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Different Anatomical Aspects of *Datura fastuosa* L.

ItiShri Bhati[1]and Shiv Kumar Singh[2]
1. S.S. Jain Subodh P.G. Autonomous College,Jaipur.
2. Kedia Institute of Science and Technology College, Rajawas,Jaipur.
EMail ID.Shivbotany75@yahoo.com

ABSTRACT
The shoot apical meristems, seedling and seed coat of Datura fastuosa ,were studied. Datura fastuosa plant is wildly grown as annual and glabrous or slightly puberculous herbs having solitary axillary inflorescence. The flower is solitary and ovary is bicarpellary, syncarpous. The typical diarch root structure is found and the cotyledonary node is unilacunar two trace types. The shoot apex shows reproductive stages with mantle coreorganisation. In the seed coat, the macrosclerieds cells are oval with broad lumen and scalariform thickening on the radial walls.
***KEY WORDS:** -seed coat, seedling, shoot apex, vascularisation, vegetative and reproductive apex.*

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INTRODUCTION
The past two decades witnessed a resurgence of interest in apical meristems.The present piece of work is an attempt to study and correlate the various anatomical features of *Datura fastuosa*L. of the family Solanaceae, a common plant of the country.

MATERIALS AND METHODS
The seeds of *Datura fastuosa* were collected from mature plants grown in the botanical garden, Department of Botany, U.O.R. Jaipur.For shoot apical organization shoot tips were collected from mature growing plants. The radicular apices were dissected out from mature embryos. Four to five days old seedling was also fixed for studyingseedling anatomy. Seed coat anatomy was studied from mature seeds. All collected material for experimental work was fixed in Formalin-Acetic Acid –Alcohol (FAA) consisting of formalin, acetic acid and 70% ethanol in a proportion of 1: 1: 18, washed thoroughly in 70% alcohol, upgraded and dehydrated in alcohol grades, cleared in xylol and embedded in paraffin. Serial longitudinal sections of the shoot apices were cut at 5µm and serial transverse sections of the shoot apices were taken at 8µm and stained with saffranin and light green combinations. [18].

RESULTS
Morphological characters- Plants are wildly grown as annual and glabrous or slightly puberculous herbs and measure about 4-5ft in height (Figs.1A&1B).
The stem is aerial, erect, glabrous, herbaceous or woody (basal part) and branches in a zigzag manner. It is purplish and with scattered white spots.
Leaves are simple measuring about 18-20 X 10-25cm in (length X diameter) and are both cauline and ramal. They are ovate lanceolate acuminate sinuate or repand dentate with base unequally cuneate. Petiole is 8-10cm long, strong and violet. The leaves are exstipulate, alternate, greenish violet and have unicostate reticulate venation.
Inflorescence is solitary axillary having 1-2cm long and erect peduncles. The flower is solitary, 15-20cm long, purplish outside and white within and erect. It is ebracteate, long pedicellate, complete, hermaphrodite and actinomorphic. About 3-5cm long and persistent sepals constitute the calyx which is

refluxed in fruit. It is five teethed, gamosepalous, triangular-lanceolate and acuminate. Corolla is 16-18cm long violet or purplish outside white within having a limb, which is five plicate and five angled. The folds are long and cuspidate. The petals are in 5+5 and gamopetalous, valvate condition forming a funnel shape structure. Stamens are as a many as corolla lobes and adnate to the corolla. Anthers are 10-12mm long, violet dithecous and basifixed. The ovary is bicarpellary and syncarpous having a basilar and 10-12cm long style bearing small and bilobed stigma. The ovary is superior obliquely placed and having four locules with axileplacentation.The fruit is a globose capsule, with persistent calyx, dehiscing irregularly and covered with stout tubercles.Seeds are smooth discoid, dark-black and compressed. They are approximately 4mm in diameter and with surface finely pitted.

Seedling Anatomy- The type of seed germination in the species is epigeal. The vasculature is traced.

