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Population dynamics and natural enemy fauna associated with maize stem borer *Chilo partellus* in temperate conditions of Kashmir

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Abstract
A survey on the occurrence of natural enemies of Maize stem borer (*Chilo partellus* (Swinhoe) revealed the occurrence of four natural enemies: two predators (*Ctenus himalayensis, Mantis religiosa*) and two parasitoids (*Cotesia flavipes, Trichogramma chilonis*), parasitizing the maize stem borer, *Chilo partellus* (Swinhoe). The Maximums temperature and sunshine hours had a significant and positive effect on natural enemy population while rainfall had a significant and negative effect on them. Both the predators and parasitoids were active throughout the season. The preservation and augmentation of these natural enemies is very important in controlling the maize stem borer in the area. Further the tritropic interation of crop and pest needs to be validated in order to get more insight for pest control in the area.

Keywords: Maize stem borer, natural enemies, abiotic factors & preservation

Introduction
Maize (*Zea mays* L.) or corn belonging to family Graminae, is the third most important cereal crop of the world after wheat and rice. It is a major source of human food in developing countries and supplies more than 5 per cent of our dietary energy. Besides serving as human food and livestock feed, maize has its wider applications in milling industries for starch and oil extraction. It is grown in more than 160 countries all over the world, except Antarctica, out of which USA, China, Brazil, France and India are the major producers. In Kashmir valley, maize is usually cultivated at high altitude terrains and plains under rainfed conditions. The huge gap between attained and attainable yield under Kashmir conditions can be attributed to various biotic stresses. About 15.6 per cent of loss in yield due to biotic stress is caused by insect pests alone (Dhaliwal and Arora 2006) [2]. Maize is attacked by 140 different insect species with their different level of damage percentage. Out of 140 species of insect pests only 12 species are the serious pests of maize causing damage from sowing to the harvesting and also in the storage conditions (Siddiqui and Marwaha, 1993) [9]. Among these pests, *Chilo partellus* is one of the most dangerous pests and causes tremendous damage to maize crop (Kavita *et al*., 2016; Yonow *et al*., 2017) [6, 10]. To manage the pest we are having different methods but biological control has always considered a prominent tool among the pest management. Lepidoptera (Crambidae, Pyralidae, Noctuidae) stem borers are the most damaging group of insect pests attacking maize and due to their economic importance they have been the subject of extensive research. Biological control agents of maize stem borer not only lower the use of pesticides but also help in improving yield. Both predators and parasitoids have been found to be highly successful against *Chilo partellus*. Keeping in view the economic importance of predators and parasitoids, the present study was designed to assess the occurrence of natural enemies associated with maize stem borer *Chilo partellus* in temperate conditions of Kashmir, district Kupwara during Kharif 2019.

Materials and Methods
Survey was carried out to know the natural enemies complex prevailing in maize ecosystem in district Kupwara during Kharif 2019. Natural enemies associated with maize stem borer *Chilo partellus* were collected from the selected locations of district Kupwara on weekly basis by using the insect net, aspirator and sticky traps.

To determine the effects of various weather parameters on population of natural enemies of maize stem borer *Chilo partellus*, the later were correlated with weather parameters *viz.*, maximum temperature, Minimum temperature, relative humidity at morning, relative humidity at evening, total rainfall and sunshine hours. The periodicities of observations at weekly intervals were planned as per the standard weeks during the entire crop season. The data generated was subjected to standard statistical procedure as per Gomez and Gomez (1984) [11].

Results and Discussion

A survey was carried out during 2019 in district Kupwara revealed the occurrence of four natural enemies, two predators and two parasitoids associated with maize stem borer (*Chilo partellus*) which is presented in Table 1. The predators belong to orders Araneae and Mantodea while both the parasitoids belong to the order Hymenoptera.

Population dynamics of predators associated with maize stem borer

The persual of data on natural enemy population indicated absence of spider during 24th standard week and its population started increasing from 26th standard week (0.25) and reached its peak (1.15) during 36th standard week. However, from 38th standard week, the population started declining (0.35) and was minimum in 40th standard week (0.1).The data obtained on abundance of spiders in terms of average number per plant indicated a clear peak during 36th standard week. The persual of data indicated absences of praying mantis during 24th and 26th standard week and its population started increasing from 28th standard week (0.4) and reached its peak during 36th standard week (1.1). However, from 38th standard week, the population started declining (1.05) and was minimum in 40th standard week (0.25). The data obtained on abundance of the praying mantis in terms of average number of praying mantis per plant indicated a clear peak during 36th standard week. Present results are in agreement with those of Patra *et al*. (2013) [8] who reported natural enemies of maize which included seven coccinellid beetles, two predatory bugs and thirteen spider species.

