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Seasonal variation in the population density of the gall mite, *Aceria pongamiae* Keifer 1966 (Acari: Eriophyidae) within the leaf galls of *Pongamia* *pinnata* (L.)

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ABSTRACT

Aceria pongamiae is a highly host specific eriophyid mite, producing varying numbers of finger like leaf galls on *Pongamia pinnata*. *P. pinnata* is well known for its use in traditional systems of medicine for the treatment of varied human diseases. Gall formation by *A. pongamiae* adversely affects the quality of the leaves there by reducing the economic utility of the plant. The present study discusses the seasonal impact on the population density of the gall mite, *A. pongamiae* within the leaf galls of *P. pinnata*. The impact of temperature and humidity could be positively correlated with population density of the mite within the leaf galls whereas the rainfall exerted a negative correlation. The study further sheds light on percentage of damage, the relationship between the size of the galls and mite population.

Keywords: *Aceria pongamiae*, Eriophyid mites, leaf galls, *Pongamia pinnata*, population density.

1. Introduction

Eriophyid mites represent an exclusively phytophagous group with vermiform body^[1, 2] and high host specificity^[1, 3, 4] inducing diverse forms of abnormalities like galls, blisters, erineae, big buds, leaf rolling, stem and foliar deformation, silverying, bronzing of leaves etc. on their respective host plants^[5]. *Aceria pongamiae* is an eriophyid species which feeds exclusively on *Pongamia pinnata*. *P. pinnata* is a medium sized glabrous tree, mainly distributed in tidal forests of India^[6]. Historically, *Pongamia* has been used as folk medicinal plant, particularly in Ayurvedic and siddha systems of Indian medicine^[7] for the treatment of varied human diseases like bronchitis, whooping cough, rheumatism, diarrhoea, dyspepsia, gonorrhoea, leprosy and even tumors. Recent recognition of the importance of the seeds of this plant as a source for bio-fuel production^[8] extends its economic utility to industrial purposes as well. The continuous feeding of *A. pongamiae* on the leaves of *P. pinnata* leads to the formation elongate finger like pouches of varying dimensions on both surfaces of the leaves. Quite often individual galls fuse to form complex, irregularly shaped, massive structures, covering the entire laminar area including the midrib, vein and vein lets. This in several occasions results in severe distortion of the leaves. Present paper is focussed on the population studies of the gall mite, *A. Pongamia*, carried during one year period from September, 2011 to August, 2012. The influence of climatic factors on the phenology of leaf galls and population density of the mite under natural conditions is discussed in the paper along with percentage of damage induced by *A. pongamiae*.

2. Material and Methods

2.1 Study site

The present study was carried out at Eranhipalam which formed the principal collection site in the Calicut district of Kerala. It is located between 11° 12' 00" and 11° 19' 00" north latitudes and between 75° 44' 30" and 75° 52' 30" east longitudes at an altitude of 52-11 meters. Climate is typical of humid tropics. The area shows annual temperature range between 20-36 °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.

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2.2 Seasonal phenology of the gall leaf under natural condition

Phenological studies were carried out on galled leaf samples collected randomly from *P. Pinnata* trees. Observations were carried out for a period of a one year from September 2011 to August 2012. Galled leaves were collected monthly, through random sampling and galled samples were put in polythene bags and tied loosely with rubber bands for subsequent transportation to laboratory for further observation under microscope. Data were recorded on the number of immature and mature galls developed on both abaxial and adaxial surfaces of the leaves. The individual size of gall was measured using vernier callipers and size of the galled leaf was calculated graphically in order to assess the percentage of damage induced by the mite *A. Pongamia*. Data on temperature, RH, and rain fall of the study site were obtained from meteorological station in Calicut district, 3 km away from study site.

