

Study of Anatomical Features of *Crotalaria Spectabilis* Roth

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Abstract: *The Fabaceae is commonly known as the legume, pea or bean family. It is very important family due to economical importance. The compounds they contain have medicinal uses and for the oil and fats that have variety of uses. The genus Crotalaria is very large composed of 81 species, economically and medicinally useful. Crotalaria spectabilis L. is known as 'showy crotalaria' and the common name is 'Khulkhula'. Morphological and anatomical study of different parts of Crotalaria spectabilis L. like root, stem and leaf were done.*

Keywords: Anatomy, *Crotalaria*, Fabaceae

1. Introduction

Crotalaria is one of the large genus of family Fabaceae. The studies on *Crotalaria* species are very little. It is an economically and medicinally important genus. *Crotalaria spectabilis* L. have much biomass production. Species were introduced in to the USA as green manure crops to improve soil fertility, as it has root nodules that support nitrogen fixing bacteria (Williams and Molyneux 1987). , but it is toxic plant due to presence of monocrotaline alkaloids. All parts of plant are poisonous. The seeds are more poisonous. The poisoning occurs when animals consume plant parts. The diseases occurs due to poisoning are bloody diarrhea, icterus, edema and weakness. Specially causes acute poisons, liver failure (Chronic fibrosis of the liver) and death.

2. Material and methods

The plant material were collected from Melghat region of Amravati district. The collected plant material were identified with the help of standard floras (Naik 1998; Cooke 1958; Dhore 2002). Detailed morphological characters were studied with the help of fresh material. The epidermal study for trichome and stomata were done by peeling method, the peeled part were stained in safranin and mounted in glycerin on a slide. The anatomical study were done by the free hand cut transverse section of fresh and preserved material i.e root, stem and leaves and the sections were dehydrated with different alcohol grades and stained with safranin and light green by double permant staining method.(Esau, 1965) These permanent prepared slides were observed under the microscope, and photographs were shoot out by using Trinocular microscope of Carl Zess.

Morphological observation

The plant body is erect, herbaceous , subglabrous up to 70-130 cm in height , stem cylindrical , branched branches striate, solid, green in colour; Leaves simple, alternate, stipulate, subsessile, oblanceolate 6-13 × 1.8-6 cm in size, with entire margin, mucronate apex. upper leaf surface glabrous and lower leaf surface with silky hairs. With

unicostate reticulate venation; stipules large, foliaceous ovate 5-8 mm glabrous with acute apex; flowers are terminal raceme 4-15 flowered, bracteates , bracts are large ovate, foliaceous glabrous, pedicellate, peduncle is 1-2 cm long, complete, bisexual, zygomorphic. Calyx green in colour , glabrous, gamosepalous, 5 toothed two upper are 10 mm long triangular, and three lower are 13 mm long, with acute apex. Corolla bright yellow with purple veins, long than calyx, consist of 5 petals . The uppermost largest standard with 22×20 mm in size having cordate orbicular in shape, two lateral wings are with 14×11 mm in size, and two united petal to form keel with 13×10 mm in size. The stamens are 10 in two bundles ,dimorphic, ditheous, dorsifixed, with staminal sheath length 5 mm and filament length 8 mm. The gynoecium is single, free; ovary superior with 10 mm in length, style bent 14 mm in length, glabrous, stigma simple. Pods linear-oblong , glabrous , 3-5 cm long , pale brown in color ,glabrous, Seeds 20-45 in number, dark brown/ash-grey polished and reniform.

3. Epidermal Observation

Trichomes

Trichomes present on only lower surface of leaves. Trichomes unbranched, non-glandular, uniseriate , with one basal cell , body elongated, fusiform, Their average length of lower leaf surface is 160.2 µm and in range 76.8 – 307.2 µm.

Stomata

The leaf amphistomatic (i.e present on both surfaces) dorsiventral, anisocytic, rarely anomocytic and amphiparacytic type, on both surfaces , lower surface contain more stomata than the upper surface. Epidermal cell wall is thin and irregular, upper leaf surface pore average 16.2 × 3.4 µm, range 15.3 – 17.9 × 2.5 – 5.1 µm in size. guard cells average 25.6 × 22.1 µm , range 23 – 28.1 × 20.4 - 23 µm in size and subsidiary cell average 41.8 × 39.2 µm, range 28.1 – 56.3 × 30.7 – 56.3 µm in size. And lower leaf surface pore average is 12.8 × 2.8 µm , range 10.2 – 15.3 × 2.5 – 3.3 µm in size , guard cell average 14.6 × 15.3 µm , range 15.3 – 15.8 × 12.8 – 17.9 µm , and subsidiary cell

average $23 \times 40.1 \mu\text{m}$ and range $20.4 - 28.1 \times 25.6 - 48.6 \mu\text{m}$ in size

