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Inheritance of Resistance to Sorghum Shoot Fly, *Atherigona soccata*

M. K. Dhillon,* H. C. Sharma, B. V. S. Reddy, Ram Singh, and J. S. