Host-Plant Resistance to Shoot Fly and Spotted Stem Borer in Sorghum

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Introduction

Nearly 150 insect species have been reported as pests on sorghum, of which shoot fly (*Atherigona soccata),* stem borer (*ChibparteUus),* army worm *(Mythimna separata),* aphids *(Rhopalosiphum maidis, Melanaphis sacchari),* shoot bug *(Peregrinus maidis),* sorghum midge (*Stenodiplosis sorghicola),* head bug (*Calocoris angustatus),* and head caterpillars *(Helicoverpa armigera, Cryptoblabes gnidiella, Eumlemma silicula,* etc.) are the major pests in Asia.

Shoot Fly *(Atherigona soccata)*

Sources of resistance

The shoot fly lays eggs on 7-20 day old plants on the undersurface of leaves. The larvae move to the growing point and cut it. As a result, the central leaf dries up, resulting in a deadheart. Screening for resistance to shoot fly can be carried out using interlard or cage screening techniques (Sharma et al. 1992). Several workers have screened sorghum germplasm for resistance to shoot fly (Jotwani 1978, Singh and Rana 1986, Taneja and Leuschner 1985, Sharma et al. 1992). Cultivars M 35-1 (IS 1054), IS 1057, IS 2123, IS 2146, IS 4664, IS 2205, IS 5604, and IS 18551 have been widely tested, and possess moderate levels of resistance. Improved varieties CSV 5, CSV 6, CSV 7R, Swati (SPV 504), and CSV 8R have been developed using landraces, and possess moderate levels of resistance. Improved lines such as ICSV 700, ICSV 705, ICSV 717, PS 19345, PS 19349, PS 21303, PS 28060-3, and PS 35805 have moderate levels of resistance to shoot fly, and higher yield potential than landraces.

Resistance mechanisms

Nonpreference for oviposition. This is the primary mechanism of resistance to shoot fly (Taneja and Leuschner 1985, Sharma and Nwanze 1997). Significantly higher oviposition has been recorded on the susceptible cultivar CSH I (66% plants with eggs) compared with resistant genotypes IS 1034, IS 2146, IS 2265, IS 2309, IS 3962, IS 4664, IS 5566, IS 5604, IS 18369, and IS 18551 (<40% plants with eggs). However, more eggs have been recorded on shoot fly-resistant cultivars IS 1082, IS 2122, IS

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2195, IS 4664, IS 5484, and IS 5566 under no-choice than under multiple-choice conditions.

Antibiosis. Survival and development of the shoot fly are adversely affected when the insect is reared on shoot fly-resistant genotypes. Growth and development of the insect are retarded, and the larval and pupal periods are extended by 8-15 days on resistant genotypes. Survival, longevity, and fecundity of females are also adversely affected when the fly is reared on resistant genotypes (Sharma and Nwanze 1997).

Tolerance. Some sorghum genotypes exhibit an inherent ability to produce side-tillers after the main shoot is killed by shoot fly. These genotypes can produce reasonable yields if the plant is not attacked again (Taneja and Leuschner 1985). Tillers of resistant cultivars are less preferred for egg-laying. Resistant cultivars have a higher rate of tiller survival than do susceptible cultivars.

Factors associated with resistance

Seedling vigor. Seedling vigor is negatively associated with deadheart formation. Shoot fly-resistant lines have rapid plant growth (Taneja and Leuschner 1985), greater seedling vigor, longer stems and internodes, and a short peduncle (Sharma and Nwanze 1997).

Glossiness. The glossy leaf trait (pale green, shiny leaves) in sorghum is associated with shoot fly resistance (Taneja and Leuschner 1985). Intensity of glossiness of the leaves at the seedling stage is positively associated with resistance.

Leaf surface wetness. Cultivars with a high transpiration rate are preferred for oviposition. Shoot fly-resistant lines have low leaf surface wetness, and are characterized by a smooth amorphous wax layer and sparse wax crystals (Sharma and Nwanze 1997).