4. Anatomical Observation

4.1 T. S. of Root

The trasverse section of root showed almost circular outline . Externally present 3 to 4 layered cork phellem . below the cork present 1 to 2 layered phellogen composed of thin walled rectangular cells of phellogen cambium which measured $16.6 \times 40.9 \mu\text{m}$ in average and $15.3 - 17.9 \times 35.8 - 46 \mu\text{m}$ in range. Below the phellogen present 2 to 3 layered periderm some stone cells present in cortical tissue which measured $17 \times 17.9 \mu\text{m}$ in averaged and $10.2 - 23 \times 12.8 - 25.6 \mu\text{m}$ in range. Below the periderm 5 to 6 layers of cortex , it is composed of rounded to squarish cells, loosely arrange which measured $30.7 \times 38.4 \mu\text{m}$ in average and $17.9 - 46 \times 25.6 - 51.2 \mu\text{m}$ in range. Below the cortex present single layered endodermis composed of squarish to rectangular cells, which measured $17.3 \times 32.2 \mu\text{m}$ in average and $12.8 - 20.4 \times 17.9 - 51.2 \mu\text{m}$ in range. Below the endodermis present 2 to 3 layered pericycle, it is parenchymatous composed of rounded, oval cells filled with chloroplast which measured $24.5 \times 40.9 \mu\text{m}$ in average and $20.4 - 30.7 \times 25.6 - 51.2 \mu\text{m}$ in range. In the pericycle observed groups of stone cells or sclerides . Below the pericycle 25 to 30 layered well developed phloem tissue, composed of oval, rounded, polygonal , which measured $9.8 \times 23 \mu\text{m}$ in average and $7.6 - 12.8 \times 20.4 - 25.6 \mu\text{m}$ in range. cells loosely arranged with intercellular spaces an intermittently present stone cells and fibers in group may be isolated and that is present singly . Below the phloem present broad cambium 8 to 9 layered, ring of cambium composed of rectangular, flattened , compressed cells, which measured $7.6 \times 19.6 \mu\text{m}$ in average and $5.1 - 10.2 \times 12.8 - 28.1 \mu\text{m}$ in range. Below the cambium present secondary xylem and primary xylem forms continues broad cylinder; in secondary xylem proto-xylem present towards the periphery which measured $76.8 \times 70.8 \mu\text{m}$ in average and $61.4 - 102.4 \times 51.2 - 102.4 \mu\text{m}$ in range, meta- xylem towards the centre which measured $132.2 \times 133.1 \mu\text{m}$ in average and $102.4 - 179.2 \times 122.8 - 140.8 \mu\text{m}$ in range. Vessels too much enlarged, thick walled densely scattered. Primary xylem present at the centre, In primary xylem protoxylem measured $65.7 \times 40.1 \mu\text{m}$ in average and $38.4 - 76.8 \times 25.6 - 64 \mu\text{m}$ in range. And metaxylem $93.8 \times 69.1 \mu\text{m}$ in average and $89.6 - 97.2 \times 58.8 - 76.8 \mu\text{m}$ in range. xylem polyarch. In the xylem present fibers and some stone cells and also present parenchymatous tissue with granules. Medullary rays uniseriate, biseriate to broad multiseriate , composed of rectangular , oval, and elongated parenchymatous cells which measured $48.6 \times 25.6 \mu\text{m}$ in average and $38.4 - 56.3 \times 23 - 28.1 \mu\text{m}$ in range, medullary rays runs from primary xylem through the secondary xylem and phloem , in the phloem region they get dilated shows wedge shaped structure. Pith absent.

