INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 11, No. 5, p. 253-259, 2017

RESEARCH PAPER OPEN ACCESS

Description and distribution of tissues in seed head bearing internode of sun ecotype of cogon grass [(*Imperata cylindrica* L.) Beauv.]

S. N. Sima*[1], A. K. Roy[2], N. Joarder[1]

[1]*Laboratory of Plant Anatomy & Morphogenesis Department of Botany, Rajshahi University, Bangladesh*

[2]*Department of Genetic Engineering & Biotechnology, Rajshahi University, Bangladesh*

Key words: Cogon grass, *cortex, distribution of tissues.*

http://dx.doi.org/10.12692/ijb/11.5.253-259 Article published on November 30, 2017

Abstract

The seed head bearing internodes of Cogon grass were circular and solid in nature with noticeable cuticle presence. Vascular bundles were arranged in two concentric circles in the hypodermal regions but no vascular bundles were in the leaf gap region .The outer circle bundles were small and medium but the inner circle bundles were large in size. Large and medium vascular bundles were equal in number (range 6-9) but the small bundles were more in number compared to large bundles (more than 11 in number). Xylem and phloem in the large and medium bundles were in the same line; phloem was external to xylem and protoxylem was in the centre. Vascular bundles were described as conjoint, collateral, endarch and closed and were surrounded by bundle sheath of parenchymatous in nature. Phloem was completely surrounded by 2-3 layers of very thick walled cells. Fundamental tissue consisted of thin walled parenchyma cells and was not differentiated into cortex, endodermis and pith.

* **Corresponding Author:** S. N. Sima ✉ sima_bot2006@yahoo.com

Introduction

Cogongrass [*Imperata cylindrica* (L) Beauv.] is a perennial rhizomatous grass that grows in a wide range of habitat.

It can invade and over-take disturbed ecosystem forming a dense mat of thatch and leaves that make it nearly impossible for other plants to coexist. Two ecotypes, viz. 'Sun' and 'Shade', exist in Bangladesh. Shade ecotypes are shorter in size and flower all round the year; while the sun ecotype has tall leaves and flower in autumn (October-November).

The leaves of sun ecotypes originated directly from the ground level with 1-2 erect internodes which are very short in length that develops from the underground rhizome. Seed head bearing internode is the third internode from the ground which bears fluffy, white, plume like seed head. The length of seed head bearing internode is considerably long. It is cultivated in Bangladesh in many regions, otherwise grow as wild and weeds, as an economic grass used in roof making of village cottage and as floor dust sweeper.

A large number of publications are available on botany, ecology, growth pattern etc. of Cogon grass (Chang and Chou, 1997; Brook, 1989; Bryson and Carter, 1993; English, 1988; Eussen, 1980; Holm *et al.*, 1977) but no anatomical works are available. As Cogon grass is a C4 plant, few publications on Kranz anatomy are available (Hameed and Asraf, 2009).

The present histological work on seed head bearing internode of Cogongrass was undertaken to describe types and distribution of tissue system and special anatomical adaptation as seen through transverse sections.

Materials and methods

Plant materials

Cogon grass [*Imperata cylindrica* (L) Beauv.] was used as the plant materials in this, study. Microscopic observations were made on the tissues in seed head bearing internode of the sun ecotype of the plant.

Method

Samples from a population of Cogon grass were collected from protected area of Bangladesh Betar Transmission Centre near Rajshahi University. Ten plants each from three sample area were collected at full blooming season i.e. in late October, 2010. A piece of two cm length was taken from the base of fully bloomed seed head bearing internode of the main tiller of a thickest ramet for anatomy.

The material was fixed in FAA fixative for 46 hours and subsequently transferred to acetic alcohol solution for long term storage. Free hand sections were prepared by a series of dehydrations in ethanol using the standard single stain technique with safranine. Measurements were taken with a research microscope with the aid of image analysis using *Motic J1.0* software with the help of a Macintosh Computer. Data for anatomical traits were recorded using 10 plants from each of the three sample area.

The anatomical traits recorded were dermal tissue, mechanical tissue, vascular tissue and ground tissue. Standard errors were calculated using between plants within a sample area following a standard statistical procedure.

