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RESEARCH ARTICLE

IMPACT OF ABIOTIC FACTORS ON POPULATION FLUCTUATIONS OF CITRUS PSYLLA (DIAPHORINA CITRI) IN FAISALABAD (PAKISTAN)

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ABSTRACT

Citrus psylla (Diaphorinacitri) is sap sucking bug that is belonging to family Psyllidae and having the order is Hemiptera. It has become one of the potential pests of citrus orchards in Pakistan. Its nymph sucks the cell sap and produce honeydew, while on the other hand adults are carrier of greening disease in citrus plant. Data was collected from 10 plants selected randomly from an acre field. Nymph population was scouted on twig basis from the four sides of plants. Adult population was scouted by sweeping the Arial net across the four geographical sides of the plant. Minimum and maximum temperature of a day was found negatively correlated but highly significant to the nymph population of citrus psylla .Relative humidity of evening and morning of a day is also significant. Maximum and minimum temperature of a day was found to be highly significant and relative humidity of evening and morning was found to be negatively correlated but highly significant to the adult population. Rainfall was found to be insignificant for both Adult and Nymph population.

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INTRODUCTION

Pakistan is bestowed with enormous agricultural assets on account of its fertile land, fine irrigated plain areas. Variety of weather and vintage approaches of farming Pakistan produces 12.0 million tons of fruits and vegetables in which citrus fruit is above all. Citrus fruit is leading in regards to production followed by mango, dates, and guava. Citrus specie is small to medium sized shrub and cultivated both in tropics and sub tropics. Citrus is valued for its fruit which is either eaten directly or processed into juice or beverages. Citrus species also have medicinal values. Citrus has many other uses like it serves as a fodder for animals; its wood is crafted and can also be used for fuel purposes. Citrus is attacked by a number of pests like citrus whitefly, leaf miner, aphids, citrus scales, lemon butterfly, snails, but citrus psylla has a potential pest status among all. During the 1st year of attack damage is not significantly observed, but soon yield decreases and top bunches start to dry up.

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During the 2nd year of attack new shoots are destroyed, defoliation occur, tree starts to dry and bear small insipid fruit. During the 3rd year of consecutive attack nothing is left on plant (Hussain and Nath, 1927; Bindra, 1969). Citrus psylla adults are of grey color and usually found on the lower side of leaves with hind wing raised at its back. Oviposition takes place immediately after mating. Eggs are of almond shape with round basal portion and pointy proximal end. Color of eggs is yellow when freshly laid but changes to brown as they are near to hatching. Incubation period is 3-6 days in summer while 10-20 days in winter. Nymphs take 15 days in summer and 45 days in winter to become an adult. A female can lay eggs 500-800. Eggs can be laid singly or in cluster form. A female (14-80 days) can also live longer than a male (11-75 days). Its nymph has five instars. Overwintering adults may live up to 6 months (Mangat, 1966; Hoy and Naguyan. 1996; Bhaggat Nehru. 1999). Nymph suck the cell sap which deplete the nutrients of the cell and produce honey dew, which invites the sooty mold to grow and leaf surface become darkened. This reduces the leaf surface area due to which the photosynthetic activity gets disturbed. On the other hand adult is the vector of citrus greening disease (Kapoor, Vishwanath, Rao, 1967).

This pest was being considered as a sporadic or secondary pest of citrus in 1940 but in 2004 the bacteria responsible for this disease was found and status of this pest was changed from sporadic to potential pest of citrus (Silva *et al.* 1968; Yamamoto *et al.,* 2000. Fecundity is very high development occurs at high rate, nymphal mortality is less. (Hussain & Nath, 1972).Over wintering adults may live up to 6 months (Chakourbortyet *al.* 1976). In Haryana, Punjab (India) citrus psylla is one of the ferocious pests of citrus plant. Adult and nymph both cause the damage to the plants. (Lakra, Gupta, Kharub, 1977).

