

Article

Seasonal dynamics of *Panonychus ulmi* (Koch) (Acari: Tetranychidae) on four varieties of mulberry in Kashmir valley, India

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Abstract

The present study was conducted to measure the population dynamics and seasonal variation of *Panonychus ulmi* (Koch) on four commercial mulberry varieties viz. Goshorami, KNG, Tr10 and Ichinose in Kashmir valley. Observations were made fortnightly on the mite density per leaf by selecting five plants from each of four accessions and five branches from each plant with the help of 20x hand lens. Influence of weather parameters on the population build-up and seasonal variations were quantified. The population of *P. ulmi* was highly affected by weather parameters and was very low during spring and reached maximum in the midst of summer in the varieties selected. Tr10 and Goshorami varieties were found the most susceptible with the highest population number; however, other varieties showed little resistance. Correlation and multiple regression analysis showed significant relation between *P. ulmi* population build-up and weather parameters. It can be concluded, that *P. ulmi* is a serious pest of mulberry plants and can cause significant loss to mulberry foliage. Temperature and relative humidity are the key factors determining rapid multiplication of this mite in mulberry ecosystem.

Key words: European red spider mite; population; *Morus* spp.; abundance; weather parameters.

Introduction

Mulberry, *Morus* spp. (Urticales: Moraceae) is the sole food of silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae). Perennial nature of mulberry besides luxuriant foliage, affords food and shelter for a variety of insect and non-insects. Infestation by insect pests reduces the leaf yield and feed value of mulberry leaf by deteriorating the nutritional value that is a chain reaction affecting the silkworm rearing, silk production, silk quality and profitability. More than 300 species of insect and non-insect species of pests are reported to infest one or the other part of the mulberry plant (Reddy and

Narayanaswamy 1999). Besides a number of insect pests on mulberry foliage, mites belonging to families of Tetranychidae and Eriophyidae are found to cause leaf damage to the tune of 5–10% in India (Narayanaswamy *et al.* 1996).

The European red spider mite, *Panonychus ulmi* (Koch) (Acari: Tetranychidae) is a major pest in almost all fruit growing regions of the world (Hardman *et al.* 1985). In India, *P. ulmi* has been recorded from peach, plum, apple, wheat, fig, hibiscus, tomato, apricot and ivy from Jammu and Kashmir (Kumar and Balla 1993). It has been reported for the first time as a serious pest of mulberry in the Terai zone of West Bengal, India (Karmakar *et al.* 1998). A study in Kashmir valley has revealed the threat from *Panonychus* sp., which is impairing the quality of mulberry leaves and adversely affecting the biological and economic parameters of silkworm and resultant cocoon, when silkworm larvae were fed with mite infested leaves (Dar *et al.* 2011; Ramegowda *et al.* 2012). About, 16 species of mites have been recorded on mulberry as pest throughout the world, of which 8 species have been documented in India (Rajalakshmi *et al.* 2009). Information on the diversity and damage potential of mites to mulberry is meagre in general and Kashmir valley in particular, which is the temperate region of the country. In this background, current study has been undertaken to delineate the abundance of *P. ulmi* on different varieties of mulberry as well as to understand seasonal behaviour and varietal performance.

Material and methods

The State of Jammu and Kashmir falls in the great north-western complex of the Himalayan ranges with marked relief variation, snow-capped mountains, antecedent drainage, complex geological structure and rich temperate and subtropical flora and fauna (Raina 2002). Studies were made at Central Sericulture Research and Training Institute, Central Silk Board, Gallandar, Pampore. It is located at 33° 59' 50" N latitude and 74° 55' 5" E longitudes and at an altitude of 1574 m above mean sea level on the bank of river Jhelum along the National Highway 1A. Studies were made from May to October during 2011 and 2012 on four commercial varieties of mulberry (*Morus* spp.), Goshoerami (*M. multicaulis*), KNG, Ichinose and Tr10 (*M. alba*). Seasonal variation of mulberry mites was studied following the methodologies of Rama Kant and Bhat (2010) and Dar *et al.* (2012). All the four selected commercial mulberry varieties were examined for the presence of mites and their densities. Five plants from each variety (one plant from each corner and one from the centre of plot leaving the border rows plants in a plot of 25 m² with plants spaced at 0.9 m either way) with five branches from each plant and 10 fully opened leaves from tip on each branch were observed randomly with the help of 20x hand lens. Observations on population build-up of *P. ulmi* were made separately, fortnightly from all the selected varieties of mulberry to know the host preference of the species.

Data on weather parameters [*i.e.*, maximum and minimum temperatures (T_{\max} and T_{\min}), relative humidity (RH %) and rainfall (RF) (mm)] were obtained from the automatic weather station (WatchDog® 2700, Spectrum Technologies) of the Institute during the study period to understand their role in population build-up and seasonal variation of *P. ulmi*.

