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Alterations in The Carbohydrate Contents In Leaf Galls of *Cinnamomum Verum* (Presl.) Due to Infestation By The Gall Mite, *Aceria Doctersi* (Nalepa, 1909) (Acari: Eriophyidae)

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ABSTRACT

Aceria doctersi (Nalepa, 1909) is a highly host specific eriophyid mite inducing varying numbers of pouched galls on the leaves, leaf petioles, inflorescence and young shoots of Cinnamomum verum (Presl.), one of the most economically important spice cum medicinal crop. In the present study, quantitative analysis was carried out to estimate the carbohydrate contents present in mite induced young (10 days old), mature (35 days old), samples of C. verum, following the method of Sadasivan and Manikam, (2008). A significant increase in carbohydrate contents was observed in both the young and mature gall tissue when compared to the tissue around rim of gall, heavily infested galled leaf and uninfested (control) leaf tissues (P<.0001). Thus, the results of the study could establish that gall formation by A. doctersi would substantially lead to a reduction in the growth rate, leaf area, biomass etc. of the host plant, C. verum.

KEYWORDS : *Aceria doctersi, Cinnamomum verum*, galls, total carbohydrates

INTRODUCTION

Eriophyid mites are highly host specific, phytophagous, microscopic mites that cause deformities on host plants species (Keifer, 1982, Weis, *et al*. 1988),) These mites induce varying feeding abnormalities like the formation of erinea and galls, witches brooms, leaf curling, blisters, rusts, silvering, fruit russetting, bud deformation, catkins, etc on their host plants (Castagnoli,1996). Besides morphological alterations, gall formation changes the source–sink relationships between it and the adjacent tissues. Gall-inducers are phloem parasites and they do not remove leaf tissue, but form specialized feeding and sheltering structures that act as sinks (Larson and Whitham 1997). Neoplastic formations developed in the form of galls involve parasitism and are believed not to benefit the host plants (Armstromg 1995, Silva *et al*. 1996).

A. doctersi (Fig:2) is an eriophyid species which feeds exclusively on *C. verum*, an important plant of multiple utility as spice and perfumery crop apart from its extensive use in ayurvedic and traditional Chinese medicines for its hypoglycaemic, digestive, antispasmodic and antiseptic properties. In addition, Cinnamon essential oil is stomachic, carminative (Sumy *et al*., 2000) and considered to have a strong germicidal and fungicidal activity (Sandigawad and Patil 2011). *A. doctersi* while sucking up the sap from the leaves, inflorescence and tender stem of *C. verum*, stimulates the formation of innumerable number of pouched galls of varying dimensions. Quite often, individual galls become fused to form complex, irregular, massive structures, covering the entire leaf lamina including the midrib, veins and vein lets. This in several occasions result in severe distortion and subsequent drying up of leaves.

Considering the medicinal and nutritional importance of *C. verum*, the present work was taken up to understand the severity of damage induced by *A. doctersi* on the total carbohydrate content of the plant, there by assessing the impact of galling in the physiological activity and associated protective leaf pigments.

MATERIALS AND METHODS

The collection of leaves/leaf galls of *C. verum* was made from various localities of Malappuram district of Kerala for a one year period, from April, 2013 to April, 2014. The samples of both young and mature galls, approximately of the age of 10 days and 35days respectively collected from the host plant randomly were transported to the laboratory for subsequent microscopic observation under a Zeiss Stemi DV4 Stereo Zoom Microscope (Carl Zeiss, International). The galls were cut off using a slicer, and all life stages of the mite, *A. doctersi* residing in the galls were carefully removed with the help of a Camel hair brush. For rating the degree of damage, 8 categories were considered as follows: (A) 10 days old uninfested leaf (control for young) (B) 35 days old uninfested (control for mature) (C) 10 days old leaf tissue around rim of gall; (D) 35 days old leaf tissue around rim of gall (E) 10 days old heavily infested galled leaf. (F) 35 days old heavily infested galled leaf (G) 10 days old intact gall tissue; (H) 35 days old intact gall tissue. For biochemical analysis, 9 replicates were prepared for each set to be used for control and experiment.

Estimation of total carbohydrates

Both uninfested and experimental samples (100 mg. each) were homogenized with 5ml 2.5N HCl. and then allowed to stand in a water bath (100° C) for 3hours following the method of Sadasivan and Manikam, (2008). Dark green colour developed was read spectrophotometrically at 630 nm against glucose standards.

