Dhaka Univ. J. Biol. Sci. **20**(2): 205-208, 2011 (July) **- Short communication**

ANATOMICAL ADAPTATIONS OF *MYRIOSTACHYA WIGHTIANA* HOOK. F. TO SALT STRESS

PARVEEN RASHID AND ASHFAQUE AHMED

Department of Botany, University of Dhaka, Dhaka-1000, Bangladesh

Key words: Anatomy, Salt stress, Stem, Leaf, Root, *Myriostachya wightiana*

A naturally adapted salt tolerant grass, *Myriostachya wightiana* found in the coastal saline area of Bangladesh, was studied for its adaptive mechanism in the internal structures of stem, leaf and root. In the stem, adaptive features include thick epidermis, 4 - 5 layers thick walled sclerenchyma cells in the hypodermis, vascular bundles with prominent metaxylem, large phloem area, sclerification in the vascular bundles and around lacunae while in the root thick epidermis, lignification in the exodermis, thick cortex were noticed. Development of salt glands in the leaf, thick epidermis, sclerification in the vascular bundles, prominent metaxylem and large phloem area were found. All these anatomical modifications seemed to be crucial for its survival under saline environments.

Morphological and anatomical adaptations in plant body are capable of minimizing detrimental effects of salt stress.(1) Natural populations, particularly many grass species had shown good tolerance to salinity.(2)

Myriostachya wightiana Hook. f., belonging to the family Poaceae, is a perennial grass grows along the muddy creeks and channels in inter-tidal mangrove swamps of Ganges Delta of India and Bangladesh and extending into Myanmar, Malaysia and Vietnam. It is the only species of the genus *Myriostachya* found in Bangladesh. In the western shoreline of Bangladesh where salinity is low, *Myriostachya wightiana* appears first within two years following surfacing of land from water. The grass is pioneer in the succession of the area and colonizes the area rapidly to cover the land and grows to a height of 1.0 - 1.5 m within two years. Plantation program of different mangrove species especially after *Sonneratia apetala* starts the appearance of this grass in this part of the coast.(3) This species can be identified in the field by its pedicillate spikelets with long awns. The plant is used as good fodder, thatching material and long wiry flexible roots also used as cordage. It checks soil erosion effectively.

Naturally adapted salt tolerant plants provide an excellent material for investigating the adaptive mechanism they use to encounter salinity. By using this plant as a model, research can play an important role in improving the salt tolerance of non-halophytic plants. The present studies were focused to examine anatomical adaptations of *Myriostachya wightiana* to saline conditions.

A salt tolerant grass *Myriostachya wightiana* Hook. f. was investigated to study the leaf, stem and root anatomical adaptations against salt stress in the Botany department of Dhaka University. The plant was collected from the salt affected soils of Rangabali village in Patuakhali district of Bangladesh. The plant was uprooted along with mud and poured into polythene bag. It was then carried to the Botany department of Dhaka University and transplanted in earthen pots. For studying stem and leaf anatomy, a 2 cm piece from the base of the third internode, for leaf anatomy a 2 cm piece from the middle of top fully grown leaf, and for root anatomy a 2 cm piece of the thickest adventitious root from the root-culm junction were selected. Free-hand sectioning slides were prepared. Sections were stained in safranin and fast green and mounted on glass slide in 20% glycerin and studied immediately with the help of microscope. Micrographs of the sections were taken with a camera (Olympus, model: IUT) fitted on a stereo microscope.

A portion of transverse sections of stem is shown in Fig. 1A, B. From figures it is observed that epidermis is composed of thick walled single layer parenchyma cell. Beneath the epidermis there are 4 - 5 layers small, thick walled sclerenchymatous cells constitute the hypodermis. Prominent lacunae were noticed towards the periphery of the stem forming a ring around the stem and each lacuna is surrounded by three layers of sclerenchyma cells. Small vascular bundles are present towards the periphery while larger ones are present towards the centre. The metaxylem and phloem are very prominent and larger in size. Sclerification was noticed around metaxylem as well as phloem. Thick walled sclerenechyma cells are noticed surrounding smaller as well as large vascular bundles. Pith is large and hollow. Thick epidermis is a characteristic feature of salt tolerant species.[4] This characteristic is critical under limited moisture availability as thick epidermis is capable of checking water loss through stems.[5] The characteristic feature of increased sclerification and reduced size of sclerenchyma cells gives rigidity to the stem. It may offer some resistance to water loss through the stem and again may play a crucial role in adaptation to unfavorable conditions. Earlier reports on *Spartina alterniflora*[6] and *Puccinellia tenuiflora*[7] support the present findings. Increased metaxylem area and phloem area perhaps play important role in conduction of water and photosynthates, particularly under adverse saline conditions. This has been supported by previous reports in different plant species.[8]

