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Seasonal Variation in the Population Density of the Gall Mite, *Aceria doctersi* (Nalepa, 1909) (Acari :Eriophyidae) Within the Leaf Galls of *Cinnamomum verum* (Presl.)

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Abstract: ***Aceria doctersi is a highly host specific phytophagous eriophyid mite, infesting and inducing varying numbers of pouched galls on the leaves, leaf petioles, inflorescence and the young shoots of Cinnamomum verum, one of the most economically important spice and medicinal crop. Gall formation by A. doctersi adversely affects the quality of the leaves, thereby reducing the economic utility of the plant. The present study discusses the seasonal impact on the population density of the gall mite, A. doctersi within the leaf galls of C. verum, carried out in the Calicut University Campus, Malappuram Dt., Kerala from January, 2012 to December, 2012. The impact of temperature and humidity could be positively correlated with the population density of the mite within the leaf galls (r = 0.58, r = 0.237) whereas rainfall exerted a negative correlation (r = - 0.182). The study also sheds light on percentage of damage, relationship between size of the galls and mite population density.***

Keywords: *Aceria doctersi*, Eriophyid mites, leaf galls, *Cinnamomum verum*, population density.

1. Introduction

Eriophyid mites are the smallest phytophagous mites ranging in size from 0.15 to 0.3 mm. Most of them are host specific, and induce varying abnormalities such as gall formation, russeting, stunted growth, witches broom effect, erineal formation, leaf / shoot defoliation etc. in host plants. Plant responses to insect herbivory vary depending up on the type of herbivore [1], [2] intensity of parasitism [3-5] and distribution patterns of herbivores [6], [7]. The response can be chemical (*e.g.*, synthesis of defense compounds – [8]), physiological (*e.g.*, changes in photosynthetic rate - [9]) or morphological (*e.g.*, architectural changes – [10]). Within host plants, seasonal changes in the morphology of plant parts, nutritional quality of plant tissues and mites limited dispersal from overwintering sites affect gall density [11-14]. Cycles in insect populations are usually attributed to delayed density–dependent interactions between insects and their food, competitors, or natural enemies [15]. A second potential source of population cycles that has received less attention is periodic fluctuations in a biotic factors [16]. If weather patterns are both cyclic and major determinants of insect population change, then weather can generate insect population cycles [17]. *A. doctersi* is an eriophyid mite which feeds exclusively on *C. verum*, an important economic crop of multiple utility in medicine [18] . The mite while sucking the sap from the leaves, inflorescence and tender stem of *C. verum*, stimulates the formation of innumerable number of pouched galls of varying dimensions, covering the entire leaf, often resulting in severe distortion and subsequent drying up of leaves.

In the present paper, a study carried out during the one year period from January, 2012 to December, 2012 on the influence of climatic factors on the phenology of leaf galls and population density of the mite, *A. doctersi* under natural conditions is discussed along with data on the percentage of damage induced.

2. Material and Methods

2.1 Study site

The principal collection site in the present study was the Calicut University Campus located in the Mlappuram district of Kerala. The Campus is located latitudes of 11.25 latitudes and 75.78 longitudes and an altitude of 47 m elevation. The climate is typical for the humid tropics. The area shows an annual temperature range of 20-36^{o} C and RH of 60-80%. The region usually receives 3068.18 mm rain fall per year. Summer season extends from February to May. The south West monsoon period is from June to September and North East monsoon period is from October to November. The winter period usually extends from December to January. During summer, the highest day temperature is in between 31° C to 38° C.

2.2 Seasonal phenology of leaf galls under natural condition

Phenological studies were carried out on galled leaf samples collected randomly from *C.verum* (Fig.1a). Galled leaves were collected monthly, through random sampling and galled leaf samples were put in polythene bags and transported to the laboratory for further observation under stereomicroscope. Data were recorded on the number of immature and mature galls developed on the abaxial and adaxial surfaces of the leaves. The size of individual gall was measured using a vernier calliper and

entire surface area of galled leaf was calculated graphically in order to assess the percentage of damage induced by the mite. Data on temperature, RH, and rain fall recorded in the study site were obtained from meteorological station in Malppuram, 12 km away from the study site.

2.3 Assessment of Population density of *A. pongamiae*

The galled leaves collected from the field were cut in to six pieces with a sharp blade and individual piece was subjected to observation under LEICA optical microscope and the number of different stages of the gall mite were counted and recorded (Fig.2). In order to correlate the impact of physical factors like the temperature, RH and rain fall on the population density of the mite and the % of damage induced, Pearson correlation was followed.

