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Seasonal population dynamics of *Aceria erineus* (Nalepa) (Acari, Eriophyidae) on walnut trees in Kashmir, India

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ABSTRACT: Population fluctuation of *Aceria erineus* in relation to abiotic factors on different walnut orchards of Kashmir was roving surveyed in 27 agricultural sites in nine districts of Kashmir during May 2018 to April 2019. In each district, three sites were selected randomly and the incidence of the mite was recorded at fortnightly intervals throughout the crop growth period. Field surveys indicated the presence of the pest in the entire surveyed region in varying intensity with maximum incidence recorded in Kupwara (21.77±1.39 mites per leaf), Baramulla (19.27±1.09 per leaf), Shopian (18.4±2.47 per leaf), Budgam (18.33±1.24 per leaf) and Pulwama (18.24±1.75 per leaf) respectively. Significant positive correlations of mite populations with minimum temperature were found in Shopian and all the districts of north Kashmir. Significant negative correlation was also found between mite population and rainfall except Anantnag district where it was non-significant. Maximum and minimum temperatures as well as sunshine hours had non-significant positive correlation, whereas relative humidity had non-significant negative correlation with the mite population.

KEYWORDS: Blister mites, abiotic factors, seasonal variations

The Jammu and Kashmir is the major walnut producing region in India and almost entire quantity (98%) of walnut is exported from this region. Jammu and Kashmir is the major walnut producing region contributing more than 85 percent of total production of the country. Common walnut (*Juglans regia* L.) is cultivated in the districts of Poonch, Pulwama, Anantnag, Ganderbal, Kulgam, Budgam, Kupwara, Baramulla and Srinagar. Among these districts, Shopian was on the forefront in walnut production in the past. The trend has changed and nowadays district Kupwara is leading in walnut production (Anonymous, 2015). Pest and disease management is a challenge in walnut because of giant size trees. Among the non- insect pests of crops, mites are probably the most notorious ones and gaining tremendous importance in the recent years owing to their devastating nature (Tabasum and Buhroo, 2022). Several eriophyoid mites are known to occur on walnut and other species of *Juglans* (Amrine and Stasny, 1994). Eriophyoids are obligatory plant feeders with unusual morphological, biological and behavioural specialization compared to other Acari (Skoracka *et al.,* 2010). Many of them are major pests of agricultural and ornamental crops, wild plants, grasses, and plants of urban and community forestry but rarely cause their death (Lindquist *et al.,* 1996).

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A number of eriophyoid species are considered to be main pests on some crops, while others are known to be a quarantine threat for several countries. *Aceria erineus* (Nalepa) (Acari, Eriophyidae) is a small, yellowish-white, slender, wormlike mite, measuring about 0.25mm long. They have a waxy white colour and generally can only be seen with a stereomicroscope. The walnut blister mite attacks the lower surface of the leaves of Persian (English) walnut (Miller and Thamson, 1937). The infestation caused by this mite is noticeable as shiny, convex swellings on the upper surface of the leaf blade and on the underside as patches of shallow, large, solitary concavities lined with felty, yellowish hairs, among which the mites are found. Walnut blister mites overwinter beneath bud scales. When spring time temperatures rise, the mites feed among the leaf hairs on the undersides of the leaves. Several generations occur during the summer, which attack new foliage as soon as it unfurls. Since the degree of incidence of blister mite changes with season, it is desirable to have a thorough understanding of the seasonal incidence of the mite for the development of suitable management programmes. Hence, an attempt was made to determine the effect of weather factors on the incidence and dynamics of this blister mite on walnut trees of Kashmir.

Studies on the seasonal variation of walnut blister mite *A. erineus* were carried out from May 2018 to April 2019 on different walnut orchards of Kashmir. Roving surveys were conducted in 27 agricultural sites in nine districts of Kashmir *viz.,* Anantnag, Pulwama, Shopian, Srinagar, Ganderbal, Budgam, Baramulla, Bandipora and Kupwara. The experimental plots were kept completely free from insecticidal applications. In each district, three sites were selected randomly and the incidence of the mite was recorded at regular intervals throughout the crop growth period. Five plants were selected randomly at each site and tagged as a replication. Altogether, six leaves from different layers (top, middle and bottom) from each main side of the tree canopy (north, south, east and west) were collected from fifteen randomly selected plants per sampling date, making a total 90 leaves collected fortnightly. After conducting on-site visual sampling of pests, the samples were put in polythene bags and tied loosely with rubber bands for subsequent transportation to laboratory for further observation under stereo binocular microscope. Data on the mite population was recorded throughout the crop growth period and mean number of mites per leaf was calculated for each sampling period. Concerning the significant factors emerged, ANOVA was carried out and a post hoc test Fisher's Least Significant Difference (LSD) was applied for the comparison of means of different fortnights within the district. Simultaneously, the weather data on maximum and minimum temperature (°C), relative humidity (%), sunshine (h), and rainfall (mm) were also collected from the Indian Meteorological Department (IMD) Rambagh Srinagar. The data on the mite population used in the analysis and correlation coefficient was worked out with above meterological parameters. All the statistical procedures were carried out using MS Excel software and SPSS software. To arrive at meaningful results with respect to the impact of weather parameters on the population dynamics of blister mite, the data collected from three sites of each district was pooled and the relationship between the mite population per leaf and the average weather parameters was worked out using correlation analysis at 5 per cent significance level.