Fig. 1C represents a part of transverse section of leaf. It is revealed from the figure that there are many ridges and furrows on the adaxial surface of the leaf and each ridge contains one smaller vascular bundle near the adaxial surface and below it a larger one. Sclerification is noticed in the vascular bundles. Patches of sclerenchyma are also found at the tip of large vascular bundle below the epidermis on the abaxial surface and at the tip of each ridge. Some unicellular salt glands (trichomes) are present in the furrows on the adaxial surface and are connected with the epidermal cells. The epidermis is very thick on the abaxial surface. Prominent chlorenchyma cells are present surrounding the ridge and in between large vascular bundle on the abaxial surface. Salt glands are the characteristics of many halophytes and mangrove species. The unicellular cell functions when optimum concentration of salt is reached within these cells (salt glands), they burst and eliminate the salts. New cells are formed continuously in place of the bursted ones.

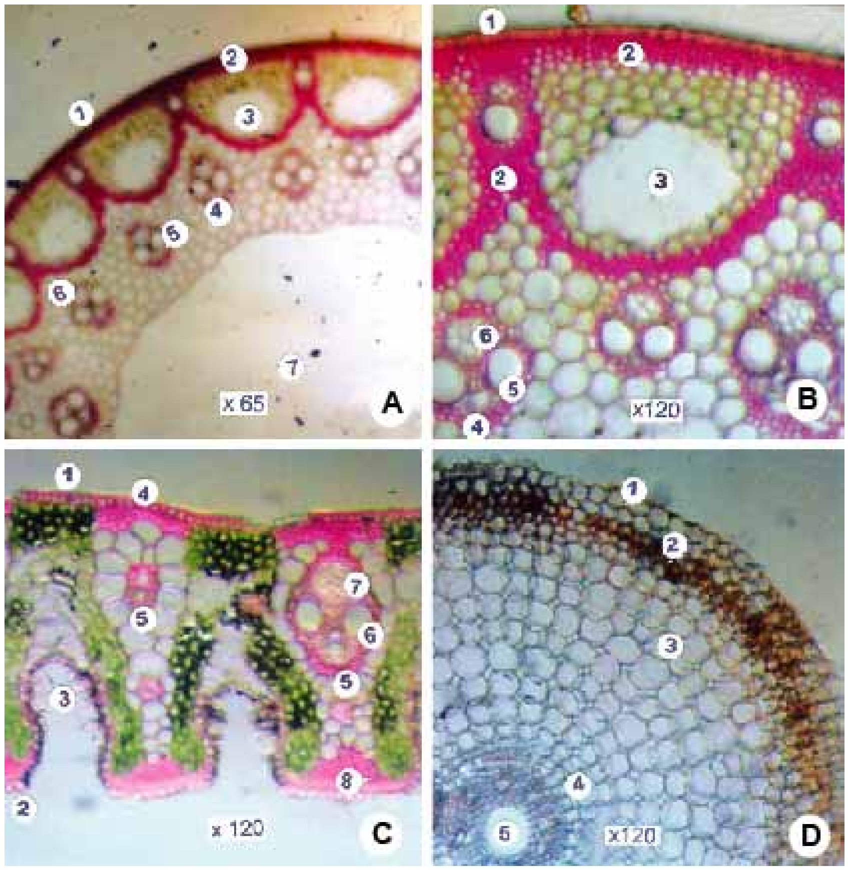

Fig. 1. Internal structure of *Myriostachya wightiana*. T.S. of stem (A, B) exhibiting epidermis (1), sclerenchyma cells (2), lacunae (3), vascular bundle (4), metaxylem (5), phloem (6) and hollow pith (7). T.S. of leaf (C) showing abaxial (1) and adaxial (2) surface, salt glands (3), epidermis (4), vascular bundle (5), metaxylem (6), phloem (7) and sclerenchyma cells (8). T.S. of root (D) exhibiting epidermis (1), lignified exodermis (2), cortex (3), endodermis (4) and pith (5).

