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NATURAL PARASITIZATION ON LEAFMINER, *CHROMATOMYIA HORTICOLA* (GOUREAU) (DIPTERA: AGROMYZIDAE) IN FIELD PEA

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ABSTRACT
The present paper reports the occurrence of two hymenopteran parasitoids of Agromyzid leaf miner, *Chromatomyia horticola* (Goureau) (Diptera: Agromyzidae) from Pantnagar (India). The parasitoids recorded were *Diglyphus sp*. (Eulophidae: Hymenoptera) and *Opius sp*. (Braconidae: Hymenoptera). The activity of *C. horticola* commenced during 52th standard week (Dec. 23 to Dec. 29) and it attained peak during the 7th standard week (Fab. 12 to Fab. 18). The per cent parasitization during course of investigation ranged from 5.26 to 58.13% (mean = 27.21 $\pm$ 15.92). The peak period of parasitization was observed during 11th standard week (Mar. 12 to Mar. 18) at 58.13 per cent of parasitization. The variations of temperature, relative humidity and rainfall caused approximately 64, 42 and 20 per cent of the variation in the per cent parasitization, respectively. The number and diversity of parasitoid species at Pantnagar has the potential to effectively control *Chromatomyia horticola*.

INTRODUCTION

Agromyzid leafminer, *Chromatomyia horticola* (Goureau) is a highly polyphagous species infesting many agriculturally important plants like vegetable and ornamental plants in both the temperate and tropical regions (Spencer, 1973). It is more common in the Mediterean area and occurs widely throughout Asia (Gencer, 2004). The larvae of this species feed within the leaves of the host plants and this can severely reduce yields and/or kills the plants at high fly density. In Kashmir Valley (India), *C. horticola* was earlier reported infesting some vegetable crops like, pea, kale, mustard, rape, turnip, radish and some ornamental flowering plants (Zaka-ur-Rab, 1981 and Bhagat *et al.,* 1989). The farmers use various insecticides to control the pest but the insecticides cause a reduction in the density of most parasitoid species after applications, resulting in resurgence of the leafminer (Saito *et al.,* 2008). Moreover, *C. horticola* is less susceptible to insecticides due to its hiding nature. The large outbreak of *C. horticola* might be resulted from a combination of low susceptibility to insecticides in the species and the destruction of the parasitoid complex due to frequent insecticide applications (Saito, 2004). Due to its resistance development against insecticides makes control measures ineffective. At the same time, **a**gromyzid leaf miners are known to have rich natural enemy communities and they play a very important role in leafminer suppression with reduced insecticide use. Several studies have been conducted on the natural enemies of *Chromatomyia horticola* in various countries. Eleven parasitoid species in Southeast China (Chen *et al.,* 2003), seven (Gencer, 2004) and eight (Gencer, 2005) parasitoid species in Turkey, twenty-one parasitoid species in Japan (Saito *et al.,* 2008), four parasitoid species in Iran (Fathi, 2011) and sixteen species in Russia (Yefremova *et al.*, 2015) have been reared from *C. horticola*. However, there have only been a few studies on the natural enemies of *Chromatomyia horticola* in India (Bhat and Bhagat, 2009; Ahmad *et al.,* 2010). According to previous records, all natural enemies of agromyzids are members of the Hymenoptera. These parasitoids belong to the Chalcidoidea, Ichneumonidea and Cynipodea (Hymenoptera). Of these, chalcidoid parasitoids are reported to constitute the most dominant group (Gencer, 2005). Therefore, the main objective of this research was to determine the parasitoids of *C. horticola* at Pantnagar and their potential use in biological control programs.

MATERIALS AND METHODS

Field surveys of leafminers and their parasitoids on field pea were made during *Rabi* season of 2012-13 at Pantnagar (India). Weekly collection of pea leaf miner infested leaves were made randomly from the field during the moths from December to March, which is the period when infestation of *C. horticola* occurs on pea crop at Pantnagar. Samples sizes were variable due to the availability of infested leaves. Infested leaves were brought to the laboratory and reared in small jars covered with muslin cloth till the emergence of adult flies or their parasitoids as described by Gencer (2005). Samples were

maintained at room temperature (25 to 30ºC) and supplied daily with some drops of water for maintaining appropriate humidity. The numbers of emerged adults of leaf miner and parasitoids were collected from containers and preserved separately in small vials containing 70 per cent ethanol for identification. Parasitoids were identified in Biological Control Laboratory at Pantnagar. The per cent parasitism was calculated weekly according to the following formula as adopted by Mills (1997) and Van Driesche (1983).

$$\text{Percent parasitism} = \frac{\text{No of adults parasitoid emered}}{\text{No. of host adult insects} + \text{no. of parasitoid adults}} \times 100$$

