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Seasonal Parasitization of Larval Parasitoid *Cotesia flavipes* against Sugarcane Stalk Borer

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ABSTRACT: Borers are the major pests of Sugarcane ecosystem which is parasitized by the gregarious parasitoid *Cotesia flavipes*. But the efficiency of *Cotesia flavipes* and the peak parasitization period were not clearly known. So, the present investigations were carried out on Seasonal parasitization of larval parasitoid *Cotesia flavipes* against sugarcane stalk borer at Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University during 2020-2021. To observe the natural parasitization against borer in the sugarcane ecosystem BO 154 variety was planted in 0.5-acre field. The work was mainly focused on gregarious parasitoid *Cotesia flavipes* on stalk borer. *Cotesia flavipes* parasitization on stalk borer started from the second fortnight of June and attained peak parasitization during the second fortnight of September and continued till December first fortnight. Maximum parasitization of 30.6 per cent was observed in the second fortnight of September. *Cotesia flavipes* parasitization significantly correlated with minimum temperature and 14.00 hrs relative humidity.

Keywords: Seasonal parasitization, Sugarcane borer complex, *Cotesia flavipes*, weather parameters.

INTRODUCTION

Cotesia is one of the most diverse genera of the subfamily Microgastrinae (Hymenoptera, Braconidae) with 300 species already described and probably over 1000 species worldwide. *Cotesia flavipes* (Cameron, 1891) is an important gregarious larval endo-parasitoid that attacks a wide range of lepidopteran larvae including sugarcane borers, *viz.*, the shoot borer, *Chilo infuscatellus* Snellen, the internode borer, *Chilo sacchariphagus indicus* (Kapur), the stalk borer, *Chilo auricilius* Dudgeon, the sorghum stemborer, *Chilo partellus* Swinhoe, the Plassey borer, *Chilo tumidicostalis* Hampson, the Gurdaspur borer, *Acigona steniellus* (Hampson), all belonging to the order Lepidoptera, family Crambidae; it also attacks the pink borer, *Sesamia inferens* Walker and *Sesamia uniformis* Dudgeon (Lepidoptera: Noctuidae), and the top borer *Scirpophaga excerptalis* Walker (Lepidoptera: Pyralidae) (Subramaniam, 1939; Bhatnagar, 1948; Krishnamurti and Usman 1954; Khanna *et al*., 1957; Butani, 1958; Sastry and Appanna 1958; Butani, 1972). In India, it is widely distributed over various regions and found parasitizing different sugarcane borers (David and Eshwarmoorthy, 1986) and *Chilo partellus* (Kishore, 1986; Mohan *et al.*, 1991) with parasitization ranging from 4.0 to 21.6 per cent. *Cotesia flavipes* plays a major role in the sugarcane ecosystem against all sugarcane borers except root borer in India. The highest level of parasitism of *Cotesia flavipes* is observed on *Chilo partellus* Swinhoe (Srikanth *et al*. 1999) with up to 17.9 per cent followed by *Chilo sacchariphagus indicus* Kapur 8.3 per cent and *Chilo infuscatellus* Snellen with 1.1 per cent of parasitization at Coimbatore. Whereas in case of top borer, and internode borer, the population of *Cotesia flavipes* was observed for about 3 years continuously and in case of Plassey borer, the per cent parasitization of *Cotesia flavipes* was observed to be ranging from 1.50 to 9.12 per cent and 1.30 to 8.42 per cent respectively (Deka and Sharma 2005). However, natural parasitism studies have been mainly done on *Chilo partellus* and *Chilo infuscatellus*, especially from northern India. So far not much systematic studies have been conducted to monitor the seasonal fluctuations of the parasitoid on sugarcane stalk borer, *Chilo auricilius* Dudgeon, a pest of sugarcane in peninsular India (David and Nandagopal 1986). Hence this work is taken up in this experiment to study about the seasonal fluctuations in per cent parasitization of *Cotesia flavipes* on sugarcane stalk borer, *Chilo auricilius* Dudgeon.

