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Population dynamics of the leaf curl aphid, *Brachycaudus helichrysi* (Kalt.) and its natural enemies on subtropical peach, *Prunus persica* cv. Flordasun

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Population dynamics of leaf curling aphid, *Brachycaudus helichrysi* (Kalt.) and natural enemies associated with the pest were studied. The initial occurence of the alate forms of *B. helichyrsi* on peach was noticed as the first alates (1.33/10 leaves) in the 3rd week of October, 2004. In the aphid colonies, alates appeared (2.33 alates/10 leaves) in the 3rd week of February and their percent population increased gradually in proportions. However, the winged aphids totally disappeared from 2nd week of December to 2nd week of February. There was a decline in the aphid population from 3rd week of April (12.62%) and onwards both apterous and alate forms disappeared from the host plants. During 1st week of February, the overwintering nymphs developed into apterous adults. There was a rapid increase in aphid population (170.67/10 leaves) and peak population (592.00/10 leaves) was recorded in 3rd week of March when the mean atmospheric temperature and relative humidity were 16.2°C and 74.44% respectively. A positive correlation was observed between the population build up of the pest and combined effect of atmospheric temperature and relative humidity ($R_{1.23}$ = 0.7051). The independent effect of humidity ($r_{13.2}$ = 0.7741) and atmospheric temperature ($r_{12.3}$ = 0.5551) was also found positively correlated with population build up of the pest. Overwintering stage of the pest from December - January revealed that nymphs produced in the last week of November overwintered in the axils and bases of dormant buds of peach tree. The population of overwintering nymphs was more in January (3.0/10 buds) than in December (0.67/10 buds). *Coccinella septempunctata* L., *Leis dimidiata* F., *Coelophora sauzeti* Muls., *Ischiodon scutellaris* (F.), *Paragus* (*Paragus*) *serratus* (Fabr.) and *Paragus* (*Pandasyophthalmus*) *tibialis* (Fallen) were recorded as aphidophagous predators and *Diaeretiella rapae* M'Intosh and *Aphidius* sp. as parasitoids of the pest.

Key words: Population dynamics, *Brachycaudus helichrysi* (Kalt.), natural enemies, peach cv. Flordasun

INTRODUCTION

The peach, *Prunus persica* (L.) Balsch is grown around the world between 25° and 45° latitudes above and below the equator (Childers, 1975) and its commercial cultivation is in vogue in a number of countries like the U.S.A, Italy, France, Japan, Argentina, Australia, Mexico, Korea, Germany, New Zealand, Turkey, Canada, Chile, India etc.

In India, peach cultivation is more or less confined to the mid hill zones of the Himalayas extending from Jammu and Kashmir to Khasi hills at an attitude of 1500 - 2000 m above mean sea level. Low chilling cultivators are also grown in sizeable area in the sub-mountainous regions and eastern parts extending from Punjab, Haryana, Delhi to Western Uttar Pradesh. Limited cultivation also exists in the hills of the South and in the North eastern region of the India (Ghosh, 1976).

However, in Jammu and Kashmir, peach cultivation is restricted to the temperate and intermediate agro climatic zones. Inspite of early bearing, high yield potential of this

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fruit crop and concerted efforts of both the government and some non-governmental organizations to motivate farmers to accept its commercial cultivation, the area and production have not increased substantially due to the fact that peach is subjected to the ravages of the leaf curling aphid, *Brachycaudus helichrysi* (Kaltenbach), which is one of the major limiting factors for its successful cultivation under sub-tropical conditions (Verma and Singh, 1990). The pest is highly polyphagous, infesting about 175 species belonging to 115 genera into 49 plant families in India (Ghosh and Verma, 1988; Thakur et al., 1995). This pest is also a vector of *Plum Pox virus* which further aggravates the situation and imparts a sickly appearance to the host plant (Maison and Massonie, 1982). Keeping in view the economic importance of this pest, this research work was initiated to study its population dynamics and natural enemies associated with it.