Results

The seed head bearing internodes were more or less circular in outline with solid pith (Figure 1A). Cross sections as viewed were having large pith which was parenchymatous in nature. Vascular bundles were arranged in the hypodermis in two definite incomplete circles. A wide leaf gap was noticed and this region of the transverse section had no vascular bundles and made up with parenchyma ground tissue. Vascular bundles of the outer circles were of two types, small and medium size arranged alternately.

The vascular bundles of the inner circles were large and positioned in between three outer circle vascular bundles. Large bundles had bundle sheath extension towards outer anticlinal direction touching the epidermis.

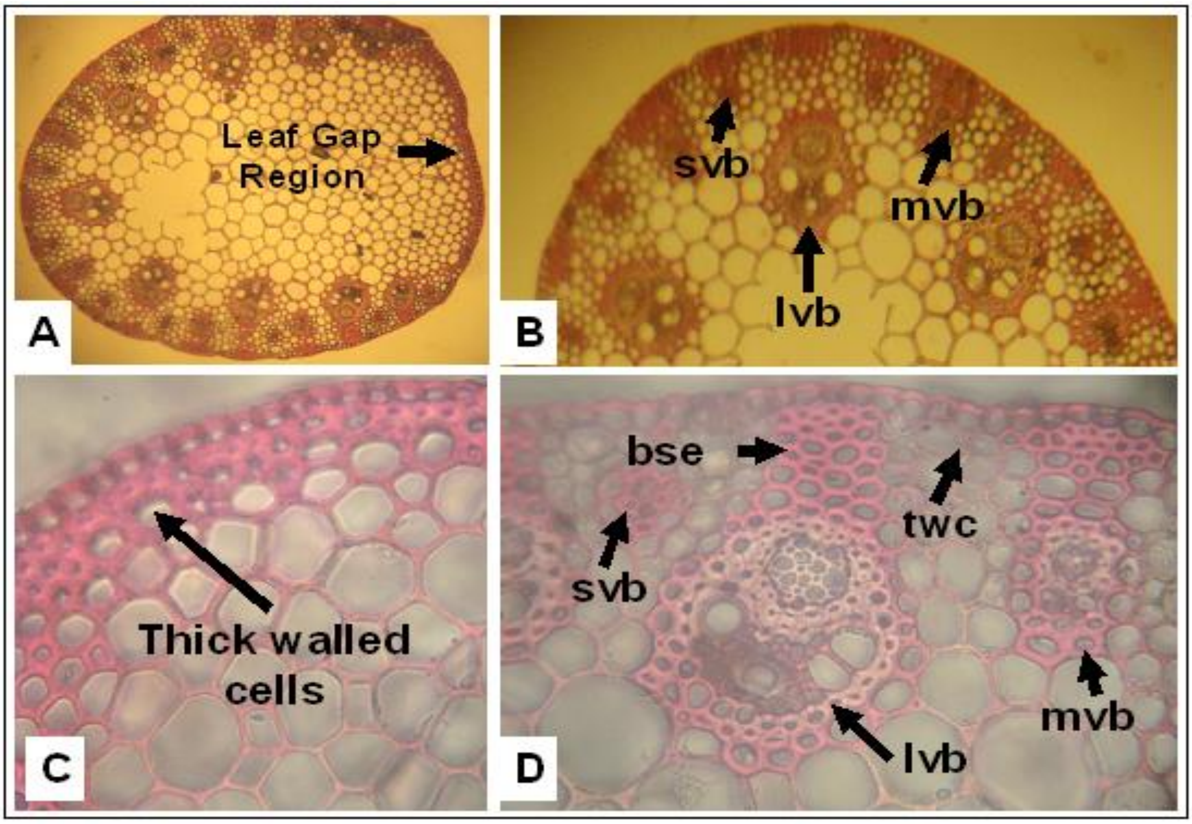

Fig. 1. Transverse section showing gross anatomical structure of seed head bearing internode of Cogon grass. A. Vascular bundles are arranged in two rings in the hypodermis with a large leaf gap. B. Enlarged view of T.S. C. Enlarged view of leaf gap region. D. Hypodermis showing three different types of vascular bundleslvb = large vascular bundle; mvb = medium vascular bundle; svb = small vascular bundle; bse = bundle sheath extension; twc = thin walled cells.

It provided mechanical strength of the internodes. Fundamental ground tissue was made up with thin walled parenchyma cells of various sizes.

