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Role of weather factors in deciding the population of *Diaphorina citri* Kuwayama on curry leaf

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ABSTRACT

Citrus psyllid, Diaphorina citri Kuwayama is known to cause serious damage to tender shoots, which in turn reduces the leaf yield in curry leaf plants. The pest is emerged as serious on curry leaf growing in and around Dharwad during the recent years. Thus it is important to understand the role of different factors promoting psyllid population on curry leaf plant. The changing weather parameters may also be one among few important factors promoting higher psyllid population. The influence of weather factors on citrus psylla, Diaphorina citri Kuwayama population on curry leaf (Murraya koenigii L.) was studied in 2018 and 2019. The average psyllid population ranged from 1.96 to 38.85 per 4 terminal shoots. There was no nymphal population from the 15th to 18th SMW during 2018 and 2019. The nymphal population peaked during the 37th SMW during both years. The adult population was recorded throughout the year with fluctuation. The adult population peaked (26.20 and 30.10 per 4 terminal shoots) during the 38th SMW (3rd week of September) in both years. Correlation analysis for both years indicated that maximum temperature exhibited a significant and positive correlation with the adult population. Similarly, evening relative humidity was highly significant and positively correlated with the nymphal population whereas, maximum temperature adversely affected the build-up of the nymphal population. The study is useful to find out the weak links of psyllid populations about abiotic factors that could be exploited to curb its infestation.

Keywords: *Citrus psylla, Curry leaf, Nymphs, population, Weather parameters, Terminal shoots*

INTRODUCTION

Curry leaves belong to the family Rutaceae native to India and Sri Lanka, and is presently cultivated in India, Sri Lanka, Southeast Asia, Australia, Pacific Islands, and Africa for flavoring foodstuffs. Even though the plant is widely cultivated in different parts of the world, it is still closely associated with South India where the word 'curry' originates from the Tamil 'kari' for spiced sauces [9]. Curry leaves are used for both medicinal and culinary applications. They are highly aromatic and known for their unique flavor.

Curry leaves are widely cultivated in Karnataka majorly in Dharwad, Belgaum, and Uttar Kannada. Curry leaf cultivation has become an important agricultural practice along with other agricultural activities to the farming communities in and around Dharwad due to its requirement throughout the year. The crop is either cultivated as a sole crop or intercropped with many other fruit crops, all along the bunds of their farm or even in backyards. With good management practices, a yield of about 20-25 tonnes/ha can be obtained every year and the expected market turnover is around Rs. 1,50,000 – 6,00,000 per year.

The perennial nature of curry leaves favors the occurrence of numerous insect pests such as citrus butterflies, leaf rollers, psyllids, and oriental yellow scales. The major pest which causessevere damage to growing tender shoots is citrus psylla and found throughout theyear. Both the nymphs and adults found clustered on newly emerged shootsand suck sap from these shoots resulting in the curling of leaves and in turn adversely affecting the plant vigor and growth [6]. The nymphs excrete white crystalline waxy pellets on which black sooty mould may develop and thus reducing the photosynthetic area, affecting the growth of leaves and in turn market value of leaves.

The meteorological parameters are known to have a profound influence on the occurrence, growth and development, and population build-up of insect pests in crop ecosystems which ultimately results in differential levels of infestation. The variation in agro-climatic conditions at Dharwad resulted in increased psyllids population and damage tothe curry leaf cropmaking it necessary to study the influence of various abiotic factors affecting the population fluctuation of citrus psyllid in curry leaf. Despite its wide occurrence and serious damage to curry leaf plants, very little attention has been given to psyllid. Hence the present study of the influence of weather parameters on psyllid population was undertaken. The study is also helpful to identify the period at which management practices need to be imposed.

MATERIAL AND METHODS

The experiment was conducted at a curry leaf garden located in the new orchard of the Department of Horticulture, University of Agricultural Sciences, Dharwad. The incidence of citrus psylla on curry leaf (Var. Suvasini) was closely monitored at weekly intervals starting from January to December2018 and 2019. The observations were recorded from randomly selected five plants

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of an unsprayed plot. The four terminal shoots in each plant were selected randomly from all four directions. The psyllid nymphs and adult numbers were recorded from the 10 cm apical portion of four terminal shoots/plants. The observations were expressed per four terminal shoots.