MATERIALS AND METHODS

The studies were carried out in the laboratory of Division of Entomology and peach orchard under Division of Pomology and Post Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Udheywalla, Jammu

Initial occurence of the alates of *B. helichyrsi* on the host and population build-up of the pest

For recording the initial occurence of the alate forms of *B. helichyrsi on* peach trees and subsequent population build up during the season, three peach trees were randomly selected and marked in the orchard where no treatment was applied. From each tree, 10 twigs were selected randomly from all geographical directions, besides one from the central whorl and from each twig 10 buds/ leaves were observed for all forms *i.e.* alate, apterous and nymphs with naked eye and hand lens (x10) at weekly intervals. The buds were observed from December and January, 2004 while the leaves were observed during the rest of the year. All forms of aphid were counted. The observations on leaves were recorded weekly starting from first week of September to last week of August in the following year. The data, thus generated were analysed statistically as per the methods advised by Panse and Sukhatme (1978).

Simple and multiple correlations of the aphid population were also worked out with weather parameters. The data for weather parameters viz., atmospheric temperature and relatively humidity were obtained from the Meteorology station of Water Management Research Centre (ICAR), Jammu, India.

Overwintering of *B. helichyrsi*

Weekly observations were also recorded on the axils and bases of the dormant buds under microscope in the laboratory to see the overwintering egg, nymphal or adult stages.

Natural enemies of *B. helichyrsi*

The maggots of syrphid and grubs of coccinellids were collected from the aphid infested peach trees and were reared in the laboratory by providing them aphids as daily feed till the adults emerged. Similarly, the parasites were collected from the aphid mummies in the laboratory. The adults of the predators and para-sites thus obtained were got identified by the taxonomy section of Division of Entomology, IARI, New Delhi.

To record the population of predators and parasites, three untreated peach trees were selected and kept under observation. Population of each predator was determined on the randomly selected branches/ bunches at weekly interval commencing from 1st week of March to 4th week of April for the period under study. Similarly, for recording the population of parasites, a random sample of 100 aphids was kept under observations in the laboratory to see the intensity of parasitism based on the formula given Root and Skelsey (1969).

$$\text{Parasitism (\%)} = \frac{\text{Total aphid mummies}}{\text{Total live aphids + Total aphid mummies}} \times 100$$

RESULTS AND DISCUSSION

Initial appearance of the alate forms of *B. helichyrsi*

The first alates (1.33/10 leaves) of *B. helichyrsi* appeared in the 3rd week of October of respective years. The population of winged aphids continued to increase and maximum population (3.67 alates/10 leaves) was recorded in 3rd week of November. Thereafter, the population of winged aphids declined until disappear from 2nd week of December to 2nd week of February. Their per cent population increased gradually in proportions to the apterous population till 2nd week of April (16.01). There was a decline in the aphid population from 3rd week of April (12.62%) and onwards both apterous and alate forms disappeared from the host plant. This decline in aphid population was attributed to increase in temperature and appreciable activities of the biotic agents.

Studies conducted by (Madsen and Bailey, 1958; Sandhu and Khangura, 1977; Ghosh and Raychaudhuri, 1981; Verma and Singh, 1990; and Gupta and Thakur, 1993) had revealed that the alate forms of *B. helichyrsi* migrated from the alternate hosts to the primary host (peach) during autumn between October November for laying eggs or nymphs. As observed in the present study. The slight variation in time of their initial occurrence might have been due to the difference in agroclimatic conditions, altitude of the area and cultivar of the host plant etc. However, the alate forms were not observed till 2nd week of February probably due to extreme cold weather in this northern part of the country. These observations fall in line with that of Madsen and Bailey (1958) who also did not observe the alate forms during winter months. During 3rd week of February with rising temperature, these forms again started occuring (2.33/10 leaves) and their maximum per cent population (16.01) was recorded in the 2nd week of these observations are in close conformity to the findings of Verma and Singh (1990) who also observed the of winged forms in the aphid colonies

Table 1. Population of alate and apterous morphs of *B. helichyrsi* (Kalt.) on peach cv. Flordasun.