Mite population density: Incidence of walnut blister mite was noticed in all the nine districts of Kashmir. However, the maximum leaf infestation was found in Kupwara district recording 21.77±1.39 mites per leaf, followed by Baramullah district (19.27±1.09 per leaf), Shopian district (18.4±2.47 per leaf), Budgam district (18.33±1.24 per leaf), and Pulwama district (8.24±1.75 per leaf). The low mite density was recorded in Srinagar (16.08±1.60 per leaf), Anantnag (16.75±1.42 per leaf), Ganderbal (17.57±1.79 per leaf), Bandipora (17.64±1.53 per leaf). The blister mite population commenced from the 19th standard week of May on walnut trees in all the surveyed locations. Sampling started soon after the first appearance of blisters in spring and continued until autumn. Mite populations showed an exponential growth upto the beginning of July, then the mite population declined in an inconsistent manner at the start of rainy season

Table 1. Pearson's correlation (r) between blister mite population and weather parameters in nine districts of Kashmir

Districts	T max	T min	Rf (mm)	RH1	RH2	SSH
Anantnag	0.821	0.734	-0.076	-0.076	-0.077	0.360
Pulwama	0.908	0.758	-0.031*	-0.052	-0.200	0.659
Shopian	0.864	0.58*	-0.133*	0.010	-0.271	0.593
Srinagar	0.811	0.667	-0.157*	-0.084	-0.133	0.320
Ganderbal	0.853	0.760	-0.062*	-0.109	-0.077	0.398
Budgam	0.855	0.804	-0.003*	-0.085	-0.031	0.436
Baramulla	0.806	0.72*	-0.055*	-0.042	-0.075	0.363
Bandipora	0.856	0.80*	-0.002*	-0.117	-0.057	0.415
Kupwara	0.922	0.76*	-0.001*	-0.072	-0.219	0.666

T max = Maximum temperature; T min = Minimum temperature; Rf (mm) = Rainfall; RH1= Relative humidity; RH2 = Relative humidity; SSH = Sunshine hours; * Significant correlations at $p < 0.05$

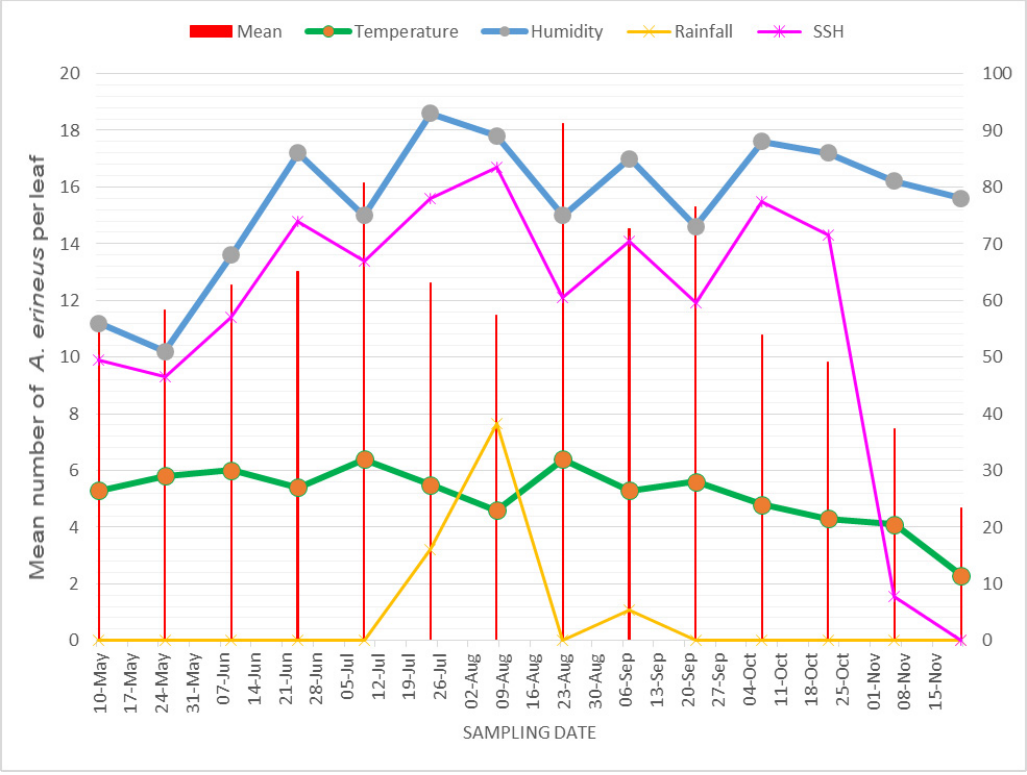

Fig. 1 Seasonal population dynamics of *Aceria erineus* on *Juglans regia* and fluctuations of temperature (°C), relative humidity (%), rainfall (mm) and sunshine (hours)

