



Seasonal Incidence and Management of Pear Psylla (*Cacopsylla pyricola* Foerster, Hemiptera, Psyllidae) in Kashmir, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Pear (*Pyrus communis*) is an important fruit crop cultivated worldwide, including the temperate regions of India, particularly Jammu and Kashmir. Pear Psylla (*Cacopsylla pyricola* (Foerster)) has emerged as a significant pest, causing substantial losses by stunting tree growth, reducing fruit size leading to premature leaf drop. The present study investigated the influence of various abiotic factors such as temperature, humidity and rainfall on the seasonal incidence and population dynamics of Pear Psylla in four locations from two districts viz., Baramulla and Srinagar, Kashmir. Regular pest monitoring and meteorological data revealed that maximum and minimum temperatures had a positive correlation with Pear Psylla populations while rainfall and maximum

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relative humidity were negatively correlated. Regression analysis showed that these climatic factors accounted for up to 95% of the variation in pest populations. The results of the evaluation of different insecticides revealed that Cyantraniliprole 10.26% OD with an efficacy of 92.74%, proved to be the most effective followed by Acetamiprid 20% SP (90.87%). These findings highlighted that the optimal temperature range for Psylla development was between 27°C and 29°C suggesting that the weather conditions played a crucial role in fluctuating pest population and can govern the integrated pest management strategies.

Keywords: Pear psylla; seasonal activity; abiotic factor; bioefficacy; insecticide.

1. INTRODUCTION

Pear (*Pyrus communis* L.) is a widely cultivated fruit tree species from the Rosaceae family. It is highly valued for its delicious and nutritious fruits making it a prevailing preference for fresh consumption and processing of various products. Pear cultivation has a long history with evidence dating back thousands of years in regions such as China and Europe (Wu et al., 2019). Over time, the cultivation of pear has spread to different parts of the world due to their adaptability to a wide range of climatic conditions.

Since prehistoric times, pear has been utilized as food, making them the second most significant fruit in the temperate region (Civolani, 2012). There are around 3,000 cultivars and over 20 main species; however, the majority of commercial variations are European or common pears (*Pyrus communis*).

Pears are the second most renowned temperate fruit in India in terms of both production and area. India ranks 6th in the world for pear production, with a total annual production of approximately 3,12,5000 metric tons in 2023. Pears are the second most popular fruit in Jammu and Kashmir, after apples and they are produced on 14,161 hectares of land with an 81,628 MT yield. District Budgam is the largest producer of pear 15,909 MT (Anonymous, 2021).

Many pests viz., San Jose scale (*Quadraspidiotus perniciosus* Comstock), the pear leaf blister mite (*Eriophyes pyri* Pagenstecher), the codling moth (*Cydia pomonella* Linnaeus), the cotton aphid (*Aphis gossypii* Glover) and the Pear Psylla (*Cacopsylla pyricola*), pest on pears in Jammu and Kashmir. In India pear-growing regions, including Jammu and Kashmir, Pear Psylla is an emerging pest (Ahmad et al., 2020). Pear Psylla produces the honeydew that promotes fruit russet and severe infestations can cause trees to droop and lose their leaves.

Psyllids, sometimes known as jumping plant lice (Chinery, 1993), are tiny, phloem-feeding insects that are members of the Psyllidae family and order Hemiptera. There have been reports of over 150 psyllid species as possible pests of temperate and subtropical plants grown in cultivation (Buckhardt, 1994). The pear psylla, or *Cacopsylla pyricola*, is a significant economic pest of pears. It was initially discovered in Connecticut in 1832 and brought to the United States (Pettit and Hutchison 1931). It is believed that Asia Minor or southern Europe is where the pest first appeared (Burts, 1970).