Month	Week	Population* load			Per cent population		Aphid counted from
		Alate	Apterous	Total	Alate	Apterous	
October	II	0.00	0.00	0.00	0.00	0.00	Leaves
	III	1.33	0.00	1.33	100.00	0.00	Leaves
	IV	2.00	0.33	2.33	85.84	14.16	Leaves
November	I	3.00	3.00	3.67	81.74	18.26	Leaves
	II	3.33	3.33	4.33	76.90	23.10	Leaves
	III	3.67	3.67	5.67	64.72	35.28	Leaves
	IV	2.00	2.00	5.00	40.00	60.00	Leaves
	V	1.00	1.00	3.33	30.03	69.97	Leaves
December	I	0.33	0.33	1.33	24.81	75.19	Leaves
	II	0.00	0.00	1.00	0.00	100.00	Buds
	III	0.00	0.00	0.67	0.00	100.00	Buds
	IV	0.00	0.00	0.67	0.000	100.00	Buds
January	I	0.00	0.00	1.67	0.00	100.00	Buds
	II	0.00	0.00	2.00	0.00	100.00	Buds
	III	0.00	0.00	2.00	0.00	100.00	Buds
	IV	0.00	0.00	3.00	0.00	100.00	Buds
February	I	0.00	0.00	5.67	0.00	100.00	Leaves
	II	0.00	0.00	14.67	0.00	100.00	Leaves
	III	2.33	2.33	170.67	1.36	98.64	Leaves
	IV	5.67	5.67	301.33	1.88	98.12	Leaves
March	I	11.33	11.33	393.00	2.88	97.12	Leaves
	II	26.67	26.67	472.33	5.65	94.35	Leaves
	III	34.33	34.33	592.00	5.80	94.20	Leaves
	IV	19.33	19.33	175.33	11.02	88.98	Leaves
	V	14.00	14.00	101.33	13.82	86.18	Leaves
April	I	13.33	13.33	87.00	15.32	84.68	Leaves
	II	8.33	8.33	52.00	16.01	83.99	Leaves
	III	4.67	4.67	37.00	12.62	87.38	Leaves
	IV	0.00	0.00	0.00	0.00	0.00	Leaves

* 10 buds/ 10 leaves, ** Over-wintering population

in the month of June which subsequently migrated to the summer alternate hosts.

Population builds up of *B. helichyrsi* during the season

With the commencement of sap flow in the trees during spring (1st week of February), the overwintering nymphs developed into apterous adults and started multiplying in the curled leaves (Table 1). There was a rapid increase in aphid population (170.67/10 leaves) and the peak population (592.00/10 leaves) was recorded in 3rd week of March when the mean atmospheric temperature and relative humidity were 16.2°C and 74.44%, respectively, (Figure 1). From 4th week of March onwards, aphid population started declining (175.33 aphids/10 leaves) and this tendency continued till 3rd week of April (37.00/10 leaves). In the 4th week of April, when the mean atmospheric temperature and relative humidity were 26.7°C and 58.62%, respectively, there was complete absence of aphid population.

During the course of recording the data, it was observed that with the onset of spring overwintering nymphs developed into apterous adults who reproduced tremendously within the curled leaves. The population of apterous aphid was more than that of alate forms. Alate aphids were more active, seen moving on the leaves, while the apterous were sedentary and remained confined to feeding sites.

