Biological Forum – An International Journal **10**(1): 75-81(2018)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

The Biology and Economic Damage of European red mites, *Panonychus ulm* Koch (Acari: Tetranychidae) in Orchards of Ganderbal Kashmir Valley, India

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(Received 15 February 2018, Accepted 17 April, 2018)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The aim of the present work is to study the Biology and Economic damage of *Panonychus ulmi* (Koch) in the orchards of Ganderbal, Kashmir Valley, Jammu & Kashmir, India. For the sake of convenience 3 orchards were selected from Lar, 3 from Safapora and 3 from Kangan. According to the plan visits were conducted and the results were noticed. To obtain economic damage, the net productivity of selected orchards with heavy infestation was measured in relation to the non infested orchards of same area, containing equal number of trees. The binomial (Presence-Absence) of sampling scheme of European red mite was also done during the project. 5 to 10 leaves from five to ten trees scattered throughout a zone selected for investigation. Leaves were scanned with the help of hand lens to determine whether or not mites were present. The table results clearly indicate that the orchard selected from Kangan location was heavily infested followed by Safapora and, Lar was least infested. The results were further used to quantify the average infestation in the selected zones of the district. It can be summarised that a decrease of 2.42 boxes of standard size and weight occurs with an average infestation of 15.33% by the damage of European Red Mite in the selected area of district Ganderbal. A tally sheet of infested and non infested leaves was done as per the plan. During the work a typical plant with few infested leaves was taken in consideration. In the total number of 50 leaves, 27 were found infested and 23 without infestation. The number of infested leaves was divided by 50 and the result was multiplied by 100 to obtain the percentage of infested leaves, which was found 54%, in the selected area.

Keywords: Mites, infestation, economy, orchards,

INTRODUCTION

European Red Mite (*Panonychus ulmi* Koch) is a major tree fruit pest (Angello *et al*., 1994; Beers *et al*., 1984; Hardman, 1984) and in Jammu and Kashmir it attacks fruits particularly apple with specificity on its Red Delicious species. However mild attack on apricot and peach has also been reported from various parts of valley including Ganderbal. Moreover, its attack on some genera of Roseacea family in the vale has also been observed. Morphologically like other members of the genus *Panonychus*, in ERM all tarsi carry a claw–like empodium with three pair of ventrally directed hairs. The red eggs of the European red mite are onion shaped with a stalk on their tops. The juveniles are green, whereas the adults are red in colour and bear prominent dorsal setae set on whitish tubercles. The adult females are dark red to reddish brown in colour characterised by white coloured eight legs with spots and hair on her back and is about 1/50 inch long. Adult male mites are smaller than females and have a characteristic pointed abdomen and are usually dull green to brown in colour (Dar *et al*., 2015).

Although a pest of diverse trees, apple suffers the most from the European red mite. Injury is caused by the feeding of all stages on the foliage. The lower leaf surface is preferred than the above one (Kim et al 2008; Marcic *et al* 2007). Under high populations both surfaces are occupied and destroyed. The injury as mentioned is caused by the piercing of the cell walls by the bristle like mouth parts and the ingestion of their content, including the chlorophyll. The injury results colour foliage which in severe cases becomes bronzed as compared to uninfested foliage. The leaf efficiency and productivity is directly affected.

Heavy infestation of mites in the early season (late May and early June) not only can reduce tree growth and yield but also drastically affect fruit bud formation, and thereby reduce yields the following year. Additionally, mites injured leaves will not respond to growth regulators applied to delay harvest crop (Parent and Lord 1971; Rather and Bano 2008; Sherwani 2010).

Ecological factors play an important role in building up red mites population. It has been observed that high populations have been recovered on orchards next to busy roads. The mite problem can be potentially minimised by reducing dusty conditions within the orchard and keeping the trees well irrigated. Within bearable limits increase in temperature and humidity has been found quite negative from economic point of view as it surely does facilitate its high fecundity (Rather *et al,* 2007; Wermelinger *et al* 1992; Sherwani *et al,* 2014). Thus, it suits in moderate temperature orchards like Kashmir. Ecologically, it ceases its activity including reproduction in winter during which mortality of eggs of the pest have been recorded since the effect of ERM's damage to foliages. Thus the need for further understanding its ecology and infestation is likely comprehensive to check further economic loss of fruit industry of Kashmir. The aim of the present work is to study the Biology and Economic damage of *Panonychus ulmi* (Koch) in the orchards of Ganderbal, Kashmir Valley, Jammu & Kashmir, India.