2.3 Population density of *A. pongamia*

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 counted the different life stages of mite, egg, I nymph, I quiescent phase, II nymph, II quiescent phase and the adult males and females along with profuse growth of glandular hairs, the so called erineia residing in the interior of the gall cavity separately (Fig 1 and 2). During severe infestation when mite population was estimated by counting the number of mites present in randomly selected group of galls, grouping of the galls was done based on their size. The population density was estimated by multiplying the number of mites present in the galls with the total number of galls present in each group of galls.



Fig 1: Arrow indicating section of gall showing inner growth of erineia with different life stages of *Aceria pongamia*

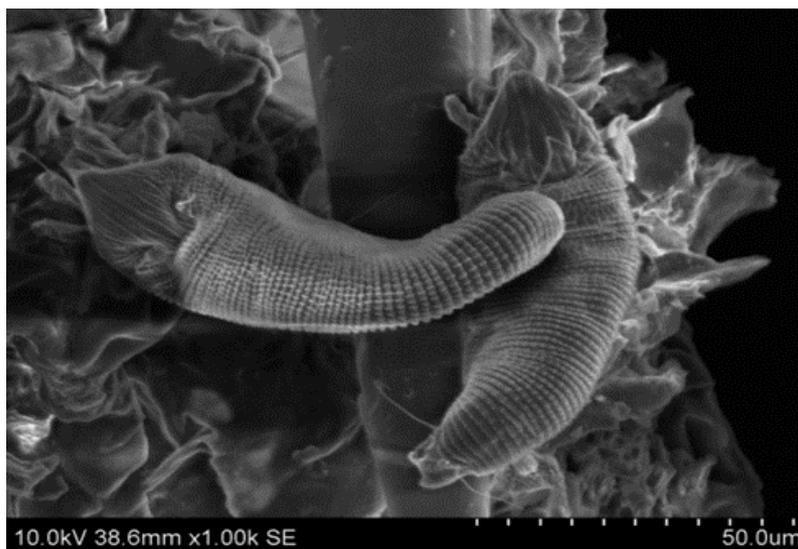


Fig 2: Scanning Electron Micrograph of adult of *Aceria pongamia* with in the gall

3. Results

3.1 Seasonal phenology of the gall leaf under natural conditions

The results on the seasonal phenology and population dynamics of *A. pongamiae* on *P. pinnata* are represented in Table 1. The initiation of infestation could be coupled with summer when leaf sprouting occurred during early days of February 2012. Gall size (1.07 mm²) and percentage of damage (2.33) was negligible during that period. Maximum average temperature and R.H during this period was 34 °C and 70.5% respectively. The percentage of damage and gall size gradually increased and reached at peak

during May, 78.73% and 50.28, respectively when average maximum temperature was 34.1 °C and R.H 77%. During this period gall covered the entire leaf area, fused to form irregular massive structure covering the entire laminar area including midrib, vein and vein lets (Fig: 3). It was further observed that each gall contained an average of 350 mites per gall belonging to different stages. The maximum total rain fall was recorded during June (724.8 mm) and minimum at December and January (0) but there was no relation with gall size and percentage of damage.

Table 1: Phenology and population density of *A. pongamiae* during September 2011 to August 2012.

Month	Total No. of Mites	No. of mites/gall	% of damage	Total No. of galls	Total area of galls cm ²	Total area of leaves cm ²
Sep-11	5878	73	12.1	80	18.35	151.74
Oct-11	3262	34	14	95	17.83	127.76
Nov-11	3262	4.8	10	44	11.79	118.6
Dec-11	36	0.9	6.7	40	8.79	130.1
Jan-12	0	0	0	0	0	0
Feb-12	4	0.2	2.33	17	1.07	45.43
Mar-12	5312	66.4	14.06	80	15.2	108.19
Apr-12	29780	221	43.73	141	34	77.75
May-12	103011	350	78.73	294	50.28	63.86
Jun-12	13634	55	57.63	274	46.8	81.2
Jul-12	2355	13.45	42.04	175	36.2	86
Aug-12	9598	69	22.75	139	20.15	88.57



Fig 3: Elongated finger like galls covering the entire leaf of *Pongamia pinnata*