The perusal of data (Table 2) revealed a positive correlation between the population build up of the pest and combined effect of atmospheric temperature and relative humidity ($R_{1.23} = 0.7051$). The independent effect of humi-

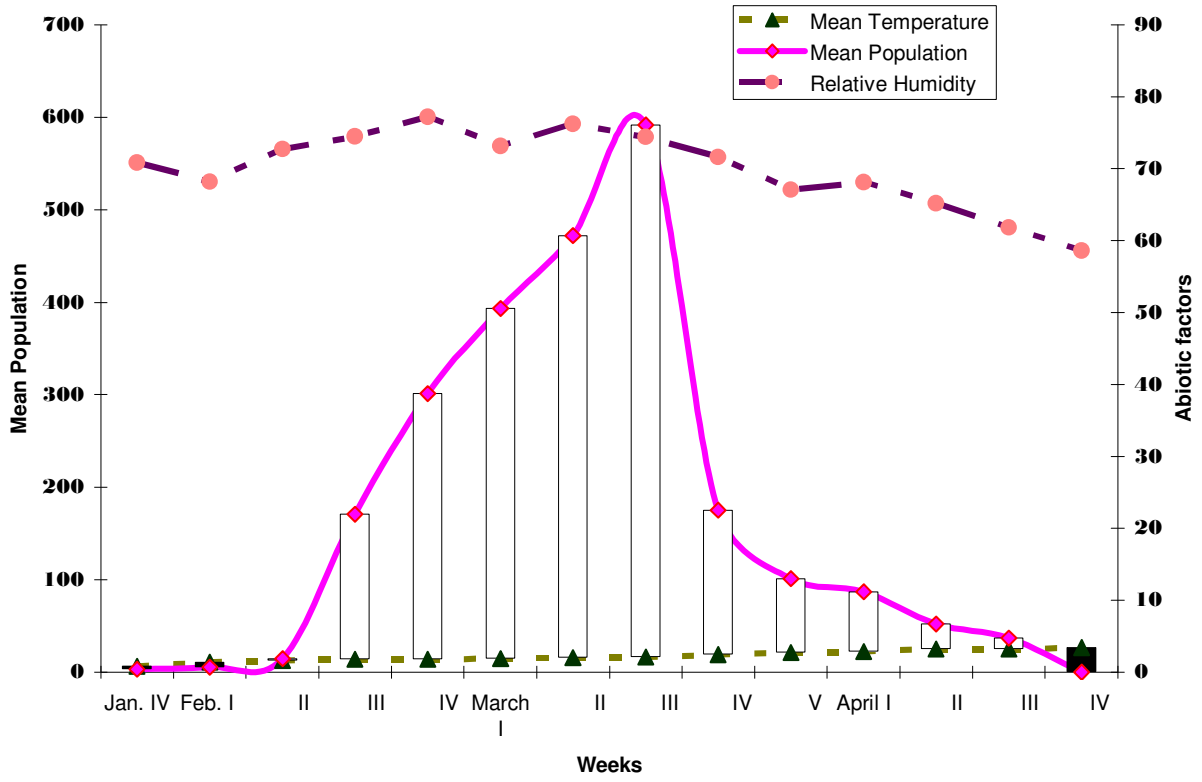

Figure 1. Influence of abiotic factors on the population builds up of *Brachycaudus helichrysi* (Kalt.).

Table 2. Seasonal population build-up of *B. helichyrsi* (Kalt.) on peach cv. Flordasun.

Month	Week	Mean aphid population/10 leaves			Mean temperature(°C) (X_1)	Mean relative humidity (%) (X_2)
		Nymphs	Adults	Total (Y)		
January	IV	3.00	-	3.00	6.6	70.85
February	I	4.00	1.67	5.67	10.9	68.20
	II	11.67	3.00	14.67	12.7	72.70
	III	120.00	50.67	170.67	13.9	74.50
	IV	202.33	99.00	301.33	14.2	77.20
March	I	263.00	130.00	393.00	14.9	73.14
	II	325.33	147.00	472.33	15.7	76.19
	III	387.00	205.00	592.00	16.2	74.44
	IV	48.33	127.00	175.33	19.0	71.60
	V	23.00	78.33	101.33	21.4	67.07
April	I	11.00	76.00	87.00	22.3	68.13
	II	3.33	48.67	52.00	24.9	65.20
	III	0.00	37.00	37.00	25.2	61.80
	IV	0.00	0.00	0.00	26.7	58.62

Multiple correlation co-efficient ($R_{1.23}$) = 0.7051*, Partial correlation co-efficient ($r_{12.3}$) = 0.5551*, ($r_{12.3}$) = 0.7741*, Coefficient of determination (R_2) = 0.4972, Significant at $P \leq 0.05$

dity ($r_{13.2}$ = 0.7741) was also found positively correlated with population build up of the pest. The analysis of independent effect of atmospheric temperature on the population fluctuation of aphid reflected a positive correlation ($r_{12.3}$ = 0.5551).

