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Population fluctuation of black cutworm, *Agrotis ipsilon* (Hufnagel) in chickpea

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Abstract
The population trend of black cutworm, *Agrotis ipsilon* (Hufnagel) and its larval parasitoid, *Blepharella lateralis* Macquart in chickpea was studied at Regional Agricultural Research Station (RARS), Shillongani, Assam during *rabi*, 2018-19 and 2019-20. Larval population of *A. ipsilon* first appeared in the fourth week of November, 2018and second week of December, 2019. The population showed a steady increase and reached a peak (13.80 no. of larvae/sqm and 8.80 no. of larvae/sqm) in third week of January in 2019 and fourth week of January in 2020, respectively. Later it showed a declining trend till harvest. The activity of *B. lateralis* commenced from the third week of December in 2018 and second week of December in 2019 and continued till the early part of March in both the cropping seasons. The extent of natural parasitism by *B. lateralis* varied from 2.10-31.20 percent in 2018-19 and 1.20-26.30 percent in 2019-20. Maximum parasitism (31.20 and 26.30 percent) occurred during the fourth week of January in both the study years. The parasitism increased with the increase in population of *A. ipsilon* larvae and fairly synchronized with the latter's maximum population. Significant positive correlation was evident between the host population and the parasitism by *B. lateralis*. Multiple regression analysis also revealed that *A. ipsilon* population was influenced by *B. lateralis*. Among the abiotic factors, maximum temperature showed significant negative correlations with the host population. Multiple regression analysis of various abiotic factors with the population of *A. ipsilon* showed 74.0-83.0 percent relationship with the cutworm population.

Keywords: *Agrotis ipsilon*, *Blepharella lateralis*, parasitoid, population fluctuation

Introduction
Black cutworm, *Agrotis ipsilon* (Hufnagel) is a polyphagous and cosmopolitan pest attacking large number of crops world-wide including India (Ram *et al*., 2001) [10]. In Assam, it is a cold weathered pest and pauses a threat to various *rabi* crops like pulses, oil-seeds, vegetables, wheat etc. grown in flood affected areas, mostly in areas submerged under water in the previous *kharif* season. The larvae of the pest are nocturnal in nature and cut the young plants at the ground level and cause severe reduction in plant population (Bhattacharyya *et al*., 2014) [5]. Chickpea is considered to be the most preferable pulse crop for black cutworm and it may cause about 70-80 percent crop damage under congenial conditions (Borah and Sarma, 2005; Anon., 2014) [3, 2]. According to Borah *et al*. (2011) [4], *A. ipsilon* multiplies actively from January to February, though its activity starts from the early part of December and continues up to March in Assam. A group of parasitoids of this pest has been reported (Mandal and Yadav, 1978; Das and Ram, 1988 and Patel *et al*., 1991) [8, 6, 9]. A techinid fly, *Blepharella lateralis* Macquart (Diptera: Techinidae) was recorded as a potential larval parasitoid on black cutworm larvae causing overall parasitism as high as 21 percent under natural conditions (Anon., 2014) [2]. The same parasitoid was also reported as a potential larval parasitoid of Bihar hairy caterpillar, *Spilosoma oblique* Walker on jute in Assam (Sarma and Borah, 2004) [11]. Black cutworm, *A. ipsilon* is a major constraint in chickpea cultivation in Assam and other north-eastern states of India but no adequate information is available on seasonal incidence in relation to biotic and abiotic factors. The present study was undertaken to elicit more information on these aspects in chickpea ecosystem of Assam.

Materials and Methods
Field experiments were conducted on chickpea (Variety: DCP-92-03) crop (sown on 9th November, 2018 and 27th November, 2019) at the experimental farm of Regional Agricultural Research Station (RARS), Shillongani, Nagaon, Assam during *rabi* 2018-19 and 2019-20.

