J. Phytol. Res. **8** (2): 171-176, 1995

DEVELOPMENTAL MORPHOLOGY OF LEAF MID VEIN GALLS OF *SALVADORA PERSICA* LINN; (SALVADORACEAE) INCITED BY *THOMASINIANA SALVADORAE* RAO (CECIDOMYIIDAE : DIPTERA)

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Thomasiniana salvadorae induced gouty galls on the mid vein of *salvadora persica*, often the basal part of the mid vein is markedly swollen, although at times either the middle part or rarely distal part may be swollen. The gall is confined and usually visible on both sides of mid vein. Sometimes, galls are agglomerated, resulting in a wrinkled leaf margin. The galls are fleshy, hard swellings with a large larval cavity in the centre part. The swelling results from diffuse hypertrophy of the cells in the ground tissue and the dermal elements. Many of the characterstic traumatric responses such as partially thickened mechanical zone, vascular arch, cells around larval cavity are described in relation to gall development. Pupation is completed inside the larval cavity, and the imagos bore their way out. The exit holes are circular, one to many per gall, occuring on the gall surface.
Keywords: Developmental morphology; Midge; Midvein gall; *Thomasiniana salvadorae*.

Introduction

Gall midge are usually quite specific as to the plant part it attacks. A species may produce galls on different organs of the same plant as *Thomasiniana salvadorae* induce galls on *salvadora persica* stem also[1]. In general midge galls on mid vein and large side veins are generally, more or less, localized globose, solid, hard and are popularly called gouty vein galls. Gall morphogenesis is the result of interaction between the morphogenetic control of the plant body[2] and the insect factor[3]. Galls on *Salvadora persica* generally develop during summer months in Jaipur, Sitamata forest and other parts in Rajasthan. The present paper deals with developmental morphology and anatomy of the mid vein galls on *salvadora persica.*

Materials and methods

Normal and galled leaves were collected from Sitamata forest and Jaipur and fixed in F.A.A. Depending upon their relative dimensions, galls were graded into various developmental stages and processed through customary methods of dehydration and embedding. Serial sections (8-12 µm) were stained with safranin- fast green combinations.

Observations

Structure of normal midvein : Both adaxial and abaxial eipdermis are made up of rectangular cells coated with cuticle. Stomata with sub-stomatal cavities are only on the abaxial side (Fig. 2H). Mesopyll is composed of 2-3 layers of thin walled compactly arranged cells, on both the sides containing chloroplasts (Fig. 2H). Vascular bundle is embeded in the colourless central part and surrounded by a bundle sheath. Bundle is accompanied by more sclerenchyma on upper side and less towards lower side (Fig. 2H). The phloem lies towards the abaxial side. Secondary growth is not very conspicuous and 2 to 4 celled wide medullary rays also observed.

External gall morphology: The galls range from 2.0-3.0 mm in diameter and 6.0-8.0 mm in length, being slightly one to five times the width of non-swollen parts of mid vein (Fig.1

A,B). Sometimes 2 to 4 galls fuse to form a compound structure. Galls are oval, subglobose, cylindrical, moniliform, glabrous, hard, woody, fleshy and indehiscent (Figs. 1 A,B). Young galls are green to pale-yellow but turn grey-brown at maturity. Along with vein a part of the lamina on either side is also involved in galling, so that the gall is pronouncedly wide with wrinkled leaf margin (Fig. 1 B). Generally galls are solitary but upto 3 galls at various stages of their development have been observed on a single mid vein. The insect escape holes are one to many on gall surface. They are circular, external openings of the tunnels of 600 to 800 um diameter extending from the larval cavity. Older galls usually burst as small pimple like warts on gall surface. The periderm like zone may occur on both adaxial and abaxial sides.

Gall Histology: The leaf mid vein galls showed profound alteration in normal characterstics of both morphological and anatomical structures. cross sections of young galls show that the epidermis is in continuation with the epidermis of normal mid vein on adaxial and abaxial surfaces without stomata (Fig. 1 C, 2I). In older galls, however periderm develops in patches but the amount and thickness depends up on the age of galls. The main bulk of gall tissues is composed of large sized thin walled, closely packed parenchyma cells. The gall parenchyma cells are large in size (32.5 x 29.0 -49.0 x 43.5 µm) as compared to the normal parenchyma cells (29.5 x 17.5 -36.0 x 27.5 µm). 4-7 layers of partially thick-walled cells constitute the mechanical zone. These cells are polygonal and strongly thickened on inner tangential and radial walls, a few layers away from the larval cavity (Fig. 1E, 2I,J).

