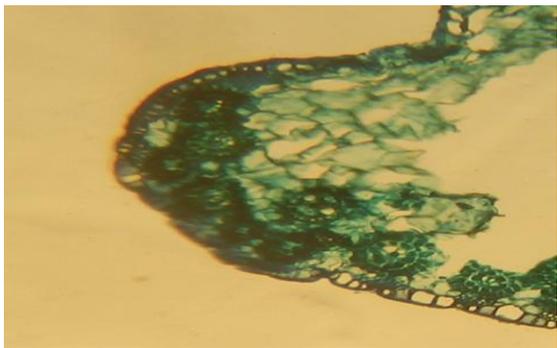
Cyperus esculentus and *Cyperus haspans*



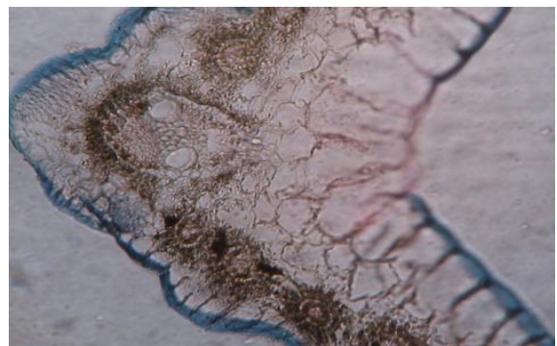
Cyperus longus and *Cyperus nutans*



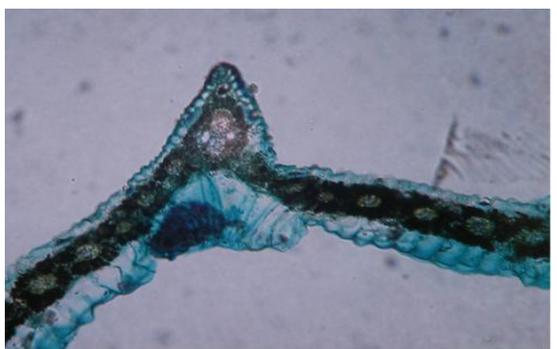
C. lavigatus bract (Head Rasool) *C. lavigatus* (Dry saline) Head Rasool



Cyperus laevigatus and *Cyperus glaber* (Wetland)



Cyperus rotundus and *Cyperus iria*



Cyperus alopecuroides and *Cyperus compressus*

Fig. Bract Anatomy of Various Species of Cyperus plants collected from the different soil regions of Punjab.