Population dynamics of parasitoids associated with maize stem borer

The data found on the natural enemy populations is given in Table 2 indicated prescence of *Cotesia flavipes* from 24th standard week (0.03) and its population started increasing from 26th standard week (0.06) and reached its peak during 36th standard week (0.60). However, from 38th standard week (0.20), the population started declining and was minimum in 40th standard week (0.06). The data obtained on abundance of *Cotesia flavipes* in terms of average number per plant indicated a clear peak during 36th standard week. The observed data on parastoids indicated the precence of *Trichogramma chilonis* from 26th standard week (0.10) and its population started increasing from 28th standard week (0.13) and reached its peak during 36th standard week (0.70). However, from 38th standard week (0.16), the population started declining and was minimum in 40th standard week (0.3). The data obtained on abundance of *Trichogramma chilonis* in terms of average number per plant indicated a clear peak during 36th standard week. Present results are in agreement with Divya *et al.* (2009) [3] who reported larval parasitoid, *Cotesia* spp. is very active in Kharif season. Parasitisation by *Cotesia flavipes* on maize stem borer has also been reported by Krishnamurti and Usman (1954) [5] and Chaudhari and Sharma (1987) [1]. Neupane *et al*. (1985) [12] also reported *Trichogramma chilonis* to be the most important egg parasitoid of maize stem borer (*Chilo partellus*).

Correlation of predators of maize stem borer *(Chilo partellus)* with important weather parameters

The persual of data revealed that correlations drawn between important weather parameters with respective number of predators *viz;* spider and praying mantis had a significant and positive correlation with maximum temperature (0.60 and 0.81) a non-significant and positive correlation (0.52 and 0.22) with minimum temperature. Similarly, they showed a non-significant and negative correlation (-0.34 and -0.56) with relative humidity (morning) and a non-significant and positive correlation (0.24 and 0.26) with relative humidity (evening).Both the predators showed a significant and negative correlation (-0.14 and -0.04) with total rainfall and a significant and positive correlation (0.19 and 0.51) with sunshine hours from all selected locations of district Kupwara. Present results are in line with Hakim *et al*. (2012) [4] who reported that the predator populations were positively correlated with temperature and relative humidity.

Correlation of parasitoids of maize stem borer *(Chilo partellus)* with important weather parameters

The persual of data showed correlations drawn between important weather parameters with respective number of parasitoids per plant, *viz; Cotesia flavipes* and *Trichogramma chlions* Parasitization had a significant and positive correlation with maximum temperature (0.38 and 0.66) a non-significant and positive correlation (0.32 and 0.42) with minimum temperature. Similarly, they showed a significant and negative correlation (-0.42 and -0.40) with relative humidity (morning) and a non-significant and positive correlation (0.44 and 0.21) with relative humidity (evening). Both the parasitoids showed a significant and negative correlation (-0.29 and -0.37) with total rainfall and a significant and positive correlation (0.77 and 0.27) with sunshine hours from all selected location of district Kupwara. Our study is more or less in close conformity with Mailafiya *et al*. (2010) [7] who found rainfall and relative humidity (morning) have a negative correlation with parasitization process of egg and larval parastoids.

Table 1: Occurrence of natural enemies against maize stem borer (*Chilo partellus)*

S. No	Common name	Scientific name	Order	Family
1	Spider	*Ctenus himalayensis*	Araneae	Ctenidae
2	Praying mantis	*Mantis religiosa*	Mantodea	Mantidae
3	Parasitic wasp	*Cotesia flavipes*	Hymenoptera	Braconidae
4	Parasitic wasp(Egg parasitoid)	*Trichogramma chilonis*	Hymenoptera	Trichogrammatidae

Table 2: Population dynamics of natural enemies associated with maize stem borer *Chilo partellus* in district Kupwara

Standard meteorological week	Temperature (ºC)		Rainfall (mm)	Relative Humidity (%)		*Ctenus himalayensis* per plant (No.)	*Mantis religiosa* per plant (No.)	Catches per sweep of *Cotesia flavipes* (No.)	Catches per sweep of *Trichogramma chilonis* (No.)
	Maximum	Minimum		Morning	Evening				
24	26.06	9.57	6.07	82.57	52.14	0.00	0.00	0.03	0.00
26	28.56	10.89	1.93	84.50	50.43	0.25	0.00	0.06	0.10
28	31.04	16.14	1.37	82.86	66.29	0.4	0.4	0.16	0.13
30	28.66	17.84	7.00	85.43	71.29	0.65	0.55	0.30	0.26
32	33.34	17.90	3.34	80.00	54.43	0.75	0.75	0.33	0.43
34	29.74	12.93	0.00	83.29	54.57	1.05	0.85	0.40	0.50
36	32.70	15.04	0.00	81.71	44.00	1.15	1.1	0.60	0.70
38	32.14	9.54	0.00	77.29	62.00	0.35	1.05	0.20	0.16
40	28.59	12.90	1.23	83.86	53.43	0.1	0.25	0.6	0.3
Mean + SE						0.50±0.08	0.55±0.09	0.29±0.06	0.25±0.07

