A Review on management strategies against Maize stem borer, *chilopartellus* (Swinhoe) on Maize (*Zea mays* L.)

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ABSTRACT: The research provides updated information on the effect of different insecticides and biopesticides against maize stem borer (*Chilo partellus*swinhoe) were carried out at different areas by different scientists. The combination of Imidacloprid and Trichogramma chilonis resulted in significantly decreased leaf injury m^{-2} (1.32) and dead hearts (4.16%) in several trials done in different agroclimatic zones. With maximum grain yield (39.5 q/ha), imidacloprid + Karanj oil significantly reduced dead heart (2.8%), plant infestation (14.1%), stem tunneling (2.7%), and number of exit holes per plant (0.6).Results of the field bio-efficacy study showed that at, Chloropyrifos 50% + Cypermethrin 5% ~~EC~~ @2500 g.a.i./ha recorded significantly lower larval populations (1.18 larvae per plant) and a lower percentage of plant damage (9.00%).As per the findings this study suggest that percentage infestation and larval population of *Chilo partellus* can be minimized by the application of combinations of insecticides and biopesticides.

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Keywords: ***Chilo partellus*, Maize stem borer, Maize, Management, Control, Insecticides, Biopesticides, Efficacy**

INTRODUCTON

Chilo partellus (Swinhoe) (Lepidoptera: Pyralidae), the maize stem borer, is one of the prominent biotic barrier to maize production worldwide(Pingali, 2000).In Asian and African countries, it is one of the most significant pest(Arabjafari and Jalali, 2007).According to available data 139 distinct insect species attack on maize crop, among these *C. partellus* is a key pest in several agroclimatic zones of India (Shukla and Kumar, 2005).*Chilopartellus* populations from Hisar, Hyderabad, Parbhani, and Coimbatore were distinct from one another based on biological characteristics and biochemical profiles of the populations, which indicated the existence of four biotypes of *C. partellus* in India (Dhillon *et al*., 2021). The adult moth's nocturnal and cryptic behavior make controlling the stalk borer extremely challenging (Singh *et al*., 2014). Scientists have undertaken numerous investigations and come to the conclusion that the maize stem borer, *C. partellus*, is a significant pest of pearl millet, *Pennisetum typhoideum* (Rich), sorghum (*Sorghum bicolor* L.), and maize (*Zea maize* L.) across Asia and Africa. (Panwar, 2005).In a similar vein, it was also observed infesting many millets, grasses, sugarcane (*Saccharum officinarum*), and rice (*Oryza sativa*)(Kauma *et al*., 2008; CABI 2007).The crop losses range from 24-84 percent. The yield losses vary widely in different regions and range from 25-40% according to the pest population density and phenological stage of the crop at infestation(Khan *et al.*, 2015).

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BIOLOGY

Research on the mating behavior of adult *C. partellus*males and females of varying ages reveals that as females get older, the hatchability and fecundity of their eggs are significantly reduced and mating in earlyage shortened both male and female lifespans. (Dhillon *et al*., 2019b).Batches of eggs are laid, usually on the plant's leaves. While there are as many as 170 eggs in a batch but the mean number of eggs in a batch is often between 35-40 (Deep and Rose, 2014).Eggs areOval-shaped, creamy white measure about 0.8 mm in length (Panchal and Kachole, **2013).** Larvae hatch from the eggs 4-8 days after oviposition (Panchal and Kachole, 2013)and in 28–35 days pupate. Larvae in their final instar measure 25–30 mm in length, and their bodies have rows of dark spots.Pupae are long, cylindrical, dark brown coloured, males are smaller than females. 5-12 days after pupation, adults emerge from pupae. The moths are pale brown coloured with an approximate wingspan of 20-30 mm.These moths live for 3-8 days.During adult stage they mate and lay eggs.*C. partellus* takes 25–50 days to complete its life cycle (Panchal and Kachole, 2013). The arrangement of the facultative kind of diapause is a crucial aspect of *C. partellus* bioecology(Dhillon and Hasan 2017a).When the host plant reaches to maturity stage, fully developed *C. partellus* larvae typically enter into diapause inside the old stems or stubbles (Ofomata*et al*., 1999).*C. partellus* in the maize and sorghum agroecosystems

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have a dormant period of 45–50 days prior to the termination of true diapause, which corresponds with its activity cycles with favorable conditions and assures efficient use of resources (Dhillon & Hasan, 2017a; Dhillon *et al*., 2017).