Primary tissue development and formation of root structure: - The differentiation of protophloem is followed by protoxylem. The protophloem initials are seen as two densely stained cell groups followed by protoxylem initials which appears alternate to the protophloem groups .The central part of the stele differentiates into the pith precursors which are broader than the procambial cells. Parenchyma cells in the pith and the cortex are pentagonal, hexagonal and octagonal to isodiametric in shape having intercellular spaces. A typical diarch root structure is observed. (Figs.2A&2B).The number of xylem cells increases at higher levels due to differentiation of *in situ* meristematic cells in the pith region. At this level vascular supply to the lateral root can also be seen coming out of pericycle region in the plant studied over here. (Figs.2C,2D,2E&2F).Each of the two or four groups of the primary phloem is gradually extended in the tangential direction towards the protoxylem points.

Transition from root to shoot structure: - The phloem groups start extending laterally at higher levels and lateral extension of each metaxylem follows this (Figs.3A&3B). Metaxylem arms separate from the protoxylem groups at higher levels inthe species worked out and collateral condition was achieved where four collateral groups were formed each having a laterally extended phloem outside one xylem

Vasularization of the cotyledons:-The hypocotylar vasculature acquires almost elliptical shape with four collateral vascular groups, each containing one or two arms of xylem separated by parenchymatous cells and one phloem arc outside. Complete obliteration of the protoxylem groups takes place at higher levels in all the six species. The two or four collateral bundles are drawn in the form of two arcs. The two collateral arcs bifurcates and two collateral vascular groups on either sides leave the axis to form cotyledonary traces (Figs.3C, 3D &3E). Each cotyledon is supplied by a pair of one bundle, one from each arc, thus the cotyledonary nodal condition is unilacunar two trace. In the present species the two cotyledonary traces remain close to each other at the base of cotyledons and fuse at higher levels and then split in the cotyledonary lamina and supply it (Fig.3F). Differentiation of tissue takes place from the epicotyl which closes the cotyledonary gaps after axillary bud vasculature separates out from the axis (Fig.3G).

Seed coat Anatomy-The cellular details are described under two different zones. The first zone is Epidermis and the second zone is Parenchymatous. The epidermis is made up of radially elongated thick walled macroslerieds. The macrosclerieds cells are oval with broad lumen and scalariform thickening on the radial walls(Fig.4A). The outer and inner tangential walls are thicker than the anticlinal walls.The outer face of the epidermis is covered with the thin cuticular layer. These macroscleried cells are broadened near the lateral sides of the seed and radial elongation at these places is more in the species studied. Inside the hypodermis a multilayered parenchymatous zone represents the second zone of seed coat. The cells are broad and isodiametric to angular and are thick walled. The thickening material is deposited on all around the cell walls and denser stained. Granular contains are deposited in almost all the cells of this zone. (Figs.4A&4B).

Shoot Anatomy-

The shoot apex is studied under two different stages i.e. Vegetative and Reproductive.

Vegetative stage: - The apex is a low dome and placed in a slanting position in relation to the axis. The cells of the youngest leaf primordium are densely stained and show divisions in various planes (Fig.5A). The tunica is two layered with rectangular or quadrangular cells and densely stained on the side opposite to the youngest leaf primordium (Fig.5B).

Reproductive stage: - The axillary buds during flowering phase change to single flower or simple cymose inflorescence. The inflorescence as well as floral apex showed a mantle-core organization (Fig.6C).

The axillary bud meristem destined to form a reproductive apex acquires a squared shape with layered superficial meristem covering a comparatively lesser organized group of cells. Both the meristematic regions are uniformly densely stained with the onset of bract or floral organ primordia initiation, the meristem becomes organized into a mantle, the superficial 4-5 layered densely stained zone, and a lighter stained subjacent core. This produces floral organs in an acropetal order. The reproductive apex produces cymes form a terminal flower and axillant meristem than form lateral flowers. The whole meristem is consumed in flowers or floral organs (Fig. 6A, 6B,&6C).