With this process they maintain a low concentration of salts in the tissue.[9] Presence of this type of salt glands is also described by Tateoka[10] in salt tolerant wild rice *Porteseria coarctata.* Thick epidermis, development of sclerotic tissue in the vascular bundle helps to reduce water loss under saline stress. Strong presence of mechanical tissue gives rigidity and protect the leaf from wind and tidal waves. Hedayetullah and Chakrovorti[11] studied the mechanical system of *P. coarctata* and several *Oryza* spp. They confirmed highest development of mechanical tissue in *Porteseria coarctata*.

Fig. 1D shows a part of transverse section of root. Epidermis is composed of single layer small, roundish thick walled parenchyma cells. A ring of 3 - 4 layers of lignified parenchyma is noticed which constitute the exodermis. Parenchymatous cell constitutes thick cortical area. Pith is small and hollow. Saline tolerant species are often characterized by lignified walls of cortical parenchyma.[7,12] These reports are in agreement with the present findings. Thick epidermis and lignified parenchyma in the cortex may help to reduce water loss through root surface.[13]

Myriostachya wightiana showed a range of anatomical adaptive features like thick epidermis (stem, leaf and root), development of sclerenchyma tissues in vascular system as well as in the hypodermis and cortex of stem and mesophyll tissues of leaf, salt secretary glands in the leaf, prominent metaxylem and large phloem area in stem and leaf, thick cortex and lignification of exodermis in the root. All these modifications are capable of minimizing detrimental effects of salt stress.

References

1. Poljakoff-Mayber A 1988. Ecological-physiological studies on the responses of higher plants to salinity and drought. Arid Zones Res. **6**: 163-183.
2. Hameed M and M Ashraf 2008. Physiological and biochemical adaptations of *Cynodon dactylon* (L.) Pers. from the Salt Range (Pakistan) to salinity stress. Flora **203**: 683-894.
3. Siddiqui NA 2001. Mangrove Forestry in Bangladesh. Institute of Forest and Environmental Sci., Univ. of Chittagong. pp. 201.
4. Awasthi OP and RK Pathak 1999. Effect of salinity levels on survival and anatomy of four scion cultivars budded on Indian jujuba. Hort. J. **12**: 53-59.
5. Nawazish S, M Hameed and S Naurin 2006. Leaf anatomical adaptations of *Cenchrus ciliaris* L., from the Salt Range, Pakistan against drought stress. Pak. J. Bot. **38**: 1723-1730.
6. Walsh GE 1990. Anatomy of the seed and seedling of *Spartina alterniflora* Lois. (Poaceae). Aquatic Bot. **38**: 177-193.
7. YuJing Z, Z Yong, H Zizhi and Y Shunguo 2000. Studies on microscopic structure of *Puccinellia tenuiflora* stem under salinity stress. Grassland China **5**: 6-9.
8. Datta SK and I Som 1973. Note on the effect of salinity on the structural changes in the stem of rice varieties. Indian J. Agri. Sci. **43**: 614-617.
9. Bal AR and SK Dutt 1986. Mechanism of salt tolerance in wild rice (*Oryza coarctata* Roxb.). Plant and Soil **92**: 399-404.
10. Tateoka T 1963. Notes on some grasses. XIII. Relationship between *Oryza* and Ehrharteae, with special reference to leaf anatomy and histology. Bot. Gaz. **124**: 264-270.
11. Hedayetullah S and AK Chakrovorti 1941. Mechanical system in five species of the genus *Oryza*. J. Dept. Sci., Bengal, N.S. **1**: 21-48.
12. YuJing Z and Z Yong 2000. Studies on ultrastructure of *Puccinellia tenuiflora* under different salinity stress. Grassland China **4**: 30-32.
13. Hameed M, M Ashraf, N Naz and F Al-Qurainy 2010. Anatomical adaptations of *Cyanodon dactylon* (L.) Pers. from the Salt range Pakistan, to salinity stress. I. Root and Stem anatomy. Pak. J. Bot. **42**(1): 279-289.

(Manuscript received on 10 January, 2011; revised on 20 February, 2011)