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Multi-Faceted Approaches to Manage *Chilo partellus* in Maize Fields

(Ritu Mishra, *Dharanikota Lalithambica Devi and Batta Ganga Bhavani)
Department of Entomology, GBPUAT, Pantnagar, Uttarakhand, India
*Corresponding Author's email: dlucky9603@gmail.com

Chilo partellus, commonly known as the spotted stem borer, is a major pest affecting maize crops in Asia and Africa. Its infestation results in significant yield losses by damaging the plant's stems, reducing the number of effective panicles, and lowering the density of fertile tillers. Addressing this challenge requires a combination of sustainable pest management practices. Biological control, through the use of natural predators and parasitoids, plays a critical role in reducing pest populations without causing environmental harm. Cultural practices, such as crop rotation, timely planting, and field sanitation, help disrupt the pest's life cycle and reduce its impact. Chemical control, when applied judiciously and targeted at specific stages of the pest's development, remains an effective tool, although it must be carefully managed to prevent resistance. Host plant resistance, by developing maize varieties with inherent resistance to *Chilo partellus*, offers a long-term solution for minimizing pest damage. The integration of these diverse approaches—biological, cultural, chemical, and resistant plant varieties—into an Integrated Pest Management (IPM) framework is widely regarded as the most sustainable and effective strategy. IPM reduces reliance on any single method and minimizes environmental and health risks. This comprehensive strategy ensures effective pest control, improved maize yield, and long-term agricultural sustainability.

Keywords: Biological control, *Chilo partellus*, Integrated pest management, Maize.

Introduction

Maize, commonly known as corn (*Zea mays*), ranks as the third most important cereal crop cultivated in India. It is called 'Queen of the cereals' with highest productivity among the cereal crops. It is an important source of carbohydrate, iron, vitamin B complex, protein and minerals, particularly supplying a high energy of 365 Cal/100g. Maize crop was originated from central Mexico and now it is cultivated in tropical, subtropical as well as temperate parts of the world ranging from 0 to 4000 meters height from sea level. Globally, it is grown on an area of 186.82 million ha with annual production of 1078.31 million metric tonnes (Anonymous, 2018). Recently, it was projected that the demand for maize in developing countries would exceed that of both wheat and rice. In India, maize ranks fifth in area under cultivation and third in terms of production and productivity. To meet the increasing demand for maize as food, feed for animals and poultry, and raw material for industrial processing, production must be significantly boosted. Maize can be grown successfully during the rainy (kharif), winter (rabi), and summer spring (zaid) seasons. Due to its diverse varieties, maize adapts well to a wide range of climatic conditions, from near sea-level to elevations of up to 2,700 meters. It thrives in tropical, subtropical, and temperate climates, with tropical and subtropical regions accounting for a larger share of global maize production. The crop is suitable for various soil types, from sandy to heavy clay soils, with deep, heavy soils being more favorable due to their better water retention capacity. However, saline and alkaline soils

should be avoided as they can negatively impact crop growth. Fertilizer needs for maize depend on the soil's condition, prior cropping practices, and the specific maize variety being grown. Typically, a balanced application of 60-120 kg of nitrogen (N), 40-60 kg of phosphorus (P), and 40 kg of potassium (K) per hectare is recommended for different ecosystems. For optimal yields, a plant density of 65,000-70,000 plants per hectare is ideal.

Various stress factors, particularly insect pests, have limited the yield potential of maize genotypes cultivated in India. Throughout its growing season, it is susceptible to a variety of pests that can cause significant damage. Arthropod pests are a major contributor to the reduced yield of maize and are at the heart of many significant challenges in maize production today. Even with the use of pesticides, substantial crop losses due to these pests persist, especially in developing countries. Maize is vulnerable to insect pest attacks from the seedling stage all the way to maturity. The maize stem borer (*Chilo partellus* Swin.) is a major pest responsible for significant grain yield losses, ranging from 24.3% to 36.3% across various agro-climatic regions of India. According to Khan *et al.* (1997), yield losses caused by stem borers in maize can vary widely by region, ranging from 25% to 40%, depending on the pest population density and the crop's phenological stage at the time of infestation. Among the 66 insect species reported in maize fields, 14 are considered major pests, including the Maize stem borer (*Chilo partellus* Swinhoe), Fall Armyworm (*Spodoptera frugiperda* Smith), and White grub (*Phyllophaga rugosa* Melsheimer, 1845). Of these, the Maize stem borer, *Chilo partellus*, has become increasingly problematic. *Chilo partellus* displays polyphagous feeding behavior, preferring several cultivated grasses, including sorghum, maize, rice, sugarcane, and millets. In addition to these primary hosts, it also feeds on various non-cultivated plants. The insect has alternative hosts within the Cyperaceae, Gramineae, Juncaceae, and Typhaceae families. Integrated Pest Management (IPM) aims to control these pests through a combination of strategies, including chemical treatments, biological controls, innovative cropping systems, modified cultural practices, the use of resistant varieties, and mechanical methods.