DISCUSSION

There are only a few reports on early differentiation of primary vascular tissue in angiosperms. Vascularisation of the seedling is of particular interest because it is the first representation of the vascular coordination between root and shoot for shadowed in the procambial system of the embryo. Investigations, which help to build an overall picture of this coordination, are of great value [2, 19, 25]. The present reports also agree with this. The protoxylem initials are seen as two denser staining recognizable groups of cells alternating with two protophloem groups. The data gathered on *Datura fastuosa* during present investigation are in accord with those of Thiel [38] who observed in some Solanaceous species that the first change in transition takes place from the diarch radial protostele of the root to the bicollateral type of bundle in the hypocotyls and cotyledons is a breaking up of the diarch xylem plate and division of two primary phloem groups each into two distinct groups. Here the protoxylem maintains its original position until the level just below the cotyledonary node. The initial centripetal differentiation of the metaxylem is followed by lateral extensions and differentiation of parenchyma cells in between the two metaxylem arms. This pattern of change over from radial to collateral condition formation is followed in the present species. The earlier workers like Eames and Mc Daniels [14], Banerji [2] and Govil [17] however, reported splitting and rotation of xylem through 180º during transition from root to shoot structure. But the data reported here are in support of Bonnier's [7, 8] supported by Kavathekar and Pillai [19].Conclusions that the transition from radial to collateral condition takes place through gradual inward shift of pole of xylem differentiations as we ascend along the axis. Deshpande and Kasat [11], Govil [17], Pillai and Kumar [27] reported connection between the root - hypocotyl and epicotyl vasculatures through the first foliar node. The anatomical changes in *Withania somnifera* were also reported by Takshak and Agarwal [37]. In the species studied here the root - hypocotyl vascular unit completely enters into the cotyledons and the first foliar leaves receives epicotylar vasculature. The downwardly differentiating epicotylar vasculature is seen at the time of departure of cotyledonary traces. The root – hypocotyls and epicotyl vascular units are separate and tend to support the Thoday's [39] suggestion of double origin of vasculature. The cotyledonary node in the present species showed a unilacunar double trace condition. Similar results were also reported by Wahua *et al*.[42] and Bhati [3] in *Capsicum annuum* .This condition has also been reported in different families of angiosperms. Literature studied revealed that there are different types of cotyledonary nodes in angiosperms [9, 10, 13, 32].Different types of cotyledonary nodes condition in angiosperms was also supported by [4, 5]. Marsden and Bailey [20] discussed the evolutionary tendencies and considered the unilacunar double trace nodal condition to be primitive.

The structure of seed coat broadly resembles the account reported by earlier workers like Soueges (1907), Netolitzky [22], Dnyansagar and Cooper [12] and Saxena [31] but differ in minor details. Soueges (1907) described the structure and development of seed coat in 146 species belonging to 26 genera of the Solanaceae including those of *Atropa, Datura, Nicotiana, Scopolia* and *Solanum*. The author recorded the presence of a chalazal cavity in mature ovules which has not been observed in plant investigated during the present study. Similarly Saxena [31]; Raghuvanshi [29] and Bhati *et al*, [6] also did not find the chalazal cavity in the plants investigated by them. Soueges [36] and Raghuvanshi [29] reported persistent middle layers in seed coat of *Capsicum*. The present data failed to support this.

The mature seed coat in the species presented here is comprised of the epidermis and parenchymatous layers. The epidermis is main mechanical layer and its cell varies in shape, size and nature. The cuticle is in the form of a thin layer in *Datura* species. Similar observations were also reported by Sharma [34] in *Atropa, Datura, Scopolia* and *Solanum*.

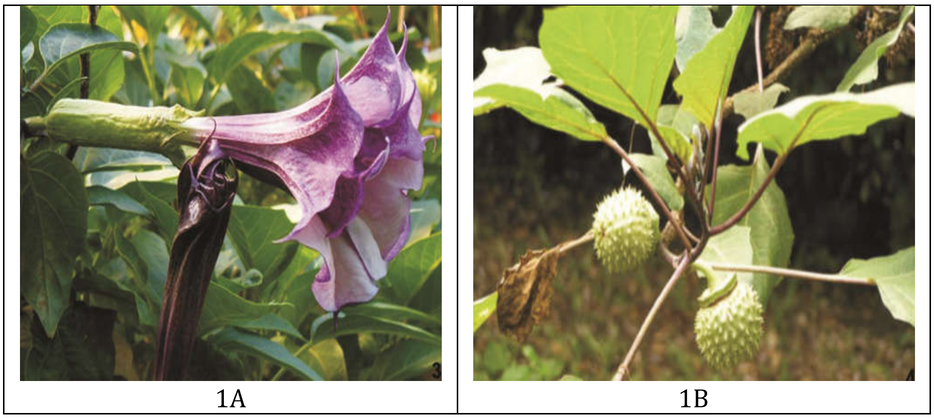
The macroscleried cells are oval with broader lumen in *Datura fastuosa.* Earlier Singh and Dathan [35] also found that the epidermal cells are small with a narrow lumen in *Marah fabaceus*. Pandey *et al.* [23] studied the mature seed coat of *Pongamiapinnata* having layer of macrosclereids followed by multilayered parenchymatous cells.

