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The Management Strategies against Maize Stem Borer, *Chilo partellus* (Swinhoe) on Maize (*Zea mays* L.): A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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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. Combining 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% @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 suggests the percentage infestation and larval population of Chilo partellus can be minimized by the application of combinations of insecticides and biopesticides.

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1. INTRODUCTION

Chilo partellus (Swinhoe) (Lepidoptera: Pyralidae), the maize stem borer, is one of the prominent biotic barriers to maize production worldwide [1]. In Asian and African countries, it is one of the most significant pests [2]. 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 [3]. *Chilo partellus* 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 [4]. The adult moth's nocturnal and cryptic behavior makes controlling the stalk borer extremely challenging [5]. Scientists have undertaken numerous investigations and conclude 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, [6]. In a similar vein, it was also observed infesting many millets, grasses, sugarcane (*Saccharum officinarum*), and rice (*Oryza sativa*) (Kauma *et al*., [7], CABI [8]. According to IIMR The crop losses range from 26-80 percent. IIMR, [9]. The yield losses vary widely in different regions according to the pest population density and phenological stage of the crop at infestation (Khan *et al.,* 2015).

2. 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 early age shortens both male and female lifespans. Dhillon *et al*., [10]. 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 and 40 [11]. Eggs are Oval-shaped, creamy white measure about 0.8 mm in length [12]. Larvae hatch from the eggs 4-8 days after oviposition [12]. and in 28–35 days pupate. Larvae in their final instar measure 25–30 mm long, and their bodies have rows of dark spots. Pupae are long, cylindrical and dark brown colored, males are smaller than females. 5-12 days after pupation, adults emerge from pupae. The moths are pale brown colored with an approximate wingspan of 20-30 mm. These moths live for 3-8 days. During the adult stage they mate and lay eggs. *C. partellus* takes 25–50 days to complete its life cycle [12]. The arrangement of the facultative kind of diapause is a crucial aspect of *C. partellus* bioecology [13]. When the host plant reaches to maturity stage, fully developed *C. partellus* larvae typically enter into diapause inside the old stems or stubbles [14]. *C. partellus* in the maize and sorghum agroecosystems have a dormant period of 45–50 days before the termination of true diapause, which corresponds with its activity cycles with favorable conditions and assures efficient use of resources (Dhillon & Hasan, [13], Dhillon et al., [15].

3. 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 dynamically [16]. 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 [17]. Three to four weeks after sowing, the stem-borer begins to infest the crop, and it does so until the crop reaches maturity [18]. 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* [19]. After hatching, stem borer larvae crawl across the plant, accumulate in the funnel and feed for a few days on the rolled leaves before attacking the stalk and stem [20]. 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 [21], The borers drilling upward after penetrating the stem at the soil level is the process that causes a dead heart. Kfir *et al*., [22]. Plant growth is hindered and subsequent bacterial and fungal infections are encouraged by exit holes and tunnels in the main stem Ndiritu [23], Songa *et al*., [24]. Dead hearts reduce translocation, ear damage, lodging, initial leaf senescence and in severe cases complete crop failure (Naz *et al.,* [25], Gupta *et al.,* [26].

4. EFFICACY OF INSECTICIDES WITH BIOPESTICIDES IN INDIA

A Combination of insecticides was tested against *C partellus* and found chlorpyrifos 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 [27]. Research was conducted to find out efficacy of bio-control agent *Trichogramma chilonis* against *C partellus*. The following treatments were used: release of *T. chilonis* alone, (Emamectin benzoate® 1.9 EC) + *T. chilonis*, (Imidacloprid 200 SL) + *T. chilonis*, Chlorpyrifos® 40 EC + *T. chilonis*, 50 eggs/card and Neem seed extract 10% (v/v) + *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 [28]. 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 [29]. The effectiveness of combined dosages of the *Trichogramma chilonis* and *Cotesia flavipes*, which is egg and larval parasitoids was examined in a study. The combination of 1, 50,000 *Trichogramma chilonis* 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 benefit 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 Karanja Seed Oil, neem oil, Bt, imidacloprid, and their combination against *Chilo partellus*. Imidacloprid and Karanja Seed 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 Karanja Seed 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, [30]. 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 chlorpyrifos 50% + Cypermethrin 5% EC. Higher grain yields were obtained with both insecticides Spinosad 45% SC and chlorpyrifos 50% + Cypermethrin 5% EC (8670 kg ha-1 and 8620 kg ha-1, respectively). Adhikari *et al*., [31]. 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*., [32-34].