Pear psylla produces severe production losses at high densities by stunting trees, reducing fruit size, causing early fruit drop, and causing premature leaf drop (Burts, 1970; Westgard and Zwick, 1972). A toxin in the saliva of feeding nymphs is the cause of these symptoms, which have come to be known as "psylla shock" (Beers et al., 1993). Foliage experiences blackening and scorching, skin to the harm inflicted by webspinning mites. The adult pear psylla is ultimately responsible for transmitting the mycoplasma like bacterium that causes pear decline disease (Lindner et al., 1961; Jensen et al., 1964) to trees through feeding (Hibino and Schneider, 1970). Pear psylla is a very challenging pest to eradicate and prompt and effective sampling of adults and immatures is necessary for effective treatment (Brunner, 1982). However, repeated applications of broad-spectrum insecticides with similar modes of action may result in the development of resistance (Saha and Mukhopadhyay 2013) and less effective control. To overcome the problems of resistance, the identification of new chemical molecules with better insecticidal properties and lower dosage with selective action is a continuous and effective process against insect pests in different crop ecosystems (Chandi et al., 2016).

Pear is an important commercial fruit crop of Jammu and Kashmir after apple and because of

the serious dimensions of pear psylla not only as a pest but also as a vector. It is necessary to work out the seasonal incidence of this pest and also to find out the field efficacy of the newer insecticides for the management of the said pest in view of the economic importance of Pear in Jammu and Kashmir and the damage caused by this pest, the studies were conducted to determine the seasonal incidence and management of Pear psylla.

2. MATERIALS AND METHODS

2.1 Seasonal Incidence

Seasonal incidence of Pear Psylla was carried out in two districts of Kashmir (Baramulla and Srinagar) with two locations from each district. From district Srinagar (1589 m a. s1), Harwan and Shalimar and from district Baramulla (1593 m a. s1), Nihalpora and Palhallan were selected. To study the seasonal incidence, data was recorded at fortnightly intervals starting from 20th SMW (Standard Meteorological Week) to 34th SMW on 10 randomly selected trees from each location. The Pear Psylla adults were collected and counted by a beating tray method and the different immature stages of Pear Psylla were monitored/counted by selecting a 1foot branch length and were tagged from individual trees from all four quadrants. The tagged pear trees were maintained free of chemical pesticides. Data on major abiotic factors such as maximum/minimum temperature, maximum/minimum relative humidity and rainfall were collected and the influence of weather parameters on incidence of pest were worked. To work out the impact of such abiotic factors and the buildup of the pest, meteorological data were procured from Meteorological departments of respective locations.

2.2 Correlation Analysis

Correlation analysis was performed between weather parameters (maximum/minimum temperature, maximum/minimum relative humidity and rainfall) and the incidence of Pear Psylla at each location. This approach aimed to determine the role of climatic factors in the buildup and fluctuation of pest populations. The correlation coefficient and regression coefficient analysis were carried out by using SAS Software (SAS Instue.1998).

2.3 Bio-efficacy of Newer Insecticides

For management studies, experiment was carried out in a pear orchard at FOH, SKUAST-

Kashmir in a randomized block design. There were six treatments and each treatment was replicated four times. Four newer insecticide molecules viz., Cyantraniliprole 10.26% OD, Flubendiamide 20% WG, Acetamiprid 20% SP and Spinosad 45% SC were evaluated in terms of their efficacy against *Cacopsylla pyricola* and were compared with Standard Check (Dimethoate 30% EC). Pre and post-count treatments were taken per 5 cm twig length randomly from four directions of the tree a day before spraying and after the 3rd, 7th. and 14 days after spraying. The efficacy of treatments was calculated according to the equation of Henderson and Tilton (1955). The data was converted into percent pest reduction over control using the conversion formula and then analyzed using the ANOVA procedure.

Henderson and Tilton formula:

$$\text{Corrected \% reduction in insect pest population} = 1 - \frac{(n \text{ in Co. before treatment} \times n \text{ in T after treatment})}{(n \text{ in Co. after treatment} \times n \text{ in T before treatment})} \times 100$$

n = Insect pest population, Co. = control, T=treated

3. RESULTS

3.1 Seasonal Incidence

3.1.1 Seasonal incidence of pear psylla on pear in district Baramulla

The data presented in Table 1 revealed that the lowest incidence of nymph and adult (10.85) was observed in the 20th SMW and the highest as 44.30 in the 24th SMW. The mean pest incidence showed an increasing trend from 20th (10.85) to 24th (44.30) SMW. The mean pest incidence declined to 36.30 in the 26th SMW and then increased to 42.25 in the 28th SMW. The mean incidence decreased thereafter from 35.30 in the 30th SMW to 26.00 in the 34th SMW.