NATURE OF DAMAGE

The damage caused by insect pest complex is determined by the field's population trends which in turn depend on the physical elements in their immediate surroundings in a dynamic manner (Isard, 2004).On sorghum and maize plants, the majority of stem borer species exhibit comparable symptoms. Maize is more susceptible to stem borer damage than other gramineous hosts due to its higher levels of sugars and amino acids (Souza, 2002).Three to four weeks after sowing, stem-borer begins to infest the crop, and it does so until the crop reaches maturity (Sarup *et al*., 1978, Subasinghe and Amarasena, 1988).The main causes of stem borer damage to maize plants are the larvae's leaf-eating and stem-tuning activities. Under natural field conditions, the first signs of infestation are characteristic leaf lesions and scarification caused by the first and second instars of *C. partellus*(Sithole, 1990). After hatching, stem borer larvae crawl across the plant, accumulate in the funnel and feed for a few days on the rollled leaves before attacking the stalk and stem (Mushore, 2005).When the infestation is severe, the larvae, either in the leaf whorl or in the stem, can cut through the meristematic tissues; the central leaves dry up to produce the 'dead heart' symptom, **(**De Groote, 2002).The borers drilling upward after penetrating into the stem at soil level is the process that causes dead heart. (Kfir and colleagues, 2002). Plant growth is hindered and subsequent bacterial and fungal infections are encouraged by exit holes and tunnels in the main stem (Ndiritu 1999, Songa *et al*., 2001).Dead hearts reduce translocation, ear damage, lodging, initial leaf senescence and in severe cases complete crop failure (Naz *et al.*, 2003, Gupta *et al.*, 2010).

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Efficacy of Insecticides with Biopesticides in India.

Combination of insecticides was tested against *C partellus* and found chloropyriphos 50% EC + cypermethrin 5%EC @1.5ml L^{-1} results with percent damage of 6.60%, crop yield (4.23 t ha^{-1}) and insect score of 1.60 (Neupane *et al*., 2016).Research was conducted in the field to determine the bio-control agent *Trichogrammachilonis*'s selectivity against *C partellus*. The following

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treatments were used: release of *T. chilonis* alone, ~~Proclaim~~ (Emamectin benzoate® 1.9 EC) + *T. chilonis*, ~~Confidor®~~ (Imidacloprid 200 SL) + *T. chilonis*, Chlorpyrifos® 40 EC + *T. chilonis*, and Neem seed extract + *T. chilonis*. Results showed that Imidacloprid + *T. chilonis* resulted in significantly lower leaf injury m^{-2} (1.32) and dead hearts (4.16 %) closely followed by the plots treated with emamectin benzoate + T. chilonis with leaf injury m^{2} (1.74) and dead hearts (7.50 %) while significantly higher leaf injury m^{2} (3.64) and dead hearts (20.0 %) were recorded in control plots(Haq *et al*.,2018).The ability of *Bacillus thuringiensis* (Berliner) and *Beauveria bassiana* (Balsamo) Vuillemin to suppress C partellus was studied. Two dose rates of B. thuringiensis (0.75 µg/g) and three dose rates of B. bassiana (1x10^{4}, 1x10^{6}, and 1x10^{8} conidia/ml) were treated alone and in combination against *C. partellus* larvae in their second and fourth larval instars. The experiment's findings showed that when the highest concentrations of *B. thuringiensis* (0,75 µg/g) and *B. bassiana* (1x10^{8} spores/ml) combination were applied , the larvae of *C. partellus* showed the highest rates of larval mortality in their second and fourth instars(Sufyan *et al*., 2019).The effectiveness of combined dosages of the *Trichogrammachilonis*and *Cotesia flavipes*, which is egg and larval parasitoids was examined in a study. The combination of 1, 50,000 *Trichogrammachilonis* parasitized eggs + 1500 *Cotesia flavipes* pupae/ha produced the best results, with the highest egg parasitization (80.47%) and larval parasitization (46.52%) of *C partellus*, resulting in maximum grain yield of 52.54 q/ha, the highest cost benifit ratio of 1:1.54, and the most economically rewarding results, according to the field trail results. (Behera, Mishra *et al.*, 2019).The field tests evaluated the effectiveness of karanj oil, neem oil, Bt, imidacloprid, and their combination against *Chilo partellus*. Imidacloprid and karanj oil (10ml + 2ml/l) combination significantly reduced the stem borer damage, including dead heart (2.8%), plant infection (14.1%), stem tunneling (2.7%), and the number of exit holes per plant (0.6). Neem oil + imidacloprid (10ml+2ml/l) and imidacloprid (2ml/l) was the second best treatment. The combination of karanj oil and imidacloprid produced the highest grain yield (39.5 q/ha), closely followed by neem oil and imidacloprid (37.5 q/ha). (Kumar and Kurley, 2020).The investigation into the biorational control of *C partellus* In Spinosad 45% SC sprayed plot, there was a lower percentage of damaged plants (0.83%) observed. A statistically significant difference was observed between the average tunnel length and the stem exit hole in the plot treated with Spinosad 45% SC and Choloropyriphos 50% + Cypermethrin 5% EC. Higher grain yields were obtained with both insecticides Spinosad 45%

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SC and Chloropyriphos 50% + Cypermethrin 5% EC (8670 kg ha-1 and 8620 kg ha-1, respectively). (Adhikari *et al.*, 2021).To evaluate the effectiveness of various dosages of chloropyrifos 50% + cypermethrin 5% EC against stem borer infestation in maize, field bio-efficacy tests were carried out. The results showed that the combination of chloropyrifos 50% + Cypermethrin 5% EC @ 2500 g.a.i./ha recorded the lowest larval population (1.18 larvae per plant) and the lowest percentage of plant damage (9.00%). This was followed by the combination of chloropyrifos 50% + Cypermethrin 5% EC @ 1562.5 g.a.i./ha (1.44 larvae per plant) and the lowest percentage of plant damage (10.12%), which was at par with each. (Kumar *et al.*, 2022).

Management statergies

Summery and conclusion

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