Population of the pest started multiplying from the fundatrix with the commencement of the flow of sap in the host plant. Observations recorded by Gupta and Thakur (1993) support the present findings since they also visualized that egg hatching or Fundatrix development rate depended on the initiation of the sap flow. A rapid increase in the pest population, synchronized with increase in temperature and humidity was observed in the 3rd week of February. The peak population (592.00 aphids/ 10 leaves) was recorded in the 3rd week of March with mean atmospheric temperature and relative humidity being 16.2°C and 74.44 %, respectively. These observations suggest that among abiotic factors, temperature and relative humidity play predominant role in determining the population of soft bodied sucking insects. These findings fall in line with those of Ghosh and Raychaudhuri (1981) and Verma and Singh (1990) who also recorded rapid multiplication of this pest parthenogenetically resulting in huge population build-up within a short period. The peak pest occurrence varies due to variation in elevation as observed by (Sharma et al., 1968) who recorded pest activity in mid February at higher elevations and by the end of January at lower elevations. The data recorded in the present study revealed that rising temperature and decreasing humidity contributed to the declining of pest population which reached its low ebb (37.00/10 leaves) in the 3rd week of April at mean atmospheric temperature and relative humidity of 25.2°C and 61.80% respectively. This change in weather conditions also led to the production of winged forms within the aphid colonies which subsequently migrated to the summer alternate hosts and completely disappeared from trees. Further, a positive correlation was observed between aphid population build up and combined effect of mean atmospheric temperature on the population fluctuation of aphid reflected a positive correlation ($r_{12.3}$ = 0.5551). However, Ram and Pathak (1987) reported humid climate and stable temperature responsible for its population build up of *B. helichrysi*.

Mode of attack

The nymphal instars and apterous adults, having succivorous feeding habits, caused considerable damage by desapping the host plant (Plate 1). These stages of the pest drain considerable quantities of sap from the buds, blossoms and newly emerged leaves. Consequently, the foliage gets distorted and leaves become profusely crumpled, undersized fruits, pre mature fruit fall and ultimately poor fruit yield is the resultant effect. The resultant effect of desapping was distorted foliage, profusely crumpled leaves, premature fruit drop, shriveled and under sized fruits and untimely low fruit yield. The present observations fall in line with those reported by Gupta et al. (1986) and Kapoor et al. (1989), who also reported the similar type of damage caused by this pest.

Overwintering of *B. helichyrsi*

Observations regarding the overwintering stage of the pest from December, to January (Table 1) revealed that nymphs produced in the last week of November over wintered in the axils and bases of dormant buds of peach tree. The population of overwintering nymphs was more in January than in December. The mean minimum number of over-wintering nymphs (0.67/10 buds) was during 3rd and 4th week of December and their maximum population (3.0/ 10 buds) was in the last week of January. The pest remained under overwintering conditions from 2nd week of December till last week of January as has also been recorded by Bennett (1955), Gupta and Thakur (1993) and Thakur et al. (1995).

Associated natural enemies of *B. helichyrsi*

Various predators and parasitoids found associated with *B. helichyrsi* are presented in Table 3. *Coccinella septempunctata* L., *Leis dimidiata* F., *Coelophora sauzeti* Muls., *Ischiodon scutellaris* (F.), *Paragus* (*Paragus*) *serratus* (Fabr.) and Paragus (*Pandasyophthalmus*) *tibialis* (Fallen) were recorded as aphidophagous predators and parasite, Diaeretiella rapae M'Intosh and *Aphidius* sp. as parasitoids of the pest (Plate 2, 3, 4 and 5).