3.1.2 Seasonal incidence of pear psylla on pear in district Srinagar

Perusal of data, Table 2 revealed that the lowest incidence of nymph and adult (6.55) was observed in the 20th SMW and the highest as 34.30 in the 24th SMW. The mean pest incidence showed an increasing trend from 20th (6.55) to 24th (34.30) SMW. The mean pest incidence declined to 29.05 in the 26th SMW and then increased to 33.50 in the 28th SMW. The mean incidence decreased thereafter from 29.85 in the 30th SMW to 14.45 in the 34th SMW.

Table 1. Seasonal incidence of pear psylla (*Cacopsylla pyricola*) on pear at different locations indistrict Baramulla during the year 2023

Baramulla	Standard Meteorological Weeks (SMW)																Mean	Overall Mean
	20 SMW		22 SMW		24 SMW		26 SMW		28 SMW		30 SMW		32 SMW		34 SMW			
	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult		
Palhallan	10.2 ± 2.85	1.9 ± 0.99	18.6 ± 4.97	4.1 ± 0.87	39.2 ± 1.75	7.3 ± 1.76	32.8 ± 2.57	6.6 ± 1.34	36.9 ± 2.46	8.9 ± 1.19	30.6 ± 1.89	7.0 ± 0.66	27.8 ± 6.01	5.1 ± 0.99	24.1 ± 2.23	3.9 ± 0.99	33.12	30.76
Nihalpora	8.1 ± 33	1.5 ± 1.08	14.6 ± 2.11	2.9 ± 0.73	35.9 ± 3.81	6.2 ± 0.78	28.0 ± 6.64	5.2 ± 0.42	32.1 ± 2.47	6.6 ± 0.51	28.3 ± 3.19	4.7 ± 0.48	25.9 ± 3.81	3.2 ± 1.47	21.8 ± 2.65	2.2 ± 0.42	28.40	
Mean	10.85		20.10		44.30		36.30		42.25		35.30		31.00		26.00		30.76	

*Each figure is a mean of 10 replication
Population count was taken on a 1ft branch

Table 2. Seasonal incidence of pear psylla (*Cacopsylla pyricola*) on pear at different locations indistrict Srinagar during the year 2023

Srinagar	Standard Meteorological Weeks (SMW)																Mean	Overall Mean
	20 SMW		22 SMW		24 SMW		26 SMW		28 SMW		30 SMW		32 SMW		34 SMW			
	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult		
Harwan	6.3 ± 1.56*	1.5 ± 1.08	12.8 ± 2.29	2.2 ± 0.63	30.6 ± 3.16	5.0 ± 1.05	26.3 ± 3.33	4.0 ± 0.66	29.5 ± 3.13	6.4 ± 1.17	27.7 ± 1.82	5.5 ± 1.08	22.1 ± 3.03	3.3 ± 1.15	15.3 ± 5.57	2.1 ± 0.73	25.07	22.87
Shalimar	4.2 ± 0.63	1.1 ± 0.99	8.1 ± 1.96	1.8 ± 0.63	28.8 ± 4.10	4.2 ± 1.03	24.3 ± 2.90	3.5 ± 0.84	25.5 ± 4.19	5.6 ± 1.42	23.3 ± 3.36	3.2 ± 0.63	18.1 ± 4.53	2.2 ± 0.42	10.3 ± 2.86	1.2 ± 0.42	20.67	
Mean	6.55		12.45		34.30		29.05		33.50		29.85		22.88		14.45		22.87	

*Each figure is a mean of 10 replication
Population count was taken on a 1ft branch

