International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Seedling Anatomy in *Helianthus Annuus*, *Tagetus Erecta* and *Zinnia Elegans* of Asteraceae

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Abstract: ***Primary tissue differentiation in two days old seedlings was studied in three species of family Asteraceae. In all the three species viz., Helianthus annuus Tagetus erecta and Zinnia elegans, two protoxylem groups differentiate at alternate positions to two protophloem groups. The typical diarch root is established in all the three species. In all the three species the cotyledonary node is of trilacunar three trace type. In H. annuus the endodermis is double layered against protophloem elements and single layered type against protoxylem elements. The pericycle is single layered and parenchymatous type.***

Keywords: *Helianthus annuus; Tagetes erecta; Xanthium strumarium; Zinnia elegans*; Seedling anatomy; diarch root

1. Introduction

Farnsworth, 2008 stated that the seedling phase in a plant's life time is the most busiest phase and the transition region in this phase is defined as the region where root system establishes connection with the shoot system and where the structural details change from level to level in relation to the differences between the two systems. Mauseth (1988) described that the interface between the root and shoot in seedling has been a problem, because of the different arrangement of the primary vascular tissues of the two organs. Van Tieghem (1970) described very briefly the transition in a few plants of compositae and Gerard (1881) reported the results of studies on seedling anatomy of two members of compositae.

In seedling anatomy three types of transition are described by Van Tieghem (1891) Sargant (1900) added the forth type of transition to the three described by Van Tieghem. Compton (1912), Harris *et al.* (1921), Gehlen (1921), Me Murray and Fisk (1936), Yarbough (1947), Kawatake (1955) are among the various workers who have studied the seedling anatomy of leguminoseae. Seedling anatomy is important for the organization of apical meristems and nature of transition.

The vasculature system of the seedling is of interest because it represent the first realization of the vascular coordination between the shoot and root; which was foreshadowed in the procambial system of the embryo (Esau, 1965). Studies of Asteraceae seedlings by Artschwager(1943) has shown that the root shoot transition region, which has both independent and common cotyledonary leaf traces, is different from eudicots and it seems to occur in the entire Asteraceae family (Dangeard 1889). The present work was carried out to study the structure and differentiation of vascular tissues in root, hypocotyls and cotyledons of three species of Asteraceae family.

2. Materials and Methods

Seeds of *Helianthus annuus,Tagetus erecta and Zinnia elegans* were germinated in petriplates lined with moist blotters. Two days old seedlings collected from the germinated seeds were fixed in FAA (Formalin Acetic Alcohol) for 24 hrs and maintained in 70% ethanol. The material were dehydrated through TBA series and embedded in paraffin. Serial transverse sections were cut at 8-12 µm and affixed to the slides using Haupt's (Johansen, 1940) adhesive. Dried sections passed through down and up xylene series and stained with safranin – light green combination. Microphotographs were taken using Nikon's microscope.

3. Observation

In *H. annuus* the root showed protoderm (single layered), protocortex (7-8 layered) and procambium at the root pole. The protodermal cells are large and thicker walled. The protocortex cells are cylindrical, vacuolated and have developed intercellular spaces. The procambial cylinder is composed of small isodiametric cells. Proximally 2 opposite groups of 2-3 cells each start becoming vacualated and thicker walled. These groups represent the first formed phloem elements. Alternating with these, two protoxylem elements are differentiated. At higher levels metaxylem and metaphloem elements are established. In *T. erecta* and *Z. elegans* the protophloem elements differentiate first followed by the protoxylem elements at alternate positions. Pericycle is single layered and parenchymatous. Endodermis in *H.annuus* is double layered against the protophloem elements and single layered against the protoxylem elements. The typical root structure is diarch with two exarch xylem groups alternating with two phloem groups in all the three species.