Statistical analysis

Influence of weather parameters prevailed during the same fortnight (SFN: 0–15 days prior to observation) and preceding fortnight (PFN: 16–30 days prior to observation) of

observation on the seasonal variation of *P. ulmi* were analyzed by deploying the Pearson correlation and multiple regression analysis using Sigma Plot 12[®] software.

Results

Influence of mulberry varieties

Investigations revealed that all the four commercial mulberry varieties were infested by *P. ulmi* and its population varied annually but in general it was recorded from May onwards until leaf fall started in last week of October. From November to April the mite populations were not recorded because they undergo overwintering diapause. The high incidences of mites were recorded on Tr10 and Goshorami, during 2011 & 2012, respectively (Figs. 1 & 2). Irrespective of the seasons, Tr10 showed highest population with 0.81 ± 0.19 mites per leaf, followed by 0.77 ± 0.14 mites per leaf on Goshorami; 0.65 ± 0.12 mites per leaf on KNG and least number 0.63 ± 0.12 mites per leaf on Ichinose (Table 1). Thus, there exists a varietal reaction, Ichinose being offered relative resistance/tolerance to population build-up of *P. ulmi* while Tr10 and Goshorami were the most susceptible on both the years.

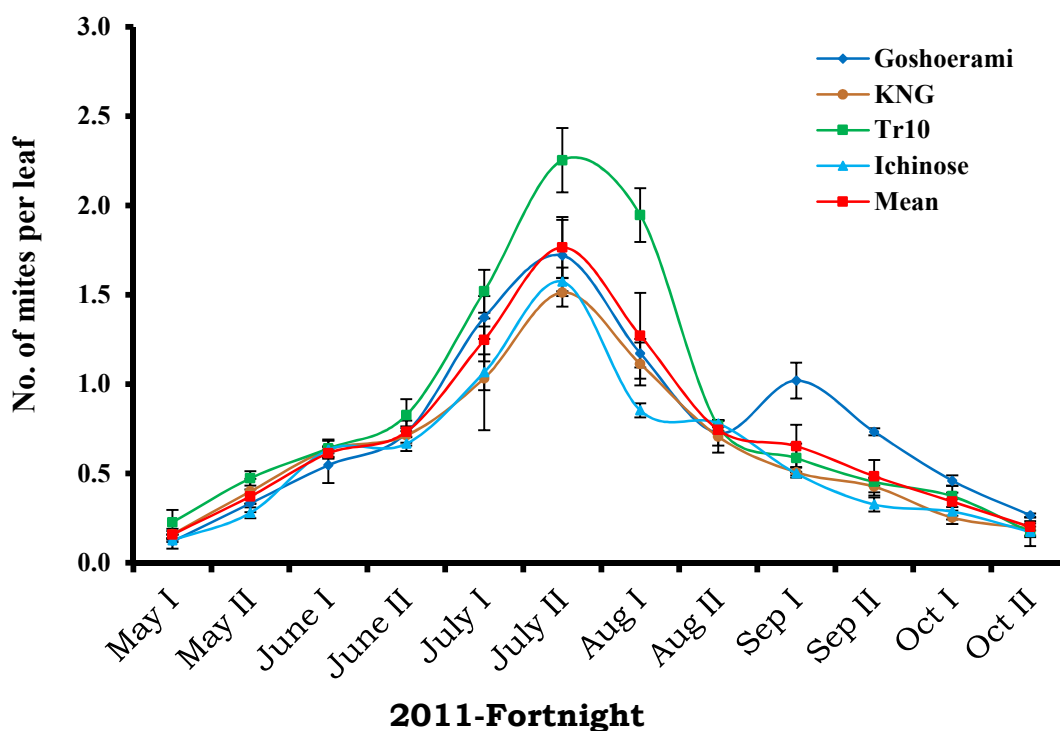


Figure 1. Seasonal abundance of *Panonychus ulmi* on four mulberry varieties at Pampore, Kashmir, India during 2011.

Seasonal abundance of P. ulmi

Panonychus ulmi was more abundant during July and August months (summer season). Mean fortnightly populations of *P. ulmi* during 2011 was very low (0.16 ± 0.02 mites per leaf) during first fortnight at the end of spring and reached to maximum (1.77 ± 0.17 mites per leaf) during 2nd fortnight of July (mid-summer) and then gradually decreased to 0.20 ± 0.02 mites per leaf at the end of October (early winter) (Fig. 1). During 2012 the mean fortnightly population of *P. ulmi* irrespective of varieties were very low

0.17 ± 0.11 mites per leaf during 1st fortnight of May (end of spring) and showed gradual increase to reach maximum of 1.83 ± 1.54 mites per leaf during 2nd fortnight of July (mid-summer) and then started coming down and reached to 0.21 ± 0.14 mites per leaf during 2nd fortnight of October at the onset of leaf fall (Fig. 2).

