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Seasonal Incidence of *Diaphorina citri* Kuwayama in Assam Lemon and Its Relationship with Weather Factors in Sub-Himalayan Plains of West Bengal

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Abstract

Seasonal incidence of citrus psylla, *Diaphorina citri* Kuwayama was studied in Assam Lemon (*Citrus limon* L. Burm) in two consecutive years in sub-Himalayan plains (terai zone) of West Bengal (India). The psyllids appeared with the arrival of new flush which occurred three times a year, the first during January last to early February (4th-5th SW), second during April-May (17th - 18th SW) and the third during September (37th-38th SW). Three peaks were recorded—one at 11th SW (6.11 psyllids/shoot), the second at 21st SW (7.50 psyllids/shoot) and the third peak at 43rd SW (5.06 psyllids/shoot). The second peak recorded the highest psyllid population. The psylla were active throughout the whole year except during the cold winter period when their population was either low or absent. Temperature showed a positive association with psyllid population (r = 0.304 for T_{Max} and r = 0.182 for T_{Min}) while RH% (r = −0.200 for RH_{Mor} and r = −0.200 for RH_{Evn}) and rainfall had a negative correlation (r = −0.013). During the 1st peak population (11th SW) the average temperature, RH% and rainfall were 30.82˚C (T_{Max}) and 16.68˚C (T_{Min}), 55.36% (RH_{Mor}) and 62.72% (RH_{Evn}) and nought respectively; while the corresponding values were 33.43˚C (T_{Max}) and 24.29˚C (T_{Min}), 76.43% (RH_{Mor}) and 75% (RH_{Evn}) and 7.85 mm respectively during the 2nd peak (21st SW). Likewise, at the 3rd peak (43rd SW), the respective values were 30.22˚C and 19.07˚C (T_{Max} and T_{Min}, respectively), 80% and 76.79% (RH_{Mor} and RH_{Evn}, respectively) and zero mm respectively.

Keywords

Seasonal Incidence, Citrus Psyllid, Assam Lemon, *Citrus limon*

1. Introduction

Citrus psylla, *Diaphorina citri* Kuwayama, commonly known as Asian citrus psylla, after its discovery from Taiwan region in the year 1907, outspread to various countries in South Asia, regions of Middle East, Southern United States and Central America and the Caribbean and South America, where citrus is grown [1]-[3]. It is predominant in China, India, Myanmar, Philippine Islands, Malaysia, Indonesia, Sri Lanka, Pakistan, Thailand and other Asian countries [1] [4]. Recently, new areas in the USA including Mexico, Venezuela and Argentina witnessed its occurrence [5]. It is treated as the most notorious pest causing severe losses to citrus orchard recording losses ranging from 83% - 95% [6]-[8]. It has earned prominent importance owing to its being a vector of the most devastating citrus greening disease that poses serious threat to citrus cultivation [7] [9]-[11]. The psyllids are considered to be the most devastating pest in India [12] and most serious in Punjab, Haryana, Himachal Pradesh and Maharashtra but a minor pest in southern India [13]. They are regarded as the limiting factor for citrus cultivation in Jammu [14]. Due to desaping of flower buds, leaves and shoots by the insect pest, leaves become distorted and curled followed by total defoliation or falling of flowers and leaves occur [9]. Seasonality of occurrence of psyllids studied by many workers reveals varying periods of their activity in a year except the commonness that their peak activity coincides/regulates with new flushes/flushing rhythms [15]-[20]. The psyllids remain active throughout the year [19] [21] [22] with the exception of either remaining absent or maintaining a low population during the hot summer and winter days [23]-[28]. The time of occurrence of the peak of *D. citri* varies in different regions in India and the frequency of peaks may also differ—four adult peaks were reported by [29], three by [17], two nymphal and two adult peaks by [22] while two nymphal peaks were recorded by [26]. Effects of abiotic factors on the activity of the psyllids are variable. Extremes of both high and low temperatures were injurious to the citrus psylla [29] and heavy rainfall during August caused a sharp decline in their population [14]. A positive and significant correlation between psyllid incidence and temperature was observed by [14]. Citrus psylla population had positive association with temperature and relative humidity [30]. [31] observed significant positive correlations of rainfall, maximum and mean temperature with *Diaphorina citri* activity. [32] however, noticed that the psyllid population had positive correlation with max. temperature and negative significant correlation with min. temperature and rainfall. Similarly, [33] noted significant positive correlation with the maximum and minimum temperature, non-significant correlation with rainfall while non-significant negative correlation with relative humidity. [14] determined the temperature and relative humidity conducive for their development, which ranged from 24.77˚C to 32.49˚C and 40.85% to 65.78% RH, respectively. [34] observed that regions with high saturation deficits (high temperatures and low relative humidity levels) were more favourable to citrus psylla.