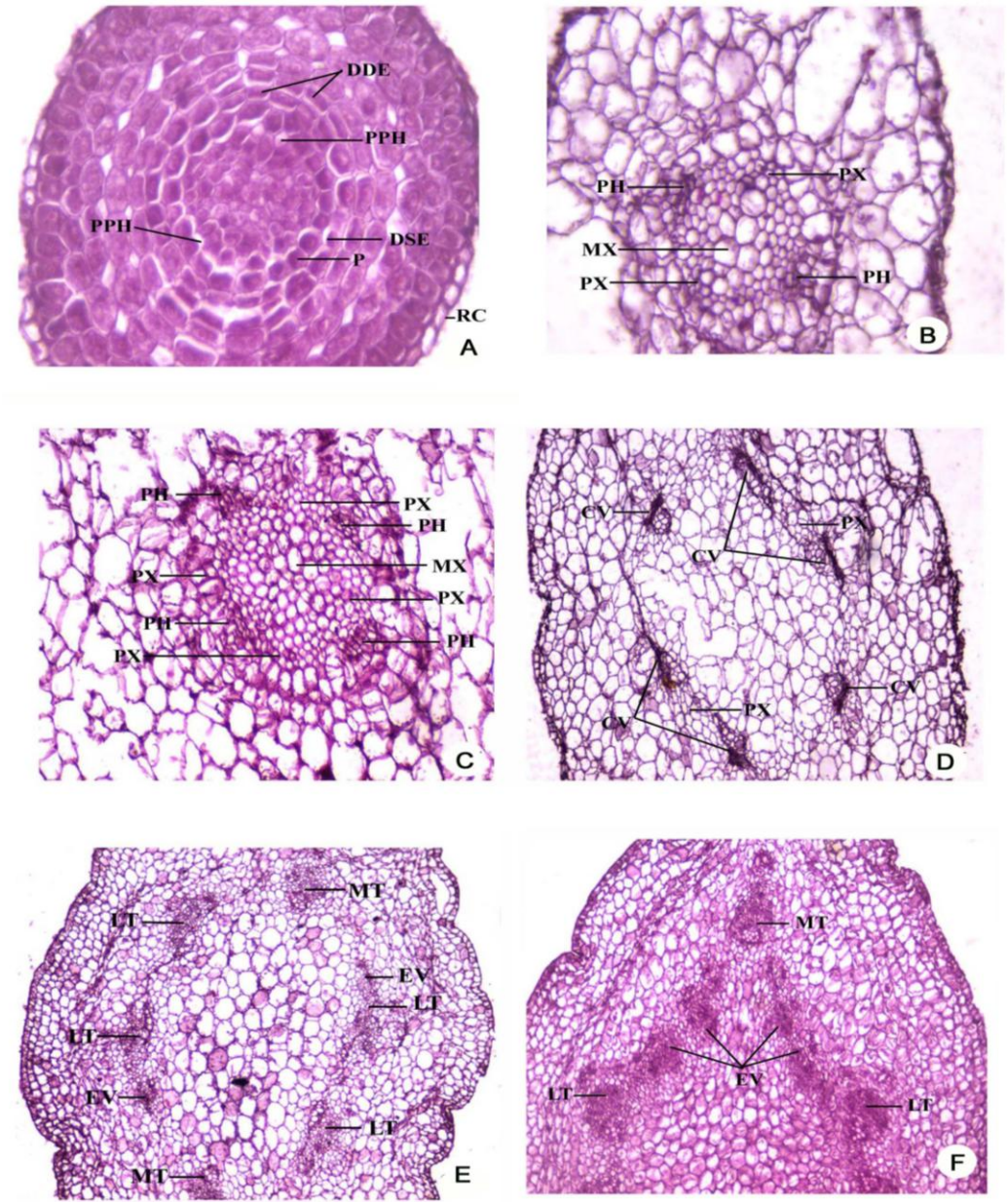