3. Results

3.1 Seasonal Phenology of the Gall Leaf Under Natural Conditions

The results of studies on the seasonal phenology and population dynamics of *A. doctersi on C. verum performed* during January 2012- December 2012 are represented in Table 1. During January gall size (2.1mm) and percentage of damage (12.57%) was found minimum and the average temperature and R.H during this period was 29.1^{o}C and 70% respectively. Then the percentage of damage and gall size gradually increased since January and reached the peak level during May (62.5% and 3mm respectively) when the average maximum temperature was 30.45^{o}C and R.H 80.5%. During this period, galls were found covering the entire leaf area, often fused to form irregular massive structures on the entire laminar area including the midrib, veins and vein lets (Fig: 1a). It was further observed that during this period, the average number of different stages of *A. doctersi* (Fig.2) was 75 per gall. The total rain fall recorded during this period was 63.3 mm. From June onwards, the % of damage (53.06%) decreased gradually and in December reached the minimum level of 13.16%. During this period the gall size also got reduced gradually. There was a positive correlation between the population of the mite and the % of damage (r=0.63). A positive correlation was also recorded between the gall size and % of damage (r=0.89).

Figure 1a: Leaf galls of *C.verum.*

Figure 1b: Subsequent drying up of leaves due to infestation by gall mite *A. doctersi.*

Figure 2: section of gall showing inner growth of glandular hairs/papillae with different stages of gall mite *A. doctersi* of *C. verum***.** (Presl.)

Figure 3: Scanning Electron Micrograph of *A. doctersi* of *C. verum*

3.2 Population density of *A. doctersi*

Results of population studies on *A. doctersi* and influence of weather parameters during September, 2011 to August, 2012 are represented in Table:1. As the temperature got increased, there was a gradual increase in total mite population. During the study period, mite population attained the peak level in May (75 mites per gall) when the temperature and R.H were 31.78^{o}C and 80.5% respectively. Results of statistical analysis showed a positive correlation between the number of mites and temperature (r=0.576). The mite population experienced a sudden decline from June to December, with the average number per gall decreasing from 22 to 17. During this period intermittent rains were available in the site. A negative correlation could be depicted between the number of mites and rain fall (r = -0.182) whereas positive correlation was recorded between the mite density and relative humidity (r = 0.237).

Table 1: Phenology and population density of *C. verum* during Jan. 2012 to Dec. 2012

Month	*Total no. of mites*	*Average no. of mites/gall*	*Average no. of gall/leaf*	*Average area of leaf*	*Average area of galls*	*%of damage*
Jan. 2012	210	15	14	16.7	2.1	12.57
Feb	336	21	16	15.7	2.3	14.64
March	551	29	19	14.3	2	14
April	1148	41	28	6.6	2.8	42.42
May	2850	75	38	4.8	3	62.5
June	726	22	33	4.9	2.6	53.06
July	540	18	30	5.2	2.4	46.15
Aug	400	16	25	6.8	2.2	32.35
Sep	528	24	22	11.2	2.1	18.75
Octo	378	21	18	13	2	15.38
Nov	323	19	17	12.4	1.9	15.32
Dec. 2012	225	17	15	15.2	2	13.16