The vegetative apex is a low dome in the species under investigation. Earlier Ramji [23], Tucker [41], Pillai and Sharma [26], Pathak [24] and Negi [21] also found this type of vegetative apex in some shrub and tree species.

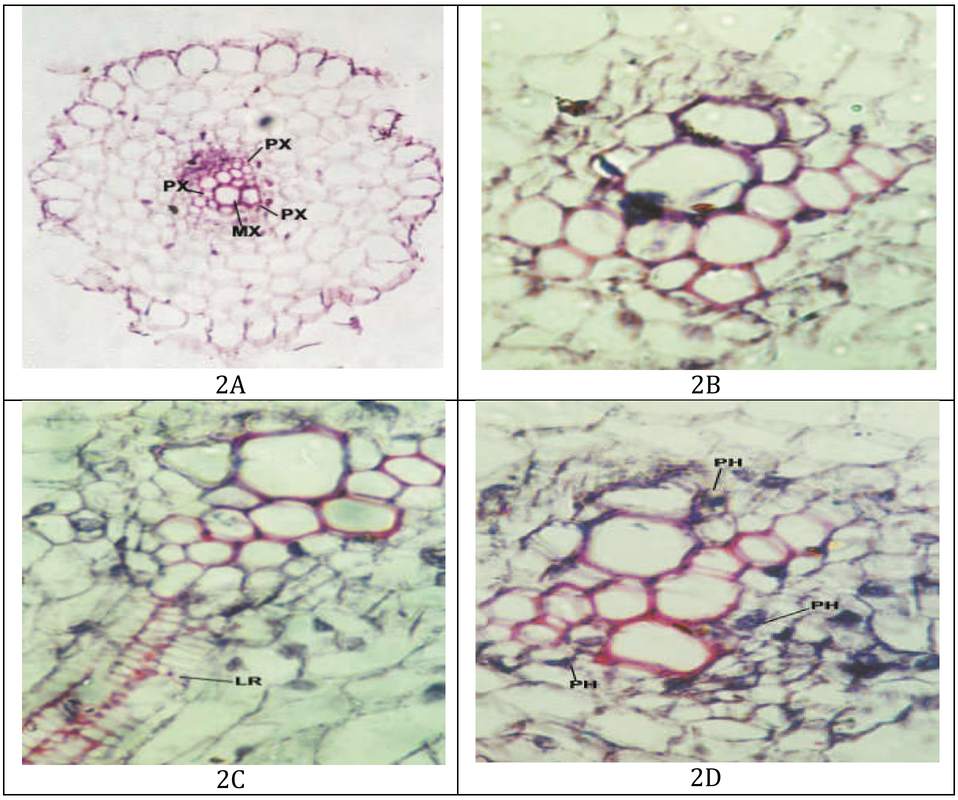
The vegetative apex showed a tunica-corpus organization with a faint cytohistological zonation having lesser cytoplasmic cells at axial tunica and distal central mother cells and this demarcation of staining behaviour between different zones persists throughout the plastochron. Gifford [15], Tolbert and Johnson

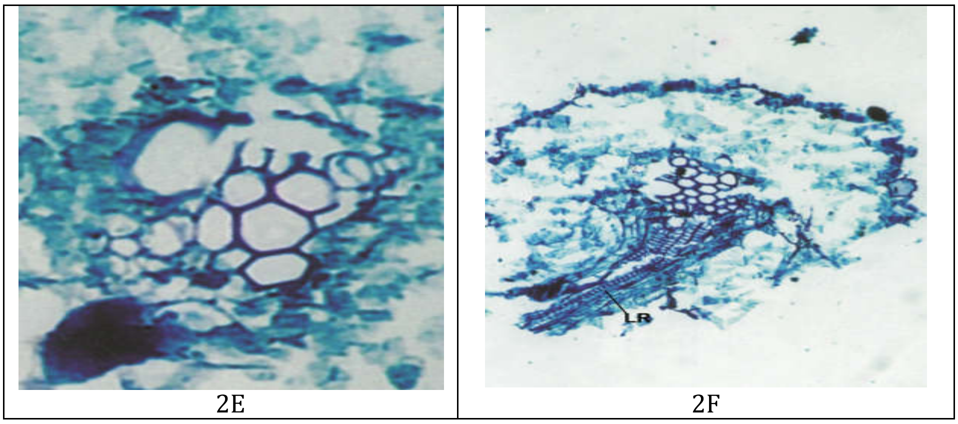
[40], Agarwal and Puri [1] and others also reported cytohistological zonation pattern in vegetative shoot apices.