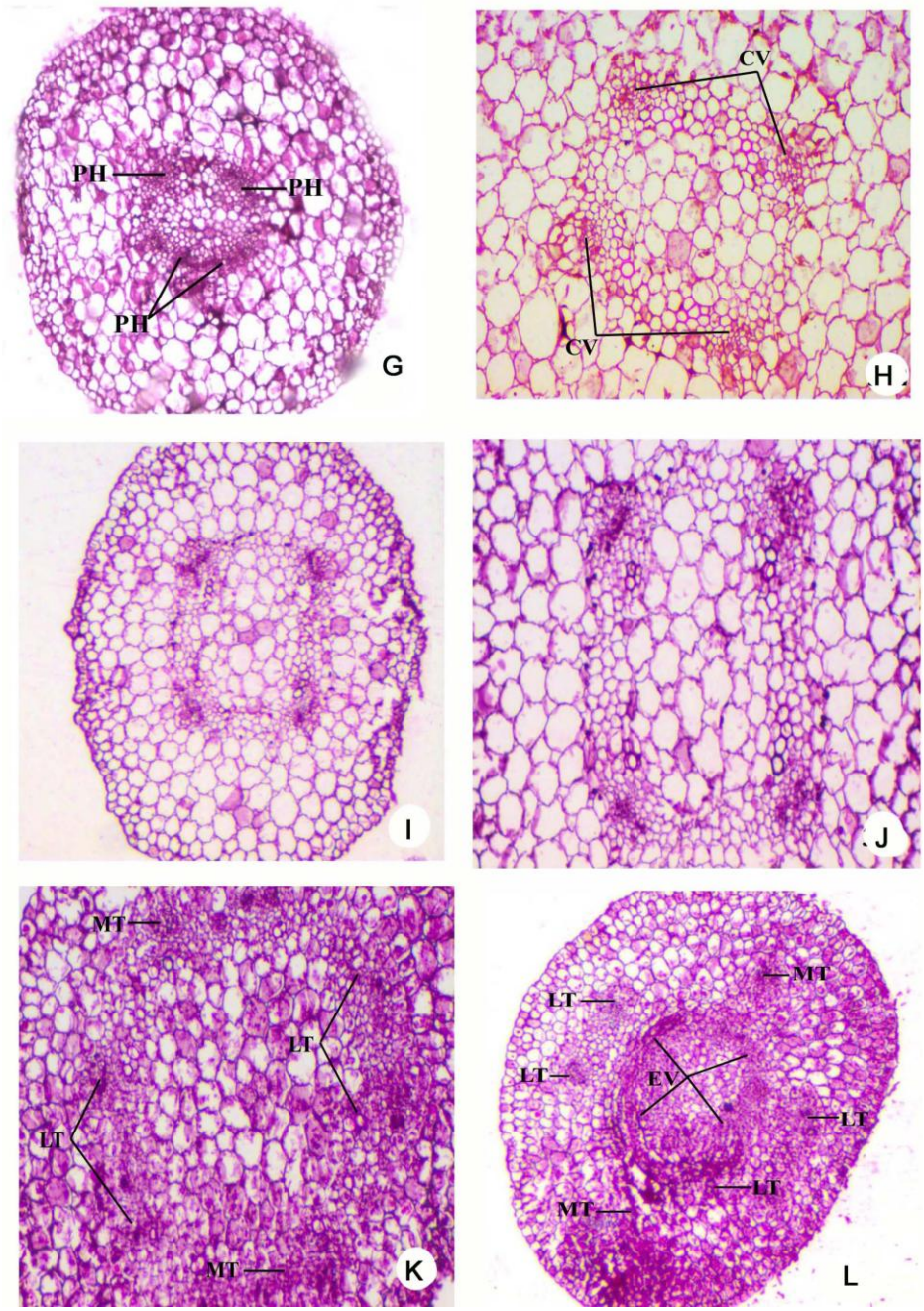