5. CONCLUSION

Lepidopteran stem borer *Chilo partellus* cause economic damage to maize and sorghum ecosystem worldwide. Mystic nature of feeding makes it difficult to manage by insecticides, the excessive use of insecticides and its associated detrimental effects have been widely criticized. When insects are frequently exposed to insecticides, they soon become resistant to them but various natural active substances with distinct modes of action, including as antifeedant, repellant, oviposition deterrent, and synergistic effects, are present in biopesticides so the resistance is not easy to occur and biopesticides are considered as a feasible alternative of insecticides. Therefore, combination of insecticides with biopesticides have synergistic and complementary effects to each other and have much higher efficacy than applying insecticides and biopesticides alone.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Pingali PI. World maize facts and trends. Meeting world maize need: Technological opportunities and priorities for the public sector. International Maize and Wheat Improvement Center, Mexico. D.F. 2000;57.
2. Arabjafari KH, Jalali SK. Identification and analysis of host plant resistance in leading maize genotypes against spotted stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera:Pyralidae). Pakistan Journal of Biological Sciences. 2007;10(11):1885-1895
3. Shukla A, Kumar A. Maize stem borer (*Chilo partellus* Swinhoe). A review of plant protection Bulletin, University of Agriculture and Technology, Udaipur, India; 2005.
4. Dhillon MK, Tanwar AK, Kumar S, Hasan F, Sharma S, Jaba J, Sharma HC. Biological and biochemical diversity in different biotypes of spotted stem borer, *Chilo partellus* (Swinhoe) in India. Scientific Reports. 2021;11(1):1-12.
5. Singh A, Dwivedi SA, Sharma RC, Mishra PK. Management of stem borer, *chilo partellus* Swinhoe on maize crop. Society for Scientific Development in Agriculture and Technology Progressive Research. 2014;9(2):284-286.
6. Panwar VPS. Management of maize stalk borer *Chilo partellus* (Swinhoe) in maize. Stresses on Maize *in Trepics.* 2005;324-375.
7. Kauma TM, Schulthess F, LeRu BP, Mueke J, Ogwang JA, Omwega CO. Abundance and diversity of lepidopteran stemborers and their parasitoids on selected grasses in Uganda. Crop Portection. 2008;27:505-513.
8. Centre for agriculture and biosciences international. Crop Protection Compendium;2007.
Available:htpp://www.cabicompendium.org/CABI, UK
9. Indian Institute of Maize Research; 2024.
Available:https://iimr.icar.gov.in/?page_id=146
10. Dhillon MK, Tanwar AK, Hasan F. Fitness consequences of delayed mating on reproductive performance of *Chilo partellus* (Swinhoe), Journal of Experimental Zoology Part A: Ecological and Integrative Physiology. 2019b;331(3):161-167.
11. Deep DS, Rose HS. Study on the external morphology of the eggs of maize borer *Chilo partellus* (Swinhoe). Journal of Entomology and Zoology Studies. 2014;2:187-189.
12. Panchal BM, Kachole MS. Life cycle of *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) on artificial diets. Iternational Journal of Plant and Environmental Science. 2013;3(4): 19-22.
13. Dhillon MK, Hasan F. Morphological changes in *Chilo partellus* (Swinhoe) undergoing diapause. Journal of Entomology and Zoology Studies. 2017a;5:1658-1661.
14. Ofomata VC, Overholt WA, Egwuatu RL. Diapause termination of *Chilo partellus* (Swinhoe) and *Chilo orichalcociliellus* strand (Lepidoptera: Pyralidae). International Journal of Tropical Insect Science. 1999;19(2-3):187-191
15. Dhillon MK, Hasan F, Tanwar AK, Bhadauriya AS. Effects of thermo-photoperiod on induction and termination of hibernation in *Chilo partellus* (Swinhoe); 2017.
16. Isard J. Influence of atmospheric condition on high elevation flight of western corn rootworm. Entomological Society of America. 2004;33:650-656.
17. Souza FS, Rebeiro RHE, Veloso CAC, Correan LA. Yielding and phenotypic stability of corn cultivars in three municipal districts of para State Brazil *Pesquisa-Agrepercuria Brazileira,* 2002;37:1269-1274.
18. Sarup P, Siddiqui KH, Marwaha, KK. Trends in maize pest management research in India together with bibliography. Journal of Entomological Research. 1978; 111:19-68.
19. Sithole SZ. Status and control of *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) in southern Africa. Insect Science and Its Application. 1999;11:481-488.
20. Mushore K. Assessment of suitability of different populations of stemborer species for the development of *Cotesia flavipes* (Hymenoptera: Braconidae) and the Establishment of the latter in Zimbabwe, Thesis, University of Zimbabwe,. 2005;14
21. De, Groote H. Maize yield losses from