RESULTS

During the course of investigation, the parasitoids, *Diglyphus sp.* (Eulophidae: Hymenoptera) and *Opius sp.* (Braconidae: Hymenoptera) were found to parasitize *C. horticola*. The activity of *C. horticola* commenced during 52th standard week (Dec. 23 to Dec. 29). The infestation of this pest was increased gradually and recorded higher adult emergence during the 7th standard week (Fab. 12 to Fab. 18) (Figure 1). After that it was decreased gradually till the harvesting. The number of adult leaf miners emerged during 9th standard week (Fab. 26 to Mar. 4) and 11th standard week (Mar. 12 to Mar. 18) were less as compared to adult parasitoid emerged whereas, during the remaining standard weeks, adult leaf miners were higher than the adult parasitoids (Table 1). The activity of leaf miner parasitoids was also commenced during 52th standard week (Dec. 23 to Dec. 29) and attained peak during 9th standard week (Fab. 26 to mar. 4). The percent parasitization was recorded lowest (5.26%) during the 1st standard week (Jan. 1 to Jan 7). It was increased gradually and peaked at 58.13 % during 11th standard week (Mar. 12 to Mar. 18) followed by 9th (Fab. 26 to mar. 4) and 10th (Mar. 5 to Mar. 11) standard weeks which recorded 54.38 percent and 41.81 percent parasitization, respectively (Fig. 2). However, in rest of the standard weeks, the percent parasitization was moderate (11.11 to 29.31%).

Statistical analysis was made to study the correlation between observed weekly percent parasitization and environmental factors *viz.*, temperature, RH and rainfall. Table 2 shows the weekly mean temperature, RH and rainfall for the year 2012 – 2013.

The data were subjected to multi variable regression analysis by taking weekly percent parasitization as a dependant variable and environmental factors as independent variables:

Regression equation for the year 2012-2013: $Y = 3.918X_1 + 0.853X_2 - 0.447X_3 - 98.272$

Where, Y= weekly percent parasitization, X_1= mean temperature, X_2 = mean RH, X_3 = rainfall.

Equation reveals that for every increase of one unit of mean temperature and RH, weekly percent parasitization increased by 3.918 and 0.853 units, respectively. Whereas, every increase of one unit of rainfall, weekly percent parasitization decreased by 0.447 unit.

Table 3 shows that mean temperature and mean RH significantly influenced the weekly percent parasitization whereas; it was non-significantly influenced by rainfall. However, 68.40 percent (0.684) of variation in the weekly percent parasitization caused by environmental factors based on R^2 value. In case of individual factor, variation caused by temperature, RH and rainfall was 64.4%, 42.3% and 20.5% respectively.

DISCUSSION

Chromatomyia horticola is a cool season pest infesting pea crop from December to March. This pest caused maximum infestation during mid February when limited control was exerted by its parasitoids (Mahendran and Agnihotri, 2013). The population of leafminer was less as compared to its parasitoid during the first fortnight of March where parasitoid showed a considerable control up to 58 percent over leaf miner. The activity of leafminer and its parasitoids commenced during last week of December. This showed synchronization between the populations of host and natural enemies. During the course of investigation, the leafminer was parasitized by *Diglyphus sp.* and *Opius sp.* Earlier researchers Saito *et al.* (2008) reported twenty one parasitoid species from *C. horticola* and the most abundant parasitoid species were *Diglyphus*

Table 1: Natural parasitization on leafminer, *Chromatomyia horticola* on pea

S. No.	Meteorological standard week	No. of leaves collected	No. of adult leaf miner emerged	No. of adult parasitoid emerged	Per cent parasitization
1	52	10	08	1	11.11
2	1	20	18	1	05.26
3	2	20	15	2	11.76
4	3	40	32	9	21.95
5	4	40	21	8	27.58
6	5	50	29	6	17.14
7	6	50	32	11	25.58
8	7	50	51	15	22.72
9	8	50	41	17	29.31
10	9	50	26	31	54.38
11	10	50	32	23	41.81
12	11	50	18	25	58.13
13	12	50	21	9	27.02
Total		530	344	158	

Table 2: Weekly percent parasitization and corresponding weekly mean temperature, RH and rainfall

S. No.	Meteorological standard week	Per cent parasitization	Mean temperature (°C)	Mean RH (%)	Rainfall (mm)
1	52	11.11	11.3	83.5	0
2	1	05.26	7.35	91	0
3	2	11.76	9.35	79.5	0
4	3	21.95	14.55	76.5	41.2
5	4	27.58	11.4	89	0.0
6	5	17.14	15.5	70	9.2
7	6	25.58	15.95	76	39.1
8	7	22.72	15.55	76	59.6
9	8	29.31	16.75	74	24.2
10	9	54.38	21.25	70.5	0
11	10	41.81	21.25	68	0
12	11	58.13	20.85	66	13.4
13	12	27.02	22.7	65.5	0
Mean		27.21	15.67	75.80	16.97
Standard deviation (S.D.)		15.92	4.92	8.21	20.30