Table 1. Seasonal abundance of *Panonychus ulmi* on four mulberry varieties at Pampore, Kashmir, India during 2011–12 (Pooled mite incidence)

Variety Fortnights 2011 & 2012	Goshoerami	KNG	Tr10	Ichinose	Mean
	Number of mites/leaf (Mean \pm SE*)				
May I	0.13 \pm 0.05	0.17 \pm 0.07	0.22 \pm 0.13	0.14 \pm 0.07	0.17 \pm 0.02
May II	0.37 \pm 0.04	0.41 \pm 0.08	0.48 \pm 0.08	0.35 \pm 0.11	0.40 \pm 0.03
June I	0.56 \pm 0.06	0.66 \pm 0.16	0.61 \pm 0.24	0.61 \pm 0.13	0.61 \pm 0.02
June II	0.74 \pm 0.10	0.73 \pm 0.10	0.83 \pm 0.27	0.71 \pm 0.17	0.75 \pm 0.03
July I	1.40 \pm 0.27	1.02 \pm 0.19	1.41 \pm 0.27	1.11 \pm 0.06	1.24 \pm 0.10
July II	1.68 \pm 0.17	1.55 \pm 0.28	2.24 \pm 0.49	1.71 \pm 0.30	1.80 \pm 0.17
Aug I	1.18 \pm 0.29	1.11 \pm 0.25	1.70 \pm 0.42	0.89 \pm 0.21	1.22 \pm 0.17
Aug II	0.73 \pm 0.12	0.72 \pm 0.27	0.80 \pm 0.13	0.73 \pm 0.18	0.75 \pm 0.02
Sep I	0.89 \pm 0.21	0.53 \pm 0.11	0.54 \pm 0.12	0.50 \pm 0.12	0.62 \pm 0.13
Sep II	0.76 \pm 0.07	0.44 \pm 0.14	0.41 \pm 0.17	0.35 \pm 0.21	0.49 \pm 0.09
Oct I	0.46 \pm 0.05	0.28 \pm 0.09	0.30 \pm 0.16	0.28 \pm 0.09	0.33 \pm 0.04
Oct II	0.28 \pm 0.05	0.22 \pm 0.17	0.18 \pm 0.07	0.15 \pm 0.05	0.21 \pm 0.03
Mean	0.77 \pm 0.14	0.65 \pm 0.12	0.81 \pm 0.19	0.63 \pm 0.12	0.72 \pm 0.05

* SE = Standard Error

Abundance of *P. ulmi* in the beginning of study in 2011 recorded was very low of 0.12 mites per leaf on Goshoerami, 0.13 on Ichinose, 0.16 on KNG and 0.23 mites per leaf of Tr10, during 1st fortnight of May, which slowly increased to reach maximum, 1.51, 1.57, 1.72, and 2.25 mites per leaf during 2nd fortnight of July, which gradually reduced to reach a minimum of 0.17, 0.17, 0.19 and 0.27 mites per leaf on Ichinose, Tr10, KNG and Goshoerami varieties, respectively in 2nd October (Fig. 1).

During 2012, the population of *P. ulmi* started from 0.13 mites per leaf on Goshoerami, 0.14 on Ichinose, 0.21 mites per leaf on KNG and Tr10 varieties during the 1st fortnight of May which gradually increased to reach the maximum, 1.85, 1.65, 1.59 and 2.22 mites per leaf during 2nd fortnight of July which gradually decreased to a lower level of 0.13, 0.29, 0.25 and 0.18 mites per leaf during 2nd fortnight of October on Ichinose, Goshoerami, KNG and Tr10 respectively (Fig. 2).

Seasonal variation in population of *P. ulmi*, irrespective of years in the beginning of study was very low of 0.13, 0.17, 0.22 and 0.14 mites per leaf on Goshoerami, KNG, Tr10 and Ichinose during 1st fortnight of May, which slowly increased to reach maximum of 1.68, 1.55, 2.24 and 1.71 mites per leaf during 2nd fortnight of July, which gradually

reduced to reach a minimum of 0.28, 0.22, 0.18 and 0.15 mites per leaf on above said varieties, respectively in 2nd October (Table 1).