The daily meteorological data were obtained for the said period from the Department of Agricultural Meteorology, University of Agricultural Sciences, Dharwad. The data about seasonal incidence was subjected to correlation analysis with meteorological parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, and total rainfall using Microsoft Excel and SPSS software. The weekly average of weather parameters was correlated with the insect population of the corresponding week except in the case of rainfall where the weekly total was correlated with the corresponding week's insect population.

RESULTS AND DISCUSSION

The population of *Diaphorina citri* Kuwayama varied with different standard meteorological weeksin the year 2018 and 2019 (Table 1). The average psyllid population ranged from 1.96 to 38.85 per 4 terminal shoots. The adult population was recorded throughout the year with the higher population during the 31st to 39th SMW (August and September), and the considerable population was recorded intermittently during the 3rd to 8th and 16th to 24thSMW. The increasing trend of psyllid adults ranging from 9.83 to 28.15 per 4 terminal shoots was found during the 31st to 38th SMW (August-September) (Fig. 1). The lower psyllid population was recorded from 42 to 2nd SMW of next year (i.e Second fortnight of October to first fortnight January in succeeding year).The low overwintering population might be a reason for their presence throughout the year. The minimum and maximum temperature range at Dharwad during the year was 12-38 °C. The prevailing minimum temperature of 12 °C might not promote the pupa to overwinter and not emerge into adulthood. The moderate temperature of 27 °C coupled with higher moisture of 87% RH might have promoted the adult emergence and their activity, especially during 31 to 40th SMW. The gradual rise in daily maximum temperature from the 7th SMW (First fortnight of February) proved conducive for the build-up of the adult population which reached its peak during the 16th to 20th SMW (April to May) i.e. 15.8 (2018) and 18.8 (2019).

The maximum population of 26.2 and 30.1 per 4 terminal shoots were recorded during the 38th SMW in 2018 and 2019 when the maximum, minimum temperature (°C), morning and evening relative humidity ranged from 30.60-24.77, 17.83-20.36, and 81.43-91.57, 52.86-83.0, respectively. The higher population during August and September could be due to new flush in curry plants as well as conducive weather conditions as also reported in Rajasthan (Pande, 1971) and Haryana (Lakra *et al.*,1983).

However, there was more nymphal population fluctuation at different parts of the year. The zero nymphal population was recorded from the 15th to 19th SMW (From the second week of April to the second week of May), a lower population was recorded from the 44th to 2ndSMW of the succeeding year, as well as from the 10th to 14th SMW and 20th to 24th SMW. The higher nymphal population was recorded during the 25th to 43rd SMW (The second fortnight of July to the second fortnight of October) (Table 1). The higher temperature coupled with low relative humidity may not favor the insect for its reproductive activity and on the other, the prevailing weather during the period will not promote the plant to put forth new shoots which might have hindered the adult to lay an egg on curry plants and hence there could not be any nymphal population during the period. The low relative humidity and the overwintering population were also responsible for the increase in nymphal population during February. With the increase in maximum temperature, nymphal population decreased from 25-26.5 to 1.6 and 0.5 per 4 terminal shoots during the 8th to 14th SMW. A high temperature ranging from 35.71 to 38.54°C prevailed during the 15th to 18th SMW in both years not favored any nymphal population on the curry plant at UAS, Dharwad.

The impact of extremes of weather parameters appeared to be more pronounced against the nymphs than the adults. A significant rise in nymphal population was observed during the 31st to 38th SMW (August-September) (27.73-46.70 per 4 terminal shoots) when the daily maximum and minimum temperature (°C), relative humidity (%), rainfall (mm), and sunshine (hrs) ranged from 27.7-35.6, 23.6-29.4, 60.5-96, 0-90 and 0-11.6, respectively during 2018 and 2019.The population was quite high till the end of September (47.8 and 54.4 per 4 terminal shoots) and thereafter psyllid population started declining maybe due to the non-availability of sufficient fresh growth and other environmental conditions as also reported by Mercado *et al.* (1991).