Vascular Bundles

Number of vascular bundles was counted to be 24.6±2.14 (range 20-29) of which large, medium and small bundles were respectively 7.4±0.96; 8.6±1.16 and 12.12±1.07. Small and medium bundles were arranged almost alternately in the immediate hypodermis. The outer and inner circle bundle ratio was 2.8: 1.

Epidermis

Epidermiswas uniseriate and was covered with thick cuticle (Fig. 1 C & D). The epidermal cells were isodiametric and thick walled. Epidermal cells were measured 2.4±0.22 mμ in anticlinal length and 2.7±0.19 mμ in periclinal length. Periclinal outer cell wall was thicker than that of periclinal inner cell wall and measured 0.4 and 0.3 mμ respectively. Anticlinal walls were also thick and measured 0.5 mμ.

Epidermis covering the leaf gap was much thicker than the other regions of the transverse section. The periclinal inner and outer wall thickness was 0.6 and 0.7 mμ respectively. Anticlinal wall thickness was 0.9 mμ (Fig. 1 C). There was a thick deposit of cutin on the outside of the epidermis and due to this the culm internodes became oily in texture.

Hypodermis

Hypodermis was parenchymatous in nature except in the region of leaf gap. In leaf gap region, hypodermis consisted of few layers of thick walled sclerenchymatous cells (Fig. 1 C & D). Number of layers of sclerenchyma cells varied between plants studied. It ranged from 2-5 layers.