3.2 Effect of Various Abiotic Factors on the Fluctuation of Pear Psylla

3.2.1 Effect of various abiotic factors on the fluctuation of pear psylla population in district Baramulla

Perusal of data, Table 3 revealed that the population of Pear Psylla at Palhallan and Nihalpora exhibited a positive correlation with maximum and minimum temperatures, with correlation value coefficients of 0.73 & 0.65 and 0.77 & 0.68 for nymphs respectively. The correlation value coefficient for adults was 0.72 & 0.56 and 0.58 & 0.41, respectively, indicating the significant influence of these factors on population fluctuations. Conversely, rainfall was negatively correlated, with value coefficients of -0.37 & -0.42 for nymphs and -0.26 & -0.24 for

adults respectively. Maximum relative humidity for nymphs was -0.37 & -0.36 and -0.10 & -0.14 for adults respectively. However, minimum relative humidity showed a positive correlation with coefficients of 0.59 & 0.60 for nymphs and 0.60 & 0.42 for adults respectively.

Perusal of data, Table 4 revealed the relationships between meteorological and Pear Psylla populations (nymphs and adults) at Palhallan and Nihalpora, using the value coefficient of determination (R²) and prediction equations to quantify these interactions. At Palhallan and Nihalpora, the R² value for the nymphs population was 0.80 and 0.82 indicating that 80% and 82% of its variation could be explained by meteorological variables, while for adults, the R² value was 0.77 and 0.62, explaining 77% and 62% of the variation.

Table 3. Correlation co-efficient between pear psylla (*Cacopsylla pyricola*) and abiotic factors in district Baramulla

Parameters	Correlation coefficient (r)			
	Palhallan		Nihalpora	
	Nymph	Adult	Nymph	Adult
Max. Temp. (°C)	0.73*	0.72*	0.77*	0.58*
Min. Temp. (°C)	0.65*	0.56*	0.68*	0.41
Rainfall (mm)	-0.37	-0.26	-0.42	-0.24
Max. RH	-0.37	-0.10	-0.36	-0.14
Min. RH	0.59*	0.60*	0.60*	0.42

*Population count was taken on a 1ft branch

Table 4. Regression co-efficients between the abiotic factors and pear psylla (*Cacopsylla pyricola*) in district Baramulla

Coefficient of determination (R ²)		Prediction equation	
Palhallan	Nymph	0.80	Y=257.13-0.04X ₁ -4.93X ₂ -16.17X ₃ -4.39X ₄ +5.46X ₅
	Adult	0.77	Y=40.84-0.15X ₁ -1.78X ₂ -5.41X ₃ - 0.99X ₄ +1.88X ₅
Nihalpora	Nymph	0.82	Y=119.71+1.45X ₁ -1.50X ₂ -5.12X ₃ - 2.23X ₄ +1.97X ₅
	Adult	0.62	Y=60.97-0.39X ₁ -1.91X ₂ -6.08X ₃ - 1.15X ₄ +1.93X ₅

Y= No. of psyllids/shoot, X₁=Maximum Temperature (°C), X₂=Minimum Temperature (°C), X₃= Rainfall (mm), X₄= Maximum Relative Humidity, X₅=Minimum Relative Humidity

Table 5. Correlation co-efficient of pear psylla (*Cacopsylla pyricola*) and abiotic factors in district Srinagar

Parameters	Correlation Co-efficient (r)			
	Harwan		Shalimar	
	Nymph	Adult	Nymph	Adult
Max. Temp. (°C)	0.58*	0.51*	0.51*	0.33
Min. Temp. (°C)	0.58*	0.42	0.51*	0.26
Rainfall (mm)	0.26	0.10	0.31	0.17
Max. RH	-0.64*	-0.55*	-0.72*	-0.62*
Min. RH	-0.04	-0.04	-0.09	0.03

*Population count was taken on a 1ft branch

Table 6. Regression co-efficients between the abiotic factors and Pear Psylla (*Cacopsylla pyricola*) in district Srinagar

