RESEARCH PAPER | Biosciences | Volume : 5 | Issue : 7 | July 2015 | ISSN - 2249-555X

Studies on the Stem Galls of Cephalandra Indica

KEYWORDS

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ABSTRACT *The stem galls in Cephalandra indica (common name – Ivy gourd) of family Cucurbitaceae is the result of association of the plant with an insect Neolasioptera cephalandrae (Order - Diptera, Family - Cecidomyiidae). The gall formation was the response of the plant to the stimulus induced by the feeding of phytophagous insect by producing abnormal growth resulting in physiological disturbance of the stem tissues. The stems had undergone considerable morphological and anatomical changes. The gall formation was due to the hyperplasia and hypertrophy of the cells of the stem. Non sporulating stage of a fungus was also found in this gall this helps in nourishing the larvae. Different developmental stages of the insect such as egg larvae and adult were found in the gall chamber of the stem. The insect and plant association were observed beneficial only to the insect.*

Introduction

Gall is the product of an active growth reaction of a plant to the feeding activity of an insect. Expression of a gall is considered as an extended phenotype of the inducer's genome (Dawkins, 2003). Growth and differentiation of the gall is contingent upon the continuous presence of the insect (Shorthouse, 1982). Only a few insect families are able to induce galls in angiosperms and gymnosperms (Buhr, 1965). The gall inducing ability of such insects is considered a highly evolved form of phytophagy. However, gall formation studies are lacking especially with family Cucurbitaceae and hence the present study. The present study is an attempt to understand the insect-plant interaction leading to galling, morphological changes during galling, structure of the gall, anatomical changes during the development of the gall and dehiscence of gall by using Cephalandra indica - Neolasioptera cephalandrae interaction.

Materials and methods

The plant selected for the present study was Cephalandra indica belonging to the family Cucurbitaceae commonly called as Ivy gourd. These plants were obtained from the agricultural land at Changanacherry, Kottayam (Dist.) Kerala.

Normal stems and galled stems of various developmental stages were collected and shape of the gall, size of the gall, type of the gall, appearance of the gall, type of sculpturing of the gall and dispersal of the insect, difference of normal stem with galled stem (size difference, shape difference weight difference, etc.) and condition and developmental stages of fresh stem in which gall formation initiates was recorded. Histological observations were made by free hand sections of galled stems and normal stems.

The insect was collected by keeping the tender twig of the plant which bears stem galls in transparent polythene bags with pin holes. The mouth of the polythene bag was tied tightly with the main axis of the twig, so that the twig can suspend freely inside the bag. Regular observations at specific intervals helped to understand the average time taken for the emergence of insect, which was behind the gall formation. The insect was identified using standard manuals.

For culturing, the gall was inoculated in M.S. medium and incubated for 3 days. Sufficiently grown cultures were smeared and observed under microscope.

Results

In Cephalandra indica almost 50-80% of the stems showed galls. The gall formation is initiated in the tender young stems and as they mature, the galls also matures so the gall formation is profuse in the season when the plant produce more young stems. Galls were also seen in tendrils and leaf petioles. The number of galls in a stem varies according to the intensity of insect attack. It was noted that a negligible area was left without galls in some stems. In some extreme cases, due to intense gall formation, the stem failed to attain maturity and they become dry. Once the gall become mature the insects make holes on the stem and escape outside. Once the insects exited from the gall it is occupied by other organisms, it includes mites, spiders and ants. These successor or secondary organisms are in no way responsible for the formation of the gall, but only utilize the gall cavities as nesting spaces and temporary retreats after the escape of the cecidozoa.

Considerable morphological differences were noted between normal stems and galled stems. (Photo 1&2). The main differences are in the size, shape and weight. Due to profuse galling an individual stem was found to be attaining irregular shape. The average diameter and length of the stem gall of Cephalandra indica is 25 mm and 40 mm respectively.

The galls are stout, fusiform ovoid or ellipsoidal usually localized but often also extensive and moniliform, solid, hard, fleshy, smooth, green or yellowish-green indehiscent, persistent swellings of tender branches, more or less circular in cross- section; with a number of larval cavities in the form of elongate axial canals, 3 or 4 in each gall. Old galls have numerous circular exit holes on the surface. Size of the gall is 25-50 mm long and 15-30 mm thick. The vegetative phase of the plant was seen to be disordered due to the profuse attack of the gall forming insect. But the plant has no threat against its existence.

The histological studies of the gall revealed that it has an

Volume : 5 | Issue : 7 | July 2015 | ISSN - 2249-555X

outer protective massy tissue. There are cavities in the gall with conspicuous sclerenchyma walls were the larvae of the insect reside. Thus the gall tissue was seen to be providing a safe lodging to the insect. Gall parenchyma is scattered with vascular bundles, cecidogenetic centre cortex, medulla and medullary rays, gall tissue chiefly of closely packed parenchyma cells.