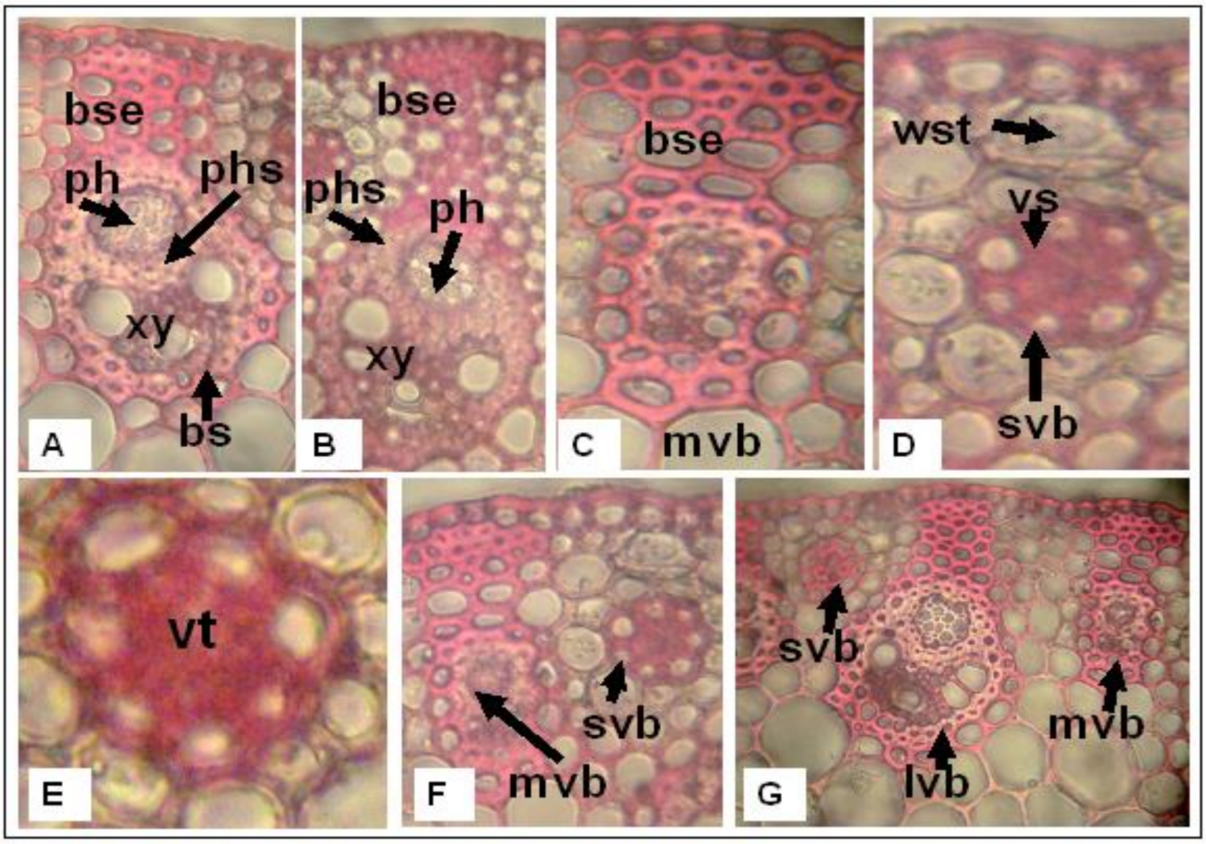

Fig. 2. Range of variation in vascular bundle structure and composition. A & B. Large vascular bundle; C. medium vascular bundle, D & E Small vascular bundles.

F. Medium and small vascular bundle; G. Small, large and medium vascular

G. Large bundle. bse = bundle sheath extension; ph = phloem; phs = phloem sheath; xy = xylem; wst = water stirage cell; svb = small vascular bundle; mvb = medium vascular bundle; lvb = large vascular bundle; vt vascular tissue.

Vascular tissue

It consisted of numerous oval shaped vascular bundles arranged in two semi-circles due to the presence of large leaf gap. The xylem and phloem, in large, medium large and small vascular bundles, were in the same line; cambium was absent; phloem was only external to xylem; and protoxylem faced the centre (Fig. 1 D; Figs. 2 A, B, F & G). Hence the vascular bundles were described as conjoint, collateral, endarch and closed. Each vascular bundle was surrounded by a bundle sheath of sclerenchyma which was prominent at the base and tip of vascular bundles.

Large vascular bundles

Vascular bundles were surrounded by a very strong bundle sheath made up of very thick walled sclerenchyma fibrous tissue (Fig. 1 D and Fig. 2 A&B).

Xylem comprised usually two oppositely arranged metaxylem elements, pitted facing the periphery and a few protoxylem elements facing the centre of the internode in a linear row. In few large bundles, metaxylem vessel number was more than two (Figs. 1 D and 2 B) and in most of the large bundles, intact single protoxylem vessel was noticed. At least in 18% large bundles had protoxylem lacuna or lacuna with obliterating protoxylem. Xylem parenchyma with very thick wall had been noted in which metaxylem and protoxylem elements were embedded.

Phloem was well developed and external to xylem. Bundle sheath completely encircled the phloem and separated phloem from xylem elements. Phloem cover consisted of very thick walled sclerenchyma cells. Phloem consisted of sieve tubes and companion cells.

The anticlinal length was slightly greater than the periclinal length. It measured 13.6±1.24mµ and 16.6±2.17 mµ, respectively in periclinal and anticlinal length. Area of vascular bundles ranged from 161-214 mµ² with a mean of 191.6±14.74 mµ². Phloem area ranged from 36-49 mµ² with a mean of 44.6±7.24 mµ². Xylem area ranged from 89-119 mµ² with a mean of 107.4±11.64 mµ². Xylem and phloem area ratio as calculated was 2.4:1. Percentage of phloem per vascular bundles was 23.28% and that for xylem was 56.05%. Percentage of phloem over xylem was 41.53%. Bundle sheath consisted of 20.72% of total vascular bundle area.

Medium large vascular bundles

This type of vascular bundle was located in the hypodermis. Vascular bundles were surrounded by very thick walled sclerenchyma tissue (Figure 2 C). Phloem was well developed but did not develop the way it was developed in large vascular bundles. Vascular bundles were more or less round or oval in shape.

It looks radially elongated due to bundle sheath extension in both the outer and inner anticlinal directions. Outer anticlinal bundle sheath extended up to the epidermis. Vascular bundle anticlinal length was 11.2±0.81mµ, periclinal length was 9.6 ±0.49 mµ and area was 94.4±7.64 mµ². Xylem and phloem was in a ratio of 0.73:1. Percentage of phloem tissue over xylem tissue was 136.41%. Percentage of phloem over total vascular bundle area was 31.36% and that for xylem was 22.98%. Bundle sheath area consisted of an area of 44.4±4.76 mµ² which was 47.03% of the vascular bundle area.

Small Vascular Bundles (Figures 2 D, E and F)

Small vascular bundles were completely round in shape. Vascular bundles were surrounded by a single layer of thick walled bundle sheath. No bundle sheath extension was noted. Vascular tissue was poorly developed and it became difficult to differentiate phloem from xylem through simple research compound microscope. The area measured was 44.1±3.76 mµ².