MATERIALS AND METHODS

The Experimental site is located at the bank of the Burhi Gandak river, a tributary of the river Ganga which flows throughout the year and becomes a major source of irrigation. It is situated at an altitude of 53 meter from mean sea level, 25°98′N latitude, and 85°64′E longitude. The climate of this region is semi-humid and subtropical region. Pusa receives a yearly average rainfall of 1021.42 mm, and almost 80 per cent

of rainfall during the monsoon season which stretches from June 15 to September 15. However, July (27th and 37th SMWs) receives the most rainfall rest of the shower received at winter monsoon extends from 15th December to 15th February (Anonymous, 2011). To observe the natural parasitization against borer in sugarcane ecosystem BO 154 variety was planted at 0.5-acre field. Mainly focused on gregarious parasitoid *Cotesia flavipes* on top borer, stalk borer and plassey borer.

Different life stages of pest like eggs, larvae, pupae were collected from the field at fortnightly interval to observe parasitization of natural enemies. Eggs were found on lower side of the leaves were collected without disturbance and observed in laboratory. Larvae and pupae were found inside the affected canes were collected from the field and observed in the laboratory. Parasitoid pupae also collected from infested canes and reared in laboratory. Larvae were reared on the piece of sugarcane stalk whereas eggs and pupae were kept in petri dish until the emergence of parasitoid. Regular observations were taken, number of larvae collected, number of larvae infected and number of parasitoids emerged were noted down. Parasitization percentage was calculated for each susceptible stage of the borer by using the following formula (Puneeth *et al*., 2014).

Parasitization percentage (%)

$$= \frac{\text{Number of parasitized eggs/larvae/pupae}}{\text{Total Number of eggs/larvae/pupae}} \times 100$$

Fig. 1. Field view.

Fig. 2. *Cotesia* pupae.

Fig. 3 & 4. Microscopic view of *Cotesia.*

RESULTS AND DISCUSSION

Seasonal parasitization of *Cotesia flavipes* against stalk borer was recorded from May to December at the fortnightly intervals. Stalk borer incidence and *Cotesia flavipes* parasitization correlated with weather parameters are presented in the Table 1. Stalk borer incidence ranged from 1.3 to 10.8 % and its peak incidence 10.8% recorded in the month of August. Gregarious parasitoid *Cotesia flavipes* parasitization on Stalk borer ranged from 0.45 to 20.89% started from the first fortnight of June month and reached its peak parasitization at the second fortnight of September. After that *Cotesia flavipes* parasitization percentage started to decline. At the time of *Cotesia flavipes* peak parasitization on stalk borer, corresponding weather parameters, *i.e.*, maximum temperature 31.6ºC and minimum temperature 25.63ºC with 92.33 RH at 07.00 hrs and 85.66 percentage at 14.00 hrs and 17.6 mm rainfall was recorded. Seasonal parasitization on stalk borer by *Cotesia flavipes* fluctuates rapidly and its pictorial representation was shown in Fig. 2. The values of correlation coefficients of weather parameters with sugarcane borers and *Cotesia flavipes* parasitization was depicted in the Table 2. Stalk borer incidence is positively correlated with maximum temperature, minimum temperature, 14.00 hrs relative humidity and rainfall. *Cotesia flavipes* parasitization on stalk borer is positively correlated with minimum temperature and 14.00 hrs relative humidity. Multiple linear regression equations and R^2values were made and depicted in the Table 3.

Borer incidence and natural parasitization depends on phenology of sugarcane, nature of borer and weather parameters (Khan *et al*., 2013). The incidence of stalk borer started from May and very active during July to September and peak incidence observed at August second week after that decreasing incidence trend observed (Fig. 6). Population of stalk borer favoured by maximum temperature, minimum temperature, 14.00 hrs relative humidity and rainfall. Present results regarding stalk borer were accordance with Hari *et al.* (2011). Incidence and infestation of sugarcane borers started declining because in this time they went under hibernation so, they cannot move to next phase of their life stage (Nath *et al.*, 2008).