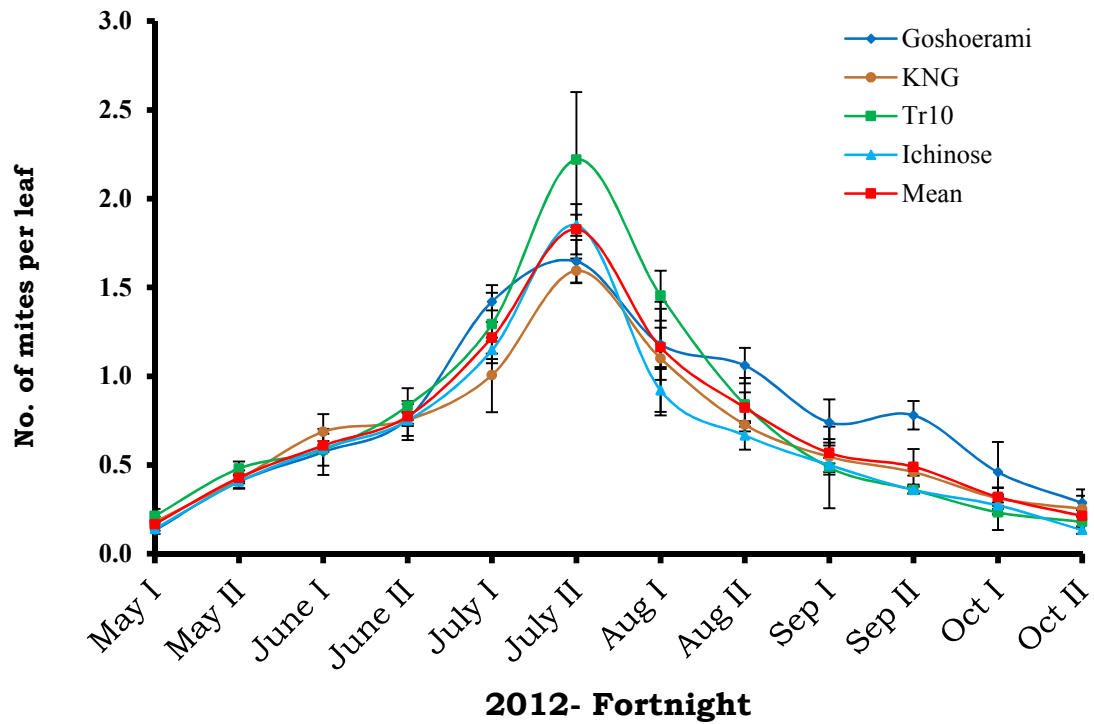


Figure 2. Seasonal abundance of *Panonychus ulmi* on four mulberry varieties at Pampore, Kashmir, India during 2012.

Table 2. Correlations of weather parameters with population dynamics of *Panonychus ulmi* on mulberry during 2011–12 at Pampore, Kashmir, India (Pooled weather and mite incidence)

Weather parameters		Mulberry variety				
		T _{max}	T _{min}	RF	RD	RH
Goshoerami	Same Fortnight	0.69*	0.77**	0.54	0.08	0.56
	Previous Fortnight	0.84**	0.77**	-0.11	-0.46	0.24
KNG	Same Fortnight	0.77**	0.78**	0.47	0.04	0.36
	Previous Fortnight	0.72**	0.63*	-0.06	-0.33	0.05
Tr10	Same Fortnight	0.72**	0.73**	0.52	0.01	0.36
	Previous Fortnight	0.66*	0.59*	-0.08	-0.34	0.44
Ichinose	Same Fortnight	0.78**	0.78**	0.40	0.01	0.34
	Previous Fortnight	0.71**	0.62*	-0.08	-0.37	0.01

*, ** Significant at p = 0.05 and p = 0.01, respectively, T_{max}: Maximum temperature, T_{min}: Minimum temperature, RF: Rainfall, RD: No. of rainy days, RH: Relative humidity.

Table 3. Multiple regression modules/equations for population dynamics of *P. ulmi* on mulberry with weather parameters during 2011-12 at Pampore, Kashmir, India (Pooled weather and mite incidence)

