Annals of Agri-Bio Research **27** (2) : 200-203, 2022 **Impact Score : 0.28 (Scopus)**

# Population Dynamics of Major Insect-Pests and Natural Enemies on Maize

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(Received : February 20, 2022; Accepted : March 18, 2022)

**ABSTRACT**

An experiment was conducted at Agriculture Research Farm, Department of Entomology, School of Agriculture, LPU, Punjab during **rabi** season 2020-22. Eggs of *Chilo partellus* were observed throughout the crop period, while *Atherigona soccata* maggot appeared in early stage crop of growth of maize. Both insects caused dead hearts where maximum damage percentage was obtained in 49th SMW by *C. partellus,* whereas in 44th SMW *A. soccata* caused damage during both the years. Natural enemies were present throughout the season and two peaks observed in coccinellids and spider population at 46th and 51st SMW. All physical factors had significant effect on maize stem borer population except temperature which had positive significant impact on *A. soccata.* This research will help to develop prediction model for sustainable maize pest management.

**Key words :** Maize stem borer, maize shoot fly, natural enemies, population dynamics

## INTRODUCTION

Maize (*Zea mays*) is a key cereal crop in India after rice and wheat having wider adaptability in different agro-climatic conditions. The insect-pests are the major biotic constraints in the crop production and their distribution and abundance of insect-pests depends on climatic condition, variety, cropping pattern, soil fertility and others (Soujanya *et al.*, 2019). From sowing to harvest, more than 150 insect-pests species were reported on maize crop (Kumar *et al.*, 2020) which included maize stem borer, *Chilo partellus*, shoot fly, *Atherigona naqvii***,** shoot fly, *Atherigona soccata* (Rond), maize leaf folder, *Marasima trapezalis*, maize aphid, *Rophalosiphum maidis*, fall army worm, *Spodoptera frugiperda,* maize cob borer, *Helicoverpa armigera* and European corn borer, *Ostrinia nutabilalus*. Among these, *C. partellus* Swinhoe (Lepidoptera : Pyralidae) is one of the devastating species and caused grain losses up to 12-95% (Dhaliwal *et al.*, 2018; Soujanya *et al.*, 2019; Singh *et al.*, 2020). The matted, *C. partellus* lays egg in a group on the upper surface of leaf. Initially, neonate larvae scrape off the chlorophyll content of newly emerging leaves and as growing larvae feed on growing stem result in dead heart (Soujanya *et al.*, 2019; Neupane and Subedi, 2019).

Population dynamics of insect-pests is a key parameter for pest management. The population of insects varies in relation to changes in both biotic and abotic environmental conditions. Abiotic factor especially, temperature and relative humidity plays important role in the species development, survival, distribution and abundance (Pandey *et al.*, 2017). To overcome yield losses, farmers depend on chemical methods due to easily available and high knock down effect. The toxic nature of pesticides and indiscriminate use of pollute, develop resistance, declining predator and pollinators and harmful to human health hazards. Thus, keeping the background in mind, population dynamics of stem borer and shoot fly were focused to prepare perdition model for sustainable management.

## MATERIALS AND METHODS

Maize variety (P1844) from Pioneer Seed Company was used for the field experiments in the present studies. The field experiment was conducted at Agriculture Research Farm, Department of Entomology, School of Agriculture, LPU, Punjab during **rabi** season 2020-22. Corn seeds were grown in the first week of October [40st Standard Meteorological Week (SMW)] following the recommended package and practices of Punjab Agricultural University except pesticides application. Crop was cultivated on ridges and furrow planting

method adopted and 60 x 20 cm row and plant to plant spacing. Damaged data were recorded at twice per week from randomly selected 20 plants after 10 days of germination (DAG) till harvesting stage. Dead heart damage percentage was calculated by using following formula :

$$\text{Per cent dead hearts} = \frac{\text{Total damaged plants}}{\text{Total number of plants}} \times 100$$

The meteorological data (temperature, relative humidity, rainfall and wind speed) were obtained from the Department of Agronomy, School of Agriculture, LPU, Punjab for the research period. The necessary analysis was performed in SPSS statistical tool (version 22).

## RESULTS AND DISCUSSION

During the fixed plot survey, total eight insect-pests were recorded during **rabi** season on maize crop at Jalandhar region. Out of these, five pests were observed at different growth stages which caused economic damage to crop (Maize stem borer, *Chilo partellus*; Pink stem borer, *Sesamia inferens*; Shoot fly, *Atherigona orientalis*; Cob borer, *Helicoverpa armigera* and Fall army worm, *Spodoptera frugiperda*) along with four insects considered as natural enemies (Spotted beetle, *Coccinella septempunctata.*, Lacewing, *Chrysoperla carnae,* Wolf spider, *Lynex* species and Rove beetle). Various researchers have reported up to 30 insect-pests causing damage from seedling to harvesting stage in north India (Kumar *et al.*, 2018; Kumar *et al.*, 2020). *Spodoptera frugiperda* observed outbreak in many parts of India during the past few years causing extensive damage (Singh *et al.*, 2020; Deshmukh *et al.*, 2021; Jindal *et al.*, 2021).