In West Bengal, citrus is cultivated in 11.71 thousand hectares with a production

of 109.40 thousand tons [35]. Darjeeling district of the state is famous for mandarin orange and recently [36] studied the impact of abiotic factors on the major pests of orange. Terai region of the state falling under the sub-Himalayan plains is suitable for cultivation of a variety of fruit plants including citrus. However, from this region, there is no information on this very important pest of citrus. Lack of proper knowledge about the pest, its seasonal occurrence and suitable management practices are considered to be the important constraints for successful cultivation of citrus, particularly, lemon. Considering the foretold perspective, the present study, being the first ever work in the sub-Himalayan plain, was undertaken on Assam Lemon plants to understand the seasonal occurrence of the citrus psylla (*D. citri*) and its relationship with weather parameters.

2. Materials and Methods

The experiment was conducted in the Assam lemon orchard of the University located at Pundibari under Cooch Behar district of West Bengal, India. The size of the selected plot was 36 × 9 sq m having plant to plant spacing of 3 m. Four plants with equal vigour and age were selected at random in the orchard during the year 2017 (Year 1) and were tagged. The tree canopy was divided into three segments, viz. top, middle and lower canopy (30 - 80 cm, 80 - 140 cm and 140 - 200 cm height of the plant above the ground level, respectively) and from each segment, three branches were selected and tagged whereas from each branch, four shoots were randomly considered. Thus, a total of 36 shoots per tree were considered for recording the populations of citrus psylla. The selected plants had an average height of approximately 2 m. First 30 cm area of the plant above the ground was discarded due to the lack of any branches. Weekly data on the population of psyllids were taken and the study was repeated in 2018 (Year 2). With a view to understand the effect of abiotic factors on the population of citrus psylla, data on weather parameters viz. max. and min. temperature, morning and evening RH% and rainfall (mm) were collected from the G.K.M.S. Project, A.M.F.U. (Agro-Meteorological Field Unit) of the University. The data obtained in simple RBD layout were statistically analyzed after square root transformation by using Statistical software R. 3.5.3 (https://cran.r-project.org/) for better interpretation of the results (Table 1 and Table 2).

Table 1. Meteorological data during 2017 (Year 1).

Standard week	Average Rainfall (mm)	T_{Max} (˚C)	T_{Min} (˚C)	Relative Humidity % (Morning)	Relative Humidity % (Evening)
1	0.00	23.57	7.29	94.14	84.43
2	0.00	19.86	5.71	94.00	80.43
3	0.00	26.14	8.29	90.00	72.14
4	0.00	23.71	7.71	95.00	70.71