The tunica-corpus organization of vegetative apex changes to mantle-core organization in the reproductive apex. The faint cytohistological zonation disappears and the mantle becomes uniformly densely stained in the axial as well as peripheral regions. This is in agreement with the observations of Gifford [16], Pillai and Sharma [26] and Sharma and Sharma [33] that during transition to reproductive phase the entire apex becomes active and a mantle-core organization is established. Plantefol [28] also related the presence or absence of zonation in inflorescence apices bearing a terminal flower or not. The species reported here had a cymose pattern of inflorescence with a terminal flower or a single axillary flower and the reproductive apex is without cytohitological zonation.

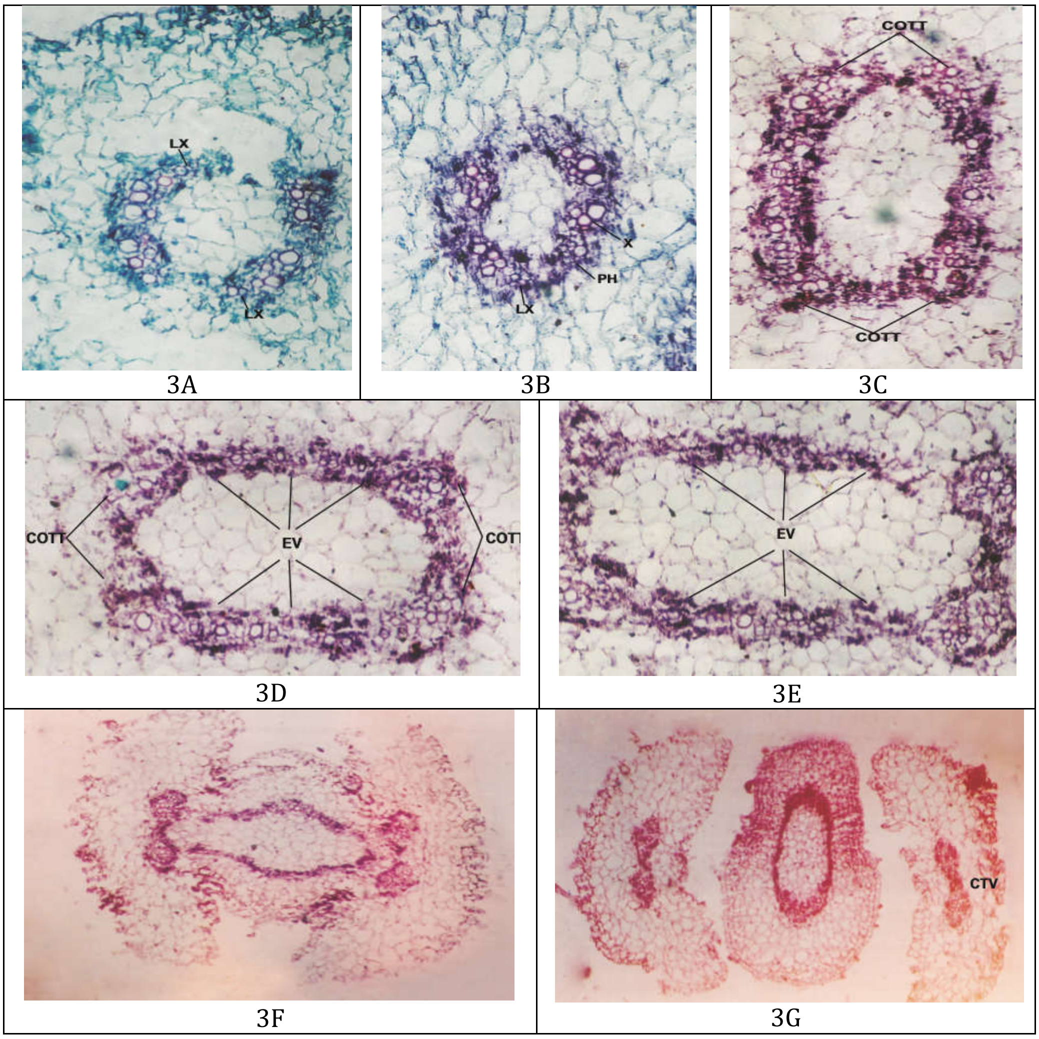


Figs. 1A&1B: Leaves, flower and mature fruit of *D.fastuosa*.