Mulberry Variety	<i>P. ulmi</i>	Module	R	R ² %	Adjusted R ²	F-value	P-value
Goshoerami	Same Fortnight	-3.923-(0.022RD)+(0.0019RF)+(0.0437RH)+(0.0135T _{min})+(0.0634T _{max})	0.80	64	0.35	2.17	0.19
	Previous fortnight	8.976 - (0.10RD)-(0.0137RF)-(0.0804RH)+(0.254T _{min})-(0.196T _{max})	0.94	88	0.78	9.001	0.009**
KNG	Same Fortnight	1.251-(0.072RD)+(0.0065RF)-(0.0208RH)+(0.0567T _{min})+(0.0097T _{max})	0.81	66	0.37	2.31	0.17
	Previous Fortnight	10.380-(0.0939 RD)+(0.00135RF)-(0.123RH)+(0.199T _{min})-(0.1390T _{max})	0.85	72	0.48	3.04	0.104
Tr10	Same Fortnight	1.845-(0.158RD)+(0.0207RF)-(0.0402RH)+(0.0508T _{min})+(0.0470T _{max})	0.79	64	0.33	2.1	0.19
	Previous Fortnight	18.049-(0.177RD)-(0.00204RF)-(0.194RH)+(0.360T _{min})-(0.299T _{max})	0.81	65	0.36	2.26	0.18
Ichinose	Same Fortnight	1.123-(0.066RD)+(0.0017RF)-(0.0172RH)+(0.0692T _{min})+(0.00107T _{max})	0.81	66	0.37	2.3	0.17
	Previous Fortnight	12.673-(0.125RD)+(0.00113RF)-(0.142RH)+(0.238T _{min})-(0.191T _{max})	0.88	77	0.58	4.093	0.058

Influence of climatic factors on population of P. ulmi

It was observed that climatic conditions *viz.*, temperature, humidity, rainfall and number of rainy days, influenced the population build-up of *P. ulmi* of which the influence of temperature was only significant. From the correlation analysis it was evident that the incidence of *P. ulmi* on four popular mulberry varieties was governed by the ability of the host and changing of climatic factors. Correlation analysis revealed that all the five weather parameters showed a positive correlation with population of *P. ulmi* with same fortnight weather (SFN) but correlations with rainfall and rainy days were not significant enough to show relation (Table 2). With previous fortnight weather (PFN) among five parameters, maximum temperature, minimum temperature and relative humidity showed positive correlation while as rainfall and rainy days showed negative correlation. *Panonychus ulmi* showed highly significant positive correlation with SFN minimum and maximum temperatures except for Goshoerami variety where only maximum temperature had a significant correlation. The positive influence of relative humidity in all the four varieties of mulberry was not significant enough wherein the impact was more with SFN than PFN except for Tr10 variety. With PFN weather among all these five weather parameters rain fall and rainy days showed negative correlation with the population of *P. ulmi* which was not significant enough to stand the relation while other parameters had the positive correlation (Table 2). Correlations were highly significant for *P. ulmi* on all the four varieties with both maximum and minimum temperatures of PFN except on KNG and Ichinose which showed significant relation with minimum temperature (Table 2).

The multiple regression modules with five weather parameters of same fortnight had fairer R² values in all four varieties but regression module for weather parameters of

previous fortnight showed reliable R^2 value except Tr10 which showed fairer reliable R^2 value (Table 3).

Discussion

Panonychus ulmi has been recorded on all the four varieties of mulberry investigated. It was predominant on Tr10 during both the years 2011 and 2012. Present investigations are not sufficient enough to define the relationship between the mites and varieties which need intensive observations along with weather and crop phenology. This study forms the beginning of mulberry varietal reaction to mites in temperate climate of Kashmir. Mite damage to mulberry under temperate climate in Japan has been documented by Ayuzawa *et al.* (1972), and Ehara and Gotoh (1992) who have reported *Panonychus citri* (McGregor) and *P. mori* and the latter causing serious damage. In the subtropical climate of West Bengal, India, Karmakar *et al.* (1998) have observed the presence of *P. ulmi* on mulberry. Earlier preliminary studies in the same mulberry fields of CSR & TI, Pampore (Dar *et al.* 2012) lend greater support to current findings as they witnessed *Panonychus* sp. causing leaf damage to some of the mulberry varieties. Rather (1989) reported *P. ulmi* from apple orchards in Kashmir valley and found that they lay eggs singly on the lower surface of the leaves. It has been reported on apple in North West Himalayan region comprising Jammu and Kashmir, Himachal Pradesh and Uttaranchal (Bhardwaj and Bhardwaj 2000). Present and earlier studies elsewhere clearly indicate the ubiquitous nature of this pest across climates.

Studies clearly revealed that highest population of *P. ulmi* was present on the 3rd and 4th leaf of the branch from the top which is very critical for the young silkworm (chawki) rearing due to their feeding preferences. Young mulberry leaves being fed to young larvae rearing will affect the performance of chawki and the mature leaves fed for latter instars will poorly nourish the voracious feeding stages thus affecting the biological as well as economic parameters of silkworms and cocoon. The harmful effects of mite infested leaf feeding on silkworms and rearing performance have been well documented (Dar *et al.* 2011; Ramegowda *et al.* 2012). As *P. ulmi* prefers to feed and breed on the top 3rd and 4th leaves, the silkworm young age larva rearing will be at a greater risk and measures to curtail this pest's menace are to be designed without affecting the silkworm safety.