Continued

5	0.00	28.00	9.29	70.71	59.29
6	0.00	28.43	11.43	79.71	49.29
7	2.73	25.57	13.00	91.29	70.71
8	0.00	30.00	12.57	73.57	47.86
9	0.00	31.00	14.29	78.57	46.43
10	0.00	32.43	15.71	65.71	44.29
11	0.00	31.71	17.14	64.57	46.14
12	0.27	31.86	17.71	60.71	43.57
13	0.00	33.43	18.14	55.00	37.86
14	0.00	34.29	19.00	46.43	39.29
15	2.81	33.43	21.86	73.57	72.14
16	9.53	28.86	19.43	83.57	68.57
17	6.64	31.71	21.00	75.00	67.14
18	4.30	31.29	22.29	80.43	69.29
19	13.16	29.71	22.00	86.86	75.71
20	8.43	31.14	23.29	82.86	72.14
21	6.47	34.00	25.29	78.57	73.57
22	28.91	31.71	24.00	93.29	76.57
23	16.81	32.57	25.29	85.57	74.00
24	1.23	35.57	26.29	77.14	62.86
25	8.27	33.86	25.71	83.57	85.00
26	20.67	31.71	25.29	95.00	83.57
27	68.66	30.71	25.14	92.86	88.57
28	17.94	32.14	25.86	84.29	77.86
29	4.29	33.71	26.00	78.57	72.86
30	2.23	33.86	26.14	81.43	71.43
31	8.47	34.57	26.14	80.00	76.43
32	21.57	31.14	25.00	90.00	89.29
33	4.61	33.71	25.14	85.71	79.29
34	7.93	34.43	25.71	84.29	80.00
35	14.24	31.71	25.43	90.00	88.57
36	35.04	31.29	23.57	89.29	84.29
37	3.24	34.71	25.00	77.14	76.43
38	0.56	34.86	26.29	80.71	75.00
39	6.11	32.29	23.86	87.71	86.43

Continued

40	7.41	31.57	23.71	85.00	86.43
41	16.19	31.86	21.86	76.43	87.14
42	0.47	31.29	21.57	84.29	86.43
43	0.09	30.14	19.43	87.14	87.86
44	0.91	27.43	18.29	87.14	87.86
45	0.00	30.43	13.57	73.57	82.14
46	0.00	30.14	11.00	70.71	79.29
47	0.00	29.86	12.29	82.14	81.43
48	0.00	30.43	14.14	84.29	82.43
49	0.00	29.71	12.43	84.57	83.57
50	0.00	25.43	10.43	92.86	84.29
51	0.00	24.86	8.14	87.71	82.57
52	0.00	21.75	11.13	93.75	88.75

Table 2. Meteorological data during 2018 (Year 2).

Standard week	Average Rainfall (mm)	T_{Max} (˚C)	T_{Min} (˚C)	Relative Humidity % (Morning)	Relative Humidity % (Evening)
1	0.00	19.93	10.49	81.29	56.71
2	0.00	21.44	9.44	61.00	49.00
3	0.00	24.36	11.54	63.86	51.43
4	0.00	21.14	11.31	60.71	50.86
5	0.00	22.47	10.10	61.86	49.57
6	0.00	20.47	10.79	63.00	50.14
7	2.79	20.56	9.76	60.00	49.29
8	0.00	25.79	12.23	65.14	51.86
9	0.14	24.66	14.11	64.14	53.71
10	0.00	27.31	11.97	66.86	51.43
11	0.00	29.93	16.21	69.57	55.86
12	1.93	28.61	15.27	68.00	54.71
13	0.00	30.59	18.30	66.86	53.14
14	0.00	32.43	19.29	56.43	49.29
15	0.39	34.57	16.43	55.00	47.86
16	0.00	36.29	19.86	45.71	33.14
17	0.23	36.43	20.14	52.14	51.43
18	10.36	30.14	21.14	77.14	68.57

Continued

19	2.16	32.71	22.43	74.29	75.00
20	5.64	34.29	23.57	77.14	60.71
21	9.23	32.86	23.29	76.43	76.43
22	17.97	32.00	23.57	86.43	77.86
23	53.81	31.00	24.00	92.86	86.43
24	3.91	34.57	25.14	83.57	75.00
25	20.69	31.00	24.86	94.29	82.86
26	8.84	32.86	25.43	89.29	82.86
27	14.74	31.86	26.29	88.57	86.43
28	8.26	33.71	26.00	85.71	80.00
29	9.97	33.43	25.57	84.29	77.14
30	7.74	34.29	26.14	80.71	79.29
31	1.83	33.29	26.29	82.86	75.00
32	8.04	33.14	26.00	85.71	83.57
33	24.54	29.57	25.57	90.71	90.71
34	25.46	29.86	24.29	95.00	90.71
35	5.51	33.43	25.00	86.71	81.14
36	0.34	32.86	25.86	85.00	83.57
37	28.81	31.43	23.86	92.14	86.43
38	8.51	30.80	24.29	89.29	88.43
39	16.59	30.86	22.86	93.57	89.29
40	0.00	33.43	22.29	79.29	81.43
41	0.00	32.57	23.29	85.00	87.14
42	3.07	31.29	20.29	85.00	85.71
43	0.00	30.29	18.71	78.57	84.29
44	0.00	31.29	17.14	80.00	82.14
45	0.00	32.14	17.00	77.86	82.14
46	0.00	29.29	17.29	91.43	87.86
47	0.00	28.29	15.14	92.14	88.57
48	0.00	27.71	13.43	92.14	84.29
49	0.00	27.29	13.00	94.29	87.14
50	0.06	23.43	13.00	90.00	89.29
51	0.00	25.29	9.14	85.00	84.29
52	0.00	25.75	8.63	85.63	83.13

