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A CASE STUDY

Spotted stem borer, *Chilo partellus* Swinhoe- a serious pest of sorghum

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Abstract **:** Spotted stem borer, *Chilo partellus* Swinhoe infests the sorghum crop from second week till maturity. Initially, the larvae feed on the adaxial surface of the whorl leaves, leaving the lower surface intact as transparent windows. As the severity of the feeding increases, the plant becomes ragged in appearance. When the larvae damage the growing point, typical deadheart symptom develops in younger plants (the entire whorl dries up) and also pinholes on the whorl of newly opened leaves are seen. Subsequently, the older larvae leave the whorl and bore into the stem at the base resulting in extensive tunneling. Peduncle tunneling results either in its breakage or complete or partial chaffy panicles affecting grain development. Resistance screening, sources of resistance, status of released varieties/ hybrids, economic threshold levels, mechanisms of resistance and various management options are discussed in this paper.

Key Words **:** Spotted stem borer, *Chilo partellus,* Sorghum, Sources of resistance, Management

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Spotted stem borer, *Chilo partellus* Swinhoe (Synonym: *Chilo zonellus*) belongs to the family Pyralidae of order Lepidoptera. It is called by several common names *viz*., spotted sorghum stem borer, spotted stem borer, maize stalk borer, spotted stalk borer, durra stalk borer and pink borer. It attacks mainly maize, sorghum, sugarcane, rice and finger millet. Several wild grasses act as alternative hosts for this pest.

Biology:

The straw-colored female moth lays nearly 400-500 flattened, overlapping yellowish eggs in masses of 10-100 on the abaxial leaf surface, usually near the midrib. The eggs hatch in 4 to 6 days. The larvae move to the leaf whorl and feed on tender leaves resulting in leaf-scarification and shot holes. Third-instar larvae move to the base of the plant and bore into the shoot. The larval period lasts for 19 to 27 days. Pupation occurs inside the stem, and the adult emerges in 7 to 10 days. During the dry season, the larvae undergo diapause and survive both in harvested stems and in the stubbles left unplowed in the field after harvest. As the favourable conditions prevail, the diapause is broken and pupation takes place, and the next generation continues (Sharma and Nwanze, 1997). Minimum temperature showed significant and negative correlation with stem borer leaf injury (Kandalkar *et al*., 2002)

Nature of damage:

It infests the crop from second week till maturity. Initially, the larvae feed on the adaxial surface of the whorl leaves, leaving the lower surface intact as transparent windows. As the severity of the feeding increases, the plant becomes ragged in appearance. When the larvae damage the growing point, typical deadheart symptom develops in younger plants (the entire whorl dries up) and also pinholes on the whorl of newly opened leaves are seen. Subsequently, the older larvae leave the whorl and bore into the stem at the base resulting in extensive tunneling. Peduncle tunneling results either in its breakage or complete or partial chaffy panicles affecting grain development.

Resistance screening techniques:

Several screening techniques have been developed to screen for resistance to the spotted stem borer such as

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screening at hot spot locations, adjusting sowing dates in the hot spot locations and artificial infestation by mass rearing (Sharma *et al*., 1992).

Sources of resistance:

Out of nearly 20,000 germplasm lines tested over three seasons at ICRISAT, 77 have been reported as resistant. Most stable resistant sources (IS-5470, IS-5604, IS-8320, and IS-18573) and improved resistant sources (ICSV-443, ICSV-700 and PB-12779-1) have been reported by Sharma *et al*. (1992). Resistant sources were also reported by Jalaluddin *et al.* (1995) (ICSV-705, IS-4881, and IS-13674) and Kishore and Kishore (2001) (PGN-1, PGN-64, PGN-20, AKENT-20, KC-1). Some other known resistant sources include IS Nos. 1054, 1055, 2123, 2146, 2165, 2312, 4664, 5469, 5470, 5480, 5604, 2205, 12308, and 13100.

Status of released varieties/ hybrids:

The *Rabi* varieties (CSV-8R, CSV-14R, Swati and M 35-1) and *Rabi* hybrids (CSH-7R, CSH-8R, CSH-12R, CSH-13R, and CSH-15R) show low level of stem tunneling (<10 %) due to stem borer. CSV-2 recorded minimum stem borer incidence (5.13% deadhearts) among *Kharif* varieties. The *Kharif* varieties (CSV-1, CSV-3, CSV-4, CSV-5, CSV-6, CSV-9, CSV-10, SPV-462, CSV-13, and CSV-15 and *Kharif* hybrids (CSH-5, CSH-6, CSH-9, and CSH-13) show less than 20 per cent deadhearts due to stem borer.

Economic thresholds:

Determination of ETLs for different genotypes is a prerequisite for formulating any pest management programme. ETLs for spotted stem borer have been estimated to be 5-25 per cent deadhearts at 20 DAE under different levels of protection. Preliminary studies conducted at Hisar indicated the ETLs for borer to be 10 per cent deadhearts at 20 DAE (Singh, 1997).

Mechanisms of resistance:

Nonpreference for oviposition: Saxena (1990) observed that oviposition was equally high on susceptible cultivars (IS-18363, IS-18463, and IS-2146), and moderately resistant cultivars (IS- 4660 and IS-2205). However, oviposition was significantly lower on resistant cultivars (IS-18520 and IS-1044).