4.2 T. S. of stem

The transverse section of stem showed prescience of ridges and furrows due to ridges and furrows outline somewhat wavy. Epidermis single layered with squarish to columnar

cells arrange compactly with thick cuticle which measured $25.6 \times 22.1 \mu\text{m}$ in average and $23 - 28.1 \times 20.4 - 25.6 \mu\text{m}$ in range. Below the epidermis present single layered parenchymatous hypodermis with squarish to oval cells , compactly arranged which measured $23 \times 29.8 \mu\text{m}$ in average and $20.4 - 25.6 \times 25.6 - 33.2 \mu\text{m}$ in range .below the epidermis 4 to 5 layered collenchymatous cortex present, cells oval , circular , squarish, irregular, loosely arranged with intercellular spaces and , filled with pigment granules, which measured 10.2×19.6 in average and $7.6 - 12.8 \times 15.8 - 23 \mu\text{m}$ in range. In furrows region cortex cells large in size than the fullrows, cells parenchymatous , polygonal , circular ,rounded, squarish with intercellular spaces which measured $35.8 \times 37.5 \mu\text{m}$ in average and $23 - 46 \times 25.6 - 51.2 \mu\text{m}$ in range. Below the cortex single layer endodermis prominently observed with compactly arranged barraled shaped cells ,which measured 17.9×40.9 in average and $17.9 \times 40.9 \mu\text{m}$ in range. Below the endodermis schlerenchymatous patches of pericycle present it is 2 to 3 layered in furrows and 5 to 6 layered in ridges, cells polygonal, oval, squarish and triangular compactly arranged which measured $22.5 \times 24.7 \mu\text{m}$ in average and $22.5 \times 24.7 \mu\text{m}$ in range. In the Pericycle some stone cells observed. Below the pericycle present phloem tissue 9 to 10 layered , cells polygonal, rectangular, squarish and oval compactly arranged which measured $20.4 \times 24.7 \mu\text{m}$ in average and $17.9 - 23 \times 23 - 25.6 \mu\text{m}$ in range. Below the phloem 2 to 3 layered cambium cells present ; Cells flattened, rectangular , interfascicular cambium forming a continous ring which measured $8.5 \times 13.6 \mu\text{m}$ in average and $7.6 - 10.2 \times 12.8 - 15.3 \mu\text{m}$ in range. Xylem present in contionus cylinder, vessels moderate in size present densely, scattered metaxylem towards periphery and proto-xylem towards centre. Vessels polygonal, squarish, oval, rounded protoxylem measured $38.4 \times 32.4 \mu\text{m}$ in average and $23 - 51.2 \times 28.1 - 35.8 \mu\text{m}$ in range and metaxylem measured in 56.3×55.4 in average and $40.9 - 76.8 \times 53.7 - 58.8$ in range. medullary rays uniseriate to biseriate, multicellular cells , oval and squarish which measured 25.6×10.2 in average and $17.9 - 30.7 \times 7.6 - 12.8$ in range. Pith very enlarged it composed of parenchymatous thin walled , loosely arranged cells, oval , circular and polygonal in shape. Central pith cells larger than the peripheral one, which measured $81 \times 85.3 \mu\text{m}$ in average and $51.2 - 115.2 \times 43.5 - 140.8 \mu\text{m}$ in range.

4.3 V. S of leaf

The vertical section of leaf showed typical dorsiventral structure. The upper epidermis and lower epidermis both single layered, with cuticle and with some pigment granules. The cells of upper epidermis circular, rectangular, oval or barrell shaped with thin walled parenchyma. These cells large in lamina region than midrib region which measured $31.5 \times 33.2 \mu\text{m}$ in average and $28.1 - 30.7 \times 30.7 - 35.8 \mu\text{m}$ in range. The lower epidermal cells smaller than the upper epidermal cells. In the mid rib region cells observed circular, rounded, oval, rectangular and squarish upright which measures $30.7 \times 27.3 \mu\text{m}$ in average and $23 - 38.4 \times 12.8 - 43.5 \mu\text{m}$ in range . Stomata's present intermediately on upper and lower epidermis. Trichome's observed only on lower epidermis. Lower epidermal cells in lamina region larger than the midrib region; cells squarish, barrell shaped