The gall cavities generally extend throughout centre to the epidermis of gall, with one cecidozoa (Fig.1D,2I). The cells around the cecidozoa cavity exhibit features of the nutritive zone having dense cytoplasm and prominent nuclei of various sizes (Fig. 2K). The gall is localized to mid vein region, thus instead of a single vascular bundle, number of vascular strands are observed due to proliferation of ray cells and consequently the xylem tissue occurs in the form of narrow bands, alternating with partially thickened proliferated medullary rays (Fig. 1C, F). starch grains are also loaded in some cells of this region (Fig. 1 F). The characterstic interxylary phloem is observed unlike normal.

Developmental morphology of the gall : The midge larva enters the host tissue generally, at the base of midvein at a very early stage of differentiation of the vein, gets burried in the embryonic ground tissue and feed on them. The activities of the larva break the physiology and biochemical coordination of the host tissues, around the larval chamber from the other parts of the organ. This isolated portion of the mid vein tissue exhibit different morphogenetic pathway. The cells in this region do not differentiate into normal tissue components of mid vein; they divide very actively by periclinal wall causing the infected part of the mid vein to assume a moniliform configuration (Fig. 1A, 2D). New attacks may be made continually on young vein, as a result, a number of galls appear at various stages of development on the same midvein (Figs. 1B, 1A-F). The cells around larval chamber become conspicuous due to development of granular cytoplasm and prominent nuclei and act as nutritive zone of gall. The ground tissues, especially those