Irrespective of the seasons, Tr10 harbored the highest population of mites followed by Goshorami, KNG and Ichinose variety. Tr10 is relatively more susceptible to the population build-up of *P. ulmi* compared to Goshorami, KNG and Ichinose, which have offered some resistance, relatively in the order. Similar results were documented on mulberry cultivars from West Bengal of which, 'Local' cultivar was found to be highly susceptible to *P. ulmi* (49.52 mites/leaf) compared to the cultivar 'KPG-II', which was least susceptible (3.89 mites/leaf) (Karmakar *et al.* 1998).

Current study revealed that, *P. ulmi* showed seasonal variations in population build-up on all the four mulberry varieties studied during both the years (2011–12). This mite species was more abundant during the July to August (summer season of the valley) than rest of the year. July month recorded the peak activity of *P. ulmi* irrespective of the mulberry varieties particularly during the 2nd fortnight of July, from then started to decline to reach the minimum level by the end of October coinciding with onset of leaf fall. Karmakar *et al.* (1998) reported that *P. ulmi* attain peak population during the second fortnight of March (19.74 mites/leaf) in mulberry gardens of West Bengal under subtropical climatic conditions. Similar results were witnessed on apple plants in Himachal Pradesh where *P. ulmi* population was highest (number per leaf) in the month of June, started reducing from August onwards and reached zero in the month of

December (Sharma and Mattu 2014). In Japan, the incidence of *Tetranychus kanzawai*, *Panonychus citri* and *Eotetranychus suginamensis* on mulberry was severe in the summer-autumn rearing season, which is a dry season (Ayuzawa *et al.* 1972). In all the studies including the present it was clearly evident that *P. ulmi* population peaks up in the hottest months of the year and was observed that climatic conditions are influencing the population build-up, significantly. Maximum and minimum temperatures of both SFN and PFN showed highly significant correlations with population build-up of *P. ulmi* on all the four varieties of mulberry. Relative humidity showed a positive, but non-significant correlation and rainfall and rainy days registered a positive but non-significant relation with same fortnight populations but negative correlation with previous fortnight population build-up of *P. ulmi*. Present findings are comparable to the findings of Prasad and Singh (2003) who observed a significant positive correlation between population of *Tetranychus macfarlanei* and temperatures. Kumar *et al.* (2003) observed that the mite population showed a non-significant positive correlation with relative humidity and weekly rainfall in French marigold.

Multiple linear regression modules of both SFN and PFN weather showed reliable or fairly reliable R^2 values with population build-up of *P. ulmi*. Weather parameters of previous fortnight contributed higher (65–88%) than the same fortnight weather (64–66%) to the population build-up of *P. ulmi* on four mulberry varieties in temperate climate of Kashmir valley. Similar results were recorded by Dar *et al.* (2012), where the population of *Tetranychus* sp. and *Panonychus* sp. on mulberry in Kashmir valley are highly influenced by weather parameters and it was observed that population of both these species showed decrease in number as the temperature and relative humidity decreased and rainfall was more. Multiple regression analysis revealed that weather parameters contributed for 78–85 percent of total variation in the population of red spider mite in okra (Mandal *et al.* 2006). Population of *T. equitorius* on mulberry was maximum during March-April and May-June followed by a reduction during August and then remained at lower level up to January-February in mulberry gardens of Tamil Nadu. The sudden fall in mite population from August onwards was attributed to the heavy rainfall during that period (Pillai *et al.* 1980). Population of mites was also higher during hot seasons in Karnataka and Tamil Nadu on mulberry (Pillai and Jolly 1986). High temperature (28–33 °C) coupled with low humidity (45–50%) favours breeding. Low temperature (25.5–27 °C) and high humidity (85–90%) coupled with heavy rain fall affects the population of *T. equitorius* (Pillai *et al.* 1980). Population of *Polyphagotarsonemus latus* which was first noticed in January started increasing till April, which reduced in May due to cultural operations like digging, weeding and pruning. Again, it slowly picked up to reach higher density during October and November at Conoor in Tamil Nadu (Chauhan *et al.* 2002) which again declined during December with reduction in temperature. Present investigations are strongly supported by the findings of Pillai *et al.* (1980) and Chauhan *et al.* (2002), wherein highest and lowest mite populations was obtained during hottest and coldest periods of the study, respectively and is in close conformity with that of Prasad and Singh (2003) where mite population started building up on pumpkin crop from the second fortnight of March and continued to reach maximum during the first fortnight of July. Reports of Sharma and Pande (1981) on the seasonal activity of *T. cinnabarinus* and *T. neocaledonicus* on brinjal at Udaipur Rajasthan lend support to the present findings on mulberry mite activity in Kashmir valley. Both *T. cinnabarinus* and *T. neocaledonicus* had almost similar population fluctuation between October to January with a low population level which increased rapidly to reach peak during May on all varieties. Ma *et*

al. (1998) reported that high temperature and drought conditions favoured the occurrence of mite. As the negative correlations with PFN rain fall and rainy days indicated it is very clear that temperature favours the *P. ulmi* population build-up while rainfall and rainy days retard them besides, the varietal factors do contribute to pest build-up. Findings indicate a need for studies on microclimate analysis in mulberry in relation to mite pest build-up in various varieties besides planting geometries.

