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Correlation of Citrus Leaf Miner (*Phyllocnistis citrella* Stainton) with Snail Population in District Sargodha, Punjab, Pakistan

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Abstract.- From January 2010 to December 2011, samples of leaves from Kinno, Musambi and Feutral were taken from the five tehsils of district Sargodha including Sargodha, Bahalwal, Silanwalli, Sahiwal and kotmomin to study the population trends in citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) and its correlation with snail population. The present study also shows the population density of citrus leaf miner in different seasons of Sargodha district, Pakistan. Population of snails on leaves was recorded as 1.322, 1.083, and 1.342 in Feutral, Kinno and Masambi, respectively in its mean values. The statistical analysis shows that there is strong correlation in the seasonal fluctuation in the population density of snails and of snail's population with citrus leaf miner *(Phyllocnistis citrella,* Stainton).

Key words: CLM, *Phyllocnistis citrella,* population density, Snails, environmental factors; Sargodha district.

INTRODUCTION

The damage caused by *Phyllocnistis citrella* (Stainton, 1856) (Lepidoptera, Gracillariidae) in furiate citrus canker outbreak (Sohi and Sandhu, 1968; Sinha *et al*., 1972; Cook, 1988; Venkateswarlu and Ramapandu, 1992; Chagas *et al*., 2001). This insect not only causes direct damage to the leaves of new sprouts, but also severely infect the twigs and fruits (Clausen, 1931; Badawy, 1967; Heppner, 1993; Prates *et al*., 1996), the direct association with citrus canker has been reported (Gottwald *et al*., 1997; Chagas *et al*., 2001). The citrus leafminer was first observed in Sao Paulo state (Prates *et al*., 1996), rises in the plant numbers which are infected with the same pest, as result the modification were occurred in the method for removing of citrus canker on September 1999 (Saopaulo, 1999; Gimenes-Fernandes *et al*., 2000; Chagas *et al*., 2001).

CLM is considered a cause to enhance the of citrus canker disease which is caused by the bacteria (Xanthomonas) by opening the leaf cuticle to infection and rise the number and damage of lesions (Sohi and Sandhu, 1968; Sinha *et al.,* 1972; Gottwald *et al.,* 1997). CLM present on the anterior and posterior surfaces of young leaves during larval stage as result damaged leaves become chlorotic. Therefore, severely infected leaves (>4 mines per leaf) are commonly deformed and may fall (Pena and Duncan, 1996). During the feeding stage of the first larval instars characteristic silvery mines are produced. The appearance of mine is silvery due to the air and condensed water vapour collected in the mine. At the maturity of host leaves, they are not be able to defect. In cases of enormous infestation, CLM defect even young fruits (Heppner, 1995). In Mauritius, CLM mines have once been examined on a young local *Pam lemouses* fruits. Larvae of CLM during extreme infections it also attack small branches even tenders and twigs. Such damage can be severe which lead to die back and minimizing tree strength and productivity (Sabine, 1971). Citrus canker Infection has been examined on citrus leaves infected by CLM. The pathogen in form of pustules

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is more plentiful along the mines on the infected leaves. The CLM present in association with citrus canker (Cook, 1988).

Snails act as the intermediate host for the spread of the parasitic infestation of the animals, birds, man and fishes (Kandel, 1954). In Pakistan many researchers conducted studies on different fresh water snails in different parts of the country (Akhtar and Khan, 1989; Akhtar, 1990; Buriro and Chaudhry, 1981; Mughal, 1993; Parveen, 1977; Sarwar, 1949).

Keeping in view above motioned facts and figures the present study was designed to estimate the population density of CLM and its correlation with snails. The present study also catches its importance's because the land of Sargodha is the hub of citrus industry.

The major objectives of the present study were to estimate the: Population density of citrus leaf miner; Seasonal fluctuation in the population density of snails; Correlation of snail's population with citrus leaf miner *(Phyllocnistis citrella* Stainton).

MATERIALS AND METHODS

Study area

The current study was conducted in the district Sargodha, Punjab, Pakistan. The data was collected from five tehsils namely Sargodha (86 SB and 79 NB), Bhalwal (7 NB and near Fisheries Station), Sillanwali (Chake124NB), Sahiwal (Dera Jara) and Kotmomin (Lilhan) shown in (location map), the coordinates of these tehsils were 32° 5' 1" N / 72° 40' 16" E ,32.8°N 73.7°E, 31.29°N 72.19°E, 31°58N 72°56E and 31°58'23"N, 73°19'32"E respectively (Punjab Portal, 2011).