MATERIAL AND METHODS

The work was initiated in the specified district and various locations within the area were selected. The aim of the project was expected to be completed in a time span of 5 months from March to July (2015), during which the infestation rate is comparatively high and pest occurs in peak compared to other months. European Red Mite shows bloom in its occurrence particularly in two months (June and July). The present work involved selection of minimum 3 orchards of Apple from each of the specified places in Ganderbal district. The places include three main tehsils namely, Lar, Safapora and Kangan. Thus in total 9 Apple orchards were put under surveillance to meet the aim of the research. The plan of the work was kept very simple and limited to the observatory orchards only. About 1 visit was conducted in the selected orchards per fortnight in the beginning months (March, April and May). However, the observations were made weekly in June & July, 2015. Entire data was tabulated and results were drawn.

For the sake of convenience 3 orchards were selected from Lar, 3 from Safapora and 3 from Kangan. According to the plan, the visits were conducted and the results were noticed. Once the data was proclaimed, infestation rate for the different venues was asserted. The figures sought were used as a means for the approximate rate of infestation. This was followed with the comparison of different infestation rates and finally the results for the same were obtained with the aid of statistical methods. The commonly used mathematical tools used method include Mean, Median and histograms. It should not be missed that the plant was declared infested only when visible marks of damage were well evident. To study the infestation rate in the district, referentially 30 plants from each of the orchards of the zone were selected and put for investigation. However, it should be noted that usually small orchards of 1 kanal were preferred. In case of large orchards, the 30 trees were randomly selected in one side of the orchards.

A. Estimation of infestation

Once the infestation rates for the different zones were calculated, they were graphically correlated with one another. The rate of Infestation in each orchard was measured by means of following formula:

$$\frac{\text{Number of trees infested}}{\text{Total number of trees present}} \times 100$$

The correlated results predicted which of the selected zones was highly infested and which of the selected one was least infested.

B. Cumulative mite day and binomial Calculation

In order to calculate the cumulative Mite Days the procedure adopted was discrete in nature. As the effects of leading damage accumulate over time, mite damage is often expressed as a combination of the population level plus an indication of the length of time of feeding. The unit is called mite day. To calculate cumulative mite days, average number of mites per leaf of two successive mite counts was taken, it was multiplied by the number of days between the count, and the result was added to the running total. Since mite population have a single peak, the peak population level is related to the total number of mite days.

The binomial (Presence-Absence) of sampling scheme of European red mite was also done during the present study. 5 to 10 leaves from five to ten trees scattered throughout a zone selected for investigation. Leaves were scanned with the help of hand lens to determine the presence of mites. The number of infested leaves was divided by total number of scanned leaves and followed by multiplication with 100. To calculate the percentage of infested leaves, the reference standard table devised by Penn state University (1992) was used.

The nearest value from the list column of the table was selected and read across to obtain the estimate number of mites per leaf for the orchard block.

To obtain economic damage, the net productivity of selected orchards with heavy infestation was measured in relation to the non infested orchards of same area, containing equal number of trees. The productivity was measured in terms of number of boxes/Kanal. It is worth noticeable that the boxes used to pack apples in Kashmir are well graduated and have same standard in terms of size and carrying capacity (carriage or volume). It was purely a field based part of the project.

Fecundity estimation: The fecundity of the European Red Mite (*Panonychus ulmi*) which was the core part of the study of biology of the said pest was determined in the laboratory. The studies were experimental in nature and were carried under laboratory conditions. The procedure was incubatory and was maintained with the assistance of runner in the department of zoology *ICSC* Srinagar. During the study the rate of offspring production was measured at different temperatures and optimum range for fecundity was asserted. More importantly fecundity with relation to variable humidity was also figured and suitable RH for optimum fecundity was revealed. Controlled experiments under incubation were conducted and analogy between RH, Temperature and Fecundity was drawn.

Mite Colony and Host Plants: Samples of European red mite were collected separately from 3 different orchards of *SKUAST-K* from the common apple varieties, three varieties of apple were more than ten years old and grown without the use of pesticides for the purpose of research in the institution. During the experiment the mites were cultured in a Petridis and fecundity was evaluated for at least 2 weeks. Initially the samples were put on freshly cut clean leaves which were obtained from the botanical garden of ICSC Srinagar. The leaves were cleaned from both sides with the help of cotton and no egg is left on the underside of the leaf was assured. The Petridis was interiorly filled with cotton to curb the movement of mites. A single leaf was put in the apparatus with a pair of male and female red mite. The apparatus were then subjected to incubation@ 25°C and 30% and a photoperiod of 16:8 [L:D] h). The mites were initially observed after two days then after 6th day followed by a regular visit after every 96 hours. So that a total of 5 visits were made to the apparatus set, however the change in leaf was made after every 48 hrs to avoid leaf shrinkage. This was made possible with the assistance of the laboratory assistant of the mentioned institute.