Trichomes. Trichomes on the undersurface of leaves are associated with shoot fly resistance (Taneja and Leuschner 1985). Shoot fly-resistant germplasm lines have trichomes on the undersurface of leaves (except IS 5622, which has trichomes only on the upper surface). Trichomes are absent in shoot fly-susceptible lines.

Biochemical factors. Such factors as the presence of irregularly shaped silica bodies in plant tissue, lignification, silica deposition, nitrogen, reducing sugars, total sugars, moisture, chlorophyll, lysine, amino acids, phenol, and phosphorus have been found to be associated with resistance to shoot fly (Sharma and Nwanze 1997).

Stem Borer *(Chilo partellus)*

Sources of resistance

Stem borer moths lay eggs on the undersurface of leaves. The young larvae feed inside the leaf whorls of 15-40 day old plants, causing leaf scarification. Third-instar larvae move to the base of the plant, bore inside the stem, and kill the growing point. As a result, the two central leaves dry up, producing a deadheart. The larvae also tunnel the stem, and often lead to completely or partially chaffy panicles or peduncle damage. Screening for stem borer resistance can be carried out at hot-spot locations or through artificial screening using laboratory-reared insects. Sources of resistance have been identified by several workers (Jotwani 1978, Singh and Rana 1989, Sharma et al. 1992). IS 1055 (BP 53), IS 1044, IS 2123, IS 2195, IS 2205, IS 2146, IS 5469, and IS 18551 show moderate levels of resistance to the spotted stem borer. The improved lines ICSV 700, ICSV 714, PB 15837-1, PB 15925, PB 15520-2-2-2, and PB 14390-4 have moderate levels of resistance, and better plant type and yield potential than the original resistance sources.

Resistance mechanisms

Nonpreference for oviposition. Ovipositional nonpreference is one component of resistance to *Chilo pattellus* (Sharma and Nwanze 1997). In cage tests, 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, low larval establishment, time interval between larval hatching and boring into the stem, larval mass, and survival rate are associated with resistance (Jotwani 1978, Sharma and Nwanze 1997). Different combinations of factors are involved in conferring resistance to C. *partellus* in various genotypes, and information on these factors is vital while breeding for resistance to stem borers.

Tolerance. In studies conducted at ICRISAT-Patancheru, lines showing resistance to deadheart formation, i.e., <20% plants with deadhearts (IS 5604, IS 5469, IS 2123, IS 5566, IS 2146, and IS 2309), also exhibited good recovery resistance. Grain yield under infested and noninfested conditions can also be used as a measure of tolerance (Sharma and Nwanze 1997).

Factors associated with resistance

Plant morphological characters. 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). Days to panicle initiation and shoot length are associated with resistance to stem borers. Genotypes with early panicle initiation (IS 12308 and IS 13100) escape deadheart formation due to inability of the larvae to reach the growing point. Faster internode elongation is also associated with borer resistance. Shoot length, moisture content, plant growth rate or seedling vigor, leaf glossiness, and ligular hairs are associated with resistance (Sharma and Nwanze 1997).

Biochemical factors. A number of biochemical factors such as amino acids, sugars, tannins, phenols, neutral detergent fiber, acid detergent fiber, lignins, and silica content are associated with resistance to the stem borer (Sharma and Nwanze 1997). The epicuticular wax layer in sorghum plants is conspicuous and hampers climbing by *Chilo* larvae (Bernays et al. 1983). Concentration of 32 C marker chemical in resistant genotypes (IS 2205) was less than half the concentration in susceptible genotypes (IS 1151, CSH 1). Larval mortality is higher when larvae are fed on a diet impregnated with a petroleum ether extract of borer-resistant lines. Methanolic extracts from the susceptible line IS 18363 caused greater feeding stimulation than did extracts from a less susceptible cultivar, IS 2205. IS 18363 has greater phenolic and sugar contents than IS 2205 (Torto et al. 1990).

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