J. Indian bot. Soc. Vol. 69 (1990) 19-23

SEEDLING ANATOMY AND NODAL VASCULATURE OF SOME CUCURBITACEOUS MEMBERS

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In all species, the primary root is tetrarch. The mode of transition is similar to type 'A' of Eames and Mac Daniels (1947). The cotyledonary node is unilacunar two traced in all species. The anatomy of three successive nodes revealed that each leaf receives three traces and leaves one gap in main cylinder. These three traces divide to form seven bundles in the petiole.

Keywords : Seedling, Nodal, Anatomy, Cucurbitaceae.

Anatomical studies in seedling have helped in uderstanding the course of primary vasculature, root-shoot transition, vascular supply of the cotyledons and relationship between the root-hypocotyl and epicotyl vasculature. The present communication describes the seedling and nodal vasculature in four species of Cucurbitaceae viz. *Cucumis sativus* (L.), *Citrullus lanatus* var *fistulosus* (Steward) Comb. nov. *Lagenaria siceraria* (Mol.) Standley and *Momordica charantia* (L.).

MATERIALS AND METHODS

Seeds were sown in Petriplates and in pots to study seedling anatomy of three successive nodes. The material was fixed in FAA (Formaline acetic acid ethyl alcohol) and preserved in 70% alcohol. The usual methods of dehydration, infiltration and embedding were followed (Johansen, 1940). The microtome sections were cut at 10-12 μ and stained with crystal violet-erythrosin combination.

OBSERVATIONS

In all the species, germination is of epigeal type. The young primary root is tetrarch (Figs . 1B, B_1). There is single central metaxylem element associated with four protoxylem groups, at the tip of the root, but higher up more metaxylem elements differentiate and they are separated from each other by central parenchymatous tissue. The pericycle is two or three-layered surrounded by an indistinct endodermis. The cortex is parenchymatous with oval cells and large intercellular spaces and is enclosed by a single-layered epiblema.

The root-shoot transition starts in lower part of the hypocotyl and the transition zone is short. The portion below the peg (Fig. 1A) exhibits a normal root structure. The metaxylem elements are separated by a well developed parenchymatous pith. At a slightly higher level, just below the peg, each xylem group shows differentiation of metaxylem elements at an increasing angle on either side of the protoxylem, thus it appears as if each vascular bundle has forked into two (Figs. 1C,C_1). At a still higher level, these meta-xylem elements differentiate more and more on the deviating angle and thus each vascular bundle has metaxylem elements arranged in two arms, and the the protoxylem lies at right angle to them. The arms of the adjacent vascular bundle are close to each other. Meanwhile the phloem patches remain in their original position and do not show any change. At a higher level, above the position of the peg metaxylem elements differentiate almost at an angle of 180° from their original position and associate with the phloem patch of their respective side. The protoxylem elements come to lie at a more deeper position. Thus four endarch, collateral, conjoint vascular bundles are formed (Figs. 1D, D_1) and each bundle is made up of two halves which are contributed by the two adjacent vascular bundles of the root.

These four bundles remain undivided in the hypocotyl or they divide to form seven or eight vascular bundles. In *Citrullus lanatus* var. *fistulosus* (Fig. 1 I), there are eight bundles, while in *Momordica charantia* (Fig. 1L) and *Lagenaria siceraria* (Fig. 1M) one of the bundles fails to divide and there are only seven