3. Results and Discussion

Seasonal incidence of *Diaphorina citri*: Enormous numbers of nymphs were seen on the young twigs feeding on the sap from the new flush shoots. The adults were mostly seen on the leaves. It was observed that the population of the adult psyllids decreased when there was lack of new shoots; whereas, the nymphs were seen only when there were new shoots. The population of nymphs increased soon after emergence of new flush, which occurred three times a year in the orchard; once during January last to early February (4th-5th SW), second during April-May (17th-18th SW) and the third during September (37th-38th SW) as observed by the author. The adult stage of citrus psylla was seen almost throughout the year.

It is evident from the results furnished in **Table 3** that the psyllid population first appeared with very low population from 3rd and 4th SW (Standard Week) in Year 1 and Year 2 respectively. With the emergence of new flushes (1st flush), the population of psyllids gradually increased in numbers and reached the maximum (peak) during 11th SW (7.67 psyllids/shoot) and 10th SW (6.56 psyllids/shoot) in Year 1 and 2 respectively. The population then progressively decreased towards the end of March (12th SW) and it remained low till 16th SW and 15th SW in Year 1 and 2 respectively. The results further showed that with the onset of 2nd flush, the psyllid population again increased from 17th SW and 16th SW in both the years of study, respectively and attained the peak during 21st SW (9.56 psyllids/shoot) and 22nd SW (7.89 psyllids/shoot), respectively. The population thereafter followed a declining trend and reduced population was noticed till 36th and 37th SW during Year 1 and 2 respectively. With the occurrence of 3rd flush, a gradual increase in the insect population was again observed from 37th and 38th SW, reaching the highest population during 43rd SW (4.89 psyllids/shoot and 5.22 psyllids/shoot) in both the years of study. It was observed that there was no population during 1st to 2nd and 52nd SW in Year 1 and 1st to 3rd and 52nd SW in Year 2 (*i.e.* during January and December). Similarly based on the pooled mean data, very low population (<1.0 psyllid/ shoot) was observed during 3rd to 7th SW (mid-January to 2nd week of February), 15th to 17th SW (mid-April to mid-May), 27th to 37th SW (mid-July to end of September) and 48th to 51st SW (December).

It is also evident from the results (**Table 3**) that there were 3 distinct population peaks in both the years of study. Based on the pooled mean values, the 1st peak was noticed at 11th SW (6.11 psyllids/shoot), the 2nd at 21st SW (7.50 psyllids/shoot) while the 3rd peak occurred at 43rd SW (5.06 psyllids/shoot). It thus reveals that among the 3 flushes, maximum incidence of the citrus psylla was observed during the second flush followed by 1st and 3rd flushes.

Long back [15] reported that the peak population of citrus psyllids synchronizes with the appearance of new flushes. Psyllid populations varied with the corresponding new and young flush as the adult females prefer young flush for egg-laying while the nymphs develop on the young leaves only [18]. Psyllid population is regulated by the flushing rhythm of plants, nutritional status of young growth, weather extreme and natural enemies [37]. Increase in psyllid population had

Table 3. Seasonal incidence of *Diaphorina citri* Kuwayama.