The incidence of immature stages like egg and maggots of shootfly appeared after 27th days of germination (DAG). The egg masses of *C. partellus* ranged between 0.10 to 0.20% per plant and 0.05 to 0.18 egg masses per plant during the **rabi** season 2020 and 2021, respectively (Fig. 1). The shoot fly, *A. soccata* maggots ranged from 0.1 to 0.15 (**rabi** 2020) per plant and 0.10 to 0.21 per plant (**rabi** 2021) (Fig. 1). Incidence of *C. partellus* appeared on 44th SMW, while *A. soccata* maggots appeared on 43rd SMW. Both immature population reached maximum at 46th SMW of both the years (Fig. 1). *Chilo partellus* egg masses appeared from 46th SMW showing zigzag pattern. In present work, *A. soccata* preferred succulent of plants for oviposition when appeared in early stage of the crop resulting in dead heart. These findings were supported by Kumar *et al.* (2020) who observed the shoot fly egg incidence in seedling stage of crop during **kharif** reason where temperature exhibited significant negative impact on egg development.

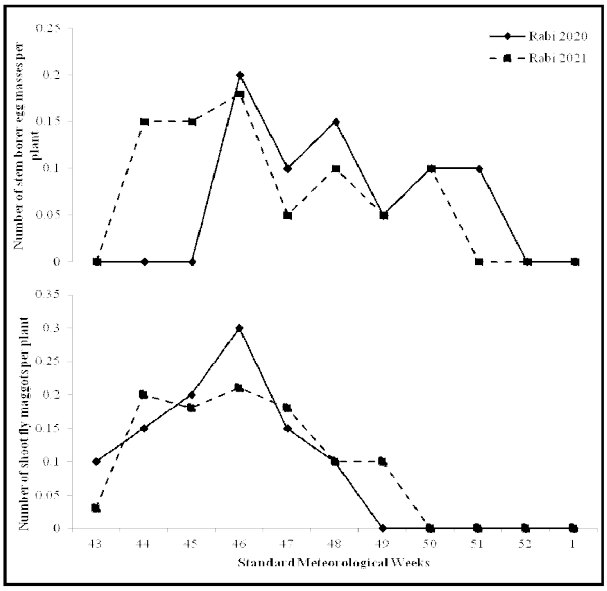


Fig. 1. Seasonal incidence of immature stage of major pests of maize.

Pests, *C. partellus* and *A. soccata* damage started from seedling stage and resulted in dead heart. The dead heart damage ranged from 0.37 to 1.62% and 0.73 to 1.88% by *C. partellus,* while *A. soccata* produced 0.37 to 1.25% and 0.13 to 1.13% during 2020 and 2021, respectively (Fig. 2). Damage gradually increased up to 49th SMW and then fell down continuously (*C. partellus*), while maximum damage of *A. soccata* was reported at 44th SMW during both the years (Fig. 2). The infestation was low in **rabi** reason because of overwintering of larvae in the maize stubbles. The present finding was supported by Singh *et al.* (2020) who reported damage (dead heart and leaf damage) by maize stem borer which gradually increased up to harvesting stage during **kharif** season. It is evident from Fig. 3 that the predator population appeared from the 43rd SMW and remained up to crop harvesting. In coccinellids, two peaks were observed in 46th

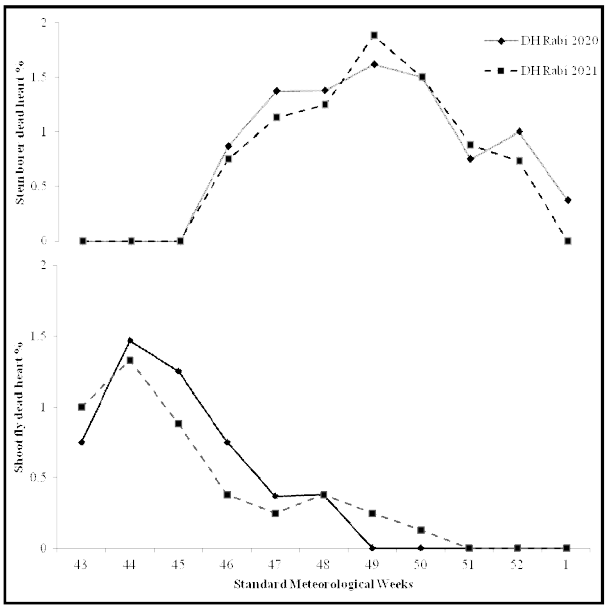


Fig. 2. Incidence of dead heart caused by stem borer and shoot fly on maize.

and 51st SMW during the both the years and same tread was observed in spider population (Fig. 3). The natural enemies like coccinellids and spider were important in the maize ecosystem to check pest population which was observed in present work. However, coccinellids and spiders were observed common natural enemies in the maize crop (Kumar *et al.*, 2020).