The total carbohydrates present in the control and experimental samples were estimated separately using the following formula,

Amount of total carbohydrates present in 1gm of the sample = mg of glucose/ Volume of test sample X (1000)

RESULTS

Mite infested leaf galls collected from *C. verum* appeared highly distorted, bearing pouched galls, both on the adaxial and abaxial surfaces (Fig:1). Results of quantitative analysis of total carbohydrates present in leaves of *C. verum* infested by *A.doctersi* revealed significantly higher amount of carbohydrates in both 10 days old (117.9±13.8mg g−1 FM) and 35 days old (76.3±3.59mg g−1 FM) intact gall tissue than the respective control (uninfested) leaf tissue (61.7±.14.12, 52.25±3.3respectively), as well as the tissue lying immediately around the rim of galls and heavily infested galled leaves. The amount of total carbohydrates in 10 days old and 35 days old tissue around the rim of gall was (75.86±3.6 mg g−1 FM, 61.5±12.3 mg g−1 FM respectively). Total carbohydrates content in heavily infested galled leaf showed 85.61±8.4 mg g−1 FM, 69.3±.12.406 mg g−1 FM for 10 days and 35 days old sample respectively (fig:3).

Fig:1 Pouch like galls on the leaf of *C. verum* covering en-

tire leaf area

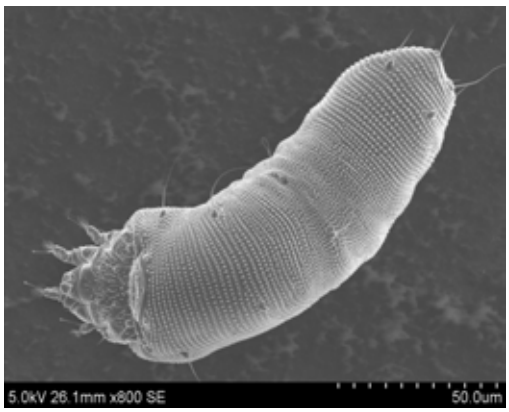

Fig:2 Scanning Electron Micrography of gall mite, *A. doctersi*

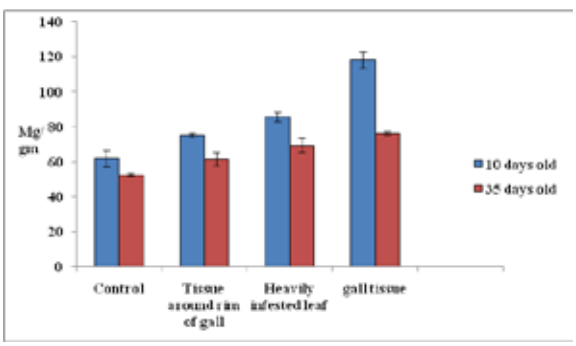

Fig: 3 - Mean± SEM (n=9) Concentration of carbohydrate contents due to infestation by *A. doctersi* on *C.verum*. (P<0.0001)

DISCUSSION

A. doctersi has been recognised as an eriophyid mite, which induces pouch like galls on both surfaces of the leaves of *C. verum*. This in several occasions results in severe distortion of the leaves in to irregular massive structures, showing symptoms of premature drying (Nasareen and Ramani 2014). The manipulation of the plant tissues by the gall inducer alters the cellular carbohydrate metabolism, inducing gall tissues to act as a sink to attend its energetic demands was clearly demonstrated by Wingler and Roitsch, 2008, there by supporting the present study. The results of the present study support the earlier findings (Hartley 1998) on the increased levels of total soluble carbohydrates in gall tissues of four eriophyid species. These alterations would suggest that gall-inducers are phloem parasites (Larson and Whitham, 1997) and which could completely control redirection of growth and physiology of attacked plant organs to their own benefit (Shorthouse *et al,*. 2005). Earlier studies also reported that galls induced by an unidentified lepidopteran species on leaves of *Tibouchina pulchra* (Family Melastomataceae) had higher levels of total carbohydrates than either surrounding leaf tissues or neighboring gall-free leaves (Motta *et al*., 2005, Patankar, 2013). Thus the results of the present study support the hypothesis that galls are important sinks of nutritional resources, and agree with the earlier findings (Bronner, 1992; Castro *et al*., 2012). Young tissues tend to be more reactive to gall formation stimuli than mature ones (Rohfritsch, 1992), because they function as sinks of photoassimilates, with higher nutrient availability and a greater potential for division and differentiation (Weis *et al*., 1988).In the present study also, intact gall tissue of 10 days old leaves had high level of carbohydrates content than that of the mature galls. This would be accounted based on the preference shown by eriophyid mites to the young and newly sprouting leaves of their host plants.