Discussion

The seed bearing internodes have typical anatomical features like many monocotyledons. The ground tissues do not differentiate into cortex and pith, but have large pith which is prominent. Metcalfe (1960) reported that there are grasses, where vascular bundles are arranged in the hypodermis and have large pith. In cereals, vascular bundles are arranged in two circles as found in seed head bearing internodes (Metcalfe, 1960; Esau, 1965; Joarder, 1980; Briggs, 1990; Kelbert*et al.*, 2004;.Sima, 2010).

Epidermal cells are isodiametric and closely attached to form a compact layer devoid of intercellular spaces. Isodiametric and radially elongated epidermal cells have been reported in grasses (Eames and Mac Daniels, 1947). Barrel shaped epidermis has been reported in wheat but radially elongated cells also noted in few genotypes (Sima, 2010). Variable sized epidermal cells depending on habitat have been reported in rice (Joarder and Eunus, 1980; Chaudhuri *et al.*, 1971). Cuticle was always found on the outside of the outer wall of epidermal cells. Presence of cutin and other deposit has been reported in grasses (Eames and Mac Daniels, 1947; Metcalfe and Chalk, 1950; Fahn, 1982; Hossain, 2011). Environmental factors influence the development of cuticle and waxes in grasses (Hull *et al.*, 1975).

In Poaceae there are two basic types of vascular bundles arrangement in the ground tissue: (i) Vascular bundles are arranged in one or two rarely three circles; and (ii) Vascular bundles are scattered throughout the entire ground tissue (Metcalfe, 1960; Fahn, 1982; Dickison, 2000). In Cogon grass, vascular bundles are arranged in two circles in the hypodermis.

Vascular bundles were of three different types, large, medium and small. Hypodermal bundles were medium and small in size while the inner circle bundles were large. Different types of vascular bundles have been reported in grasses (Metcalfe, 1960). In wheat the inner circle bundles were of two sizes (O'Brien and Zee, 1971; Sima, 2010).

Large vascular bundles were radially elongated. Metcalfe (1960) mentioned that the shape of vascular bundles varied considerably in grasses of various affinities. Anticlinal and periclinal length in wheat, rice and Cogon grass varies considerably depending on genotypes (Joarder, 1980; Sima, 2010; Hameed and Ashraf, 2009). The bundles were collateral, with phloem at the top of bundles towards the periphery of the culm and completely surrounded by fibrous tissue. Metaxylem consisted of two large vessels and protoxylem lying at the opposite pole of the bundle to that at which the phloem was situated, usually had short radial row of two or more vessels with much shorter diameters. Metcalfe (1960), Esau (1965) and Dickison (2000) considered this type as typical vascular bundles of monocotyledons. Large bundles of rice and wheat have similar composition and orientation of tissue (Joarder and Eunus 1980; Sima, 2010).

Phloem of large bundles was highly organized and has a regular pattern of narrow and wide cells. The wide cells were the sieve tube members and narrow cells were companion cells. Metcalfe (1960), Fahn (1982) and Dickison (2000) described monocotyledonous phloem as consisting of well-developed sieve tube elements and companion cells. Well-developed phloem in large bundles has been reported in rice and wheat (Joarder, 1980, 1995; Sima, 2010;).

The small vascular bundle usually located in the hypodermal region lacking large metaxylem vessels and in some bundles, the xylem and phloem was not easily distinguishable from one another in transverse section. Moreover, vascular bundles with only one-metaxylem vessels have been detected in rare occasion. Metaxylem of small vascular bundles transformed into tracheary elements and poorly developed phloem elements have been reported in grasses and cereals (Metcalfe, 1960; Fahn, 1982; Joarder, 1980; Sima, 2010).

Quantitative measurements have provided some idea regarding the extent of variations in tissue and tissue system of the sample plants. Some of the mean measurements are attached with high standard errors providing existence of variation (could be real) between plants. Moreover, between plants variation within a sample area are too high and for that sample-to-sample mean differences in some the traits were non-significant.

This high variation between plants within a sample could be due to the presence of several ecotypes, or mixture of several genotypes. Ecotype variation in *Imperata cylindrica* has been reported and most of the anatomical traits measured have different estimates (Chang and Chou, 1977; Hameed*et al.,* 2009).