A plot of 500 sqm was selected under black cutworm hot spot area in both the seasons for the field observations. The crop was grown following the agronomical practices recommended for Assam (Anon., 2009) [1]. No pesticide was applied to the crop during the entire period of observations.

The larval population of *A. ipsilon* was observed at weekly interval from one week after sowing in both the cropping seasons. Five quadrat samples (1sqm each) were selected randomly from different parts of the field in each sampling date for the study. All the cutworm infested plants and the soils in each quadrat were inspected mechanically for direct counting of larvae as they may remain curled near the base of plants or just a few inches deep in the soil. At the time of sampling of *A. ipsilon* population, 5-25 larvae (depending upon the density of the larvae) were collected on every sampling day to determine the level of parasitism. The larvae so collected at each sampling date were brought to the laboratory and reared on potato cut pieces in groups of ten in ventilated transparent plastic boxes (20x10x8 cm) until the emergence of either parasitoid or adults of *A. ipsilon*.

The data recorded on percent parasitism were correlated with host population. Daily records of meteorological parameters such as maximum and minimum temperature, average relative humidity, total rainfall and sunshine hours were noted. Simple correlations of *A. ipsilon* population with weekly averages of maximum and minimum temperature, relative humidity, sunshine hours as well as with weekly total rainfall were worked out. The data were again subjected to multiple regression analysis as per Gomez and Gomez (1983) [7] to know the impact of independent variables on the dependent variable and to assess the combined effect of various independent variables on the dependent variable.

Results and Discussion

The data on weekly larval population of *A. ipsilon* and its parasitoid, *Blepharella lateralis* Macquart during 2018-19 and 2019-20 are presented in Figure1. The larval population of *A. ipsilon* was first observed in the fourth week of November, 2018 and second week of December, 2019. The population was initially low during both the cropping seasons. However, the population increased abruptly within the next week and by the first week of January, 4.80 and 3.40 no. of larvae/sqm was registered in 2018-19 and 2019-20, respectively. The population continued to be high and had an accelerating phase followed by a declining phase. The accelerating phase operated from the first to third week of January, 2018-19and first to fourth week of January, 2019-20 during which there was a rapid increase (4.80 to 13.80 and 3.40 to 8.80 no. of larvae/sqmin 2018-19 and 2019-20, respectively) in the level of population. After reaching the peak, the level of population declined slightly and the declining phase continued with a little fluctuation till the end of March, 2018-19 and the middle of March, 2019-20. The declining phase of the larval population might be due to the rise in temperature from February onwards, which is similar to earlier observations of Ram *et al*., 2001 [10] and Anon., 2014 [2]. Moreover, the chickpea crop became less preferable to the black cutworm from February onwards due to approaching reproductive stage of the crop. This finding is in consonance with that of Sidhu *et al*. (2017) [12] who observed similar nature of *A. ipsilon* and *A. segetum*.