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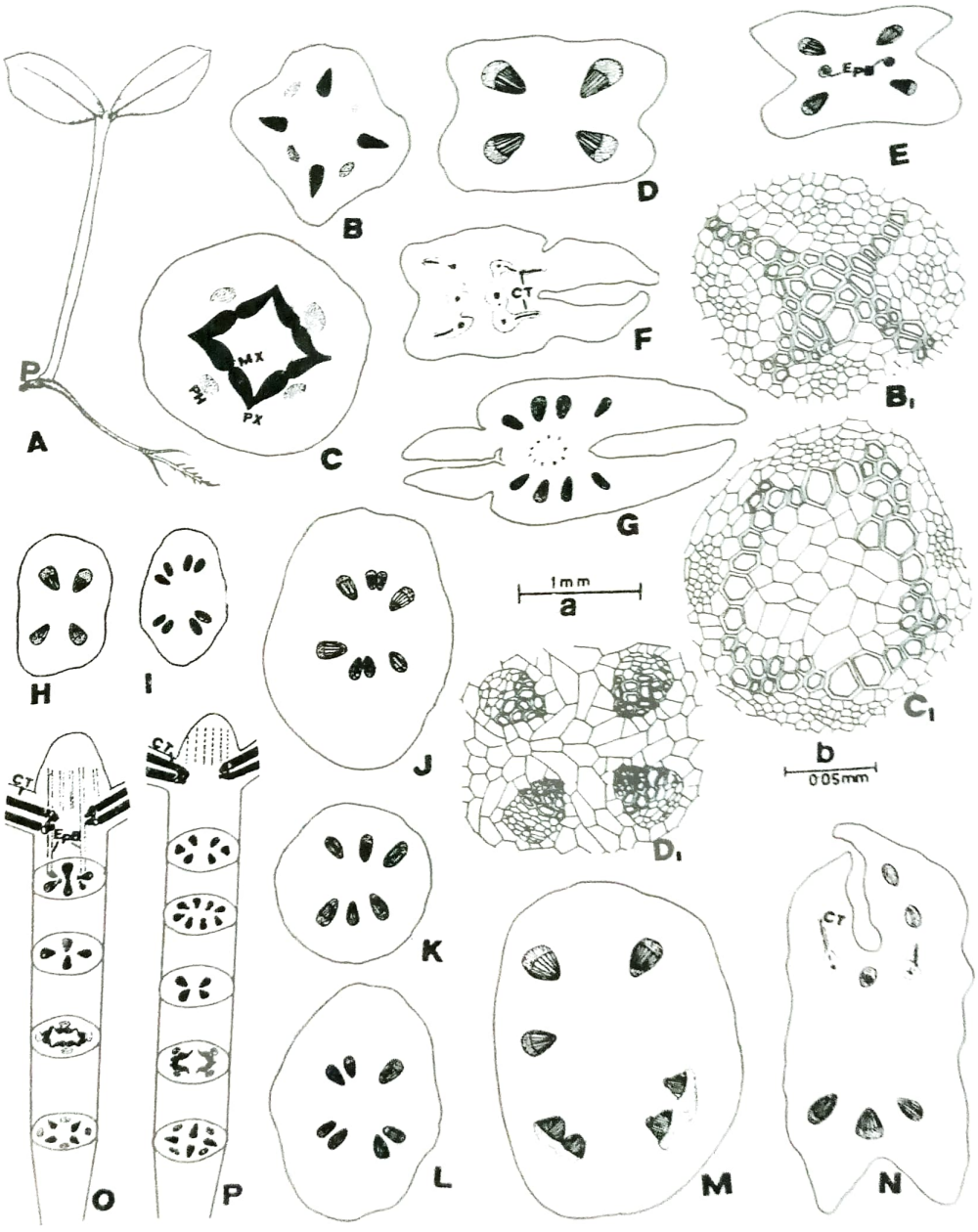

Fig. 1. A Seedling of *Cucumis sativus*; P-Peg B-G, Serial transverse sections of seedling from root to upwards of *Cucumis sativus*. B_1 D_1 Cellular diagrams of figs B-D. H.K. Serial transverse sections of seedling of *Citrullus lanatus* Var : *fistulosus* showing formation of six bundles from four bundles. L showing bundles in *Lagenaria siceraria*. M-N showing bundles and cotyledonary traces respectively in *Momordica charantia*. O P hypothetical diagrams showing course of root-shoot transition in *Cucumis sativus* and *Citrullus lanatus* Var. *fistulosus* respectively

Scale a: Figs B-N; Scale b: Figs B_1-D_1

seven vascular bundles. These vascular bundles of the hypocotyl fuse to form finally , six vascular bundles in each case (Fig. 1K). In case of *Cucumis sativus,* four bundles do not divide, on the other hand, two bundles of the epicotyl traverse downwards and lie diagonally opposite to each other (Fig. 1E). The four hypocotyledonary bundles become bicollateral during their course in the hypocotyl and the cotyledons. The inner phloem differentiates from the procambial strands, differentiated on the inner side.