TABLE 1. STATISTICAL PARAMETERS OF BRACT ANATOMY

| Species | <i>C. Glaber</i> | <i>C. difformis</i> | <i>C. Squarossus</i> | <i>C. Iria</i> | <i>C. haspans</i> | <i>C. Longus</i> | <i>C. Lwet</i> | <i>C. Ldrysal</i> | <i>C. highly</i> | <i>C. Nutans</i> | <i>C. Alopercuroides</i> | <i>C. Rotundus</i> | <i>C. Compressus</i> | <i>C. Alternifolia</i> | <i>C. Escultantus</i> | <i>Scripusm aritimus</i> |
|---|------------------|---------------------|----------------------|----------------|-------------------|------------------|----------------|-------------------|------------------|------------------|--------------------------|--------------------|----------------------|------------------------|-----------------------|--------------------------|
| Bract anatomical parameters | | | | | | | | | | | | | | | | |
| Epidermal thickness (μm) | 33.28 | 38.82 | 33.28 | 16.64 | 12.48 | 13.86 | 12.48 | 12.4 | 15.25 | 19.41 | 13.86 | 13.86 | 13.86 | 13.86 | 5.54 | 6.24 |
| Epidermal cell area (μm^2) | 1359.72 | 1590.87 | 652.66 | 231.15 | 99.71 | 176.76 | 240.21 | 190.36 | 308.2 | 262.88 | 190.36 | 235.68 | 226.62 | 308.2 | 317.26 | 20.39 |
| Cortical cell area (μm^2) | 9939.59 | 5982.79 | 870.22 | 1255.48 | 498.56 | 1994.26 | 503.09 | 5008.32 | 3716.58 | 1531.95 | 2547.22 | 1046.98 | 0 | 0 | 956.34 | 0 |
| Aerenchyma cell area (μm^2) | 30299.22 | 24021.82 | 13234.66 | 0 | 0 | 2266.21 | 0 | 14050.5 | 8249 | 3308.66 | 0 | 2266.21 | 0 | 3943.2 | 7206.54 | 0 |
| Sclerenchyma thickness (μm) | 0 | 0 | 55.46 | 40.21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18.02 | 0 | 0 | 0 | 0 |
| Collenchyma thickness (μm) | 0 | 0 | 34.66 | 74.88 | 33.28 | 34.66 | 0 | 0 | 0 | 90.13 | 0 | 41.6 | 24.96 | 30.5 | 40.21 | 81.12 |
| Vascular bundle cell area (μm^2) | 17812.41 | 3553.41 | 2995.92 | 8838.21 | 1930.81 | 3612.33 | 736.51 | 7972.52 | 6798.62 | 1631.67 | 1631.67 | 2991.39 | 5552.21 | 8575.33 | 3848.02 | 2277.54 |
| Metaxylem area (μm^2) | 1196.55 | 226.62 | 281.01 | 362.59 | 163.16 | 244.75 | 371.65 | 339.93 | 140.5 | 326.33 | 657.2 | 276.47 | 185.82 | 199.42 | 176.76 | 0 |
| Phloem cell area (μm^2) | 172.23 | 67.98 | 27.19 | 135.97 | 95.18 | 1114.97 | 190.36 | 1550.08 | 743.31 | 63.45 | 36.25 | 131.44 | 81.58 | 45.32 | 40.79 | 27.19 |
| Bulliform cell area (μm^2) | 0 | 0 | 1445.84 | 5112.56 | 2850.89 | 1908.14 | 0 | 0 | 0 | 6127.83 | 0 | 1110.44 | 1531.95 | 0 | 0 | 0 |

Cyperus rotundus (18.02) collected from the University of Agriculture demonstrated minimum phloem cell area. *C. glaber* species (17812.41) also contained maximum variety of vascular bundles followed by *C. iria* (8838.21) collected from Gujranwala. Contrary to that, *C. nutans* and *C. alopecuroides* (1631.67) collected from Khari mural and balloki covered minimum vascular area.

In *Cyperus glaber* species (1196.55) there was also a maximum range of metaxylem cell area while *Cyperus laevigatus* (highly saline soil) (140.5) collected from Sahianwala covered minimum area. *Cyperus nutans* species (6127.83) collected from the Khari mural had the maximum bulli form cell area. Where as in *Cyperus rotundus* species (1110.44), collected from the University of Agriculture, the minimum area was recorded. *Cyperus laevigatus* (wetland region) species (1903.61) collected from Sahianwala possessed maximum phloem cell area while minimum phloem cell area was recorded in two species of *Cyperus squarossus* and *Scirpus maritimus* (27.19). Other species showed moderate cell areas. The table shows the statistical values of each parameter while figures demonstrate the bract anatomy of the species collected from different regions of Punjab.

Conclusion

Cyperus species have a diverse habitat that depends upon the various anatomical features in different plants. The type of soil is the main characteristic that plays an important role in various types of plant growth. Various Adaptations of the bract anatomy such as vascular bundle thickness, epidermal thickness, and cell area, the width of aerenchyma, collenchyma, and sclerenchyma tissues, and thickness of phloem and metaxylem usually depends on the nature of the soil.

Some modifications in plants can initiate growth even in harsh climate and soil conditions while in some cases limited changes in plant's anatomy might result in moderate or no growth in challenging environments. This study revealed different bract anatomies of *Cyperus* species growing in different soils of various regions of Punjab. Genus *Cyperus* of the Cyperaceae family has different species spread in the different regions of Punjab and based on soil type, they show the relevant modifications in bract anatomy.

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