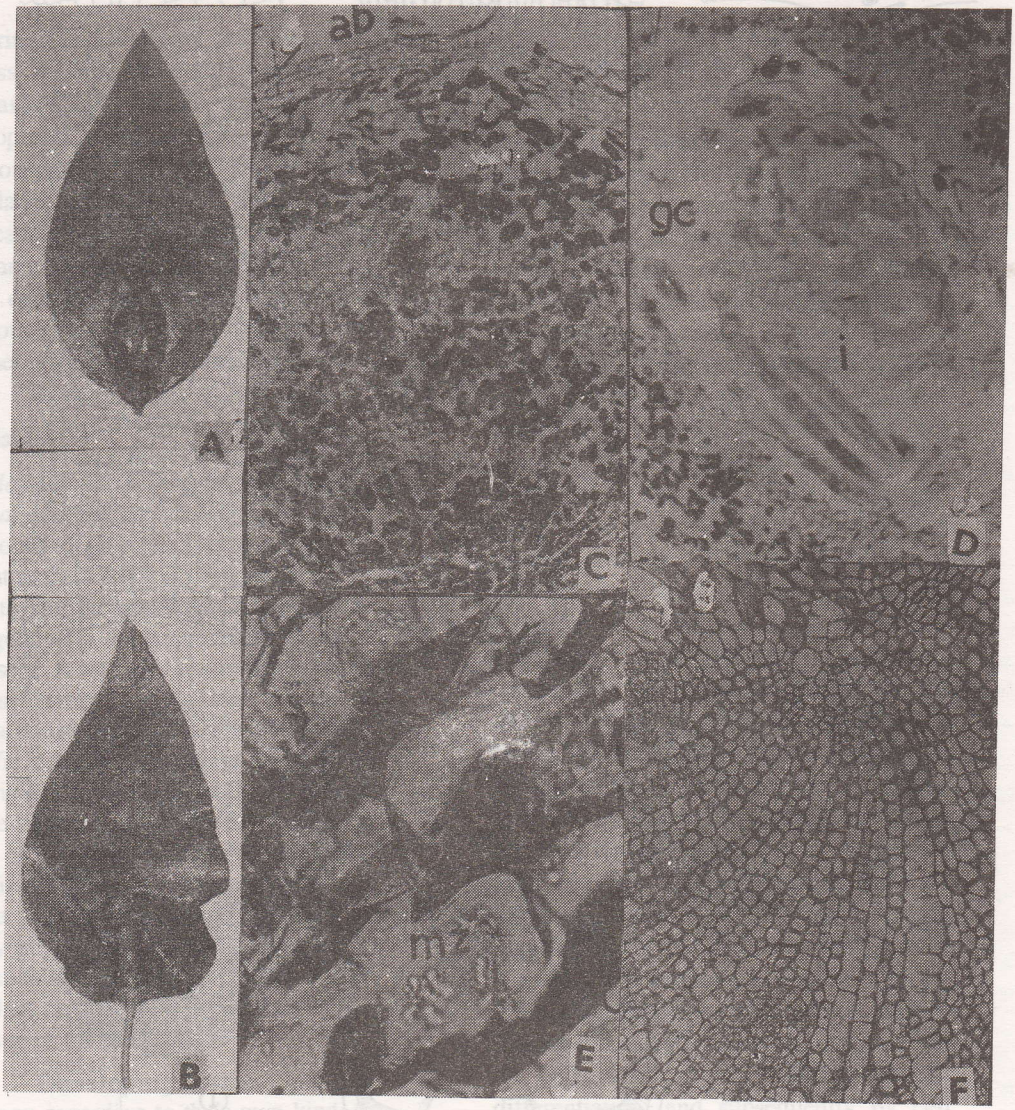

FIG I

Fig. 1. A-F.: Leaf mid vein galls of *Salvadora persica* Linn.
A-Leaf with gall on adaxial surface. B-Leaf with gall on abaxial surface showing ostiolar openings, C-A portion of a mature gall in T.S., showing abaxial side x 50. D-Aportion of gall in T.S. showing insect in gall cavity x 50. E-A portion of gall mechanical zone x 500; F-A portion of secondary xylem in T.S. showing included phloem and starch grains in xylem parenchyma x 125.