C. Rearing Unit

A modified disc method was used to rear mites for whole experiments (Kasap, 2003). A small petri dish (12.5 cm in diameter) was wrapped in a sheet of cotton wool gauze and was set upside down in a big petri dish (14.5 cm in diameter). Distilled water was added into the big petri dish and was fully absorbed by the gauze. Leaf discs (3 cm in diameter) were placed on the water-saturated gauze. The edge of the leaf was covered with wetted filter paper to prevent the escape of the tested mites and to keep the leaf fresh. During the experiments, leaf discs were replaced after every 3rd day.

RESULT AND DISCUSSION

The mite fecundity was tested at altering temperature and 3 different samples from same orchard were taken. During this part, 2 pair of mites (1M:1F pair) were put in the Petridis of same dimensions as mentioned above. They were studied for ten days and the effect on fecundity at different temperatures was evaluated under constant humidity.

Table 1: Showing eggs laid by the Mite Pair under controlled experiment.

Serial number	Visiting day	Relative humidity (RH%)	Temperature	Number of eggs laid.
1	3rd	30	25°C	0
2	8th	30	25°C	3
3	12th	30	25°C	9
4	16th	30	25°C	7
5	20th	30	25°C	8

Based on the observations made during the project and data enunciated various results were asserted which primarily include infestation rate. Infestation rate is defined as the act of infesting or the state of being infested. A plant in an orchard was declared infested and enlisted only when there were visible marks of pest attack. For obtaining infestation rate, as per the schedule 3 places were selected which included Lar, Safapora and Kangan. The data was tabulated as per the plan and following results were obtained.

Table 2. Average percentage of Infestation Rate.

Serial number	Site	Number of trees taken.	Number of infested plants	Average infestation rate (%)
1	Lar	30	3	10
2	Safapora	30	5	16
3	Kangan	30	6	20
				15.33

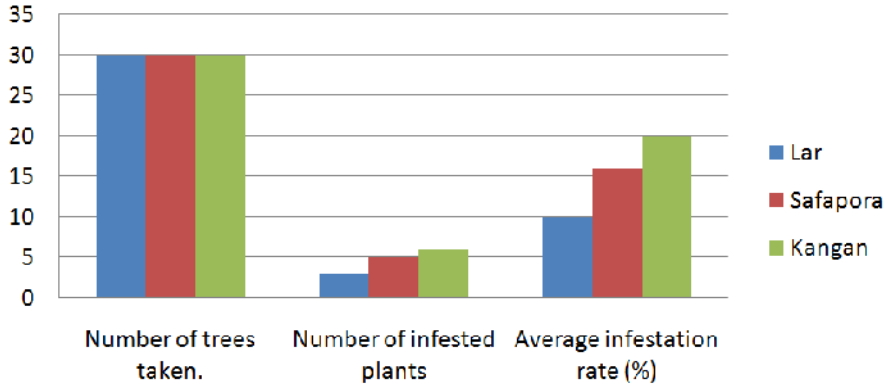

Fig. 1. Average percentage of Infestation rate.

The table results clearly indicate that the orchard selected from Kangan location was heavily infested followed by Safapora and, Lar was least infested. The results are further used to quantify the average infestation in the selected zones of the district.

The figures give us an indication about the status of infestation in the district. The infestation of European red mite indirectly affects our yield as it weakens the plant by reducing its photosynthesis rate. To obtain economic damage, the net productivity of selected orchards with heavy infestation was measured in relation to the non infested orchards of same area, containing equal number of trees. The productivity was measured in terms of number of boxes/kanal. It is worth noticeable that the boxes used to pack apples in Kashmir are well graduated and have same standard in terms of size and carrying capacity (carriage or volume). It was purely a field based part of the project. When the survey was done following results were revealed.

The table 3 clearly shows that a justifiable decrease occurs in the net productivity of apple when infested with the said pest. It can be summarised that a decrease of 2.42 boxes of standard size and weight occurs with an average infestation of 15.33% by the damage of European Red Mite in the selected area of district Ganderbal.