Antibiosis:

The main mechanism of spotted stem borer resistance in sorghum is antibiosis. High mortality in the early larval stages (Jotwani, 1978; Jotwani *et al.,* 1978) and low survival rate of larvae (Lal and Pant, 1980) have been reported in resistant genotypes. Saxena (1990) observed that larval establishment was 33 per cent lower on the borer–resistant line, IS-1044, than on the susceptible control, IS-18363.

Tolerance:

Jotwani (1978) reported significantly lower grain yield loss caused by stem borer in sorghum selections such as 124, 175, 177, 446, 447, 731, 780, 827 and 829 than in CSH-1, and attributed this to tolerance mechanism. In studies conducted at ICRISAT- Patancheru, lines showing resistance to deadheart formation *i.e*., < 20 per cent plants with deadhearts (IS-5604, IS-5469, IS-2123, IS-5566, IS-2146, and IS-2309), also exhibited good recovery resistance.

Plant morphological characters:

The morphological characters like plant height, tassel percentage, stem thickness, number of leaves, leaf length, leaf width, leaf thickness, and leaf strength are negatively correlated with deadheart formation (Khurana and Verma, 1985). Faster internode elongation is also associated with borer resistance, which is related to pushing the growing point upwards. This hampers the ability of larvae to reach the growing point, thus preventing deadheart formation.

The plant height at 10, 20, and 30 days after emergence (DAE) and seedling weight at 10 DAE, are negatively associated with leaf damage, deadheart formation, and larval survival. Shoot length at 40 DAE, ligular hairs, and leaf angle are significantly and negatively associated with deadheart formation. Moisture content of 10-day-old seedlings, and central whorl leaf at 20 DAE, are positively associated with leaf feeding and larval survival. Plant growth rate between 30 and 40 DAE and seedling vigour were negatively associated with deadheart formation. Long internodes affect the larval establishment in that the farther distance the larvae have to climb, the more they are exposed to desiccation, wash-off by rain, or attack by predators. Ligular hairs also act as a trap for the young larvae, thus reducing their success in climbing and rate of final establishment (Chapman *et al*., 1983).

Biochemical factors:

A number of biochemical factors have been reported to be associated with stem borer resistance in sorghum. These include: low sugar content (Swarup and Chaugale, 1962) amino acids, total sugars, tannins, total phenols, neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignins (Khurana and Verma 1982, 1983, 1985), and high silica content (Narwal, 1973). The epicuticular wax layer in sorghum plants is conspicuous and affects climbing by *Chilo* larvae (Barnays *et al.,* 1983). On some resistant genotypes, there is a disorienting effect, which has been attributed to the chemical composition of epicuticular wax (Woodhead and Chapman, 1986). Concentration of 32 C marker chemical was less than half in resistant genotype IS-2205 than in the susceptible genotypes, IS-1151 and CSH-1. Larval mortality is greater in diet impregnated with petroleum ether extract of the borer-resistant lines. Methanolic extracts from the susceptible line IS-18363 showed greater feeding simulation than the extracts from the less susceptible cultivar, IS-2205. IS-18363 had greater phenolic and sugar contents than the less susceptible cultivar, IS-2205 (Torto *et al.,* 1990).

Cultural control:

The off-season survival of the pest is through the stubbles left in the field after harvest as well as the stems kept for use as fodder. Uprooting and burning of the stubbles and chopping of stems prevent its carryover to the next season. Early sowing was the best method for controlling stem borer (Ameta, 2004).

Chemical control:

Effective control can be achieved by need-based application of insecticides such as carbofuran 3G or carbaryl 4G (@ 8 and 12 kg ha^{-1}) at 20 and 35 days after crop emergence. The treatment should be taken after ascertaining the infestation levels as evidenced by leaf damage symptoms. Two endosulfan applications at 25 and 35 days after germination was suggested by Gahukar and Kishore (1995) for effective control of stem borer. Early sowing with normal seed rate (8 kg/ha) along with seed soaking for 8 h in endosulfan 0.07 per cent + $CaCl_2$ (2%) + one spray with neem leaf extract 5 per cent + whorl application of carbofuran 3G @ 7.5 kg/ha at 30 days after emergence was the best module against stem borer (Ameta, 2004).

Biorational pesticides:

Among different biopesticides evaluated, *Bacillus thuringiensis* (1 g/litre), NSKE (5%), nimbecidine (5 ml/litre) and *Metarhizium anisopliae* (1g/litre) were the most effective biopesticides in reducing stem borer damage. Further, the results of cost economics studies clearly indicated that among the biopesticides, *M. anisopliae* followed by *B. thuringiensis* are the most economic treatments as they recorded highest net returns (Jose, 2001). Bhanukiran and Panwar (2005) reported that, *Bt kurstaki* and neem formulations as the next best treatments after endosulfan with respect to yield. Shekharappa (2001) reported that among the different neem based formulations evaluated NSKE and nimbecidine were found to be the most effective ones. Whereas, as Sharma and Odak (1996) reported *B. thuringiensis* applied alone as more effective than endosulfan in reducing damage due to stem borer incidence.

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