Table 3: Regression analysis

Dependant variable	Independent variables	F-value (at 5% level of significance)	R^2 value
Weekly percent parasitization	Temperature, RH and Rainfall	6.482*	0.684
	Temperature	19.920*	0.644
	RH	8.063*	0.423
	Rainfall	0.226	0.205

* Sig @ 0.05

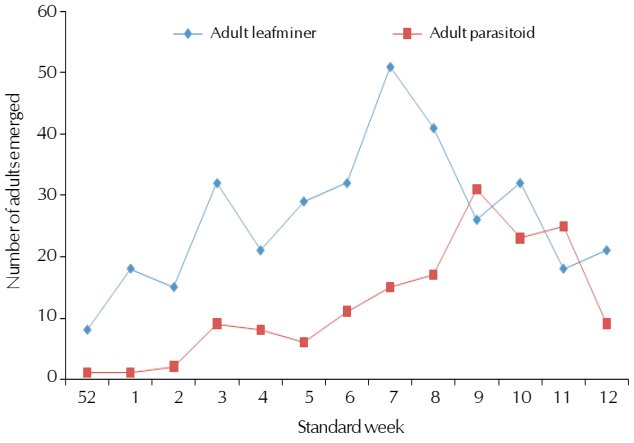

Figure 1: Weekly population of the leafminer and its parasitoid on pea crop

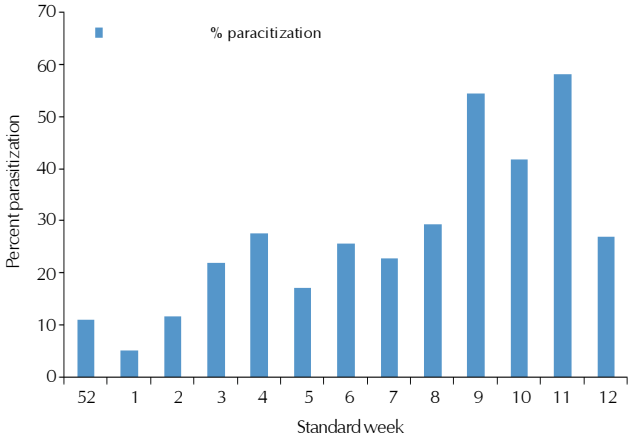

Figure 2: Weekly percent field parasitization on leafminer, *C. horticola*

isaea, D. minoeus and *Chrysocharis pentheus*, comprising 90% of the total number caught. Yefremova *et al.* (2015) reared sixteen species of Eulophidae from *Chromatomyia horticola* (Goureau) collected from 14 host plants in Russia. Two parasitic species, *D. isaea* (Walker) and *P. metallicus* (Nees), were dominant. Bhat and Bhagat (2009) reported 7 hymenopteran parasitoids of *C. horticola* in Kashmir *viz.*, 5 eulophids (*Chrysocharis horticola* Mani, *Diglyphus horticola* Khan, *Diglyphus* sp., *Pediobius indicus* Khan and *Euderus agromyzae*) and 2 braconids (*Opius* sp. and *Dacnusa* sp.). Furthermore in Kashmir, *Diglyphus* spp. were found actively associated with *Chromatomyia horticola* (Goureau) infesting brown mustard (*Brassica campestris*) and extend of parasitism ranged from 4.14 to 97.26% (mean = 38.47 ± 40.7) (Ahmad *et al.*, 2010). Gratton and Welter (2001) recorded 74% of parasitization by two eulophids, *Diglyphus spp.* and *Neochrysocharis arizonensis* together on leaf miners, *Liriomyza helianthi* Spencer and *Calycomyza platyptera* (Thomson).

Since *Chromatomyia horticola* is a major pest of pea crop at Pantnagar and difficult to control due to its hidden infestation and destruction of natural enemies by harmful pesticides. Therefore, there is a need to understand the natural enemy complex of this pest to promote natural biological control as well as to avoid the use of harmful pesticides in pea ecosystem at the time when they are actively involved in reducing the population of this pest. The present study helps the pea growers by providing information on parasitoid complex of this pest and their peak activities during the cropping season. So that

farmers can make suitable decisions of conservation of hymenopteran parasitoids by adopting selective chemicals or the use of other non-chemical methods and minimize the infestation of this pest.

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