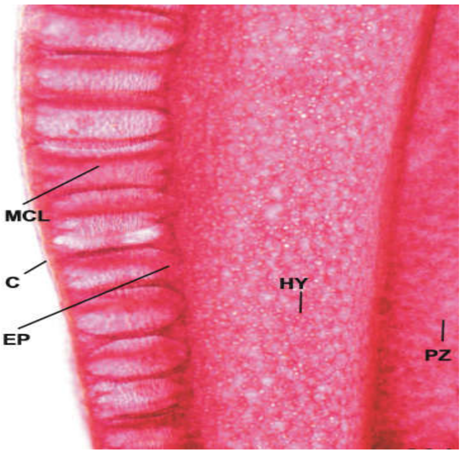




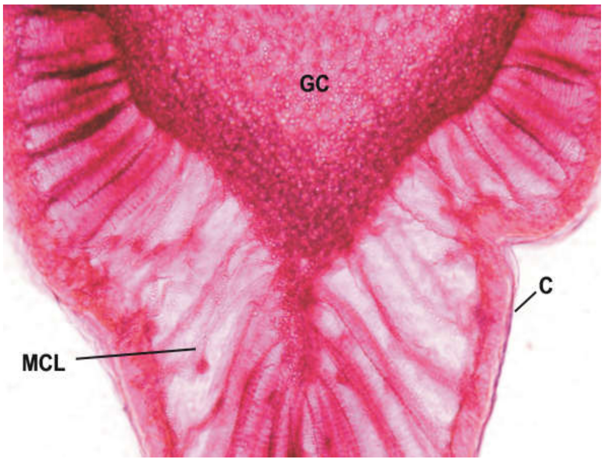
Figs.2A-2F:Serial transverse section of seedling of *D .fastuosa*.
A&2B - The typical diarch root structure X 400. C- Emergence of lateral root structure X 400. D - Xylem cells increasing by the differentiation of meristematic cells in the pith region X 400. E- Xylem cells increasing by the differentiation of meristematic cells in the pith region X 400. F- Emergence of lateral root from pericycle region X 100.
LR– Lateral root, **MX**– Metaxylem, **PH**– Phloem, **PX**– Protoxylem



Figs. 3A-3G: Serial transverse section of seedling of *D. fastuosa*.
A - Showing lateral extension of xylem arms X 400. B - Lateral arms of metaxylem separated and formation of four collateral groups around the pith X 400. C- Showing epicotylar vasculature and cotyledonary trace X 400. D&3E - Showing epicotylar vasculature and cotyledonary trace X 100. F - Showing fused cotyledonary traces X 100.
G -Transverse section of through petioles of cotyledon, showing position of vascular element in cotyledons X 100.
COTT–Cotyledonary Trace, **LX**–Lateral root, **PH**–Phloem, **X**–Xylem; **EV**– Epicotylar vasculature, **CTV**– Cotyledonary Trace Vasculature



4A



4B

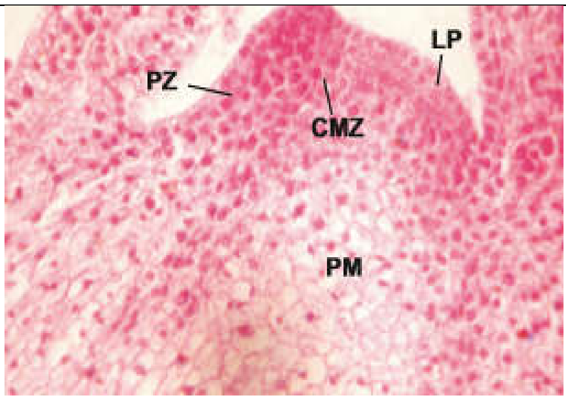
Figs.4A&4B - Structure of mature seed coat of *Daturafastuosa*.