Figure 1 (A-F): Transverse sections of seedling showing initiation of protophloem and protoxylem **(A)**, Establishment of typical diarch root **(B)**, Transverse sections of seedling in *H. annuus* through hypocotyl showing changes from diarch to tetrach condition **(C)**, formation of four collateral vascular groups and two protoxylem group **(D)**, Transverse sections of seedling in *H. annuus* showing downwardly differentiating epicotylar vascular groups in place of two protoxylem groups **(E)** and formation of six collateral bundles(**F**).

DDE – Differentiation of double layers of endodermis
CV – Collateral vascular bundle
PPH – Phloem precursors
MT – Median trace
DSE – Differentiation of single layer of endodermis
LT – Lateral trace
P – Pericycle
PH – Phloem
PX – Protoxylem
MX – Metaxylem

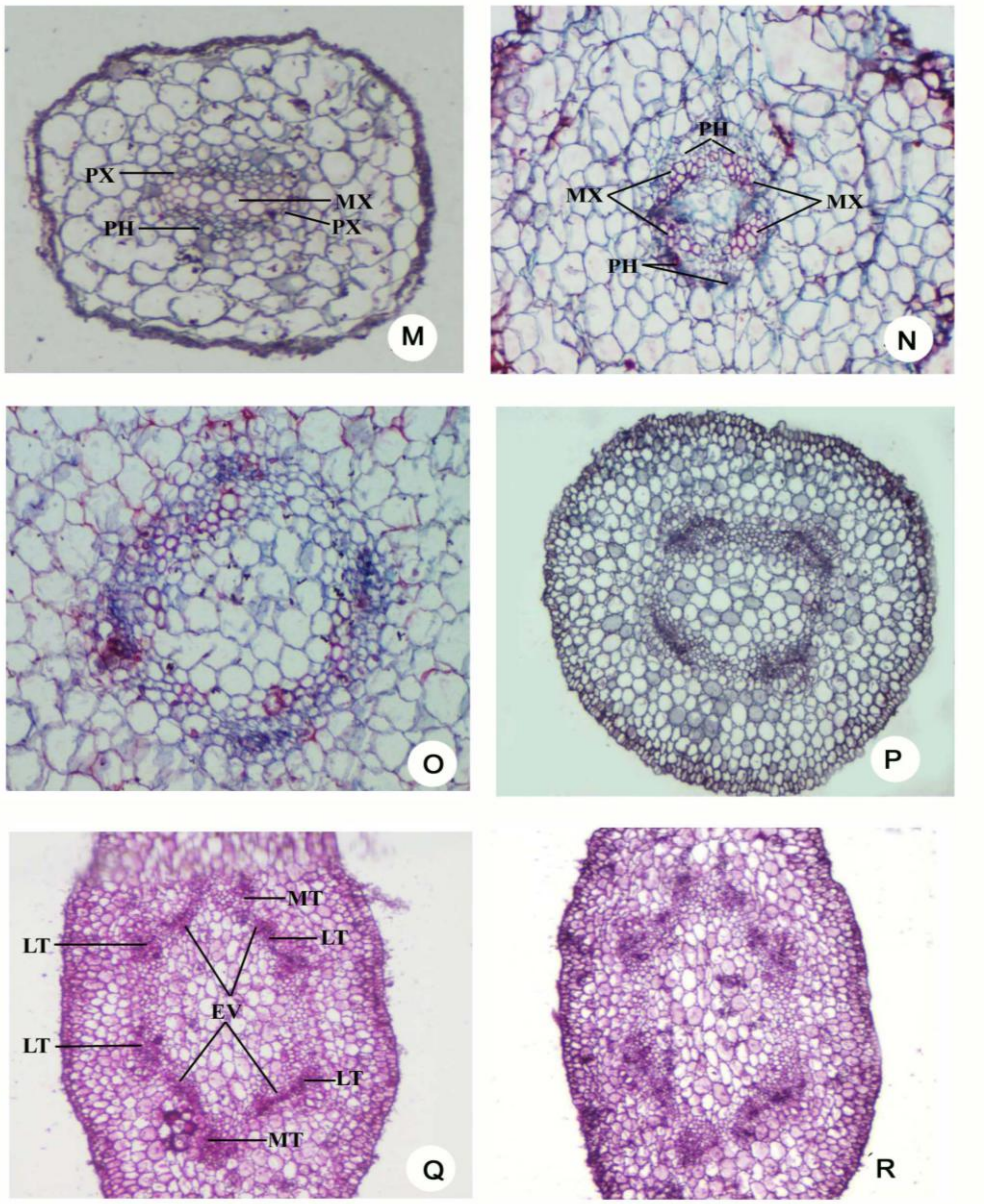
In the hypocotyl region of *H. annuus* more xylem differentiates at higher levels and the metaxylem groups split in to 4 groups. The two phloem groups extend laterally and each divide into two, so that one phloem group is established outside one xylem group forming four collateral vascular groups. Two phloem groups downwardly differentiate in the cotyledonary plane outside the small groups of xylem elements. So total numbers of six collateral vascular groups are formed. While in *T. erecta* and *Z. elegans* due to the differentiation of parenchyma and xylem four collateral vascular groups are formed, each with one xylem and one phloem group. Lateral roots are also seen in root and hypocotyl regions of *Tagetus* and *Zinnia.* The cotyledonary node is of trilacunar three trace type in all the three species. In *H. annuus* the two vascular groups prepare themselves as two median traces.