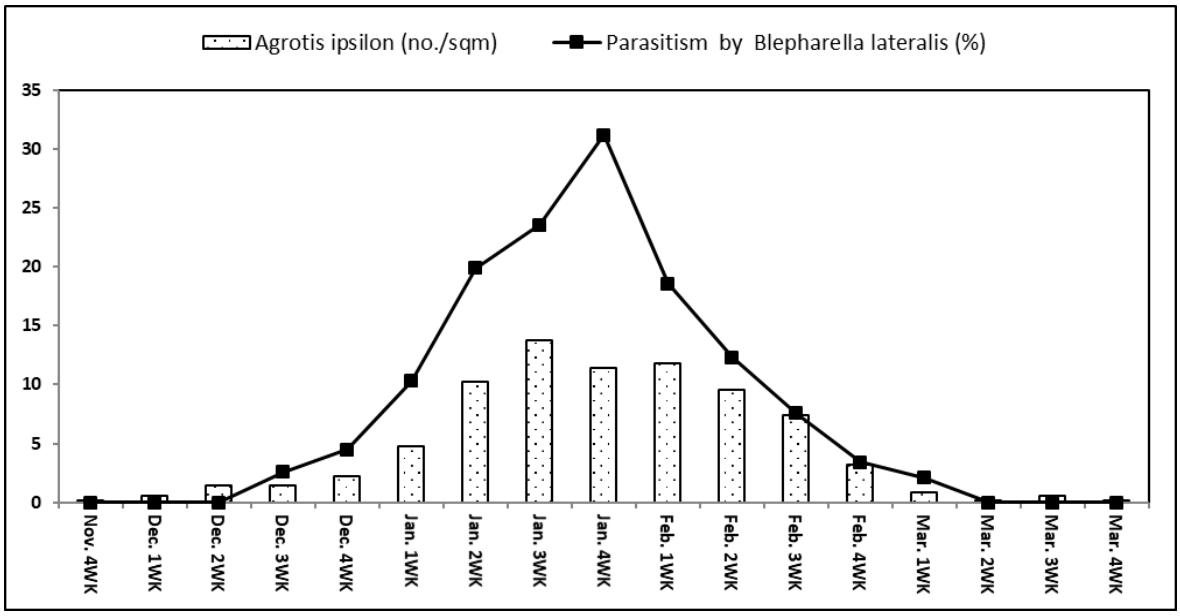
Larval parasitism by *B. lateralis* was first recorded after the appearance of its host from the third week of December, 2018 and fourth week of December, 2019. The parasitoid activity was 2.60 percent and 1.20 percent when the larval density of *A. ipsilon* was 1.40 larvae/sqm and 1.80 larvae/sqm in 2018-19 and 2019-20, respectively. The initial parasitism level was low in both the years, but increased gradually from January to attain maximum parasitism during fourth week of January, 2019 and 2020 (31.2 and 26.3 percent) respectively. The corresponding host larval population density was 11.40 larvae/sqm and 8.80 larvae/sqm in 2019 and 2020, respectively. Thereafter, the extent of parasitism gradually declined and reached 2.10 percent and 1.70 percent corresponding to the host larval population of 0.80 larvae/sqm and 1.20 larvae/sqmduring the first week of March, 2019 and the fourth week of February, 2020. The activity of the parasitoid ceased by the early part of March in both the years, possibly due to low larval population. *B. lateralis* was also reported asa potential parasitoid of *Spilosoma obliqua* Walker in jute crop by Sarma and Borah (2004) [11], where 40.27 percent parasitism was reported. A similar trend was obtained in earlier observation (Anon., 2014) [2] where the range of parasitism by *B. lateralis* on *A. ipsilon* larvae was 4.60 -21.59 percent as reported.

The extent of parasitism by *B. lateralis* showed significant positive correlations (r= 0.753** in 2018-19 and r= 0.881** in 2019-20, P=0.01) with the host population. Influence of *B. lateralis* on the host population was established by regression equations, $Y= -2.93 + 0.82X$; $R^2= 0.825$ in 2018-19; $Y= -1.89 + 0.71X$; $R^2= 0.736$ in 2019-20 (Table-1).Simple correlation analysis between the larval population of *A. ipsilon* and abiotic factors revealed a significant negative relationship with maximum temperature in the first cropping season (2018-19) while in the second cropping season (2019-20), significant negative relationship was observed with maximum temperature and minimum temperature (Table-1). The multiple regression analyses ($Y= -223.69 + 3.92X_1 + 5.40X_2 + 0.29X_3 - 0.61X_4 + 0.38X_5$; $R^2= 0.636$ in 2018-19 and $Y= -169.69 + 2.48X_1 + 3.84X_2 + 0.16X_3 - 0.08X_4 + 0.26X_5$; $R^2=0.582$ in 2019-20). Revealed that 63.60 and 68.20 percent variations in population (Y) of *A. ipsilon* were influenced by the combined effect of abiotic factors in 2018-19 and in 2019-20, respectively.