elongated with some pigment granules, which measured $19.6 \times 31.5 \mu\text{m}$ in average and $15.3 - 25.6 \times 25.6 - 38.4 \mu\text{m}$ in range. And cells in the upper lamina region measured $34.1 \times 46.9 \mu\text{m}$ in average and $30.7 - 48.4 \times 38.4 - 51.2 \mu\text{m}$ in range. Mesophyll cells showed differentiation in to palisade and spongy parenchyma , the palisade cells 2 – 3 layered, they were elongated, oval , columnar, with numerous chloroplasts in them which measured $40.1 \times 17 \mu\text{m}$ in average and $30.7 - 51.2 \times 12.8 - 23 \mu\text{m}$ in range. Spongy parenchyma cells 5 – 7 layered, thin walled rounded, oval, polygonal and irregular in shape, cells thin walled loosely arranged with intercellular spaces, which measured $31.5 \times 20.4 \mu\text{m}$ in average and $25.6 - 38.4 \times 15.3 - 25.6 \mu\text{m}$ in range. Some spongy cells contains starch grains at mid rib region. below the lower epidermis single thick walled collenchymatous layer present, which measured $38.4 \times 39.2 \mu\text{m}$ in average and $30 - 48.4 \times 28.1 - 51.2 \mu\text{m}$ in range. The remaining 7 – 8 layered parenchyma cells oval, polygonal, irregular, loosely arranged with some pigment granules and measured $47.7 \times 57.1 \mu\text{m}$ in average and $38.4 - 56.3 \times 43.5 - 71.6 \mu\text{m}$ in range. In the midrib region vascular tissue

arranged in semi-circular manner enclosed in bundle sheath, cells barreled shaped , oval single layered compactly arranged which measured $26.4 \times 57.1 \mu\text{m}$ in average and $20.4 - 33.2 \times 51.2 - 64 \mu\text{m}$ in range. Schlerenchymatous caps observed on upper and lower side of vascular tissue 4 – 5 layered thick walled, hexagonal, polygonal, squarish irregular which measured $25.6 \times 110 \mu\text{m}$ in average and $23 - 28.1 \times 23 - 25.6 \mu\text{m}$ in range, with some pigment granules. Schlerenchyma followed by 5 – 7 layered phloem, cells rectangular, squarish, rounded and polygonal which measured $9.3 \times 14.5 \mu\text{m}$ in average and $7.6 - 10.2 \times 12.8 - 15.3 \mu\text{m}$ in range. Meta-xylem 4 – 5 layered form below the phloem, cells circular, oval, elongated, polygonal thick walled meta-xylem towards periphery and proto-xylem towards centre which measured $40.1 \times 26.4 \mu\text{m}$ in average and $25.6 - 56.3 \times 20.4 - 33.2 \mu\text{m}$ in range. Below the upper epidermis 7 – 8 layered parenchymatous ground tissue observed.

Note: In range mentioned length (i.e smaller to bigger) \times width (smaller to bigger)