Citruspsylla is the most destructive pest of citrus due to which plant bears both qualitative and quantitative losses. Both causes the considerable amount of damage as the nymph suck the cell sap and deplete the nutrients from the cell, and secretes honeydew which attracts the sooty mold to grow on leaf surface and it reduces the photosynthetic area. As a result poor photosynthetic activity occurs. Adult is the carrier of a deadly disease citrus greening (Lakra *et al.,* 1983) Citrus psyllais one of the most destructive pest in Punjab, North India but not of so much importance in south India (Randhawaand Sharivastava, 1986). Besides causing the direct loss (sucking the cell sap) it actively participates in spreading the deadly disease `citrus greening'. *Diaphorina citri* is widely distributed throughout Orient and in South Asia (Pakistan& India), South China, South East Asia including Burma, Malayeshia, Taiwan, Indoneshia. (Walter *et al.,* 1989) Among the insect pest which attack citrus plants, citrus psylla is the most deadly and destructive pest and moreover citrus psylla is also vector of citrus greening in citrus plants (Su *et al.,* 1991). Among the insect pests which cause heavy loss to citrus orchards, citrus psylla is the most destructive and undoubtedly the most important of all. It also causes citrus greening in citrus plant. Citrus greening has destroyed a number of citrus orchards in Maharashter India (Chawan and A.S summanwar ; Wang *et al.,* 1996) Chien and Chu reported on the damage caused by citrus psylla, they said that psylla damage the plant by depleting the sap from plant and its saliva is also toxic due to which growth of newly emerged shoots may distort or may die. It also causes damage by secreting honeydew which invites sooty mold to grow. (Chien and Chu 1996) Population of citrus psylla fluctuates with respect to the temperature and humidity, its population reaches its peak twice in a year which coincides with the time of citrus flushing in spring and summer (Wang *et al*., 1996; Sahu and Mandal, 1997) Insecticides like Dimethoate, monocrotophos, decamethrin, confidor, fenvalvate, and botanicals like Neem oil, Spray oil and IGR were found with encouraging results. Modifications have been made from the results obtained from the use of these insecticides i.e. two sprays with 10-15 days intervals are found effective against psylla. (Shivanker *et al*., 2000).

MATERIALS AND METHODS

This study was planned and exhibited to monitor the population fluctuation of citrus psylla in Faisalabad region. An acre field of citrus was chosen from which randomly 10 plants were selected to check the abundance of citrus psylla. Arial net sweep was done across the plant to evaluate the adult population. The adult population captured in a sweep was counted and taken as per plant adult population of citrus psylla. The purpose of net sweep was even to evaluate the natural agents present at that time. Insect diversity other than citrus psylla trapped in a sweep continued to be collected and stored in cotton mealy bug lab at AARI (Ayub Agricultural Research Institute Faisalabad) for the sake of further studies and identification. Scouting of nymphs was done on twig bases, from the each side of plant i.e. east, west, north, and south. We took three twigs of 6-7 inches long from the four sides of plant i.e. east, west, north, south and calculated the nymphal population of a plant.

No insecticide was used as this study was intended to check the population fluctuation caused by natural factors i.e. Temperature, Relative humidity, Rainfall. Metrological data was obtained from Plant physiology department at AARI. The collected data were analyzed statistically by using the Fisher's analysis of variance technique and least significant difference (LSD) test at 5% probability level were used to compare the differences among treatments' means when F-value is significant for observations (Steel *et al.,* 1997)

RESULTS

Results from table no. 1 show that maximum population 16.77 of citrus psylla nymph was found at east side while the minimum population was observed that is 0.52.While at the west side maximum population of citrus psylla is 12.05 and minimum population at same side was observed that is 0.08.

Table No.1. population fluctuation of *D.citri.* nymph during the whole experiment

Date	East	West	North	South
	Mean ± s. Error	Mean ± s. Error	Mean ± s. Error	Mean ± s. Error
17-3-14	16.77±4.182	12.05±2.517	5.88±2.111	8.25±1.654
20-3-14	8.86±1.800	6.97±1.563	4.86±0.194	5.72±0.547
25-3-14	13.75±0.692	10.19±1.902	8.47±2.489	9.97±1.680
28-3-14	7.94±1.187	10.19±0.290	11.72±2.396	12.47±3.804
01-04-14	12.5±1.618	8.8±2.925	9.25±3.250	6.55±0.777
03-04-14	3.94±1.226	4.94±1.816	3.58±1.227	5.05±1.402
07-04-14	6.02±1.093	3.22±1.392	2.8±0.7822	1.88±0.555
09-04-14	0.52±0.373	3.55±0.801	1.61±0.200	1.58±0.416
15/4/2014	0.94±0.474	1.08±0.083	0.66±0.333	1.72±0.309
17/4/2014	1.16±0.166	1.86±0.431	1.66±0.384	1.52±0.237
22/4/2014	1.36±0.305	2.61±0.055	1.5±0.763	0.27±0.146
25/4/2014	1.91±0.420	1.75±0.315	0±0	1.38±0.200
29/4/2014	0.72±0.493	0.08±0.083	0.55±0.293	0.83±0.440
05-05-14	1.22±0.777	2.36±0.793	0.22±0.222	1.44±0.801
08-05-14	1.88±0.484	1.36±0.720	1.13±0.273	0.33±0.373

At north side maximum population 11.72 of nymphs was recorded and minimum population at same side was observed that is 0. Maximum population at south side was found that is 12.47 and at the same side minimum population 0.27 was recorded. There is negative correlation is due to temperature and side of experiment. Some sides are not received direct sun light so that's why there is fluctuation in the population values. (Hijam and Sharma 2014) were reported that highest population of adults and nymphs occurred during the March to June that was similar to our findings. The population of *Diaphorina*citri was highest in the end of April that is reported by Gupta and Bhatia (2000).