SW	No. of psyllids/shoot		
	Year 1	Year 2	Pooled
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.11	0.00	0.06
4	0.11	0.22	0.17
5	0.44	0.11	0.28
6	1.11	0.67	0.89
7	1.00	0.67	0.83
8	1.89	2.33	2.11
9	2.78	3.78	3.28
10	5.33	6.56	5.94
11	7.67	4.56	6.11
12	4.67	2.56	3.61
13	2.89	2.11	2.50
14	2.78	1.11	1.94
15	1.56	0.22	0.89
16	0.33	0.44	0.39
17	1.00	0.67	0.83
18	1.67	0.56	1.11
19	1.11	2.11	1.61
20	3.67	3.56	3.61
21	9.56	5.44	7.50
22	6.33	7.89	7.11
23	5.67	1.11	3.39
24	5.22	3.11	4.17
25	3.33	1.89	2.61
26	1.33	1.67	1.50
27	0.45	0.56	0.50
28	0.67	0.78	0.72
29	1.56	0.22	0.89
30	1.33	0.44	0.89
31	0.89	0.67	0.78
32	0.33	0.33	0.33
33	0.78	0.11	0.44

Continued

34	0.67	0.22	0.44
35	0.33	0.11	0.22
36	0.22	0.11	0.17
37	0.67	0.11	0.39
38	1.67	0.33	1.00
39	1.33	0.78	1.06
40	2.00	0.67	1.33
41	0.67	2.00	1.33
42	3.33	3.56	3.44
43	4.89	5.22	5.06
44	3.22	3.44	3.33
45	2.00	1.89	1.94
46	1.11	2.22	1.67
47	1.00	1.33	1.17
48	0.89	1.00	0.94
49	0.44	0.22	0.33
50	0.22	0.22	0.22
51	0.45	0.11	0.28
52	0.00	0.00	0.00

*SW: Standard Week.

correlation with flushing rhythm of plants and rainfall following dry spells [38]. Psyllid population levels are positively correlated with availability of new shoot flushes [39]. [20] observed the influence of the no. of flush-leaves and temperature on adult psyllid population whereas the no. of flush-leaves alone had association with the population of nymphs. We observed three distinct cycles of population build up in a year which synchronized with the occurrence of new flushes. Thus, our results are in full agreement with the above works. Three population peaks were noticed during March (11th SW) with 6.11 psylla/shoot (T_{Max} = 31.71˚C and 29.93˚C; T_{Min} = 17.14˚C and 16.21˚C in Year 1 and 2 respectively; RH (morning) = 64.57% and 69.57%, RH (evening) = 46.14% and 55.86% in Year 1 and 2 respectively, with no rainfall), June (21st SW) with 7.50 psylla/shoot (T_{Max} = 34.00˚C and 32.86˚C; T_{Min} = 25.29˚C and 23.29˚C in Year 1 and 2 respectively; RH (morning) = 78.57% and 76.43%, RH (evening) = 73.57% and 76.43% in Year 1 and 2 respectively; Rainfall = 6.47mm and 9.23mm in Year 1 and 2 respectively) and October (43rd SW) with 5.06 psylla/shoot (T_{Max} = 30.14˚C and 30.29˚C; T_{Min} = 19.43˚C and 18.71˚C in Year 1 and 2 respectively; RH (morning) = 87.14% and 78.57%, RH (evening) = 87.86% and 84.29% in Year 1 and 2 respectively; Rainfall

= 0.09 mm and 0.00mm in Year 1 and 2 respectively). [30] recorded four no. of peaks of citrus psyllids in the month(s) of March, June-July, August-September and October-November. [17] in south Bengal, obtained 3 peaks in a year—in the last week of June, last week of November and middle of April while [21] recorded two peaks, one during 2nd half of March or 1st half of April and 1st half of September-October. Similarly, [23] noticed two peaks, one nymphal peak in the month of March-April and one adult peak during April. [40] observed three peaks, one at the onset of March, the 2nd during last week of August and the 3rd during end of January. On the contrary, [41] recorded one peak of psyllid population in May while [22] recorded two nymphal peaks during April - May and in August - September and two adult peaks, one during May and the other in June. [26] also reported two nymphal peaks in February - March and August - September. [33] observed three peaks, one each of adult, nymph and egg occurring during 2nd half of July, 2nd fortnight of April and 1st fortnight of April. Seasonal variations and weather factors have great impact on the population developments in other insects also *e.g.* in case of mango mealybug (*Drosicha mangiferae* G.) as reported by [42] in their recent studies in Bangladesh. Thus, the present findings are in accordance with the above works and partial agreement with others. The variations in the occurrence of peak population may be owing to the difference in geographical location, plant character and climatic conditions which determine the initiation of new flushes that ultimately favour the population build up.