Data collection

The study was conducted from January 2010 to December 2011. Data was collected on monthly basis on $14^{th,}$ 15^{th} and 16^{th} of each month. From Sargodha and Bhalwal on 14^{th}, Sillanwali and Sahiwal on 15th and Kotmomin on 16^{th} of each month. Data was recorded in early morning and two hours before the sun set.

Population dynamics

From each Tehsils three orchards were selected, and from each orchard three sites were taken for analysis. From each site four plants were taken of each variety namely: *Citrus reticulate* cv. kinno; *Citrus reticulate* cv. feutral; *Citrus sinensis* cv. musambi .

The age of these plants was almost one year; they were tagged for further study. The applications of pesticides were prohibited during the whole time of experimentation.

For the study of population dynamics each plant was divided into four cardinal quadrants, and from each quadrant ten leaves were taken randomly, in this way forty leaves were collected from each plant.

Sample analysis

Leaves were placed separately in plastic bags, transported to laboratory and examined under dissecting and compound microscopes (Labomed USA, 7GA9) by using different resolutions. The numbers of larvae in each plant were recorded. For population dynamics study, mean larval population was calculated.

Infestation

For infestation (damage) total numbers of damaged leaves were counted and divided with total no. of leaves on a tree and multiplied by hundred. In this way % damage was calculated. Leaves on one branch were counted and it was multiplied by total no. of branches in a plant, in this way total no. of leave were counted in a plant. Similarly, Percentage of cankered leaves was also calculated in each plant. Mean population of snails were also recorded on infested leaves.

Infested leaves (%) = damaged leaves / total leaves x 100

Environmental factors

The temperature (°C) was measured with thermometer and humidity (%) with hygrometer. Rain fall was measured in inches by rain gauge meter. The data was recorded in the field of above mentioned environmental parameters (supplementary data).

Statistical analysis

Using R2.15.2 by CRAN for windows, three factorial analysis of variance (ANOVA) with two

interact ional factor was performed to test the significance of differences in CLM population and other parameters used in the study (Steel and Torrie, 1980).Where the significant differences were found, Tukey, the HSD pair wise comparison was applied. Student's t test was applied to detect the differences in months, Varieties, Tehsiles and varieties and varieties and months. The level of significance for each test was at $p<0.05$.

RESULTS

This interaction between larval population and snails was first time reported during this study. The maximum population of CLM larvae was recorded in April and similar case with snail's population. Secondly, in mines (canals) the sucking of fluid for snails was very easy that could be reason of higher population. Because these canals or miner after mining full of fluids of leaves. The figures in the results revealed that mines of CLM were harbor with snails in particular seasons. The snail population was highly significant in month wise, so mean value for snail population was higher April, followed by May. While, mean value for snail population was falling in same range for month December, February and January (Table I).

In the present study 540 replicates were studied for snail population; it was highly significant ($p<0.05$) in month wise, so mean value for snail population was higher April, followed by May. While, mean value for snail population was falling in same range for months December, February and January (Fig. 1). There is increase in the population of CLM influences the cankered leaves and snail population (Fig. 2).

In Sargodha, the population of snails on leaves was recorded as 3.067, 2.867, 0, 0, 1, 2.4, 1, 4, 2.6, 2.6, and 3.067 in April, August, December, February, January, July, June, March, May, November, October and September, respectively. In Bhalwal, the population of snails on leaves were recorded as 4, 1, 0, 0, 0, 1, 2, 1, 3, 0, 0, 3 in April, August, December, February, January, July, June, March, May, November, October and September, respectively. In Silanwali, the population of snails on leaves were recorded as 3, 1, 0, 0, 0, 1, 2, 1, 4, 0, 0, 2, in April, August, December, February, January, July, June, March, May, November, October and September, respectively.

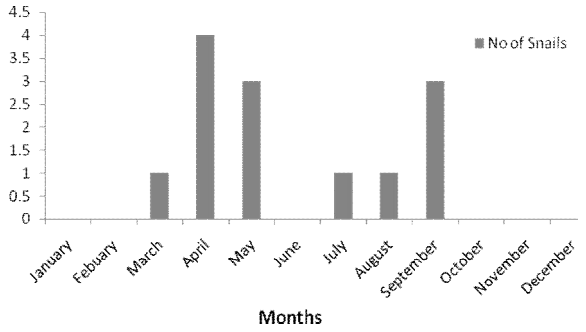

Fig. 1. Snail population in different months of study.