In all the four species studied, below the cotyledonary node there are six endarch, bicollateral bundles, arranged in a ring. These vascular bundles can be distinguished into two groups of three each, having a median and two lateral bundles. The median vascular bundle is derived from the epicotyl region as in *Cucumis sativus* (Figs. 1F,O) or it is the resultant of division of hypocotyledonary vascular bundles as in other three cases (Figs. 1K,P). In each group the median bundle branches into two and the two branches fuse with the two lateral bundles of their respective side. Later the lateral fused bundles traverse into the cotyledons of their respective side (Fig. 1G). Thus although cotyledons receive only two traces, but as a matter of fact all the three vascular bundles contribute to the supply of each cotyledon. In *Momordica charantia* the middle bundles do not contribute towards the formation of cotyledonary traces and continue upward in the epicotyl (Fig. 1N). The epicotyl vasculature is mainly differentiated from the procambial strands of the shoot, except in *Momordica charantia* which shows continuity of vasculature of the hypocotyl and epicotyl.

In all the species, the vascular pattern in three successive nodes is similar except minor variations. Hence, only one node is described in detail, There are eight vascular bundles in *Cucumis sativus* and *Lagenaria siceraria* (Fig. 2 F), 10 in *Citrullus lanatus* var. *fistulosus* (Fig. 2A) and 12 in *Momordica charantia* (Fig. 2G) in the internodal region. In *Citrullus lanatus* var. *fistulosus* and *Lagenaria siceraria* the leaf traces which are three or four fuse to form a vascular plexus (Fig. 2C) which later on splits into 7 vascular bundles (Fig. 2D). In *Citrullus lanatus* var. *fistulosus* there are 10 (Fig. 2E) vascular bundles while in *Lagenaria siceraria* there are 8 vacular bundles in the internode (Fig. 2F). Same pattern is found in *Cucumis sativus* also, In *Momordica charantia* the leaves are sub-opposite (Fig. 2J) and the plexus forms five vascular bundles in the petiole (Fig. 2 H, I) which later on divide to form seven vascular bundles. There are 12 vascular bundles in the internode of the axis.

DISCUSSION

Eames and Mac Daniels (1947) described four major types of transition, of which type B is mentioned for *Cucurbita* while Despande and Kasat (1966) have described type 'A' in many members of Cucurbitaceae. The present observations are in full conformity with the observations of Despande and Kasat (1966).

The root shoot transition takes place in lower part of hypocotyl and the seedling can be demarcated into three regions, a lower region with radial condition of xylem and phloem and with exarch condition, a middle region where an actual change takes place is an intermediate region and the upper region with endarch collateral vascular bundles and constituted of cotyledons and upper hypocotyl. There is a continuity of protoxylem elements from root to the cotyledon vasculature through the hypocotyl, but the metaxylem elements differentiate centrifugally in the upper region so that the different xylem elements formed at different length of the hypocotyl do not lie in continuous verticle files.

Many workers previously established continuity between the vasculature of epicotyl and root hypocotyl. Hufford (1938) reported indirect connections between hypocotyl and epicotyl vasculature through cotyledonary trace while Despande and Kasat (1966) established a definite relationship between root and epicotyl vasculature suggesting that the cotyledonary traces get seperated while entering epicotyl at the cotyledonary node. The present work also supports this view.

The cotyledonary node is a unilacunar two traced structure. However, with the association of the middle bundles in the formation of two cotyledonary traces, they are anatomically become three traced unila-cunar. The foliar node is also three traced unilacunar in all the species studied, but there is a tendency of becom-