In the present study there was no psyllid activity during 1st to 2nd SW (January) and 52nd SW (last week of December) (*i.e.* three weeks). During 1st and 2nd SW the T_{Max} were 23.57˚C, 19.86˚C and 19.93˚C, 21.44˚C and T_{Min} 7.29˚C, 5.71˚C and 10.49˚C and 9.44˚C in Year 1 and 2 respectively; the RH% (morning) were 94.14%, 94.00% and 81.29%, 61.00% with relative humidity (evening) 84.43%, 80.43% and 56.71%, 49.00%in Year 1 and 2 respectively. Similarly, during 52nd SW the T_{Max} were 21.75˚C and 25.75˚C and T_{Min} were 11.13˚C and 8.63˚C in Year 1 and 2 respectively; the RH% (morning) were 93.75% and 85.63% while RH% (evening) 88.75% and 83.13% in Year 1 and 2 respectively; there was no rainfall during either of the years of study in the mentioned period. Absence of population during the three weeks might be due to prevalence of very cold weather. Low population of psyllids during winter has been reported by [24]. During December - February, population becomes very low due to mortality factor owing to temperature below 5˚C [43]. During winter heavy mortality (98%) of the insect occurs and eggs fail to hatch [27] and heavy mortality in the tune of 63% and 100% occurred when adult psyllids were exposed to temperature at 0˚C for 2 and 4 days respectively [44]. [23] observed no activities of psyllids during December and January. [30] also reported about very little population during December and January. [33] similarly observed very low population of the psyllid adults, nymphs and eggs during December. Abundance of *D. citri* is linked to the occurrence of flush and psyllid development depends on accumulated thermal units. With the seasonal cycle in temperature, the psyllids will take longer time to develop in cooler months and less time in warmer

months [45]. Thus, the present findings lend support from the above.

Except the above mentioned three weeks, the psyllids were active all throughout the year. This finding lends support from a number of workers. [46] noticed year-round activity of psyllids and presence of adults even in extreme cold months. [22] recorded activity of the psyllids throughout the year with only adults living during the months of December and February. Psyllid population was also noticed all-round the year except December, January and May [20] (**Figure 1**).

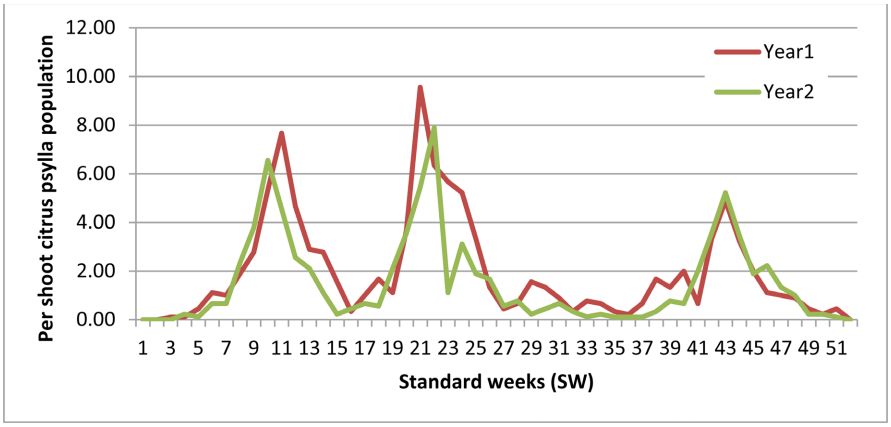

Figure 1. Seasonal incidence of *Diaphorina citri* Kuwayama.