But due to temperature change coupled with decrease of relative humidity, the nymphal population reduced from 38.4 nymphs/4 terminal shoots in 39th SMW to 2.3 nymphs/4 terminal shoots in 52nd SMW (2018) and from 43.6 to 4.5 in 2019 (Fig. 1). Similar observations were also recorded by Lakra *et al.* (1983) who reported that the nymphal population declined to less than 1.5/12 twigs during October and November and rapid fall in the population of both nymphs and adults (18-0.6 and 23.9-0.5 per 4 terminal shoots) when mean weekly minimum temperature fell from 15.56 °C to 13.33°C during 39th to 52nd SMW in 2018 and 2019.Sharma (2008) observed that the adult population of psyllid was very low during December and January but with the increase in temperature at the end of February, the activity of adults increased and there was a significant increase in the nymphal population during the 8th SMW (25 and 26.5 nymphs/per 4 terminal shoots) whereas, Atwal *et al.* (1970) observed that at a temperature of 40.0-45.0°C both the adults and nymphs died within few hours but was not observed in the current studies. However,temperatures >36.73°C were found detrimental to the population build-up of nymphs. A similar trend of psyllid population was recorded during 2018 and 2019.

The correlation between psyllid adults and maximum temperature ($r=0.624^{*}$, 0.537^{*}) was significant and positive during 2018 and 2019(Table 2) which conforms with Sharma (2008) who reported that the adult population significantly and positively correlated with maximum temperature. Devi and Sharma (2014) and Wankhade *et al*. (2015) reported a significant and positive correlation with maximum temperature which corroborates the present findings. In the present study correlation of the adult population with minimum temperature and rainfall was non-significant and positive. Whereas, the correlation with morning and evening relative humidity is non-significant and negative. From the present findings, it is clear that environmental factors had almost no effect on the build-up of the adult population.

The correlation between psyllid nymphs and mixed psyllid population and evening relative humidity ($r=0.591^{*}$, 0.623^{*}) washighly significant and positive in 2018 and 2019. Whereas, there existed a significant and negative relation with maximum temperature (-0.570*; -0.696*) in both the years(Table 2). Sharma (2008) reported a significant positive correlation between relative humidity and maximum temperature inpsyllid nymphal population which is a slight variation in the present studies. Wankhade *et al.* (2015) reported a significant positive correlation between maximum and minimum temperature and a significant negative relation with relative humidity which is a variation from the present findings. The reported variation could be slight numerical variations in the activity period of adults and nymphs or the prevailing climatic conditions in the region. Further, the psyllid population rise and fall might also depend upon the availability of new shoots coupled with prevailing weather. The variation in the arrival of new flush coupled with prevailing local weather might have contributed towards the varied psyllid population in curry leaves.

CONCLUSION

Psyllid population was observed throughout the year and the peak incidence of adults occurred during May and September. Similarly peak incidence of nymphs occurred during February and September in both the years. The psyllid population fluctuates with theavailability of new tender shoots. The correlation studies revealed that the prevailing weather at Dharwad indicatedminimum influence on the adult population except for maximum temperature with which adults exhibited a positive relationship. Further, psyllid nymphal population was found to be negatively influenced by maximum temperature and positively influenced by evening relative humidity. The maximum temperature affected the population build-up of nymphs.

FUTURE SCOPE OF STUDY

Indeed, the information obtained from studies on psyllid occurrence and its relationship with weather patterns can be valuable in developing a weather-based regression model. This predictive model can help to forecast psyllid infestations in advance, allowing for timely implementation of management practices to mitigate the impact on curry leaf.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