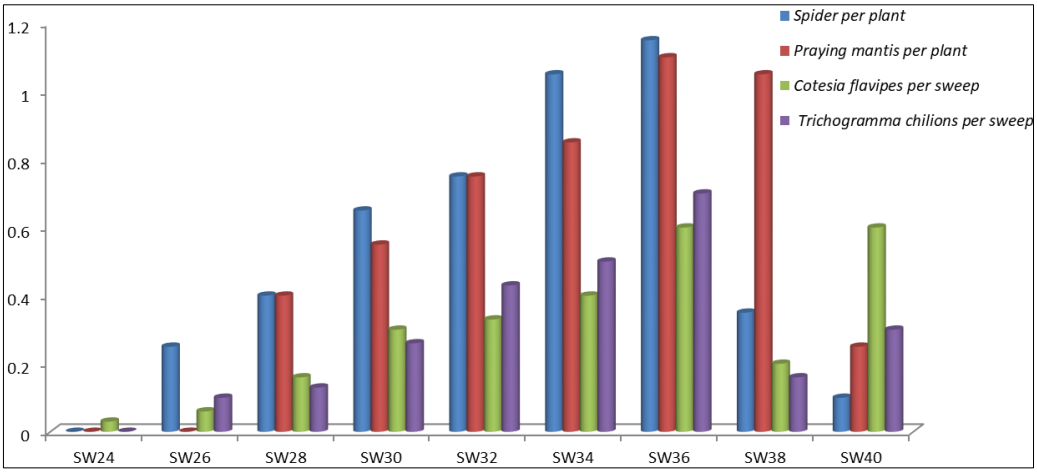

Fig 1: Population dynamics of natural enemies associated with maize stem borer (*Chilo partellus)* in district Kupwara

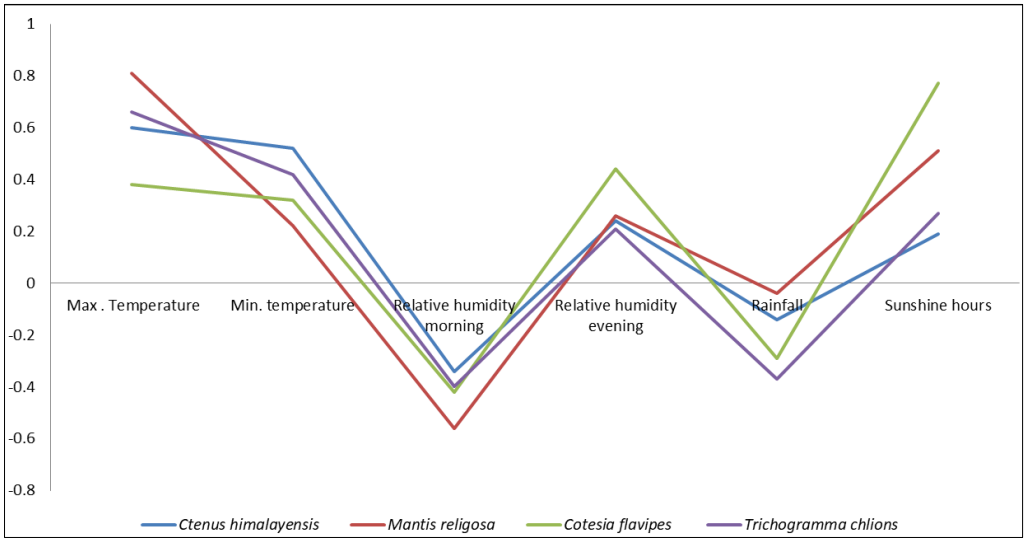

Fig 2: Correlation of natural enemies associated with maize stem borer (*Chilo partellus*) with important weather Parameters

Conclusion

The occurrence of natural enemies in an area are the indications of a healthy ecosystem. The more the natural enemies less is the chances for pest to get resistance against pesticides. The survey in district Kupwara on the abundance and occurrence of natural enemies revealed the presence of spider, preying maints, *Trichogramma chilonis* and *Cotesia flavipes*. The data on the effect of abiotic factors like Maximum temperature and sunshine hours showed a significant and positive effect on natural enemy population while rainfall had a significant and negative effect on them.

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