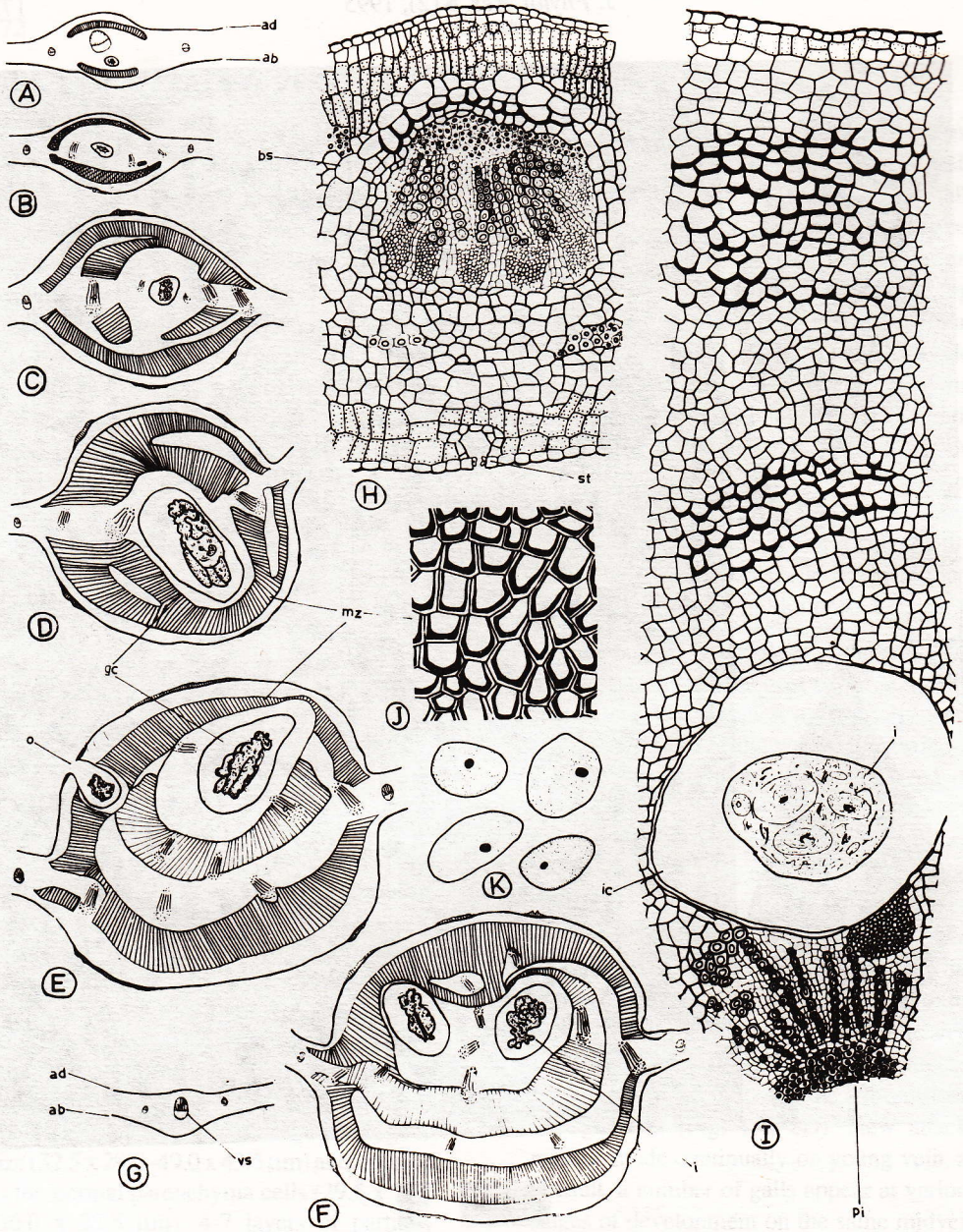

Fig. 2 A-K : Leaf mid vein galls of *Salvadora persica* Linn.
A-F : T.S. of galls showing comparative stages in development. x 14, G : Cross section of a normal leaf midvein. x 14, H: T.S. of normal leaf midvein. x 133, I : A portion of mature gall in T.S. showing insect in insect cavity. x 133. J: A portion of mechanical zone in T.S. cells showing partial thickning on their walls. x 254. K: Representive samples of gall parenchyma nuclei. x 640
Ad- adaxial epidermis ab= abaxial epidermis; vs= Vascular strands; bs= bundle sheath; mz= mechanical zone; ic = insect cavity; i = insect; st = stomata; gc = gall cavity; sg = starch grains; o = ostiole.

bordering the gall cavity proliferate and possess meristmatic activity results in increase gall biomass. During gall development secondary vascular tissues are conspicous (Fig. 1 F). The main vasculaure losses its characterstic nature and scattered vascular strands observed in gall parenchyma. The meristmatic activity of ray cells also add the thickness of gall, quite often 2 to 3 galls arise closely packed together to form a multichambered structure (Figs. 1 B, 2 F).

Discussion

Developmental principle involved in Normal and Gall morphogenesis : Gall is the product of an active growth reaction of a plant to the feeding activity of an insect. Growth and differentiation of the gall is contigent upon the continued presence of the insect[4]. A well synchronised interaction process involving (i) a high degree of mutual adjustment and (ii) extra-ordinarily specific behavioural patterns in both the participants is the hall mark of galling, choice of the appropriate developmental stage of the host tissue,highly specilized colonization and ovipositional behaviour of the gravid female, and triggering of many physiological modifications in the gall, such as directed growth responses of the plant organ eventually leading to the nature of the gall inducer[5-8].

Developing organ have a tendency according to their own kind, to grow with little about a certain mean size, and to have in fact a certain absolute limitations of magnitude[9]. These intrinsic morphogenetic factors that bring about the totality of picture of endomorphic features are maintained in the course of development of galls on *Salvadora persica* and they suffer only amplification but not more radial alteration[10].

Types of morphogenetic reactions in gall zone: Among the reactions involved in the gall on *Salvadora persica*, all but hypertrophy are the result of traumatic boring by the larvae. The characterstic diffuse hypertrophy is possibly a specific reaction to the physiological stimulus provided by the cecidozoa. Different sectors of ground tissue in one and the same gall suffering different degree of enlargement is often, though not always, depend on their proximity or otherwise to the larval cavity. The gall parenchyma appear to suffer a retardation of wall thickening and lignification (inner tangential and radial wall only) in the gall. However, it is not possible to assess this acurately in view of gradients in differentiation one the same mid vein at different levels, and the hypertrophy the elements suffer in gall region. All the same, the gall in which almost all the medullary parenchyma cells become sclerified shows marked enhancement of the sclerification process in gall zone. Age of the mid vein and level of differentiation of different elements at the time of gall initiation may account for the differences. Gall biomass is generally proportional to feeding intensity of the gall midge. The midge secretes salivary fluids on plant-cells to modify cell wall and the cells reacts to this stimulus by cell differentiation, and subsequently by cell proliferation[11]. Nutritive tissue appears as a consequence of feeding activity of the gall midge, remaining well connected with the vasculature of the normal plant organ. Larval feeding activity is primarily responsible for the shape of *Salvadora* gall.

Acknowledgement

Thanks are due to the U.G.C. for the award of a research grant. Thanks are also due to Prof. V.B. Sanexa, Principal, M.L.V. Government College, Bhilwara for encouragement.

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