3.2 Population density of *A. pongamiae*

Population dynamics of *A. Pongamiae* and influence of weather parameters during Sep.2011 to Aug.2012 are represented in Table 1 and Figures 4-6. The number of all stages of mites varied considerably during the study. The initiation of infestation could be coupled with summer when leaf sprouting occurred during early days of February. As the temperature increased there was a gradual increase in total mite population. During the study peak in mite population was recorded in May (350 mites per gall) when the temperature and R.H was 34.1 °C and 77% respectively. Statistical

analysis showed that the number of mites and temperature showed a positive correlation ($r=0.284$). Observation shows, once the mites established new colonies, rapid multiplication occurred leading to build up of peak population in May due to gradual increase in temperature. There was a sudden decline in mite population from June to November, with the average number of mites per gall decreasing from 55 to 5. This was due to intermittent rains during that period. Results depicted negative correlation between number of mites and rain fall ($r = -0.073$) and positive correlation of the same with relative humidity ($r = 0.013$).

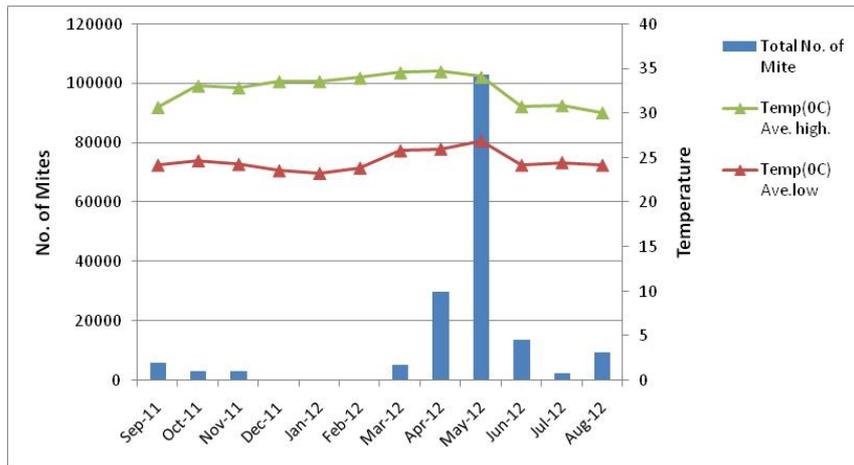


Fig 4: Influence of temperature on the seasonal abundance of *Aceria pongamiae*

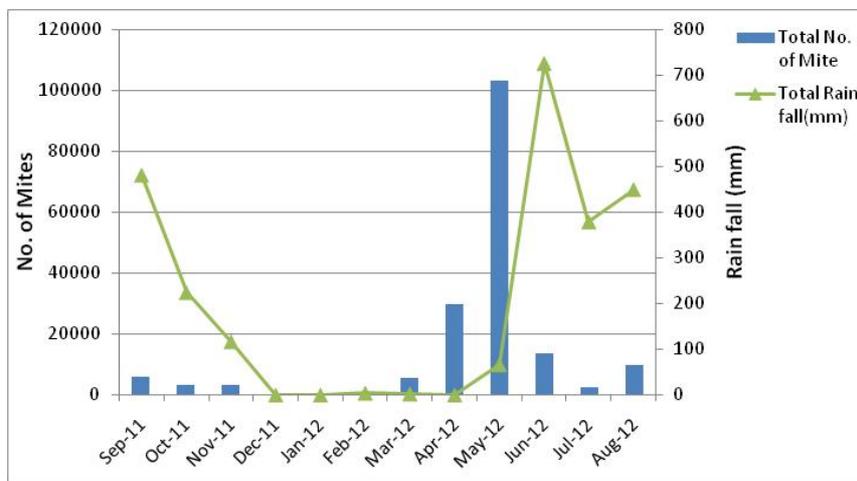


Fig 5: Influence of rain fall on the seasonal abundance of *Aceria pongamiae*

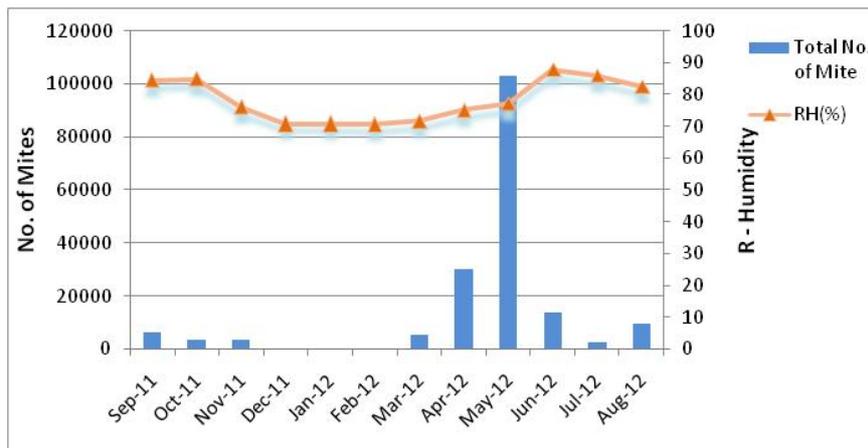


Fig 6: Influence of relative humidity on the seasonal abundance of *Aceria pongamiae*

4. Discussion

A. Pongamiae has been recognised as an eriophyid mite, which induces finger like or pouched galls on both surfaces of the infested leaf. Quite often individual galls fuse to form complex, irregularly shaped, massive structures, covering entire laminar area including

the midrib, vein and vein lets. This in several occasions results in severe distortion of the leaves in to irregular massive structure, showing symptoms of premature drying. This clearly indicates that mite infestation drastically affects the photosynthetic activity of the plant, in turn leading to a reduction of biomass, as reported earlier