Cogon grass possesses some anatomical adaptive features to withstand harsh environment. These adaptive traits were bundle sheath cover, phloem surrounded by very thick wall sclerenchyma tissue, greater proportion of xylary tissue, strong bundle sheath extension in the inner and outer anticlinal direction extended up to the epidermisand thick hypodermal cells in the region of leaf gap. Some specific anatomical adaptations in a range of salt ecotypes of Cogon grass have been reported and developed these adaptations due to population grown in the harsh environment (Hameed and Ashraf, 2009).

References

Brook RM. 1989. Review of literature on *Imperata cylindrica* (L.) Raeuschel with particular reference to South East Asia. Tropical Pest Management **35,**12-25.

Bryson CT, CarterRC.1993. Cogongrass, *Imperata cylindrica (*L.) Beauv., in the United States. Weed Tech. **7,**1005-1009.

Briggs KG.1990. Studies of recovery from artificially induced lodging in several six-row barley cultivars. *Can. J. Plant Sci.* **70,** 173-181.

Chang KT, Chou CH. 1977. Ecotype variation of *Imperata cylindrica* populations in Taiwen: I.

Morphological and molecular evidences. Bot. Bull. Acad. Sin. **38**,215-223.

Chaudhuri BB, Dana S, Basak SL. 1971. Effects of fertilizers on anatomy of rice stem. Indian Agriculture **25**,149-159.

Dickison WC.2000. Integrative Plant Anatomy. Academic Press, USA.

Eames AT, Mac Daniels LH.1947. An Introduction to Plant Anatomy. 2nd Edition, McGraw-Hill, New York.

English GR. 1988. The regulation of axillary bud development in the rhizomes of cogon grass (*Imperata cylindrica* (L.) Beauv.). Master Thesis, University of Florida, Gainesville. 122 pgs.

Eussen JHH. 1980. Biological and ecological aspects of alang-alang (*Imperata cylindrica* (L.) Beauv.). BIOTROP **5**,15-22.

Esau K. 1965. Plant anatomy.2nd ed. John Wiley and Sons, New York.

Fahn A.1982. Plant Anatomy. 3rd ed. Pergaman Press. Oxford, New York.

Hameed M, Ashraf M. 2009. Anatomical and adaptations to salinity in cogon grass [*Imperata cylindrica* (L.) Raeuschel] from the salt range, Pakistan. Plant soil.**32**, 229-238.

Holm LG, Plunknett DL, Pancho JV, Herberger JP. 1977. Imperata cylindrica (L.) Beauv., in the World's Worst Weeds: Distribution and Biology. University Press of Hawaii, Honolulu, 62-71 P.

Hossain MA. 2011**.** Culm Internode and Leaf Anatomy of Two Economic Grasses of Bangladesh. M.Sc. Thesis, Department of Botany, Rajshahi University, Bangladesh.

Hull HM, Morton HL, Wharrie JR. 1975. Environmental influences on cuticle development and resultant foliar penetration. Bot. Rev. **41**,421-52.

Joarder N. 1995. Quantitative anatomy of basal internode and in vitro response of leaf tissue of rice (*Oryza sativa*). Ph.D. Thesis., Rajshahi University, Bangladesh.

Joarder N, Eunus AM. 1980. Analysis of some mechanical tissues in lodging and non-lodging rice varieties. ORYZA **17**,15-21.

Joarder N. 1980. Comparative anatomy of basal internodes of some lodging and non-lodging rice varieties. M. Phil. Thesis, Rajshahi University.

Kelbert AJ, Spaner D, Briggs KG, King JR. 2004. The association of culm anatomy with lodging susceptibility in modern spring wheat genotypes.Euphytica.**136**,211-221.

Metcalfe CR, Chalk L. 1950. Anatomy of the Dicotyledons. Clarendon Press, Oxford.

Metcalfe CR.1960. Anatomy of the Monocotyledons. I. Gramineae. Clarendon Press. Oxford.

O' Brien TP, Zee SY. 1971. Vascular transfer cells in the vegetative nodes of wheat. Australia Journal Biological Sciences**24**,201-217.

Sima SN. 2010. Studies on culm anatomy and yield related traits in some genotypes of wheat (*Triticum aestivum* L.). Ph.D Thesis, University of Rajshahi, Bangladesh.