

Seasonal Activity of *Chilocorus bijugus* Mulsant on San Jose scale, *Quadraspidotus perniciosus* (Comstock) in Apple Ecosystem

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Among the coccinellid predators, *Chilocorus bijugus* Mulsant was found to be the most effective against the San Jose scale, *Quadraspidotus perniciosus* (Comstock), a serious pest of apple in India and elsewhere (Pruthi and Rao, 1951; Chanyuvadze, 1976; Thakur *et al.*, 1989). So far, only very little attention has been given to study the seasonal activity of the predator on San Jose scale in the apple ecosystem. A study was therefore conducted to obtain quantitative data on *C.bijugus* in the different apple ecosystem of Himachal Pradesh for developing effective biocontrol strategies for San Jose scale.

The study was carried out in the neglected apple orchards at Janerghat (Shimla) and Patlikhul and Shamshi (Kullu) from April to December, 1988. To record the field population of *C.bijugus*, field visits were made twice a month in the selected orchards. The population was recorded by direct counting of the adults and other immature stages from different parts of the plants. The observations were made for 10 to 16 h at 2 h interval on 20 randomly -selected plants having almost the same age group at each locality. Each observation lasted for 10 to 15 minutes.

Data on weather parameters *viz.*, maximum and minimum temperature, relative humidity and rainfall, were collected during the period of study to work out the relationship between the predator activity and weather parameters.

The data on the seasonal variation in the population of *C.bijugus* in the apple crop ecosystem during 1988 have been depicted in

Table 1 and its correlation with weather parameters in Table 2. The study revealed that for the first time, the eggs of *C.bijugus* were seen in the second quarter of April at Shamshi (Kullu) and a mean of 2.5 eggs per plant was observed. The egg count increased steadily and peak oviposition (10 eggs per plant) was observed at Patlikhul in the first fortnight of June. The eggs were not seen in the fields during the months of July, August and September but observed in the first and second fortnight of October (Table 1).

The grubs were first observed on the apple plants in the second fortnight of April and their population increased steadily till June. The population declined sharply thereafter up to 15th July. The activity of grubs was again observed in the third week of September except at Janerghat (Shimla) where it reappeared in the first fortnight of October. The larval population had ceased completely after 15th November in the fields. Similar trend was observed with the pupal population.

The adults were active on apple during April. The peak population was observed in May and June, and the population declined by the end of July or first week of August. After that the adult counts were nil up to 15th September. Again the adult activity started after the second fortnight of September and increased steadily till the end of October after which it declined slightly, and there was no activity of the adults during December to March.

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Table 1. Field population of developmental stages and adults of *C.bijugus* at various localities in Himachal Pradesh during 1988

Month of sampling	* Mean number of population per plant at each locality											
	Janerghat (Solan)				Patlikhul (Kullu)				Shamshi (Kullu)			
	eggs	grubs	pupae	adults	eggs	grubs	Pupae	adults	eggs	grubs	pupae	adults
April I	-	-	-	-	-	-	-	-	-	-	-	4.0
II	-	-	-	3.0	-	-	-	5.0	2.5	5.2	-	6.0
May I	3.6	5.0	-	7.0	6.0	10.5	5.0	13.6	3.0	6.0	6.4	15.0
II	7.2	10.5	12.1	11.6	8.6	12.3	12.0	15.4	6.5	12.0	10.0	17.0
June I	5.2	12.8	15.6	13.9	10.0	18.0	15.0	20.0	5.0	15.0	12.0	18.0
II	4.3	15.0	14.8	16.0	5.0	16.0	13.5	16.5	6.0	14.5	11.2	14.6
July I	-	4.5	8.6	9.2	-	7.8	8.9	10.0	-	5.6	7.0	8.0
II	-	-	4.0	6.0	-	-	-	3.7	-	-	-	4.5
August I	-	-	-	-	-	-	-	2.0	-	-	-	-
II	-	-	-	-	-	-	-	-	-	-	-	-
September I	-	-	-	-	-	-	-	-	-	-	-	-
II	-	-	-	-	-	3.8	-	5.0	-	3.0	-	2.0
October I	-	3.5	-	4.5	2.0	5.5	-	10.0	3.0	10.0	-	10.0
II	2.0	6.8	5.5	6.0	-	4.3	6.0	12.0	4.0	15.0	12.0	11.7
November I	-	3.8	4.0	3.6	-	-	4.0	10.5	-	6.0	10.5	8.0
II	-	-	-	-	-	-	-	4.0	-	-	5.0	3.0