Chilo partellus

Common name*:* Spotted Stem borer: *Chilo partellus* was first identified by Charles Swinhoe in 1885 (CABI 2019). Originating in Asia, this species is now widespread and has also shown severe impact in Africa. It is recognized as a serious pest in northeastern India, a major threat in Pakistan, and a significant challenge to the successful cultivation of maize and other cereal crops in various regions across the globe. The spotted stem borer (Chilo partellus) is the most significant insect pest affecting maize during the Kharif season in India, causing yield reductions of up to 26–80% across various agroclimatic regions (Ochieng, Onyango, & Bungu, 1985). Lepidopterous stem borers significantly reduce maize yields by affecting the crop's growth from seedling stage to maturity, limiting the potential harvest.

Classification

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Crambidae
Genus: *Chilo*
Species: *Chilo partellus*

Description: Chilo partellus undergoes several developmental stages: egg, larva, pupa, and adult. Among these, the larval stage is the longest, lasting 29 to 36 days, followed by the

pupal stage, which lasts 7 to 12 days, and the incubation period, which ranges from 3 to 6 days. Adult females lay their eggs on the aerial parts of host plants, typically on the leaves. Each female can lay about 150 to 160 eggs, which are flat, oval, and creamy white, later darkening as the larvae develop. The eggs, measuring 0.75 to 1.25 mm in length, hatch within 5 to 6 days, usually in the early morning. Studies show that 72% of eggs are laid on the underside of maize leaves, particularly near the midribs. The incubation period varies with the season, being longer (6 to 7 days) from September to February and shorter (4 to 5 days) from May to August. Similarly, the larval stage of Chilo partellus lasts 35-36 days during the winter season and 29-30 days in the summer, typically comprising at least five instar stages, though six instars have also been reported. Adults emerge from the pupae in the late afternoon or early evening and are active during the night (CABI 2019). Early instar larvae enter the whorls of young maize plants, where they scrape off the chlorophyll from the leaves, then move downward to feed on the growing stem, often causing the plants to develop dead hearts. After the third molt, the larvae bore into the stem and begin tunnelling.

Nature of damage: The first sign of infestation in young plants is a series of oval perforations in the leaves of the unfolding whorl. This damage is caused by the feeding of young larvae. As the larvae mature, they burrow into the leaf midribs, damage the growing point (leading to a condition known as "deadheart"), or bore into the stem.

Intregated Pest Management: Effective Integrated Pest Management (IPM) strategies to control stem borers in maize fields include practices such as Pull and Push Technology, Agroecosystem Analysis (AESA), Indigenous Technical Knowledge (ITK), chemical pesticides, pheromone traps, host plant resistance, intercropping, avoiding mulching, crop rotation, and the protection of natural enemies. Using a coordinated approach that combines cultural and mechanical practices with chemical and biological pesticides is more effective in controlling stem borers than relying on any single method alone.

- Collect and destroy stubble.
- Perform deep ploughing in summer (not advised under conservation agriculture).
- Plant Napier grass as a trap crop along the fence.
- Intercrop cowpea and maize in a 2:1 ratio.
- Release Trichogramma chilonis twice, at 7 and 15 days after germination, using 8 cards per hectare (equivalent to 150,000 parasitized eggs per hectare).
- Remove and burn dead hearts.
- Apply Chlorantraniliprole 18.5 SC at 150 ml per hectare when infestation reaches 10%.

Biological control: Biological management aims to keep pest populations below the Economic Injury Level (EIL) by utilizing natural predators and other beneficial organisms to control the pests.

Natural Enemies: Utilizing natural enemies to repel pests is an effective strategy for controlling the maize stem borer. A list of natural enemies that target the maize stem borer is provided in the table.

Table:1 Natural enemies of maize stem borer *Chilo partellus* *(CABI 2019).*

	Parasitoids	*Predator*
Maize stem borer Chilo partellus	*Cotesia flavipes (Larval Parasitoid)*	*Chrysoperla carnea*
	Cotesia sesamiae(Larvae Parasitoid)	Coccinellids
	Dentichasmias busseolae(Pupa Parasitoid)	Praying mantids
	Lixophaga diatraeae(Larvae Parasitoid)	Dragonflies
	Trichogramma chilonis(Egg Parasitoid)	Pentatomid bugs, Reduviid bugs
	Trichogramma evanescens(Egg Parasitoid)	Rove beetles

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