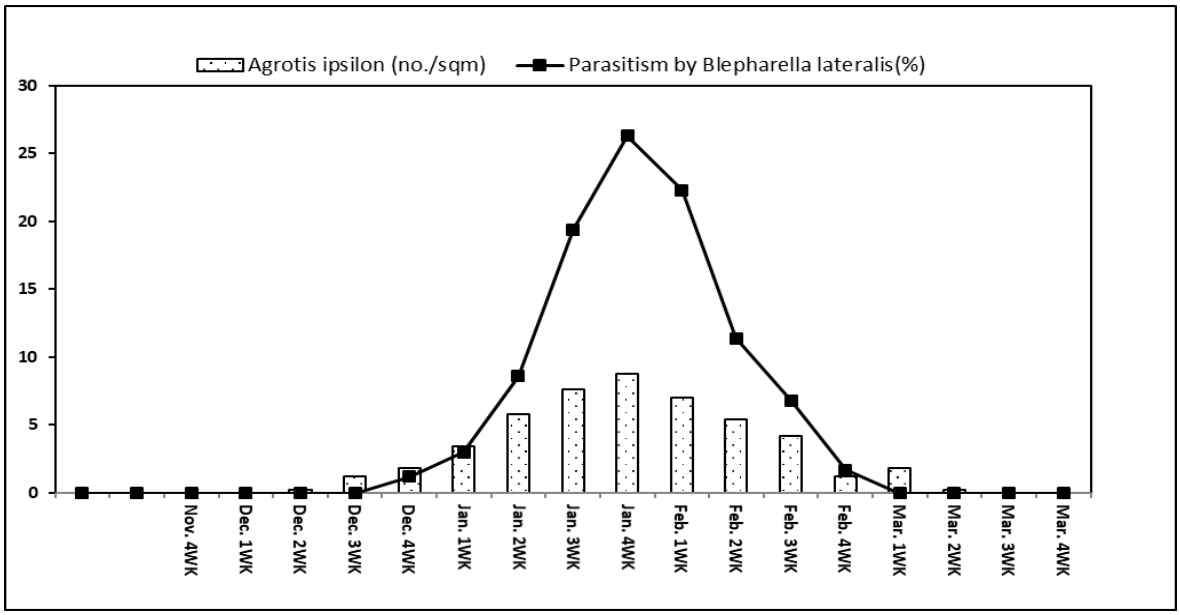
Table 1: Correlation and multiple regressions between *A. ipsilon* and its parasitoid, *B. lateralis*, and abiotic factors

Correlation particulars	**Correlation co-efficients (r)**	
	2018-19	**2019-20**
***A. ipsilon* vs Parasitism by *B. lateralis* (X)**	0.753**	0.881**
Regression equation: 2018-19	$Y= -2.93 + 0.82X$; $R^2= 0.825$	
Regression equation: 2019-20	$Y= -1.89 + 0.71X$; $R^2= 0.736$	
Correlation particulars	Correlation co-efficients (r)	
A. ipsilon vs	2018-19	2019-20
Max. temperature (X_1)	-0.508*	-0.412NS
Min. temperature (X_2)	-0.614*	-0.540*
Average relative humidity (X_3)	0.018NS	0.086NS
Total rainfall (X_4)	0.231NS	-0.074NS
Sunshine (X_5)	0.106NS	0.262NS
Regression equation: 2018-19	$Y= -223.69 + 3.92X_1 + 5.40X_2 + 0.29X_3 - 0.61X_4 + 0.38X_5$; $R^2= 0.636$	
Regression equation: 2019-20	$Y= -169.69 + 2.48X_1 + 3.84X_2 + 0.16X_3 - 0.08X_4 + 0.26X_5$; $R^2=0.682$	

*Significant at 5% **Significant at 1% NS= Non-Significant



2018-19



2019-20

Fig 1: Parasitism of *A. ipsilon* by *B. lateralis* during 2018-19 and 2019-20

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