CONCLUSION

Eriophyid gall mites significantly influence fundamental physiological processes in leaves of their host plants. A significant increase in total carbohydrates in the galls revealed the potential of the gall mite, *A. doctersi* to affect adversely the general health of host plant, through redirection of carbohydrates of attacked plant organs to their own benefit. This would lead to a reduction in the growth rate, leaf area, biomass etc. of the plant and reducing the economic utility of the plant in the preparation of ayurvedic medicines, production of oil etc.

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REFERENCES

Armstrong, W. P. (1995). To be or not to be a gall. Pacific Hortic 56:39 - 45. | Bronner, R. (1992). The role of nutritive cells in the nutrition of cynipids and cecidomyiids. In: Shorthouse, J.D., Rohfritsch, O. (Eds.), Biology of Insect Induced Galls. Oxford University Press, New York, pp. 118–140. | | Castagnoli, M. (1996). Ornamental coniferous and shade trees. In: Lindquist EE, Sabelis MW, Bruin J (eds) Eriophyoid mites—their biology, natural enemies and control. Elsevier, Amsterdam, pp 661–671 | | Castro, A. C., Oliveira, D. C., Moreira, A. S. F. P., Lemos-Filho, J. P., & Isaias, R. M. S. (2012). Source–sink relationship and photosynthesis in the horn-shaped gall and its host plant Copaifera langsdorffii Desf. (Fabaceae) South African Journal of Botany, 83:121–126. | | Hartley, S. E. (1998). The chemical composition of plant galls: are levels of nutrientsand secondary compounds controlled by the gall former? Oecologia, 113:492–501. | | Keifer, H., Baker, E., Kono, T., Delfinado, M., & Styer, W. (1982). An illustrated guide to plant abnormalities caused by Eriophyid mites in North America., USDA, Agriculture Handbook Number 573. | Larson, K. C., & Whitham, T. G. (1997). Competition between gall aphids and natural plant sinks: plant architecture affects resistance to galling. Oecologia, 109: 575-582 | | Motta, L., Kraus, J. E., Salatino, A., & Salatino, M. L. F. (2005). Distribution of metabolites in galled and non-galled foliar tissues of Tibouchina pulchra .Biochemical Systematics and Ecology, 33:971–981. | | Nasareen, P. N. M., & Ramani, N. 2014. Seasonal variation in the population density of the gall mite, Aceria pongamiae Keifer 1966 (Acari: Eriophyidae) within the leaf galls of Pongamia pinnata (L.). Journal of Entomology and Zoology Studies, 2:126-130 | | Rajit, P., Gregory, S., Behzad, M., Steven, F. O., & Alyssa, R. (2013). The Effects of Mite Galling on the Ecophysiology of Two Arctic Willows, Arctic, Antarctic, and Alpine Research, Vol. 45, (1) , pp. 99–106 | | Rohfritsch, O.(1992). Patterns in Gall Development. In Shorthouse DJ; Rohfritsch O eds., Biology of Insect-Induced Galls. Oxford University Press, New York, pp. 60-86. | | Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. 3rd Edn, New Age International Publishers, New Delhi, India, ISBN-13: 9788122421408 | Sandigawad, A. M., & Patil, C. G. (2011). Genetic diversity in Cinnamomum zeylanicum Blume. (Lauraceae) using random amplified polymorphic DNA (RAPD) markers African Journal of Biotechnology Vol. 10(19), pp. 3682-3688, | Shorthouse, J. D. Wool, D. Raman, A. 2005. Gall-inducing insect –Nature's most sophicticated herbivores. Basic and Applied Ecology 6: 407–411. | | Sumy, O., Ved, D. K., & Krishan, R. (2000). Foundation for Revitalisation of Lcoal Health Traditions. pp. 105-107. | | Weis, A., Walton, R., & Crego, C. (1988). Reactive plant tissue sites and the population biology of gall makers. Ann Rev. Entomol; 33:467–486. | | Wingler, A., & Roitsch, T. (2008). Metabolic regulation of leaf senescence: interactions of sugar signalling with biotic and abiotic stress responses. Plant Biology 10:50–62. |