and as the at-mospheric relative humidity increased from mid july to the first week of August, again the population started to grow from mid August to September. Subsequently the population dropped rapidly in the month of october and remained at extreme low levels in November (Fig. 1). From December to March, the mite populations were not recorded because they undergo overwintering diapause. During the summer, the females migrate from the erineum to the terminal buds, where they overwinter (Keifer *et al.,* 1982).

Correlation between mite population and weather parameters: The relationship between *A. erineus* population and weather parameters was assessed through correlation analysis. Mite population showed non-significant positive correlation with maximum and minimum temperature in all the districts of valley with the exceptions of significant positive association with minimum temperature in Shopian district and all the districts of north Kashmir. With relative humidity, mite population showed non-significant negative correlation in all the districts of the valley. Significant negative correlation was also found between mite population and rainfall except Anantnag district where non-significant negative correlation was found. With Sunshine hours, mite population showed non-significant positive correlation in all the districts of Kashmir (Table 1).

The walnut growing regions of Kashmir showed slight to severe infestation with the maximum incidence in Kupwara district followed by Baramulla district and the least incidence was noticed in Srinagar and Ganderbal districts. The variations in mite incidence in the study locations may be due to the interplay of various biotic and abiotic factors that influence the pest population. The highest density and activity of *A. erineus* was observed during the beginning of July and late August. During these months, the average temperature and relative humidity were 32 °C, 75 percent respectively. The prevailing high temperature coupled with low humidity was observed to be very advantageous for the rapid multiplication of this species of mite.

The seasonal variation of this species is comparable to that of other eriophyids. The mite's incidence was recorded on walnut trees throughout the crop growth period, indicative of overlapping generations. *A. erineus* showed a bimodal dynamic, with two distinct population peaks during early July and late August, this behaviour has been reported for other eriophyids in temperate zones that produce malformations such as *Phytoptus phloeocoptes* (Nalepa) in peach and *A. cinerea* in walnut, where it has been observed that the greatest abundance of malformations and number of individuals occur in the months where summer begins and decreases as winter begins (Boczek 1974; Keifer *et al.,* 1982). The results are also in agreement with the findings of Canales *et al.* (2019) on soursop where two population peaks were described, but contrast the data coming from Italy where *Aculus schlechtendali* peak population was observed only in the month of July on apple orchard (Simoni *et al.* 2018); similar results have been reported for *Aculus schlechtendali* by Hoyt (1969), Herbert (1974), Easterbrook (1979) who found the populations peak in July or early August.

Populations of *A. erineus* were positively and non-significantly correlated with temperature in almost all the districts indicating that higher temperature would be ideal for the build-up of mite population. This is in conformity with the findings of Abou-Awad (1981) for *Eriophyes mangiferae*. Significant positive correlation of mite population with minimum temperature was found in Shopian and all the districts of North Kashmir, as shown by Ranjan and Ray (2015) for *A. litchi*, Abou-Awad *et al.* (2011) for *Calepitrimerus baileyi*, Abou-Awad *et al.* (2011) for *A. mangiferae* and *Metaculus mangiferae*. Not only temperature but also humidity affects the population growth of eriophyoid mites. In this study, relative humidity (morning and evening) had non-significant negative correlation with blister mite which is in accordance with the Ranjan and Ray (2015), Kamuran (2020) but in contrast to the findings of Abou-Awad *et al.* (2011) who found significant positive correlation between mite population and relative humidity. In addition, sunshine hours were found to be positively and non-significantly correlated with mite population

which agree with the findings of Thakur and Sharma (1990) for *A. litchi.* Significant negative correlation was also found between mite population and rainfall. This observation is in conformity with the findings of Nasareen and Ramani (2014) for *A. pongamiae* on *Pongamia pinnata*, Nasareen and Ramani (2015) for *A. doctersi* on *Cinnamomum verum* Ranjan and Ray (2015) for *A. litchi* on Litchi trees. Present investigations showed that in Kashmir valley, the incidence of *A. erineus* is high during the months of July and August, which indicates that appropriate plant protection measures should be applied during these months to prevent the crop loss.

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