The various tissues surrounding the gall is undergoing hyperplasia and hypertrophy which were revealed in photographs taken (Photo 3 & 4). In comparing with normal stem the sections of galled stems at different developmental stages revealed the role of an insect and a part of its life cycle in the gall formation. The young gall of early developmental stages showed the presence of eggs in the locule of the young galls. The sections of galls of subsequent developmental stages showed the presence of larvae of the insect residing in the locules of the gall. The fully matured gall showed an opening, the ostiole. It is through this ostiole the mature insect escapes.

The insect was identified as Neolasioptera cephalandrae belonging to the family Cecidomyiidae, order Diptera, class Insecta and phylum Arthropoda. The insect is off white coloured during its larval stage. The adult is a minute small midge. The observations tend to conclude that Cephalandra indica is the specific host to Neolasioptera cephalandrae and continuous observations showed that the insect was a temporary inhabitant. The insect and plant association was found only beneficial to the insect. The plant harbours the eggs, larvae and adults in the stem galls. Thus the insect had a part of its life cycle in the host plant. The plant uses its energy and metabolism to restrict the insect in the galls.

The gall was cultured in M.S medium and was seen that some mycelium was growing from the cut ends of the gall (Photo 5). The mycelium was separated and observed under microscope and found that the fungus had septate branched mycelium. The culture method confirmed that a fungus was associated with gall and the introduction of fungus is thought to be simultaneous with oviposition.

Discussion

The reason of stem gall formation in Cephalandra indica was found to be a galling insect namely Neolasioptera cephalandrae. The gall was found to be initiated due to the oviposition by the insect on the stem. The gall formation was brought about by the hyperplasia (abnormal cell division resulting in large number of cells which in turn result in tumour formation) and hypertrophy (cells gets enlarged or increase in cell size) of the cells of the stem due to plant insect interaction. The present findings are in tune with available reports Ananthakrishanan (1982). The proliferation of stem tissue was for providing lodging for the insect larva. The insect was not a permanent inhabitant.

The emergence and dispersal of the insect was found to be through an aperture, the ostiole on the surface of the galled stem. The gall insect lays its eggs in the tender stem of the plant. The tender stem allows the insect to complete its full life cycle from egg to adult within it before it dries off. The fungus associated with the gall is having a nutritive role. The plant had to waste its energy and metabolism to resist the insect. The defense of the plant against the insect was expressed or established as stem galls. This interaction cannot be listed under mutualism or commensalism because the vegetative phase of the plant was suffering and a lot of energy was used by the plant to restrict the insect within the gall. According to the study it was found that the galling is a type of parasitism and therefore the gall insect is a pest.

Gall formation or Cecidogenesis is a complex phenomenon involving the recanalisation and reorientation of plant development and such growth activities result in the insects becoming partially or completely enclosed so that the gall insect grow, mature and reproduce within the galls (Ananathakrishnan, 1985). An interaction between the offensive stimuli involving growth substances released by insects and the defensive response by plants (Rosenthal and Janzen, 1979) appears to be the hallmark of gall production. Although some modest reduction in growth and reproduction of the host may occur (Price et al., 1987; Abrahamson and Weis, 1987) rarely do they affect the plant's growth, development and reproductive fitness. However, beyond a particular point of physiological recovery, ecological recovery of the host plant should take place. To facilitate this recovery, the host plant employs simple tolerance as its primary line of defense against the feeding insect, for which the plant compensates itself by generating the gall. Increased tolerance is probably the first evolutionary response by plant populations to most kinds of damage (Mattson et al., 2012).

The tolerance factors as established by (Berryman, 2012) are also found to be substantiated in the present study. The interactional processes involved in gall formation were revealed earlier and the present findings are in accordance with (Nef, 2012).

The stem gall in the present study is a dehiscent one. So the insect has to come out through the regular openings, the ostioles on the surface of the gall, which becomes enlarged as the galls become more and more mature. The gall cavity after the escape of insect is found to be occupied by secondary inhabitants like ants, mites spiders etc. but they are in no way involved in the process of gall formation nor do they have any association with the gall insect.

Conclusion

The stem gall formation in Cephalandra indica was found to be due to the interaction of the plant and an insect Neolasioptera cephalandrae. The reason for gall formation was found to be a response to the stimulus induced by the feeding of phytophagous insect that leads to abnormal growths. The massive gall tissue was the result of hyperplasia and hypertrophy. A gall had a massive outer tissue, inside of which was a cavity where the insect was lodged. A fungus was also found to be present in the gall, which adds to the complexity of interaction. The vegetative phase of the plant was seen to be disordered due to the profuse attack of the insect. But the plant had no threat against its existence. According to the study it was found that the galling is a type of parasitism and therefore the gall insect is a pest. More studies for elucidating the plant-insect interaction and gall formation were recommended.

Volume : 5 | Issue : 7 | July 2015 | ISSN - 2249-555X

Photo 1. Normal stem

Photo 2. Stem with gall

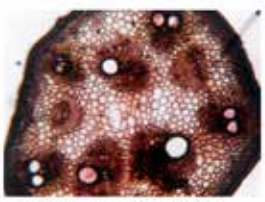

Photo 3. Normal stem C.S (10X10)

Photo 4. Gall stem C.S (10X10)

Photo 5. Fungal growth in inoculated gall sample

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