Interactions between weather parameters and psyllid population: The results (**Table 4**) revealed that in Year 1, the psyllid population was significantly and positively correlated with the T_{Max} and T_{Min} and significant negative correlation with both morning and evening RH % while there was a non-significant negative correlation with the rainfall. On the other hand, all the correlations were non-significant but similar in trend in Year 2. Based on pooled mean data, the 1st peak population of psyllids was observed during 11th SW when the temperature, RH% and rainfall were 30.82˚C (T_{Max}) and 16.68˚C (T_{Min}), 55.36% (RH_{Mor}) and 62.72% (RH_{Evn}) and nought respectively. In case of 2nd peak in 21st SW, the corresponding values were 33.43˚C (T_{Max}) and 24.29˚C (T_{Min}), 76.43% (RH_{Mor}) and 75% (RH_{Evn}) and 7.85 mm respectively. Similarly, when 3rd peak was attained during 43rd SW, the respective values were 30.22˚C (T_{Max}) and 19.07˚C (T_{Min}), 80% (RH_{Mor}) and 76.79% (RH_{Evn}) and zero mm respectively.

Table 4. Correlation between weather parameters and incidence of *D. citri* Kumawaya.

Population	Values of correlation co-efficient (r)				
	T_{Max}	T_{Min}	RH% (Mor)	RH% (Evn)	Rainfall
Year 1	0.398**	0.277*	−0.360**	−0.361**	−0.069
Year 2	0.166	0.054	−0.049	−0.049	−0.048
Pooled	0.304*	0.182	−0.200	−0.200	0.013

**Significant at 0.01 level (2-tailed). *Significant at 0.05 level (2-tailed). Mor = morning; Evn = evening.

The populations of insects are influenced by different weather parameters. [29] reported that extreme high and low temperatures as well are injurious to the citrus psyllids. [28] noticed greater activity of citrus psylla in the spring and post-monsoon flushes, whereas low temperature during the winter and high summer temperature of 40˚C were highly detrimental to its population buildup. They further mentioned that moderate rain reduced the population by washing away the psyllids and dry days caused an immediate increase in the population of the pest; heavy and continuous flushing coupled with low temperature and high humidity favoured psylla outbreak. [14] noticed that heavy rain in the month of August adversely affected the psyllid population, which resulted in a rapid dwindling of the population. They also found the temperature and RH (relative humidity) in the range of 24.77˚C to 32.49˚C and 40.85% to 65.78%, respectively, favoured the development of the psyllids and a significant positive correlation between psyllid incidence and temperature. They also observed that temperature and humidity had combined effect on the population build-up of *Diaphorina citri* in the tune of 79.4%. [21] and [31] observed that temperature and psyllid population maintained a positive correlation. [21] reported that psyllid population was negatively correlated with relative humidity. [32] reported that *Diaphorina citri* population had negative significant correlation with rainfall. [33] also observed that adult and nymphal population maintained a significant positive association with max. and min. temperature and a negative non-significant correlation with RH%. [47] also stated that the max. and min. temperatures had significant positive correlation with *D. citri* population, while rainfall showed non-significant association in acid lime ecosystem. These findings are in consonance with the results of present study. On the other hand, [30] reported a positive correlation between psyllid population and relative humidity and [31] mentioned that there were significant positive correlations between rainfall and *Diaphorina citri* activity on kagzi lime and [33] recorded a non-significant correlation between rainfall and citrus psyllid in acid lime. These results contradict the present findings.

4. Conclusion

Population of citrus psyllid was observed throughout the year except during the cold winter month and three population peaks were noticed during March (11th SW), June (21st SW) and October (43rd SW). Abundance of psyllids synchronized with new flush shoots which occurred thrice in a year. Very low population was noticed during 3rd to 7th SW (mid-January to 2nd week of February), 15th to 17th SW (mid-April to mid-May), 27th to 37th SW (mid-July to end of September) and 48th to 51st SW (December). The population of psyllids maintained a significant positive association with max. and min. temperature whereas the relative humidity and rainfall showed a negative association. These findings may be of great help for the management of this notorious pest. This is the first ever work on this pest in the region.

Authors' Contribution

Research work designed and planned by (T.K.H), the paper was prepared by (T.D. and S.B.) and data was statistically analysed by (D.S.G.), critically examined and edited by (T.K.H.).

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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