stem borers in Kenya. International Journal of Tropical Insect Science. 2002;22:89-96.
22. Kfir R, Overholt WA., Khan ZR, Polaszek A.Biology and management of economically important Lepidopteran cereal stem borers in Africa. Annual Review of Entomology. 2002;47:701-731
23. Ndiritu CG. Kenya: Biotechnology in Africa: Agricultural Biotechnology and the Poor, Persley GJ, Lantin MM ,(eds.). Consultative Group on International Agricultural Research. Washington DC. 1999;109-114.
24. Songa JM, Guofa Z, Overhalt WA. Relationships of stem borer damage and plant physical conditions to maize yield in a semi arid zone of Eastern Kenya. International Journal of Tropical Insect Science. 2001;21(3):224-43.
25. Naz, F., Faridullah, M. and Din, M. (2003). Insect pest of maize and their losses. *Asian Journal of Plant Sciences.* 2(5): 412-4.
26. Gupta S, Handore K, Pandey I.P. Effect of insecticides against *Chilo partellus* (Swinhoe) damaging *Zea mays* (maize). International Journal of Parasitology Research. 2010;2(2):4-7.
27. Neupane S, Bhadari G, Sharma SD, Yadav S, Subedi S.Management of stem borer (*Chilo partellus* Swinhoe) in maize using conventional pesticides in Chitwan, Nepal. Journal of Maize Research and Development. *2016;*2 (1):13-19.
28. Haq I, Sattar S, Ahmed B, Zeb Q, Usman A. Compatibility of Chemical and Biological Control for the Management of Maize Stem Borer, *Chilo Partellus*, (Swinhoe) (*Lepidoptera; Pyralidae*). Sarhad Journal of Agriculture. 2018;34(4):896-903.
29. Sufyan,M. Abbasi A, Wakil W, Gogi, MD, Arshad M, Nawaz A, Shabbir Z. Efficacy of *Beauveria Bassiana* and *Bacillus Thuringiensis* Against Maize Stem Borer *Chilo Partellus* (Swinhoe) (Lepidoptera: Pyralidae). *Gesunde Pflanzen*. 2019;71: 197-204.
30. Kurly S, Kumar B. Eco-friendly management of maize stem borer with botanical and chemical insecticides. The Pharma Innovation Journal. 2020;10(2): 135-137.
31. Adhikari B, Saplota, R, Thapa, RB, Bhandari, G, Dahal KC. Biorational Management of Maize Stem Borer *Chilo partellus* (Swinhoe). Azarian Journal of Agriculture. 2021;8(2):38-44.
32. Ravikumar A, Kumar AV, Basavaraj K. Field Bio-Efficacy of Chloropyrifos 50% + Cypermethrin 5% EC against Fall Armyworm, Stem Borer and on Natural Enemy Maize During 2020-21 harif Season. Environment and Ecology. 2022;40(2A):554-559.
33. Behera P, Mishr, BK. Biological control of maize stem borer, *Chilo partellus* (Swinhoe) in Kharif maize through combined releases of *Trichogramma chilonis* (Ishii) and *Cotesia flavipes* (Cameron) in Odisha. Journal of Entomology and Zoology Studies. 2020;8 (1):1647-1651
34. Khan IA, Khan M, Akbar R, Saeed M, Farid A, Ali, Ijaz, Ala, M. Assessment of different control methods for the control of Maize Stem Borer*, (Chilo partellus)* Swinhoe in Maize crop. Journal of Entomology and Zoology Studies. 2015;3(4):327-330.

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