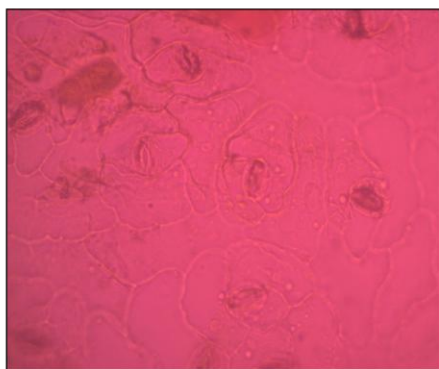
Habit



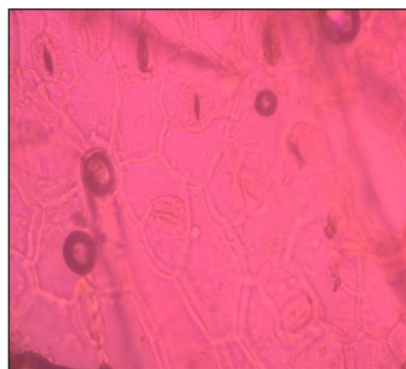
Androecium & gynoecium



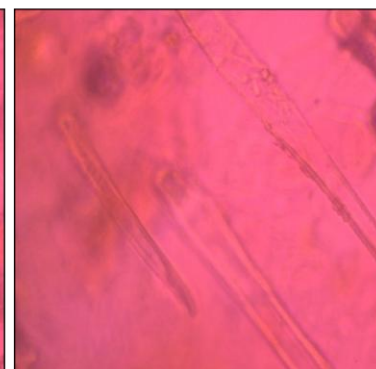
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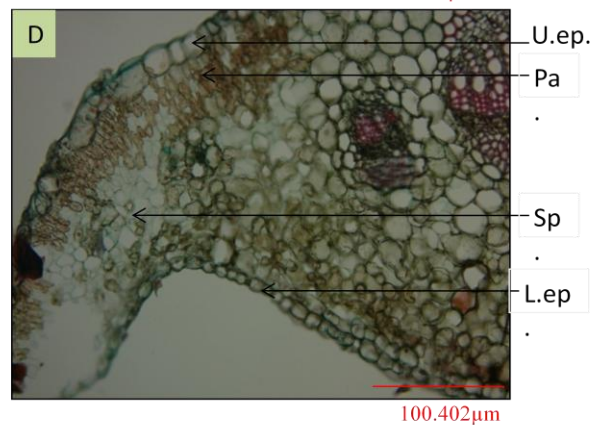
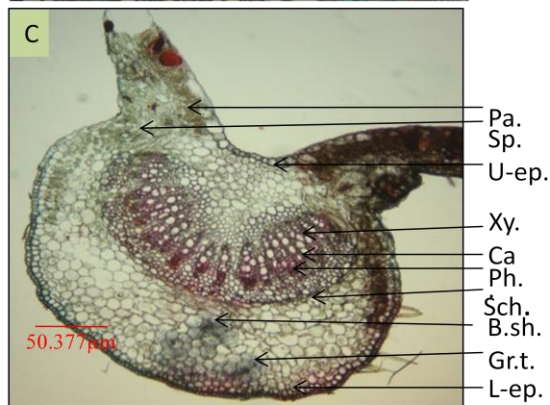
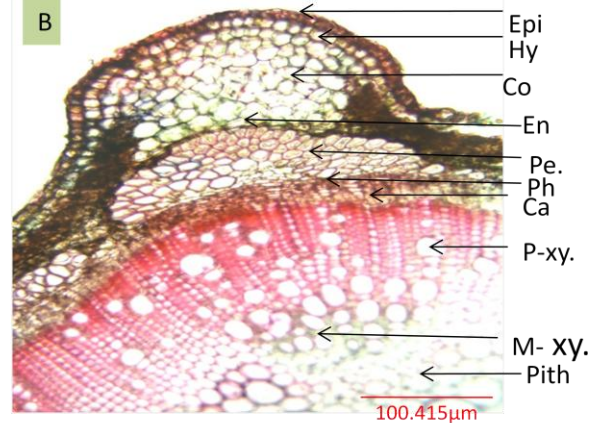
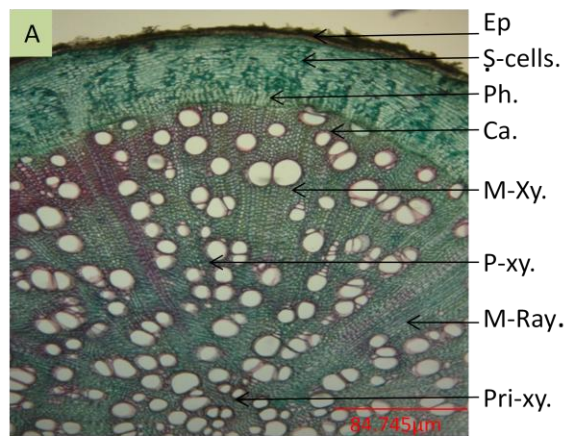
A) Leaf upper surface stomata



B) Leaf lower surface stomata



C) Leaf surface trichomes



A- T. S. of root , B- T. S. of Stem , C- V. S. of Leaf, D- Leaf lamina, Epi- Epiblema, Ep- Epidermis, U-ep- Upper epidermis, L-ep- Lower epidermis, Pa- Pallisade, Sp- Spongy parenchyma, G-Ti Ground Tissue, Sc-Ca- Schlerenchymatous cap. Hy- Hypodermis, Pe- pericycle, Co.- Cortex, En- Endodermis, B.sh- Bundle sheath, Pe- Pericycle, Ph- phloem, Ca- Cambium, pr-Xy- Primary xylem, Sec.xy- Secondary xylem, M-xy- Metaxylem, P-xy- Protoxylem, M-ray- Medullary ray, Ve- Vessel, Pi- Pith, Tr- trichome. G. ti- Ground tissue, St-Ca.- stomatal cavity., S-Cell – Stone cells

Table I : Morphological characters

	Characters	Observation
Vegetative	Habit	Herb
	Plant Height	70-130
	Life form	Erect
	Surface	Subglabrous
	Type	Simple
Leaf	Shape	Oblanceolate
	Dimensions (cm)	6-13×1.8-6
	Apex	Mucronate
	Upper leaf surface	Glabrous
	Lower leaf surface	Silky hairy
Stipules	Length	10
	Shape	Ovate
	Apex	Acute
	Pubescence	Glabrous
Inflorescence	Position / type	Terminal receme
	Peduncle (cm)	1-1.5
Bract	No. of flowers	4-15
	Shape	Ovate
	Pubescence	Glabrous
Calyx	Calyx tube (mm)	4
	Upper sepal (mm)	10
	Lower sepal (mm)	13
	Teeth shape	Triangular
	Apex	Acute
Corolla	Pubescence	Glabrous
	Colour	Bright yellow
	Standard Size (mm)	22×20
	Standard shape	Cordate orbicular
	Wing size	14×11