Fig.4A - Enlarge view of lateral side of Fig.1 showing oval shaped macrosclerieds cells X 400.

Fig.4B -Enlarge view of lower side of Fig.1 X 400.

C–Cuticle,**EP**–Epidermis, **GC**–Granular Contents, **HY**–hypodermis

MCL– Macrosclerieds cells,**PZ**– Parenchymatous zone



5A

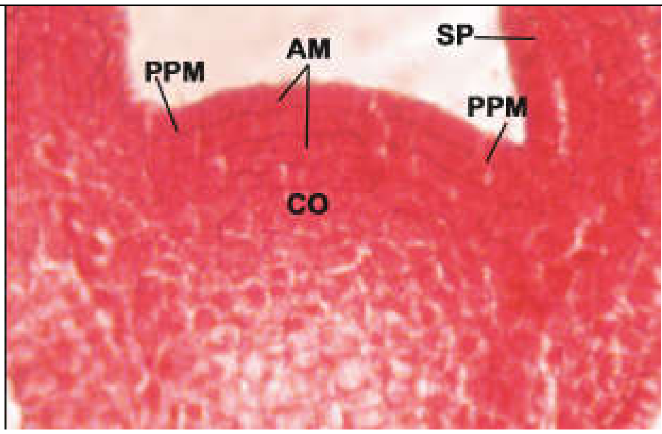
5B

Figs.5A&5B: Median longitudinal sections of the vegetative shoot apex of *D.fastuosa*.

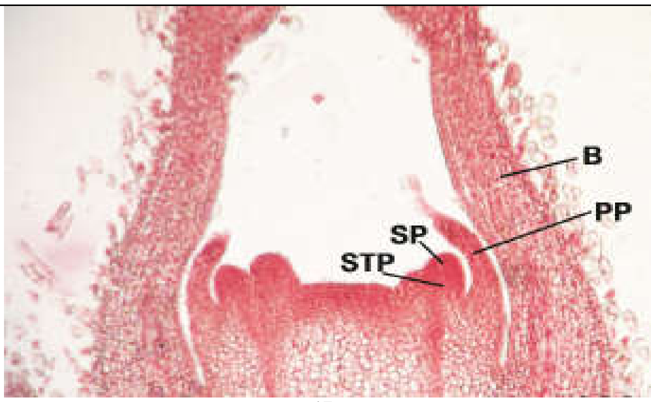
Fig. 5A- At minimal stage X 400.

Fig. 5B- At minimal stage X 400.

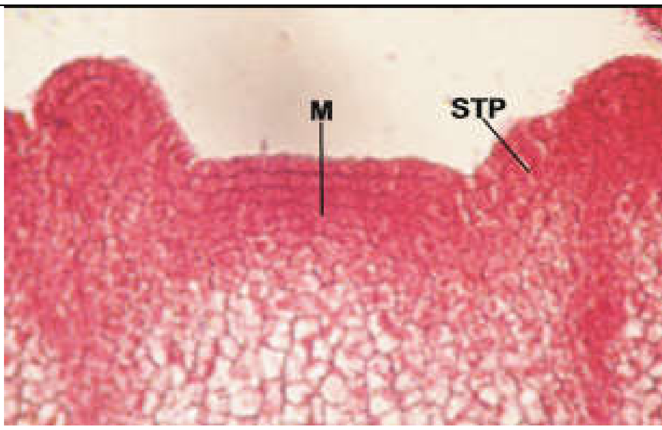
CMZ–Central mother cell zone,**LP**–Leaf primordial, **PM**–Pith meristem,**PZ**–Peripheral zone,



6A



6B



6C

Figs.6A&6C:Median longitudinal sections of the reproductive shoot apex of *D.fastuosa*.

Fig. 6A- Floral primordium with sepal primordia X 400.

Fig. 6B- Floral primordium with petal and stamen primordia X 100.

Fig. 6C- Enlarge view of Fig.21 X 400.

AM–Axial mantle,**CO**–Core,**M-**Mantle,**PPM**–Peripheral mantle,**PP**–Petal primordial, **PZ**–Peripheral zone **SP**–Sepal primordial, **STP**–Stamen primordia

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