The two bundles on either sides of the median bundles prepare themselves as laterals to the two cotyledons. So each cotyledon is supplied by one median and two laterals and three gaps are formed in axis vasculature. While in *T. erecta* and *Z. elegans* out of the four collateral vascular groups (CV_1, CV_2, CV_3 and CV_4) CV_2 and CV_4 leave as median traces of the 2 cotyledons. The other two vascular groups (CV_1 and CV_3) bifurcate. The two branches formed in this way, one branch leaves as lateral trace to one cotyledon and other as lateral trace to the second cotyledon. This way each cotyledon is supplied by three traces. There are four gaps formed in the axis vasculature and each cotyledonary node is of trilacunar three trace type.



Figures G-L: Transverse sections of *T. erecta* showing diarch root structure **(G)**, Formation of 4 collateral bundles **(H)**, Transverse sections of seedling showing organization of cotyledonary traces **(I, J)**, Transverse sections of seedling showing branching of two collateral bundles to four lateral of two leaves (split laterals) **(K)**, Departures of three traces to a leaf **(L)**
MT - Median trace

LT - Lateral trace
EV - Epicotylar vasculature
PH - Phloem
CV - Collateral vasculature



Figures M-R: Transverse sections of seedling in *Z. elegans* showing diarch root **(M)**, Lateral extensions of metaxylem **(N)**, Transverse sections of seedling showing four collateral vascular groups formation **(O,P)**, Transverse sections of seedling showing organization and departure of cotyledonary traces **(Q,R)**.

PX - Protoxylem
PH - Phloem
MX - Metaxylem
EV - Epicotylar vasculature
LT - Lateral trace
MT - Median trace

4. Discussion

Primary tissue differentiation in two day old seedlings in three species of the Compositae studied here showed appearance of protophloem first followed by the protoxylem at alternate position. In *H. annuus* the endodermis is double layered against protophloem elements and single layer against protoxylem elements. Sheirer and Hillson (1973, 74) reported this differential type of endodermis in *H. annuus.* The pericycle is single layered and parenchymatous type in all the three species. In *H. annuus* the root showed complete filling of central region by metaxylem. The beginning of hypocotyls is marked by initiation of *in situ* parenchyma differentiation in the central region, due to which the metaxylem splits into 4 groups. The phloem groups also extend laterally and each divides into two, so that one phloem group is established outside one xylem group forming collateral vascular groups. The data seems to

support Eames and Mac Daniels and others (1947). In all the three species the cotyledonary node is of trilacunar three trace type with split laterals in the *Tagetus* and *Zinnia.*

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