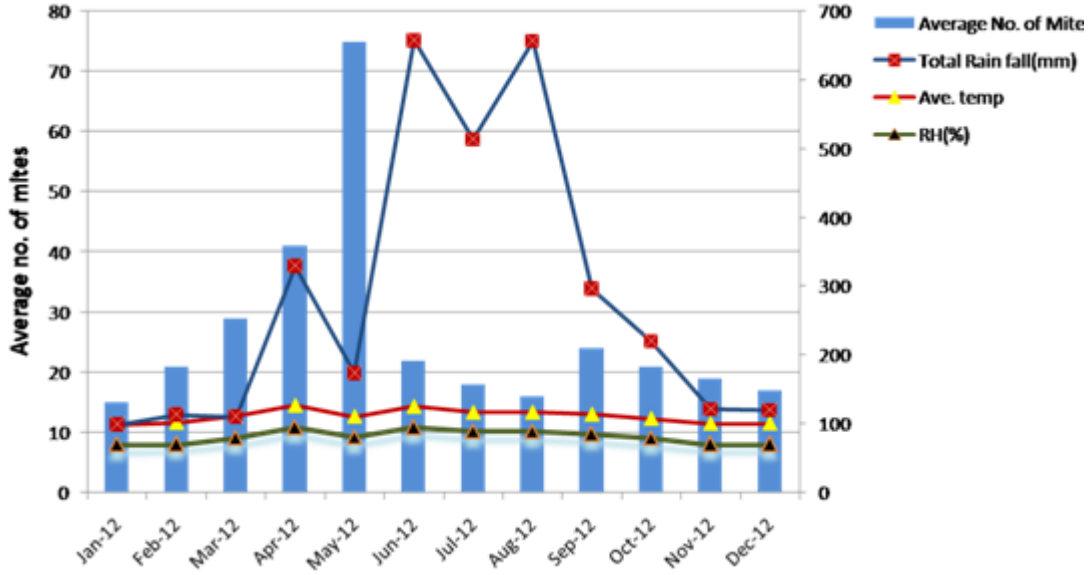

Figure 3: Influence of temperature, RH, and rain fall on the seasonal abundance of *A.doctersi*

4. Discussion

C. doctersi has been recognised as an eriophyid mite, inducing pouched galls of varying dimensions on the leaves, inflorescence and tender stem of *C. verum.* In several occasions, severe distortion and subsequent drying up of leaves could be observed (Fig.1b), clearly indicating that mite infestation drastically affects the photosynthetic activity of the plant, in turn leading to a reduction of biomass [19-20]. Results of studies on the seasonal phenology of the galled leaf under natural conditions showed highest percentage of damage with greater number of galls during May, leading to a significant reduction in leaf area, thereby supporting the earlier findings [19]. Population studies carried out on *C. verum* enabled to record seasonal fluctuations in the mite density within the leaf galls. There was a gradual increase in the population density since January and which reached the peak level in May. This observation is in conformity with the findings of [21] who reported a maximum population density of *A. litchi* during April- May and minimum during November- December. Similar trends in the population of *Aculus euphorbiae* feeding on *Euphorbia* spp. were also reported by [22], who reported lower mite population in winter. Species like *A. dalbergiae* also attained peak population during May, as observed by [23] . The population of *E. mangiferae* reached peak in late May, and then fluctuated during June, July and August[24] . During the present study, the mite population was found to exhibit a decline since June, which would be a reflection of the negative impact of rain fall received by the site. Though *A. doctersi* was found to reside in highly secluded niches available in the gall cavity, the minute external openings of the galls would permit the entry of rain water in traces, thereby leading to negative impact on mite population [19]. Rain water was found to exert a negative correlation with the mite density, as evidenced during the study. The results of the present study enabled and record a decline in mite population since June, which would be a better reflection of the negative impact of the rain fall received by the site.

5. Conclusion

The feeding activity of the mite generally led to the formation of epiphyllous and hypophyllous galls of varying numbers, covering the entire surface. The highest percentage of mite damage (62.5%) and the average number of mites (75/gall) could be observed during the summer month, May. In December and January, found to harbour very low number of eriophyids (17/gall and 15/gall respectively). This in several occasions results in severe distortion and subsequent drying up of leaves. Results of statistical analysis showed the impact of temperature and humidity could be positively correlated with the population density of the mite within the leaf galls ($r = 0.58$, $r = 0.24$) whereas rainfall exerted a negative correlation ($r = - 0.14$).