Androeium	Keel Size	13×10.1
	Staminal sheath length	5
Gynoecium	Filament length	8
	Ovary length	10
	Style length	14
	Style pubescence	Glabrous
Pod	Size (cm)	3-5
	Shape	Linear-oblong
	No. of seeds	20-45
Seeds	Shape	Reniform
	Colour	Dark brown

Table II: Root Anatomy

Cell type	Dimensions in <i>C. spectabilis</i> L.	
	Average (µm)	Range (µm)
Epiblema	16.6 × 40.9	15.3 – 17.9 × 35.8 - 46
Cortex	30.7 × 38.4	17.9 – 46 × 25.6 – 51.2
Endodermis	17.3 × 32.2	12.8 – 20.4 × 17.9 – 51.2
Pericycle	24.5 × 40.9	20.4 – 30.7 × 25.6 – 51.2
Phloem	9.8 × 23	7.6 – 12.8 × 20.4 – 25.6
Cambium	7.6 × 19.6	5.1 – 10.2 × 12.8 – 28.1
Sec. Protoxylem	76.8 × 70.8	61.4 – 102.4 × 51.2 – 102.4
Sec. Metaxylem	132.2 × 133.1	102.4 – 179.2 × 122.8 – 140.8
Pri. Protoxylem	65.7 × 40.1	38.4 – 76.8 × 25.6 – 64
Pri. Metaxylem	93.8 × 69.1	89.6 – 97.2 × 58.8 – 76.8
Medullary Rays	48.6 × 25.6	38.4 – 56.3 × 23 – 28.1
Stone cells	17 × 17.9	10.2 – 23 × 12.8 -25.6 bn
Pith	-	-

Table III: Stem Anatomy

Cell type	Dimensions in <i>C. spectabilis</i> L.	
	Average (μm)	Range (μm)
Epidermis	25.6 \times 22.1	23 – 28.1 \times 20.4 – 25.6
Hypodermis	23 \times 29.8	20.4 – 25.6 \times 25.6 – 33.2
Cortex	10.2 \times 19.6	7.6 – 12.8 \times 15.8 – 23
Endodermis	17.9 \times 40.9	12.8 – 23 \times 30.7 – 51.2
Pericycles	22.5 \times 24.7	17.9 – 25.6 \times 15.3 – 33.2
Phloem	20.4 \times 24.7	17.9 – 23 \times 23 – 25.6
Cambium	8.5 \times 13.6	7.6 – 10.2 \times 12.8 – 15.3
Protoxylem	38.4 \times 32.4	23 – 51.2 \times 28.1 – 35.8
Metaxylem	56.3 \times 55.4	40.9 – 76.8 \times 53.7 – 58.8
Medullary rays	25.6 \times 10.2	17.9 – 30.7 \times 7.6 – 12.8
Pith cells	81 \times 85.3	51.2 – 115.2 \times 43.5 – 140.8

Table IV: Leaf Anatomy

Cell type	Dimensions in <i>C. spectabilis</i> L.	
	Average (μm)	Range (μm)
Upper epidermis	31.5 \times 33.2	28.1 – 30.7 \times 30.7 – 35.8
Lower epidermis	30.7 \times 27.3	23 – 38.4 \times 12.8 – 43.5
Arm region upper epidermis	34.1 \times 46.9	30.7 – 48.4 \times 38.4 – 51.2
Arm region lower epidermis	19.6 \times 31.5	15.3 – 25.6 \times 25.6 – 38.4
Palisade Mesophyll	40.1 \times 17	30.7 – 51.2 \times 12.8 – 23
Spongy Parenchyma	31.5 \times 20.4	25.6 – 38.4 \times 15.3 – 25.6
Ground tissue	47.7 \times 57.1	38.4 – 56.3 \times 43.5 – 71.6
Schlerenchyma tissue	25.6 \times 110	23 – 28.1 \times 23 – 25.6
Endodermis	26.4 \times 57.1	20.4 – 33.2 \times 51.2 – 64
Phloem	9.3 \times 14.5	7.6 – 10.2 \times 12.8 – 15.3
Xylem	40.1 \times 26.4	25.6 – 56.3 \times 20.4 – 33.2

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