Cotesia flavipes parasitization in sugarcane borers peered by Nagarkatti (1980) in northern part of India which is a very important gregarious parasitoid of sugarcane borers. *Cotesia flavipes* females attracted to cues which is released from borer-infected sugarcanes

(Setamou *et al.*, 2002). Numerous studies have explained the tritrophic interaction between plants, pests, and parasitoids (Buchel *et al.*, 2011). *Cotesia flavipes* parasitization mainly based on the availability of host and also depends on weather parameters (Shankarganesh *et al.*, 2013). Minimum and maximum temperature positively correlated with *Cotesia flavipes* parasitization. Similar results were obtained by Hemchandra and Singh (2008). Relative humidity at 14.00 hrs positively correlated with *Cotesia flavipes* parasitization on sugarcane borers whereas 7.00 hrs relative humidity and rainfall negatively correlated with *Cotesia flavipes* parasitization on sugarcane borers. These results were accordance with Kumar *et al.* (2017). Maximum parasitization of *Cotesia flavipes* observed in the month of September, this also accepted by Nath and Saikia (2018). Similar results of *Cotesia flavipes* parasitization on top borer found by Kumar *et al*. (2017), on stalk borer found by Tomar (2004) and on plassey borer found by Nath and Saikia (2018). Natural parasitization plays a major role in pest control and it significantly reduces the incidence of borers (Alam 1980). Combination of natural enemies like *Trichogramma* sp., *Isotima* sp. and *Cotesia* sp. also led to fabulous result in pest control (Parra and Zucchi 2004; Behera and Mishra 2020).