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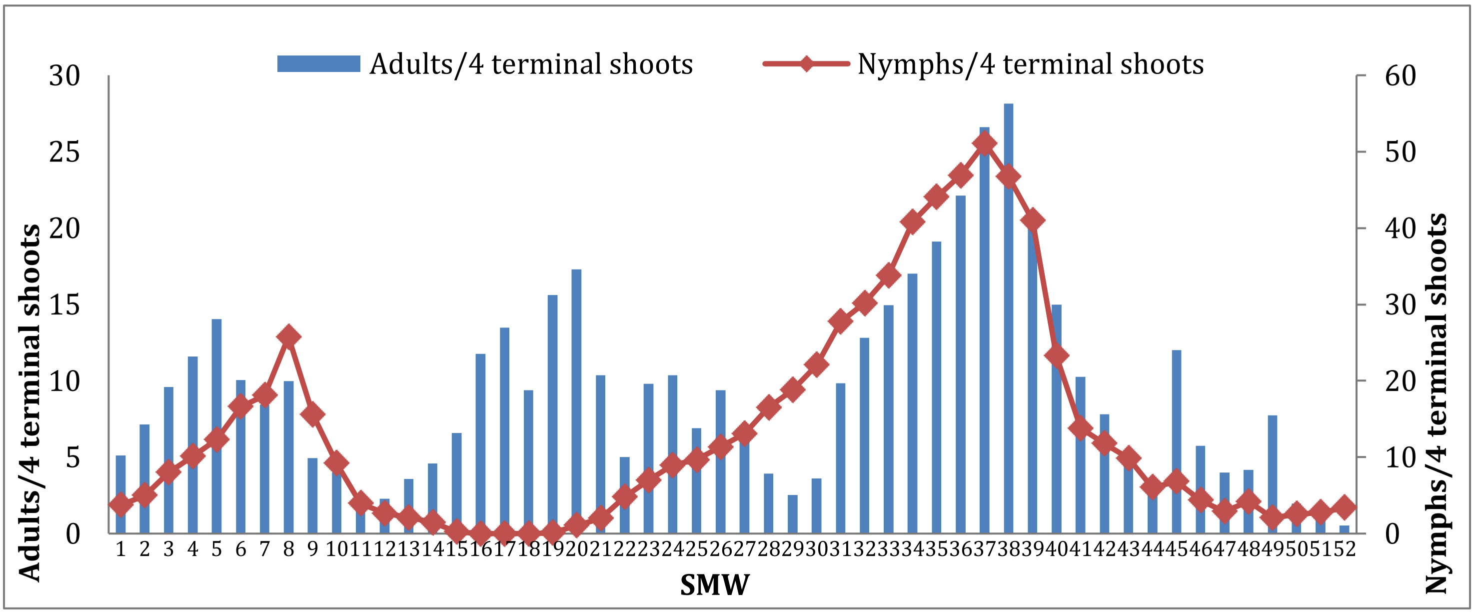

Fig 1: Population fluctuation of citrus psylla, Diaphorina citri on curry leaf during 2018 and 2019 at Dharwad

Table 1: Seasonal incidence of citrus psylla on curry leaf during January to December 2018 and 2019

Months	*SMW	2018	2019		2018	2019		
		Psyllid adults/4 terminal shoots	Psyllid adults/4 terminal shoots	Avg Psyllid adults/4 terminal shoots	Psyllid nymphs/4 terminal shoots	Psyllid nymphs/4 terminal shoots	Avg Psyllid nymphs/4 terminal shoots	Avg Psyllids/4 terminal shoots
January	1	6.40	3.85	5.13	3.20	4.30	3.75	4.44
	2	7.60	6.70	7.15	4.80	5.20	5.00	6.08
	3	10.20	9.00	9.60	7.40	8.60	8.00	8.80
	4	11.80	11.40	11.60	9.40	10.80	10.10	10.85
	5	13.60	14.50	14.05	11.00	13.60	12.30	13.18
	6	7.60	12.50	8.95	14.40	18.80	15.10	12.03
	7	6.00	10.90	7.95	16.20	20.00	18.10	13.03
	8	7.20	12.75	9.50	25.00	26.50	25.75	17.63