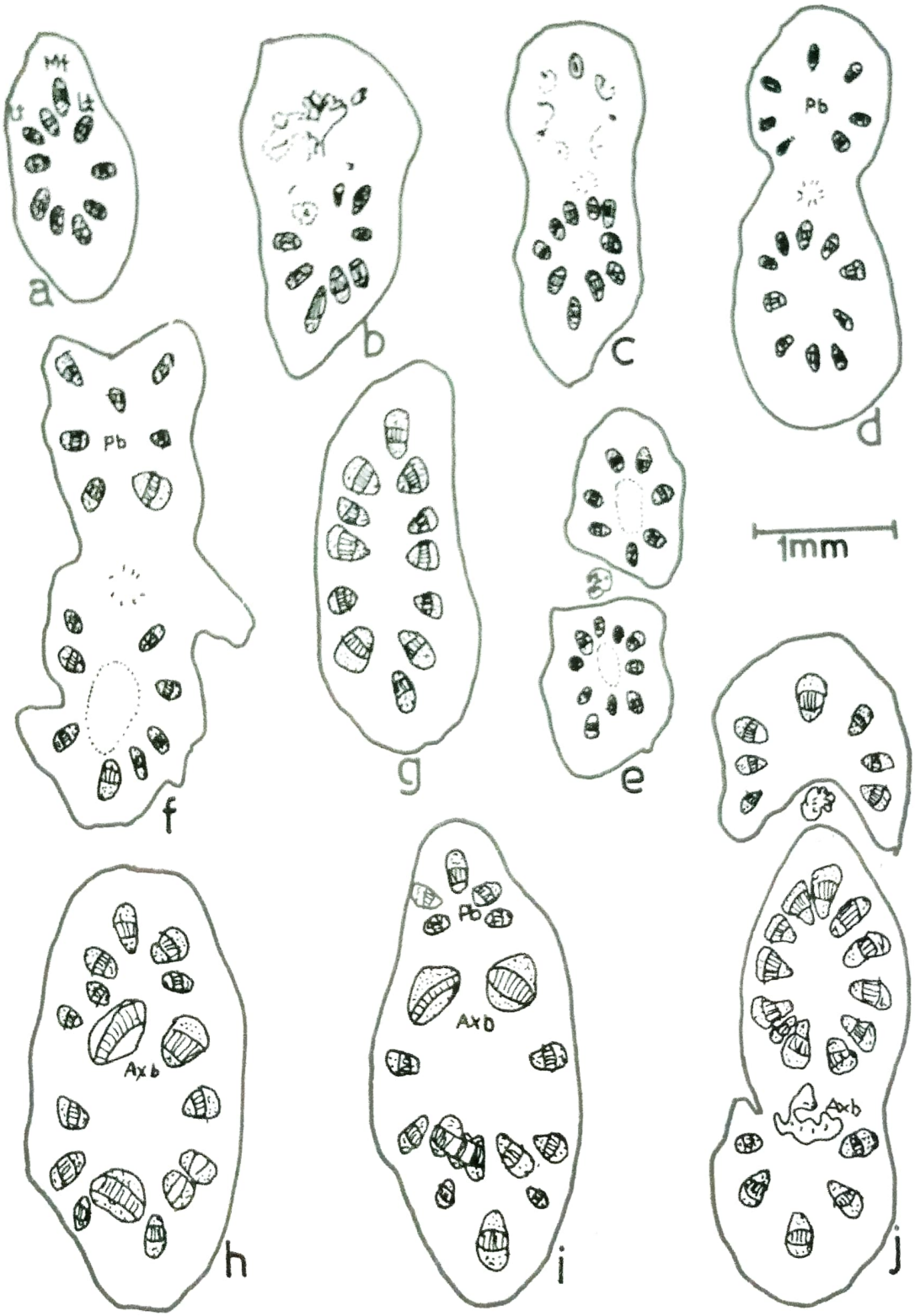

Fig. 2. A-E serial transvevse sections of 3rd node of *Citrullus lanatus* Var: *fistulosus*., F 2nd node of *Lagenaria sicoraria*, G-J serial transverse sections of 2nd node of *Momordica charantia*.

ing multitraced unilacunar structure. Marsden and Bailey (1955) and Bailey (1956) suggest that where foliar node is trilacunar, the cotyledonary node is unilacunar double traced. In this respect our observations on the species studied here are in agreement with the conclusions made by the above authors. Takhtajan (1969) suggested that trilacunar 3 traced or multilacunar 2 traced is the primitive node while Conde & Stone (1970) described unilacunar two traced node in Juglandaceae as primitive type. However, Dickison (1975) suggested trilacunar three traced node as primitive.

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