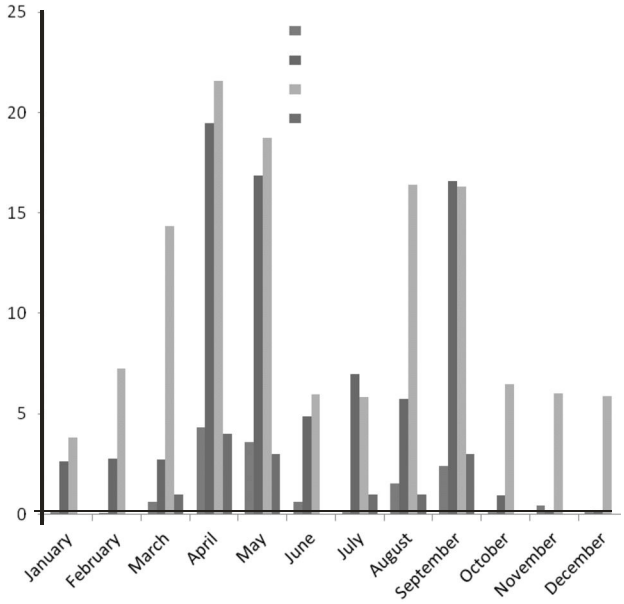

Fig. 2. Increase in the population of CLM influences the cankered leaves and snail population.

In 2011, Population of snails on leaves were recorded as 4, 1, 0, 0, 0, 1, 2, 1, 3, 0, 0, 3 in April, August, December, February, January, July, June, March, May, November, October, September, respectively, in Sahiwal. In Kot Momin, the population of snails on leaves were recorded as 3, 1, 0, 0, 0, 1, 2, 1, 4, 0, 0, 3, in April, August, December, February, January, July, June, March, May, November, October and September, respectively.

Fig. 3. Relationship of mines, snail and canker recorded in Sargodha and Silanawalli. The figures indicate that most population of snail was present on mines of CLM indicating very strong correlation of snail population with CLM.

The results of present study provide us useful information for further study. The output of this project may be the development and implementation of environmentally safe, effective, and sustainable control programmes for all citrus producing countries in the region. So, any improvement in the citrus, economy is expected to bring improvement in the livelihood of the people around the world.

DISCUSSION

This interaction between larval population and snails was first time reported during this study. The maximum population of CLM larvae was recorded in April and similar case with snail's population. Secondly, in mines (canals) the sucking of fluid for snails was very easy that could be reason of higher population. Because these canals or miner after mining full of fluids of leaves. The figures in the results revealed that mines of CLM were harbor with snails in particular seasons.

In addition to this interaction lot of work was reported on snails like: Capinera (2001) reported that snails normally feed only within the temperature

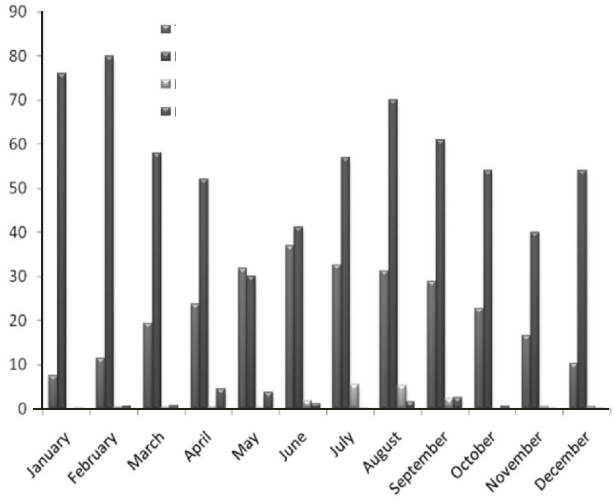

Fig. 4. Larval population of CLM in different Tehsiles and its correlation with temperature, humidity and rain fall.

range of 5 to 21°C. Kandel (1954) reported Snails act as the intermediate host for the spread of the parasitic infestation of the animals, birds, man and fishes. The temperature and humidity also play an important role in development of the snail. Basinger (1931) described the snails feeding on cultivated plants may become serious pests. In California, enormous populations sometimes become established in citrus groves and cause serious damage to leaves and fruits.

So it is concluded from the present study that there is strong correlation between CLM larvae and snail population. These larvae facilitate the feeding of snail population.

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