Co-efficient of determination (R ²)			Prediction equation
Harwan	Nymph	0.94	$Y=110.08-0.10X_1+1.67X_2-0.12X_3-1.34X_4+0.13X_5$
	Adult	0.78	$Y=9.42+0.25X_1+0.10X_2-0.00X_3-0.19X_4+0.04X_5$
Shalimar	Nymph	0.95	$Y=162.57-1.21X_1+2.15X_2-0.21X_3-1.62X_4+0.01X_5$
	Adult	0.75	$Y=3.29+0.38X_1-0.06X_2+0.03X_3-1.15X_4+0.05X_5$

Y= No. of psyllids/shoot, X1=Maximum Temperature (°C), X2=Minimum Temperature (°C), X3= Rainfall (mm), X4= Maximum Relative Humidity, X5=Minimum Relative Humidity

Table 7. Bioefficacy of various insecticides in population reduction of pear psylla (*Cacopsylla pyricola*) at FOH, SKUAST-K, Shalimar during the year 2023

Treatments	Insecticide Used	Dosage (ml/g per litre)	Pre-treatment count	Percent pest reduction Days after treatment			Overall Mean
				3 DAT	7 DAT	15 DAT	
T ₁	Cyantraniliprole (10.26%OD)	1.2	18.25 (25.29)	90.03 (71.59) ^e	92.37 (73.96) ^d	95.84 (78.23) ^d	92.74 (74.59)
T ₂	Flubendiamide (20%WG)	0.12	18.50 (25.47)	73.36 (58.92) ^a	77.41 (61.62) ^a	80.84 (64.04) ^a	77.20 (61.47)
T ₃	Acetamiprid (20%SP)	0.15	19.25 (26.02)	89.19 (70.80) ^d	91.32 (72.86) ^c	92.11 (73.68) ^c	90.87 (72.41)
T ₄	Spinosad (45% SC)	0.25	16.50 (23.96)	79.52 (63.09) ^b	83.12 (65.74) ^b	84.65 (66.93) ^b	82.43 (65.25)
T ₅	Dimethoate (30% EC)	1.0	18.75 (25.65)	86.13 (68.13) ^c	91.09 (72.63) ^c	91.90 (73.46) ^c	89.70 (71.28)
T ₆	Control (water)	-	19.50 (26.20)	18.75 (25.65)	17.50 (24.72)	19.25 (26.02)	18.50 (25.47)
CD(p<0.05)				0.75	0.92	0.94	

Each figure is a mean of four replications and each replicant is a mean of four observations.

*Figures within parenthesis are ARC sine transformed values of percent mortality

Pre/post count was taken on a 5cm twig

3.2.2 Effect of various abiotic factors on the fluctuation of pear psylla population in districts Srinagar

Perusal of data, Table 5 revealed that the population of Pear Psylla at Harwan and Shalimar exhibited a positive correlation with maximum and minimum temperatures, with correlation value coefficients of 0.58 & 0.58 and 0.51 & 0.51 for nymphs respectively. The correlation value coefficient for adults was 0.51 & 0.42 and 0.33 & 0.26, respectively, indicating the significant influence of these factors on population fluctuations. Conversely, rainfall was weakly correlated, with value coefficients of 0.26 & 0.31 for nymphs and 0.10 & 0.17 for adults respectively. Maximum relative humidity for nymphs was -0.64 & -0.72 and -0.55 & -0.62 for adults respectively. However, minimum relative humidity showed a negative correlation with coefficients of -0.04 & -0.09 for nymphs and -0.04 & 0.03 for adults respectively.

Perusal of data, Table 6 revealed the relationships between meteorological and Pear Psylla populations (nymphs and adults) at Harwan and Shalimar, using the coefficient of determination (R^2) and prediction equations to quantify these interactions. At Harwan and Shalimar, the R^2 value for the nymphs population was 0.94 and 0.95 indicating that 94% and 95% of its variation could be explained by meteorological variables, while for adults, the R^2 value was 0.78 and 0.75, explaining 78% and 75% of the variation.