The dead heart (r = - 0.532, r = - 0.332 and r = - 0.503) and egg masses (r = - 0.428, r = - 0.506 and r = - 0.365) laid by *C. partellus* were exhibited negative and non-significant, while *A. socatta* observed significant positive relation with maximum and minimum temperature and rainfall during both the years, respectively (Table 1). The present study resulted that the abiotic factor especially temperature influenced larval development of the *C. partellus* and *A. socatta* in **rabi** maize in Punjab. These findings are supported by Dhaliwal *et al.* (2018) and Kumar *et al.* (2020) who stated that the temperature and rainfall had negative impact on maize stem borer population, while relative humidity had positive relation when crop was grown as per the recommended date. A maximum population of egg, larvae, pupa and adult of *C. partellus* was obtained in the month of August, whereas the parasitization by *Cotesia flavipes* gradually increased during the **kharif** season in Haryana (Singh *et al.*, 2020). The research work concluded that the population of *C. partellus* and *A. soccata* was managing crop to avoid extensive grain loss. This population dynamics will help to develop pest models for maize in early stage grower to developed sustainable pest management strategies.

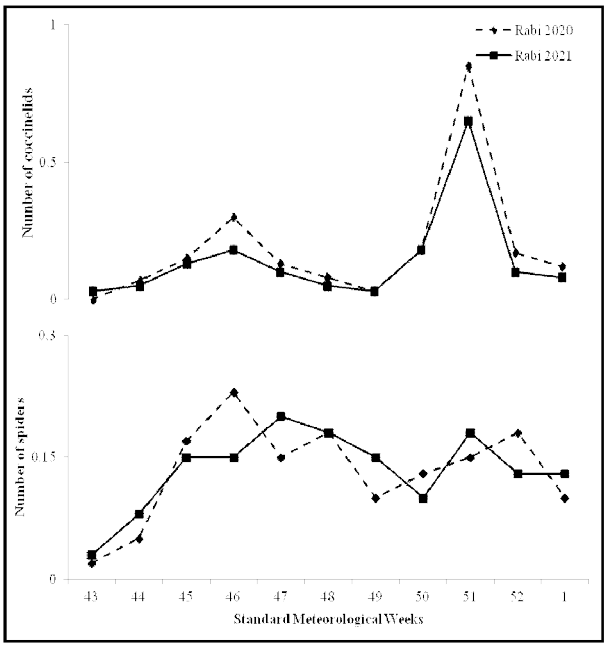


Fig. 3. Incidence of natural enemies on maize.

**Table 1.** Impact of abiotic factors on major pests of maize during **rabi** season

| | 2020 | 2021 | 2020 | 2021 | 2020 | 2021 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| | % DH caused by *C. partellus* | | No. of eggs/plant laid by *C. partellus* | | % DH caused by *A. soccata* | | No. of *A. soccata* maggots/plant | |
| Maximum temperature (°C) | -0.532$^{NS}$ | -0.428$^{NS}$ | -0.023$^{NS}$ | 0.527$^{NS}$ | 0.893** | 0.891** | 0.741** | 0.682* |
| Minimum temperature (°C) | -0.332$^{NS}$ | -0.506$^{NS}$ | 0.034$^{NS}$ | 0.411$^{NS}$ | 0.777** | 0.942** | 0.656* | 0.616* |
| Morning relative humidity (%) | 0.623* | 0.277$^{NS}$ | 0.157$^{NS}$ | -0.595$^{NS}$ | -0.720* | -0.798** | -0.391$^{NS}$ | -0.714* |
| Evening relative humidity (%) | 0.383$^{NS}$ | 0.227$^{NS}$ | -0.032$^{NS}$ | -0.535$^{NS}$ | -0.633* | -0.743** | -0.348$^{NS}$ | -0.616* |
| Wind speed (Km/h) | 0.476$^{NS}$ | -0.498$^{NS}$ | 0.490$^{NS}$ | 0.442$^{NS}$ | -0.141$^{NS}$ | 0.828** | 0.051$^{NS}$ | 0.463$^{NS}$ |
| Rainfall (mm/week) | -0.503$^{NS}$ | -0.365$^{NS}$ | -0.406$^{NS}$ | -0.346$^{NS}$ | -0.406$^{NS}$ | -0.346$^{NS}$ | 0.115$^{NS}$ | -0.342$^{NS}$ |

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed), DH – Dead heart and NS–Not Significant.

**ACKNOWLEDGEMENTS**

The authors are grateful to Administration of School of Agriculture, LPU for providing research facilities and the Department of Agronomy for providing meteorological data.

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