The fecundity of the European Red Mite (*Panonychus ulmi)* which was the core part of the study of biology of the said pest was determined in the laboratory. The studies were experimental in nature and were carried under laboratory conditions. The procedure was incubatory and was maintained with the assistance of runner in the Department of Zoology *ICSC* Srinagar. During the study the rate of offspring production was measured at different temperatures and optimum range for fecundity was asserted. More importantly fecundity with relation to variable humidity was also figured and suitable RH for optimum fecundity was revealed.

Table 3: Nature of plants and average productivity/plant.

Serial number	Total Area	Number of plants	Nature of plants	Production in terms of boxes	Average productivity.
1	3 kanals	90	Infested (15.33%)	453	5.03/plant
2	3 kanals	90	Non infested	671	7.45/plant

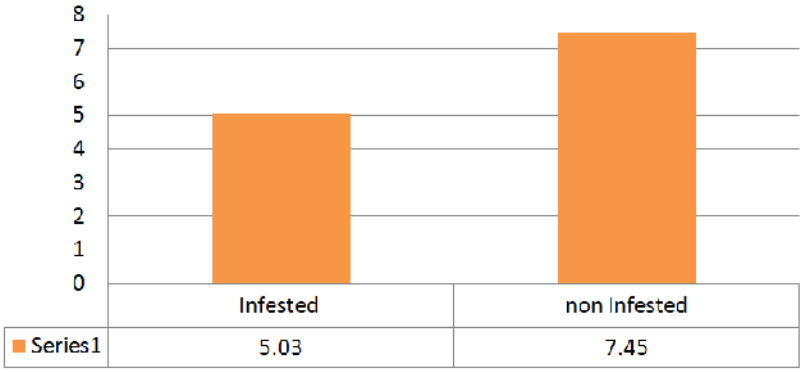

Fig. 2. Average productivity of infested and non-infested plant.

Controlled experiments under incubation were conducted and analogy between RH, Temperature and Fecundity was drawn. A small petri dish (12.5 cm in diameter) was wrapped in a sheet of cotton wool gauze and was set upside down in a big petri dish (14.5 cm in diameter). Distilled water was added into the big petri dish and was fully absorbed by the gauze. Leaf discs (3 cm in diameter) were placed on the water-saturated gauze. The edge of the leaf was covered with wetted filter paper to prevent the escape of the tested mites and to keep the leaf fresh. During the experiments, leaf discs were replaced after every 3rd day. For the purpose 3 petridis were separately incubated at three different temperatures with 40 RH and net number of individuals born were figured out.

Table 4: Fecundity of different samples under variable temperature.

Serial number	Petridis	Number of observatory days	Incubated temperature	Standard births	Relative humidity.	Individuals hatch out	Deviation
1	A	21	15°C	35	40	17	18
2	B	21	25°C	35	40	32	3
3	C	21	35°C	35	40	26	9

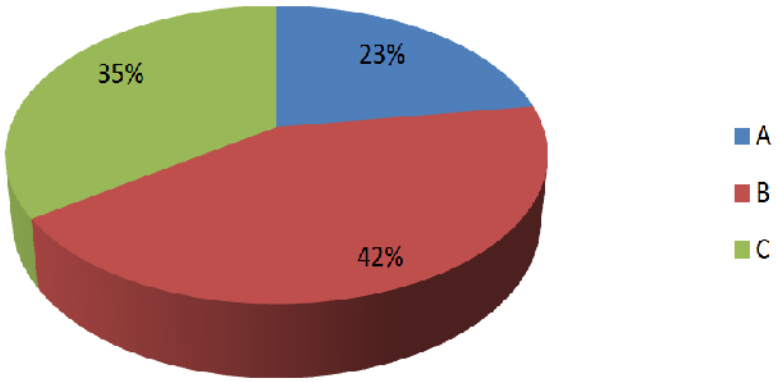

Fig. 3. Fecundity of mites per petriplate.

It was clearly quantified that maximum number of individuals are born @ 25°C within given set of conditions. To calculate the cumulative Mite Days the procedure adopted was discrete in nature. As the effects of leading damage accumulate over time, mite damage is often expressed as a combination of the population level plus an indication of the length of time of feeding. The unit is called mite day. To calculate cumulative mite days, average number of mites per leaf of two successive mite counts was taken, it was multiplied by the number of days between the count, and the result was added to the running total. Since mite population have a single peak, the peak population level is related to the total number of mite days

Table 5: Showing Cumulative Mite Day.