C. septempunctata appeared in the 1st week of March whereas, *L. dimidiate*, *C. sauzeti* and *I. scutellaris* in the 2nd week of March (Table 4). Their population started building up and the maximum population was recorded in the 4th week of March which synchronized with the post peak aphid activity.

Adults and grubs of coccinellids and maggots of the syrphid flies were found feeding on aphids. The coccinellids captured the aphids by their legs and punctured them on the abdominal region by their powerful jaws and finally sucked out body contents. In some, complete swallowing of the prey was observed. The population of *C. septempunctata* was than all other predators, followed by *I.* scutellaris (2.50 per bunch) and maximum parasitism (7.25%) by *D. rapae* and *Aphidius sp*. was recorded in the 4th week of March. On wild weed, *Ageratum*, the maggots of two small species of *Diptera* namely *P. serratus* and *P. tibialis* were also preying on the aphids during November. Thalji (1981), Voicu et al. (1987) and Verma and Singh (1989) also reported the association of various predacious coccinellid beetles and syrphid maggots with *B. helichyrsi.* Predation of this pest by various

Table 3. Natural enemies complex of *B. helichyrsi* (Kalt).

Natural enemies	Order	Family
Coccinella septumpunctata Linn.	Coleoptera	Coccinellidae
Leis dimidiate F.	Coleoptera	Coccinellidae
Coleophora sauzeti Muls.	Coleoptera	Coccinellidae
Ischiodon scuilellaris (F.)	Diptera	Syrphidae
Paragus (*Paragus*) *Serratus* (Fab.)	Diptera	Syrphidae
Paragus (*Pandasyophthalmus*) *tibialis* (Fallen)	Diptera	Syrphidae
Diaeretiella rapae M'Intosh	Hymenoptera	Braconidae
Aphidius sp.	Hymenoptera	Braconidae

Table 4. Incidence and abundance of natural enemies associated with *B. helichrysi* (Kalt.) on peach.

Natural enemies	Weekly mean population*												
	March					April				May			
	I	II	III	IV	V	I	II	III	IV	I	II	III	IV
Coccinella Septumpunctata L.	0.75	1.75	2.50	3.25	3.00	2.75	2.50	2.25	1.75	1.00	0.50	-	-
Leis dimidiate F.	-	1.25	1.75	2.00	1.50	1.75	1.50	0.75	-	-	-	-	-
Coelophora sauzeti Muls.	-	0.50	0.75	1.00	1.00	0.75	0.50	0.25	-	-	-	-	-
Ischiodon scuilellaris F.	-	0.75	2.00	2.50	2.25	1.75	1.50	0.50	-	-	-	-	-
1.*Diaeretiella rapae* M'Intosh													
2. *Aphidius* sp.	3.25**	4.25	6.75	7.25	6.50	5.25	1.25	0.75	-	-	-	-	-

Mean of four observations per bunch/branch/tree. Per cent parasitism by parasitoid.

coccinellid species has also been reported by Bhagat et al. (1988), Chakrabarti et al. (1995), Bharadwaj (1995), Semyanov et al. (1996) and Sharma (2001). Observations regarding the association of hymenopteran parasites are confirmed by the findings of Verma and Singh (1989); Carver et al. (1993); Bhagat and Mir (1995) and Singh et al. (1995) who reared *Aphidius* spp. and *D. rapae* from *B. helichyrsi.* These natural enemies have been observed playing significant role in suppressing the pest population (Semyanov et al., 1996).

In the present investigations, the maximum per cent parasitism by *D. rapae* and *Aphidius* sp. was 7.25 which is almost similar to the findings of Verma and Singh (1989), who recorded 8.05% parasitism by *Aphidius matricariae* During the course of present studies, maggots of small dipteran species were found preying upon aphids on wild *Ageratum.* Predation on aphids by these species have not been reported from Jammu and Kashmir, as such they represent new records from this region. However, Agarwala et al. (1983) have reported the predation of aphids by *Paragus* species from the West Bengal and Sikkim.

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