3.3 Bioefficacy of Various Insecticides against pear psylla (*Cacopsylla pyricola*) on Pear

Perusal of data Table 7 revealed the findings from a field experiment that assessed the effectiveness of several newer groups of insecticides on pear psylla documented that Cyantraniliprole proved to be the most effective with an efficacy of 92.74%. The next effective treatment was Acetamiprid, reducing the population by 90.87 percent compared to that of the control group. Dimethoate and Spinosad, with percent population reductions of 89.70 and 82.43 percent, respectively were next effective treatment. However, Flubendiamide proved to be the least successful treatment with an efficacy of 77.20 percent.

4. DISCUSSION

The infestation of pear psylla began in May (20th SMW) at all the experimental locations and a

peak was recorded in June and July. These results corroborate with those obtained by Radjabi and Behechti (1975). Nonetheless, the *Cacopsylla pyri* peak population was noted by Stratopoulou and Kapatos (1992) in May and June. According to Akbar et al. (2017), June was the month when the first and second nymphal instars of *Cacopsylla bidens* reached their peak population. According to Meinaz et al. (2017), the first week of July showed the peak incidence of adult psylla.

(The results of the experiment revealed that pear psylla population positively correlated with maximum and minimum temperature, minimum relative humidity and negatively correlated with Rainfall and maximum relative humidity.) The current studies have revealed that temperature is the primary factor influencing the fluctuations in the pear psylla population. The observations of Lakra et al. (1983) and Khan et al. (1984) support this observation for citrus psylla (*Diaphorina citri*). Our findings are supported by studies of Khan et al. (1984) on Citrus psylla, who found a high activity period in June and July along with an increase in temperature and a decline in population along with an increase in relative humidity and rainfall. In Meghalaya, Rao and Pathak (2001) also noted the highest number of adult *Diaphorina citri* in June and discovered a positive correlation with the lowest temperature, which was also noted in this investigation. Our results are consistent with the findings of Ahmed et al. (2014) who discovered strong positive correlations in the case of the leucana psyllid (*Heteropsylla cubana*) between psyllid damage and mean minimum temperature, mean maximum temperature, and mean daily temperature. A decrease in the number of psyllids in the eucalyptus psyllid, *Blastopsylla occidentalis*, was observed by Soufo and Tamesse (2015), in response to an increase in relative humidity and rainfall. Rainfall and psyllid populations were found to have a weakly positive correlation by Virender et al. (2007) in their studies on olive psylla (*Euphyllura pakistanica*).

Cyantraniliprole has proven to be highly effective against pear psylla due to its unique mode of action as a diamide insecticide, targeting ryanodine receptors in insect muscle cells, leading to paralysis and death (Cordova et al., 2006). Its systemic and translaminar properties allow it to protect all parts of the plant, ensuring comprehensive pest control. The insecticide offers long-lasting residual activity, reducing the need for frequent reapplications (Lahm et al.,

2007). Additionally, it is effective against pear psylla at all life stages, ensuring broad-spectrum control and life cycle disruption (Dinter et al., 2014).

Acetamiprid was the second most effective treatment, with a reduction rate of 89.19–92.11%, similar to Youssef and Seham's (2015) findings. Dimethoate showed 89.70% effectiveness, consistent with earlier studies (Pielou & Downing, 1960; Rajagopal et al., 1990). Spinosad, with 82.43% efficacy, has notable knockdown effects but loses potency after 5-8 days (Bangels et al., 2010). Flubendiamide, primarily targeting lepidopterans, was less effective against pear psylla due to its hemipteran nature.

5. CONCLUSION

Maximum and minimum temperature showed a significant and positive correlation with maximum and minimum temperature and minimum relative humidity in all location, whereas rainfall and maximum temperature showed significant and negative correlation. Rainfall, maximum and minimum temperature were main cause for fluctuation of Psyllid population. Moreover, 27-29°C was ideal temperature pest population buildup. The results of the evaluation of different insecticides revealed that cyantraniliprole 10.26% OD with an efficacy of 92.74%, proved to be the most effective followed by Acetamiprid 20% SP (90.87%).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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