February	9	2.40	7.50	4.45	15.20	16.00	15.60	10.03
March	10	2.00	6.00	3.60	8.60	9.80	9.20	6.40
	11	1.60	3.40	2.50	3.25	4.60	3.93	3.21
	12	2.20	2.35	2.28	2.60	2.70	2.65	2.46
	13	2.67	4.47	3.19	2.20	2.00	2.10	2.64
April	14	4.00	5.15	4.58	1.60	1.30	1.45	3.01
	15	5.40	7.75	6.15	0.00	0.50	0.25	3.20
	16	11.40	12.15	11.78	0.00	0.00	0.00	5.89
	17	12.60	14.35	13.48	0.00	0.00	0.00	6.74
May	18	8.80	9.95	9.38	0.00	0.00	0.00	4.69
	19	14.40	16.85	15.63	0.20	0.00	0.10	7.86
	20	15.80	18.75	17.28	1.40	0.75	1.08	9.18
	21	9.60	11.10	10.35	2.60	1.40	2.00	6.18
	22	4.40	5.60	5.00	4.40	5.20	4.80	4.90
June	23	9.00	10.60	9.80	6.60	7.35	6.98	8.39
	24	11.20	9.50	10.35	8.60	9.30	8.95	9.65
	25	6.80	7.00	6.90	9.20	10.10	9.65	8.28
	26	8.80	9.95	9.30	10.60	12.05	11.33	10.31
July	27	6.00	6.15	6.08	12.00	14.15	13.08	9.58
	28	3.40	4.45	3.93	14.40	18.60	16.50	10.21
	29	2.40	2.65	2.53	17.20	20.40	18.80	10.66
	30	3.20	4.00	3.60	21.20	22.95	22.08	12.84
August	31	10.40	9.25	9.83	26.00	29.45	27.73	18.78
	32	12.00	13.60	12.80	28.40	31.90	30.15	21.48
	33	13.60	16.30	14.45	32.40	35.10	33.75	24.10
	34	14.80	19.20	16.00	38.80	42.80	40.80	28.40
	35	16.40	21.80	19.10	41.40	46.70	44.05	31.58
September	36	19.40	24.85	22.13	43.00	50.75	46.88	34.50
	37	23.80	29.40	26.60	47.80	54.40	51.10	38.85
	38	26.20	30.10	28.15	44.60	48.80	46.70	37.43
	39	18.00	23.90	20.95	38.40	43.60	41.00	30.98
October	40	13.80	16.15	14.98	14.40	32.10	23.25	19.11
	41	9.00	11.50	10.25	12.60	14.95	13.78	12.01
	42	8.40	7.20	7.80	11.00	12.60	11.80	9.80
	43	5.40	4.70	5.05	9.00	10.70	9.85	7.45
	44	2.80	4.05	3.43	5.60	6.50	6.05	4.74
November	45	10.60	13.40	11.00	6.20	7.40	6.80	8.90
	46	2.40	9.05	3.75	3.80	4.95	4.38	4.06
	47	3.40	4.60	4.00	2.25	3.50	2.88	3.44
	48	4.40	3.95	4.18	3.00	5.35	4.18	4.18
December	49	8.20	7.25	7.55	1.33	2.80	2.07	4.81
	50	1.60	2.30	1.95	2.00	3.10	2.55	2.25
	51	1.20	1.15	1.18	2.20	3.30	2.75	1.96
	52	0.60	0.45	0.53	2.25	4.50	3.38	1.95

*SMW= Standard meteorological week

Table 2: Correlation between insect pests population on curry leaf and weather parameters during 2018 and 2019 (January-December)

Parameters	Correlation					
	2018			2019		
	Psyllid adults/4 terminal shoots	Psyllid nymphs/4 terminal shoots	Mixed psyllid population	Psyllid adults/4 terminal shoots	Psyllid nymphs/4 terminal shoots	Mixed psyllid population

Temperature-_(⁰C)	Max.-_Temp.	0.624*	-0.570**	-0.382**	0.537*	-0.696**	-0.460**
	Min.-_Temp.	0.474	0.285	0.162	0.306	0.051	0.250
Relative-_humidity (%)	Mor.-_RH	-0.064	0.467	0.348	-0.187	0.443	0.362
	Eve.-_RH	-0.306	0.591**	0.475**	-0.191	0.623**	0.515**
Rainfall-_(mm)		0.145	-0.132	-0.023	0.298	0.564	0.233

*Correlation significant at the 0.05 level

**Correlation significant at the 0.01 level

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