^[9] who proved that mite infestation adversely affected the growth of *P. pinnata*. The results obtained during the present investigation revealed that tender and newly sprouted leaves were more susceptible to the attack of *A. pongamiae*. Young plant tissues would present immediate responses against gall formers when compared to already differentiated tissues ^[10]. The results of the seasonal phenology of the gall leaf under natural conditions showed percentage of damage and number of gall to be highest during May, leading to a significant reduction in leaf area. Population studies carried out on *A. pongamiae* enabled to record seasonal fluctuations in the mite density within the leaf galls. The initiation of infestation was recorded in February, reaching to peak population in May. The decline in mite population since June would be reflecting the negative impact of rain fall received by the site. Even though the mites enjoy a highly secluded habitat available within the leaf galls, rain fall exerts an adverse effect by penetrating through the holes in to the interior of the gall cavity. Our results have been found to be in conformity with the findings of (Aratchige *et al.* 2012) ^[11] who reported a significant negative impact of rainfall on the population density of *Neoseiulus baraki*. Low number of mites recorded inside the dried galls during October and November could be possibly explained on the grounds of their escape in search of suitable sites like the under surfaces of the bark or to hibernate/or tide over the unfavourable conditions through the phenomenon of deuteroecy. The plants shed the leaves in January. The trend observed on the population fluctuation of *A. pongamiae* has been found to be in accordance with the findings of ^[12] who reported maximum population density of *A. litchi* during April- May and minimum during November-December. Another study ^[13] also recorded similar trends in population of *Aculus euphorbiae* feeding on euphorbia spp. recording a lower population in winter.

5. Conclusion

The results revealed that tender and newly sprouted leaves were more susceptible to the attack of *A. pongamiae*. 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 (78.73%) and number of mites (350/gall) could be observed during summer months, especially in May. After May the population showed a sudden decline. In October and November months, galls started to dry and were found to harbour very low number of eriophyids. This could be detrimental to the plant, adversely affecting the quality of leaves and thereby reducing the economic utility of the plant in the preparation of ayurvedic medicines. Loss/reduction in the leaf area would also drastically affect the photosynthetic machinery of the plant, thereby leading to biomass loss.

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