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References


- Ayuzawa, C., Sekido, I., Yamakawa, K., Sakurai, U., Kurata, W., Yaginuma, Y. & Tokoro Y. (1972) *Handbook of Silkworm Rearing*. Agricultural Technique Manual 1, Fuji Publishing Co., LTD, Tokyo, Japan, 319 pp.
- Bhardwaj, S.P. & Bhardwaj, S. (2000) European Red mite- an emerging problem of apple. *In: Sharma, V.K. and Azad, K.C (Eds.), Horticulture technology vision 2000 and beyond, Vol. 2: protection and presentation*. Deep and Deep publications Delhi, India, pp. 428– 432.
- Chauhan, T.P.S., Narayan, N. & Kumar, N. (2002) *Polyphagotarsonemus latus* (Banks): A new pest of mulberry. *Indian Journal of Forestry*, 25(2): 171–176.
- Dar, M.Y., Illahi, I., Agrawal, O.P., Mittal, V. & Ramegowda, G.K. (2011) Impact of mite infestation on mulberry leaf and silkworm, *Bombyx mori* L. *Indian Journal of Entomology*, 73(4): 378–381.
- Dar, M.Y., Ramegowda, G.K., Mittal, V., Illahi, I., Dhar, A. & Agrawal, O.P. (2012) A preliminary study on mite damage assessment in mulberry. *Munis Entomology and Zoology*, 7 (2): 899–903.
- Dar, M.Y., Illahi, I., Agrawal, O.P., Mittal, V. & Ramegowda, G. K. (2012) Preliminary studies on the mulberry mite diversity and dynamics in Kashmir, India. *Indian Journal of Entomology* 74(1): 1–8.
- Ehara, S. & Gotoh, T. (1992) Description of two *Panonychus* spider mites from Japan with a key to species of the genus in the world (Acari: Tetranychidae). *Applied Entomology and Zoology*, 27 (1): 107–115.
- Hardman, J.M., Herbert, H.J., Sanford, K.H. & Hamilton, D. (1985) Effect of populations of the European red mite, *Panonychus ulmi*, on the apple variety red delicious in Nova Scotia. *Canadian Entomologist*, 177 (10): 1257–1265.
- Karmakar, K., Ghosh, J. & Senapati, S.K. (1998) Relative abundance and biology of European red mite *P. ulmi* (Koch) (Acari: Tetranychidae) infesting mulberry. *Environmental Ecology*, 16 (1): 101–104.
- Kumar, R. & Bhalla, O.P. (1993) An epidemic outbreak of *P. ulmi* (Koch) (Acari: Tetranychidae) in apple orchards of Himachal Pradesh, India. *Current Sciences*, 64 (10): 709.