Mean \pm SE 1.23 \pm 0.349, 3.44 \pm 0.513, 3.59 \pm 0.544, 4.49 \pm 1.203, 1.76 \pm 0.421, 4.34 \pm 0.573, 3.58 \pm 0.534, 7.09 \pm 0.594, 1.67 \pm 0.355, 5.13 \pm 0.559, 4.11 \pm 0.590, 6.77 \pm 0.58

* Mean of 20 observations

I = Observation taken between 1-15 and

II = between 15-30 days of month

The level of population recorded was nil from January to March and December

The present findings on the population trend were in agreement with the findings of Williams (1970) who reported that larvae, pupae and adults of *C.discoideus* were observed during May to August but the adults were seen up to October on *Aulacaspis tegalensis*. Similarly, Rosen and Gerson (1965) reported that the number of larvae of *C.bipustulatus* reached peak levels in April, June and October on *Q.perniciosus*. However, in our present study, the adult population was not observed in the field during August which may be due to high rainfall as well as the activity of hyperparasitoid, *Aprostocetus neglectus* (Domenichini) (Hymenoptera : Eulophidae) on *C.bijugus* grubs. The extent of hyperparasitism ranged between 15.85 to 33.77% minimum being at Katrai and maximum at Nagar of Kullu district in Himachal

Pradesh. This agrees with the reports of Pruthi and Rao (1951), Murashevskaya (1969) and Ma *et al.* (1985) and who reported that *Chilocorus* spp. was effective against *Q.perniciosus* during summer but the population declined sharply in the rainy season due to the activity of a number of chalcid and eulophid parasitoids viz., *Tetrastichus coccinellae* Kurdj, *Homalotylus flaminus* (Dalm.) and *Phalacrotophora fasciata* (Fall) from the end of July. The present finding on occurrence of *C.bijugus* population during the month of October was also in conformity with the observation of Kapur (1954) who observed *C.bijugus* in October at Tangmarg (7000-7500') in Kashmir on San Jose scale infested apple trees. Rawat *et al.* (1988 a,b) reported that the population build up of

Table 2. Correlation of *Chilocorus bijugus* population with the weather parameters at different localities in Himachal Pradesh

Locality	Stage of the Predator	Weather parameters				
		Maximum temperature	Minimum temperature	Maximum relative humidity	Minimum relative humidity	Rainfall
Janerghat (Shimla)	Eggs	0.7282*	0.3414	-0.3467	-0.3513	-0.3614
	Grubs	0.7125*	0.3307	-0.2492	-0.2886	-0.3314
	Pupae	0.6999*	0.4300	-0.0125	-0.0360	-0.0861
	Adults	0.7673**	0.4641	-0.0763	-0.1070	-0.1583
Patlikhul (Kullu)	Eggs	0.5538	0.3319	-0.9752**	-0.6296	-0.3470
	Grubs	0.6180	0.4629	-0.9263**	-0.5279	-0.2587
	Pupae	0.5703	0.4394	-0.8858**	-0.5029	-0.2893
	Adults	0.5731	0.2897	-0.8018**	-0.6829*	-0.4825
Shamshi (Kullu)	Eggs	0.5438	0.2138	-0.8964**	-0.7205*	-0.5561
	Grubs	0.4999	0.1934	-0.7276*	-0.6894*	-0.5714
	Pupae	0.3851	0.1148	-0.6700**	-0.7216*	-0.5652
	Adults	0.5738	0.2334	-0.8386**	-0.7156*	-0.5361

* Significant at 5% level

** Significant at 1% level

C. bijugus was generally during summer in Himachal Pradesh.

The relationship of the population of predatory beetle *C. bijugus* with weather parameters was studied using correlation coefficient (Table 2). Maximum and minimum temperature showed positive correlation with the predator population while the relative humidity and rainfall showed negative correlation.

In general, the predator population attained the peak in May-June and again in October. The low population of *C. bijugus* during rainy season (July to September) and the following winter months (December to March) may be due to the heavy rainfall and low temperature which directly influenced the population of *C. bijugus* in the fields. Further, the population during the rainy season may have declined due to the activity of hyperparasite, *A. neglectus*.

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KEY WORDS : *Chilocorus bijugus*, predator, seasonal activity, *Quadraspidotus perniciosus*

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