Sample date	Weakly count mites/leaf	Average (first count and last count)	Days between counts	No. Days x Average	Running Total*
June 1	0.10				
June 6	0.15	0.13	5	0.63	0.63
June 14	0.50	0.33	8	2.60	3.23
June 23	1.30	0.90	9	8.10	11.32
June 28	4.70	3.00	5	15.00	26.32
July 2	12.60	8.65	4	34.60	60.92
July 14	10.20	11.40	12	136.80	197.72

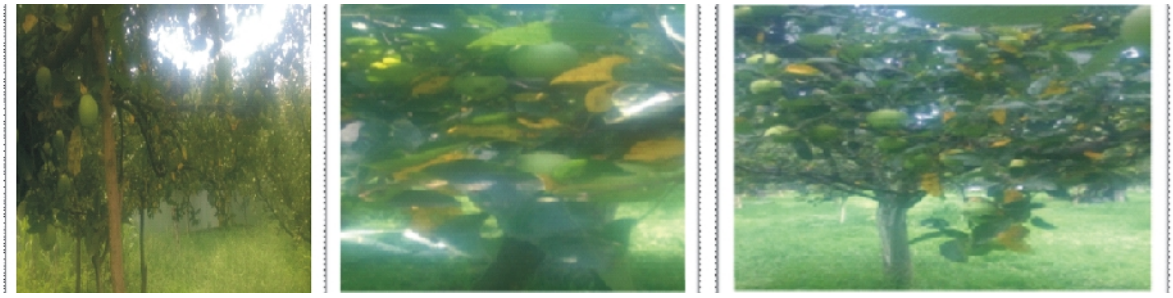

Plate 1: Apple trees infested by European Red Mite.

Plate 2: Infestation on leaves by European Red Mite.

The binomial (Presence-Absence) of sampling scheme of European red mite was done randomly from five to ten trees scattered throughout a zone selected for investigation. Leaves (5-10) were scanned with the help of hand lens to determine mites' presence. Trace of total number of leaves scanned and total number of leaves infested by one or more mite. The number of infested leaves was divided by total number of scanned leaves and followed by multiplication with 100. To calculate the percentage of infested leaves, the reference standard table devised by Penn state university (1992) was used. The nearest value from the first column of the table was selected and read across to obtain the estimate number of mites per leaf for the orchard block.

A tally sheet of infested and non infested leaves was done as per the plan. During the work a typical plant with few infested leaves was taken in consideration. During the investigation 50 leaves examined. In the total number of 50 leaves, 27 were found infested and 23 uninfested. The number of infested leaves was divided by 50 and the result was multiplied by 100 to obtain the percentage of infested leaves, which is 54%. Thus on the plant under investigation a rough estimate of 1.3 mites per leaf are found.

CONCLUSION

The work undertaken was completed in the set time of 5 months and it was conclude that, European Red Mite - (*Panonychus ulmi* Koch) is a major tree fruit pest in Jammu and Kashmir attacking fruits particularly apple with specificity on its Red Delicious species. However, mild attack on apricot and peach was also been reported from various parts of valley including Ganderbal. Moreover its attack on some generas of Roseacea family in the vale has also been brought in notice. The fecundity of the European Red Mite (*Panonychus ulmi)* which was the core part of the study of biology of the said pest was determined in the laboratory. To calculate cumulative mite days, average number of mites per leaf of two successive mite counts was taken, it was multiplied by the number of days between the count, and the result was added to the running total. Since mite population have a single peak, the peak population level is related to the total number of mite days. The binomial (Presence-Absence) of sampling scheme of European red mite was also done during the project. To calculate the percentage of infested leaves, the reference standard table devised by Penn state University (1992) was used. A tally sheet of infested and non infested leaves was done as per the plan. During the work a typical plant with few infested leaves was taken in consideration. During the investigation 50 leaves examined. In the total number of 50 leaves, 27 were found infested and 23 uninfested. The number of infested leaves was divided by 50 and the result was multiplied by 100 to obtain the percentage of infested leaves, which is 54%. Despite heavy spraying growers had a terrible loss due to scale infection this year. The loss is not less than few crores and figures are still peaking. This study is useful in enumerating our damage and will verily provide workers an edge in exploring further reasons and controlling methods for the said pest. In future it will serve the purpose of researchers for decades.

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