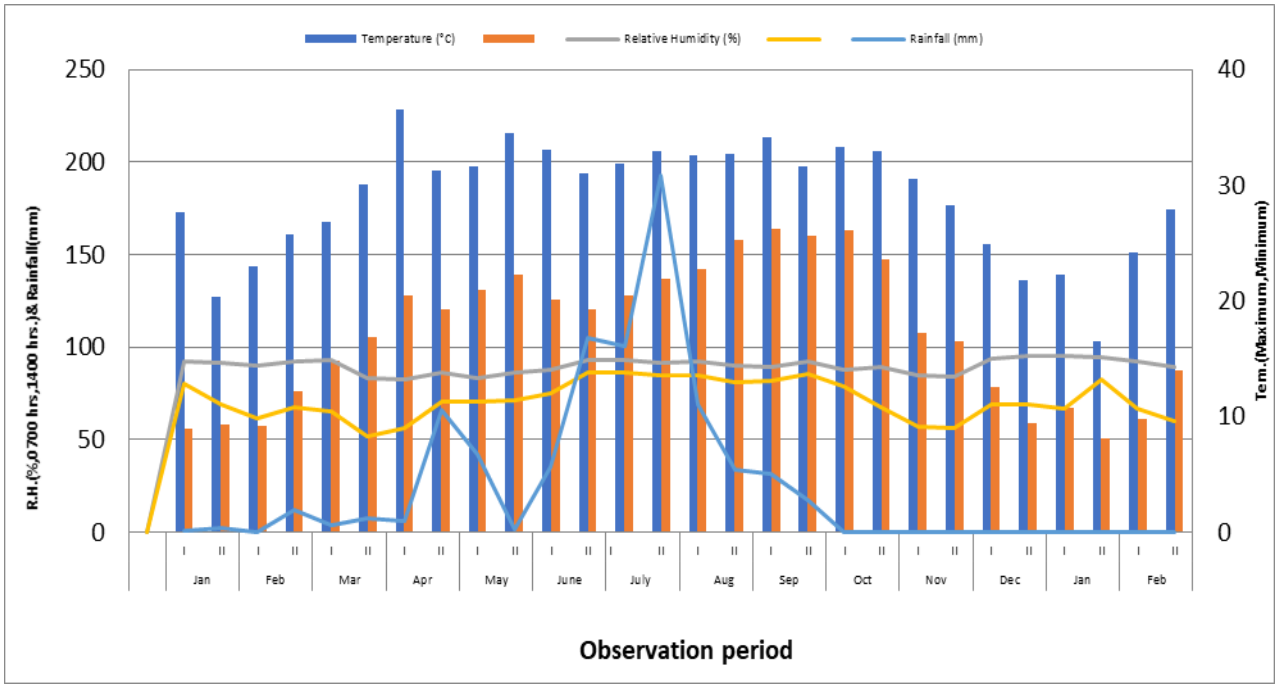

Fig. 5. Meteorological observation during the investigation period 2020-2021 at Pusa.

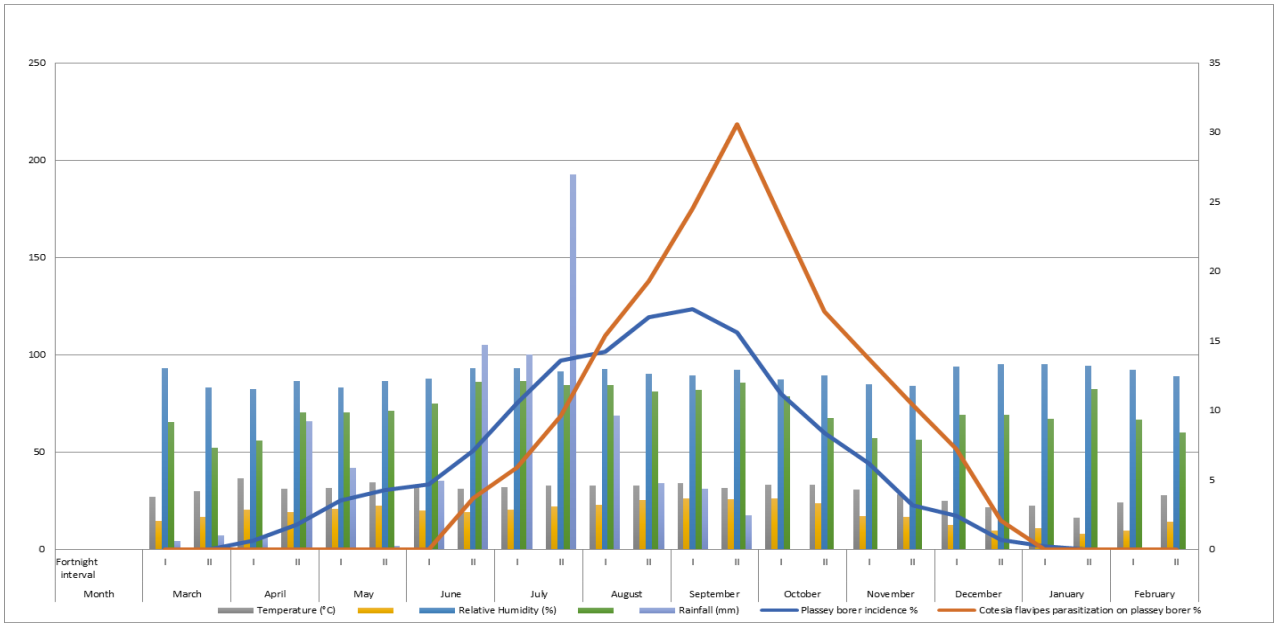

Fig. 6. Seasonal parasitization of *Cotesia flavipes* Cameron against stalk borer *Chilo auricilius* Dudgeon.

Table 1: Seasonal parasitization of *Cotesia flavipes* Cameron against stalk borer *Chilo auricilius* Dudgeon.