- Kumar, S., Prasad, S. & Singh, R.N. (2013) Population trends of two spotted spider mite (*Tetranychus urticae*) in relation to abiotic factors on French marigold (*Tagetes patula*). *Indian Journal of Agricultural Sciences*, 73(5): 303-304.
- Ma, S.E., Wang, J.H. & Xu, C.R. (1998) The occurrence of the spider mite and its control. *China fruits*, 2: 34–36.
- Mandal, S.K., Sattar, A. & Banerjee, S. (2006) Impact of meteorological parameters on the population build up of red spider mite in okra, *Abelmoschus esculentus* L. under North Bihar condition. *Journal of Agricultural Physics*, 6(1): 35-38.
- Narayanaswamy, K.C., Geethabai M. & Raghuraman, R. (1996) Mite pests of mulberry - A review. *Indian Journal of Sericulture*, 35(1): 1–8.
- Pillai, S.V. & Jolly, M.S. (1986) Studies on the population build up and control measures of the red spider mite, *Tetranychus equitorius* (McGr.). *Indian Journal of Sericulture*, 25(1): 15–21.
- Pillai, S.V., Krishnaswami, S., Bhat, D.V. & Ranganath, B.K. (1980) Studies on egg laying, sex ratio, seasonal incidence and control measures of red spider mite (*Tetranychus equitorius* McGr) infesting over the mulberry plants. In: Muthukrishnan, T.S. & Srerangaswamy, S.R. (Eds.), *Proceedings of Sericulture Symposium and Seminar*, Tamil Nadu Agriculture University Coimbatore, India, pp. 181–185.
- Prasad, R. & Singh, R.N. (2003) Influence of abiotic factors on incidence of *Tetranychus macfarlanii* (Acarina: Tetranychidae) on pumpkin (Cucurbita: Maschata) and its control. *Indian Journal of Agricultural Sciences*, 73: 181–183.
- Raina, A.N. (2002) *Geography of Jammu and Kashmir State*. Radha Krishan Anand and Co., Pacca Danga, Jammu, 38 pp.
- Rajalakshmi, E., Sankaranarayanan, P. & Pandya, R.K. (2009) The Yellow Mite *Polyphagotarsonemus latus* a serious pest of mulberry under Nilgiris hill conditions. *Indian Journal of Sericulture*, 48(2): 187– 190.
- Rama, K. & Bhat, M.M. (2010). Mulberry foliar, fungal diseases and insect pest calendar in Uttarakhand. *Indian Silk*, 48(10): 10–13.
- Ramegowda, G.K., Dar, M.Y., Mittal, V., Ahmed, S.N., Guruswamy, D., Illahi, I., Agarwal, O.P. & Dhar, A. (2012) Preliminary studies on the effect of mite damaged mulberry leaves on performance of silkworm, *Bombyx mori* L. *Munis Entomology and Zoology*, 7(2): 926–930.
- Rather, A.Q. (1989) Studies on mites (Acari) associated with stone fruits in subtropical, temperate and cold arid zones of Jammu and Kashmir. In: Channabasavanna, G.P. and Viraktanath C.A. (Eds.), *Progress in Acarology – Proceedings of the VII International Congress Acarology*, Bangalore, India, 2: 183–189.
- Reddy, D.N.R. & Narayanaswamy, K.C. (1999) Present status of the thrips infesting mulberry. *Indian Journal of Sericulture*, 38: 1–7.
- Sharma, H.S. & Pande, Y.D. (1981) Seasonal incidence of *Tetranychus* sp. on four improved varieties of brinjal. In: Channa Basavanna, G.P (Ed.) *Contributions to Acarology in India*: Acarological Society of India, Bangalore. 46 pp.
- Sharma, M. & Mattu, V.K. (2014) Diversity and Seasonal Variation in population of a phytophagous and predatory mites associated with apple trees in District Kullu (H.P.). *Asian Journal of Advanced and Basic Science*, 2(3): 130–137.

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دینامیسم فصلی *Panonychus ulmi* (Koch) (Acari: Tetranychidae) روی چهار رقم توت در دره کشمیر، هند

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چکیده

مطالعه در انستیتوی آموزشی و پژوهشی مرکزی پرورش کرم ابریشم، جاده مرکزی ابریشم، پمپور در دره کشمیر هند در طی فصل‌های زراعی سال‌های ۲۰۱۱-۲۰۱۲ برای تعیین دینامیسم جمعیت و تغییرات فصلی کنه *Panonychus ulmi* (Koch) روی رقم‌های تجاری توت (گوشورامی، کی‌ان‌جی، تی‌آر ۱۰ و ایچینوز) انجام شد. مشاهدات هر دو هفته یک بار از می تا اکتبر بر انبوهی کنه در هر برگ صورت گرفت. ۱۰ برگ باز از بالای هر شاخه، پنج شاخه از هر گیاه و پنج گیاه از هر رقم به صورت تصادفی به کمک عدسی دستی ۲۰× بررسی شدند. تأثیر آماره‌های آب‌وهوایی بر تشکیل جمعیت و تغییرات فصلی اندازه‌گیری شد. جمعیت *P. ulmi* با آماره‌های آب‌وهوایی به شدت تحت تأثیر قرار می‌گیرد و در طی ماه می (فصل بهار) بسیار پایین بود و به بیشینه خود در میانه تابستان در هر چهار رقم رسید. رقم‌های تی‌آر ۱۰ و گوشورامی بسیار حساس با بیشترین جمعیت تشخیص داده شدند در حالی که دیگر رقم‌ها مقاومت کمی داشتند. مدل ضریب همبستگی و رگرسیون چندگانه ارتباط مهمی بین تشکیل جمعیت *P. ulmi* با آب‌وهوای آن دو هفته و دو هفته پیش نشان داد. می‌توان نتیجه گرفت که *P. ulmi* آفت جدی درختان توت است و می‌تواند خسارت مهمی به برگ‌های توت وارد سازد. حرارت و رطوبت نسبی عامل‌های کلیدی برای تعیین تکثیر سریع این کنه در اکوسیستم‌های درختان توت هستند.

واژگان کلیدی: کنه قرمز اروپایی؛ جمعیت؛ *Morus spp.*؛ فراوانی، آماره‌های آب‌وهوایی.

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