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References

[1] **Hartnett, D. C. & W. G. Abrahamson.** 1979. The effects of stem gall insect on life history patterns in *Solidago canadensis*. Ecology. 60: 910–917
[2] **Nykanen, H. & J. Koricheva.** 2004. Damage-induced changes in woody plants and their effects on insect herbivore performance: a metaanalysis. Oikos. 104: 247–268.
[3] **Craig, T. P.; P. W. Price & J. K. Itami.** 1986. Resource regulation by a stem-galling sawfly on the arroyo willow. Ecology. 67: 419–425
[4] **Fay, P. A. & D. C. Hartnett.** 1991. Constraints on growth and allocation patterns of *Silphium integrifolium* (Asteraceae) caused by a cynipid gall wasp. Oecologia. 88: 243–250.
[5] **Karban, R. & I. T. Baldwin.** 1997. Induced response to herbivory. Chicago, The University of Chicago Press, 330 p
[6] **Marquis, R. J.** 1992. A bite is a bite is bite? Constraints on response to folivory in *Piper arieianum* (Piperaceae). Ecology. 73: 143–152.
[7] **Zangerl, A. R. J. G. Hamilton. T. M. Miller. A. R. Crofts. K. Oxborough. M. R. Berenbaum & E. H. De Lucia.** 2002. Impact of folivory on photosynthesis is greater than the sum of its holes. Proceedings of the National Academy of Science. 99: 1088–1091
[8] **Abrahamson, W. G. & A. E. Weis.** 1987. Nutrition ecology of arthropod gall maker, p. 235–258. *In*: F. Slansky & J. G. Rodriguez (ed.). The nutrition ecology of insects, mites and spiders. NY, John Wiley & Sons, Inc., 1032 p.
[9] **Andersen, P. C. & R. F. Mizell.** 1987. Physiological effects of gall induced by *Phylloxera notabilis* (Homoptera: Phylloxeridae) on pecan foliage. Environmental Entomology. 16: 264–268.
[10] **Nakamura, M.; Y. Miyamoto & T. Ohgushi.** 2003. Gall initiation enhances the availability of food resources for herbivorous insects. Functional Ecology. 17: 851–857.
[11] **Burgess, J. E, Thompson, M. M.** 1985. Shoot development and bud mite infestation in hazelnut (*Corylus avellana*). Ann Appl. Biol. 107, 397–408.
[12] **Vuorisalo, T. Walls, M. Niemela, P. & Kuitunen, H.** 1989. Factors affecting mosaic distribution of galls of an eriophyid mite, *Eriophyes laevis*, in alder, *Alnus glutinosa*. Oikos. 55:370–374.
[13] **Kuczyński, L. & Skoracka, A.** 2005. Spatial distribution of galls caused by *Aculus tetanothrix* (Acari: Eriophyoidea) on arctic willows. — Exp. Appl. Acarol.36 : 277–289
[14] **Ishihara, M. I, Yamasaki, M. & Yoshikawa, J.** 2007. Spatial distribution and abundance of bud galls caused by eriophyoid mites among host trees *Carpinus tschonoskii*. J. Appl Entomol. 131:585–587
[15] **Berryman, A.A.** 1994. Population dynamics: forecasting and diagnosis from time series. Individuals, Populations, and Patterns in Ecology (ed. by S. R. Leather, A. D. Watt, N. J. Mills and K. F. A. Walters), pp. 119–128. Intercept, Andover, U.K.
[16] Burroughs, W. J. 1992. Weather Cycles: Real or Imaginary? Cambridge University Press, Cambridge.
[17] **Williams, D. W. & Liebhold, A. M.** (1997). Detection of delayed density dependence: reply. Ecology. 78:320–322.
[18] **Lu, T. Sheng, H. Wu, J. Cheng, Y. Zhu, J. & Chen, Y.** 2012. Cinnamon extract improves fasting blood glucose and glycosylated hemoglobin level in Chinese patients with type 2 diabetes. , Nutr Res. 32:408-412.
[19] **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
[20] **Nasareen, P. N. M. Shibuvardhanan, Y. & Ramani, N.** 2013. Damage assessment og gall mite *Aceri pongamiae* Keifer 1966 (Acari:Eriophyidae) on *pongamia pinnata* (L.) Piere. A. Sabu and A. Augustine (eds.), Prospects in Bioscience: Addressing the Issues, Springer India.
[21] **Sharma, D. D, Sigh, S. P. & Akhauri, R. K.** 1986. Relationship between the population of *Aceria litchi* on litichi (Litchi chinensis) and weather factors. Indian J Agric Sci. 56:59-63.
[22] **Bacic, J. R, & J. Petanovic.** 1995. A study of fluctuations in the Spurge Eriophyid mite, *Vasates euphorbiae* Pet. population. pp. 163–171. In: Kropczynska K, Boczek J and A. Tomczyk. (Eds.). The Acari. Physiological and Ecological Aspects of Acari–Host Relationships; Dabor, Warsaw.
[23] **Hossain, M. A. Rahman, M. M. Nursat, Z. & Das, B.C.** 2002. Seasonal occurrence of sissoo plant infesting eriophyid mite, Aceria dalbergiae Channabasavanna (Acari: Eriophyidae) and toxicity of some insecticides on it. Pakistan journal of biological sciences. 5:1246-1248.
[24] **Abou-Awad, B. A.** 1981. Ecological and biological studies on the mango bud mite, *Eriophyes mangiferae* (Sayed) with description of immature stages (Eriophyidae: Eriophydiae). Acarologia. 22: 145- 150.

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