Month	Fortnight interval	Plassey borer incidence %	*Cotesia flavipes* parasitization on plassey borer %	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)
				Max	Min	07.00 hrs	14.00 hrs	
March	I	0	0	26.85	14.8	93	65.5	4.1
	II	0	0	30.03	16.83	83	52	7.13
April	I	0.6	0	36.55	20.5	82.5	56	6.1
	II	1.8	0	31.3	19.25	86.5	70.5	65.8
May	I	3.5	0	31.6	20.9	83	70.5	41.9
	II	4.3	0	34.55	22.3	86.5	71	1.8
June	I	4.7	0	33.13	20.06	87.66	75	35.13
	II	7.1	3.7	31	19.25	93	86	105
July	I	10.5	5.9	31.9	20.45	93	86.5	100.3
	II	13.6	9.6	32.9	21.9	91.5	84.5	192.8
August	I	14.2	15.4	32.65	22.8	92.5	84.5	68.7
	II	16.7	19.3	32.7	25.3	90	81	34
September	I	17.3	24.5	34.1	26.25	89.5	82	31.2
	II	15.6	30.6	31.6	25.63	92.33	85.66	17.6
October	I	11.2	23.8	33.3	26.15	87.5	78.5	0
	II	8.4	17.1	33	23.6	89.5	67.5	0
November	I	6.2	13.7	30.6	17.2	85	57	0
	II	3.2	10.4	28.3	16.5	84	56.5	0
December	I	2.4	7.2	24.95	12.55	94	69	0
	II	0.7	2.1	21.8	9.46	95	69.33	0
January	I	0.2	0	22.31	10.77	95	67	0
	II	0	0	16.46	8.12	94.18	82.31	0
February	I	0	0	24.18	9.8	92.07	66.64	0
	II	0	0	27.89	14	89	60	0

Table 2: Correlation coefficient matrix of weather parameters with sugarcane stalk borer incidence and parasitization.

Parameters	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)
	Max	Min	07.00 hrs	14.00 hrs	
Stalk borer incidence %	0.490*	0.703**	0.229	0.729**	0.546**
Cotesia flavipes parasitization on stalk borer incidence %	0.372	0.678**	0.096	0.474*	0.034

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level

Table 3: Multiple linear regression model for the effect of weather parameters on stalk borer incidence and parasitization.

Parameters	constant	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)	R^2 value	Regression equation
		Max	Min	07.00 hr	14.00hr			
Stalk borer incidence %	-35.9281	-0.1918 (-0.6621)	0.6585 (2.4791)	0.3653 (2.0309)	-0.0056 (0.0612)	0.0186 (1.4266)	0.7933	$Y = -35.9281-0.1918X_1 + 0.6585X_2 + 0.3653X_3-0.0056X_4 + 0.0186X_5$
Cotesia flavipes parasitization on stalk borer incidence %	-34.3367	-1.5364 (-2.8845)	2.4047 (4.9245)	0.6275 (1.8977)	-0.2196 (1.2993)	-0.0147 (0.6127)	0.7961	$Y = -34.3367-1.5364X_1 +2.4047X_2 + 0.6275X_3-0.2196X_4 + -0.0147X_5$

→ Figures in parentheses are "t" value

CONCLUSIONS

Larval parasitoid *Cotesia flavipes* reduced 20 per cent of stalk borer infestation in natural field condition. And the peak parasitization of *Cotesia flavipes* coincided with peak activity of Stalk borer which is the great advantage for better management of pest. In addition to natural population, if release *Cotesia flavipes*, we can control the stalk borer effectively. At the same time, we can significantly reduce the insecticide usage and plant protection cost.

FUTURE SCOPE

Series of Experiments to be taken to check the compatibility of *Cotesia flavipes* with new generation pesticides which helps to identify comparatively safer chemical as a component of sugarcane IPM.

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Conflict of Interest. None.

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