Table No. 2. population fluctuation of *D.citri.* adult during the whole experiment

Date	Mean ± s. Error
17-3-14	12.61 ± 0.563
20-3-14	13.16 ±1.669
25-3-14	18.83 ±1.782
28-3-14	24.69 ±1.045
01-04-14	18.33 ±0.693
03-04-14	21.3 ±0.714
07-04-14	30.36 ±3.680
09-04-14	46.61 ±2.621
15/4/2014	54.55 ±3.227
17/4/2014	69.11 ±3.279
22/4/2014	77.41 ±6.230
25/4/2014	77.88 ±2.983
29/4/2014	57.38 ±1.953
05-05-14	49 ±3.469
08-05-14	51.47 ±1.163

Results from table no 2 show that on the 1st date of experiment the population was counted 12.61 then on further experimental dates this population trend was found to be (13.61, 18,83, 24.69, 18.33, 21.3, 30.36, 46.61, 54.55, 69.11, 77.41, 77.88, 57.38, 49, and 51.47). This shows that the population was minimum on the starting days but with the gradual increase in temperature the population of adult tends to rise until a point at which the population was at its peak with maximum activity. After that particular point population began to decline a bit. These results are in lined with Yamamoto *et al*. (2001) who also reported that peak population of *Diaphorina* citri during the beginning of summer season.

Table No 3. Correlation of citrus psylla (Nymphs) with different A biotic factors

Max Temp	Min temp	R.H morning	R.H evening	Rainfall
-0.7120	-0.6717	0.6103	0.6709	-0.0619
p value	p value	p value	p value	p value
0.0029**	0.0061**	0.0157**	0.0062**	0.8266ns

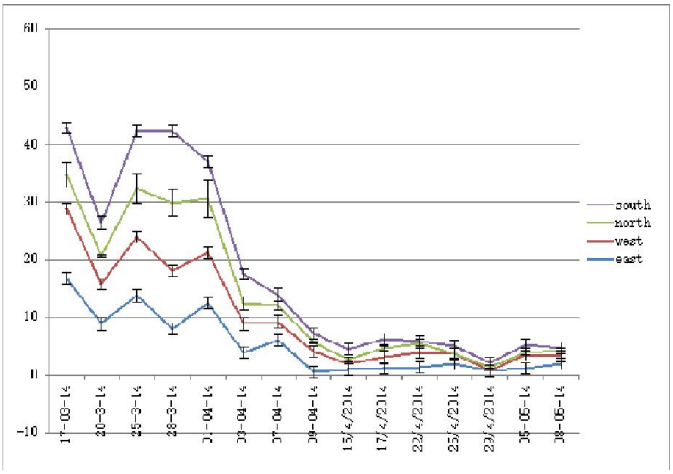
Whereas:
(**) = highly significance
(NS) = non significance

Table No 4. Correlation of citrus psylla (Adults) with different A biotic factors

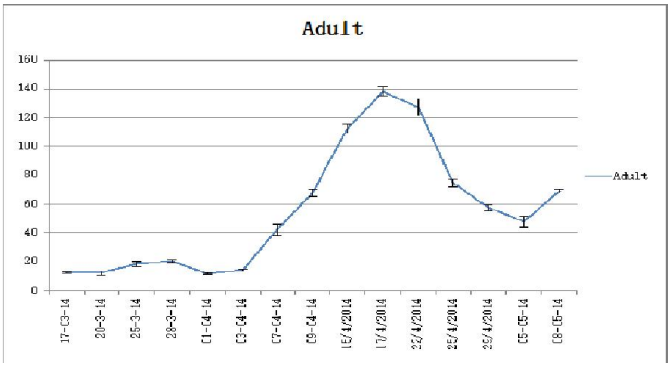
Max temp	Min temp	R.H morning	R.H evening	Rainfall
0.5864	0.6023	-0.5923	-0.5240	0.2436
p value	p value	p value	p value	p value
0.0216**	0.0175**	0.0200**	0.0450**	0.3817ns

Whereas:
(**) = highly significant
(NS) = non significant

Results from table No. 3 show that statically maximum and minimum temperature is negatively correlated to citrus nymph population. Relative humidity of morning and evening is highly significant and positively correlated to the nymph population of citrus psylla. Rainfall show complete non significance to nymph population. In Florida McFarland and Hoy (2001) who reported that increased in Relative humidity also increased in D. Citri population that is similar to our study.Results from the Table No. 4 show that statistically maximum and minimum temperature is highly significant (**) to the adult population. Similarly relative humidity of morning and evening is also highly significant (**) to the adult population of citrus psylla, but rainfall shows non significance to adult population of citrus psylla.



Graph 1. Graphical representation of population fluctuation of D.citri nymph during whole experiment

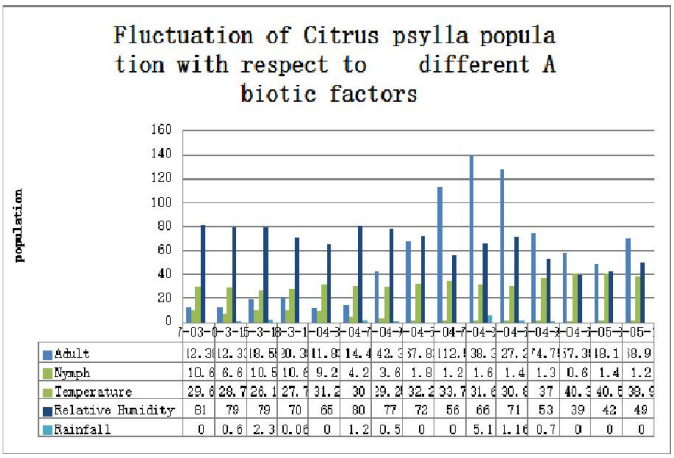


Graph 2. Graphical representation of population fluctuation of D. citriadult during whole experiment

DISCUSSION

The conducted experiment revealed that population of *Diaphorina citri* fluctuates time to time. The results obtained from table No. 3 show that the maximum and minimum temperature is highly significant but negatively correlated to the citrus psylla nymph population. Negatively correlated means that if the temperature rises there will be less nymph population, similarly if the temperature decreases the population of citrus psylla nymphs will increase (as the graph show). But this fluctuating trend of citrus psylla nymph population is only possible under a certain range of temperature i.e. optimum temperature. Optimum temperature found through this experiment for psylla is 28- 33 ^{0}C. Result showed that in start February, when the temperature was mild

the population of the nymph was abundant and adults were very less present.



Graph No.3. Population fluctuation and its correlation with different A biotic factors.

With the passage of time when the temperature began to rise slightly in March and April the population of adults began to rise. Till the end of April both adults and nymphs were observed but with the start of May when temperature began to raise more the nymphs showed a decreasing trend in population. In the 1st decade of May the population of adults was at its peak and nymph population was critically low. Citrus psylla being the part of citrus orchards in Pakistan is the most destructive pest of citrus orchards. (Abbas, 2001). Three peaks were observed in case of citrus psylla nymph population 1st in mid-April, 2nd in the end of June, and 3rd in the end of September (Sahu and Mandal., 1997). Psyllid population in citrus orchards peaked twice a year which coincides with the period of flushes during spring and summer (Wang*et al*., 1996).

The results obtained contradict with (Sahu and Mandal., 1997) but found at par with R.K Lakra and Zilesingh in 1983 in India who reported that when the flushes sprouts i.e. in February and March a steep rise in psylla population is observed resulted from the eggs laid by overwintering adults. The high population continued from mid-February to mid-May. There was a significant decline in psyllid population from November to February. But during the winter season very few adults survived.

Conclusion

Citrus psylla is one of the most potential pests of citrus now days. Although it was not considered as a potential pest in the past but when the fact was revealed that citrus psylla is the carrier of citrus greening in citrus, it turned its status from sporadic to potential pests of citrus orchards. Both the nymph and adult cause the damage either by sucking the cell sap and depleting the cell constituents or by transmitting greening disease in citrus plants. It remains active throughout the year. Its population fluctuates throughout the year and show ups and down in population trend. In Feb to May when the temperature is mild and new flushes start to bloom its population sows its peak. In start of February when temperature is low the nymph population was abundantly found whereas few of the adults were recorded. But when the temperature gradually increases the population of adult citrus psylla begins to increase. Up to a certain level of temperature the population shows maximum activity and reaches its peak. But further increase in temperature again results in a slight decline in population trend. The parasitoid *Temarixiaradiata* was recorded at mild temperature in Mid-February to Mid -March. Meanwhile some other natural enemies like Syrphid fly, Ladybird beetle were also found, but when the temperature starts to rise at high rate the parasitoids and predators begin to disappear.

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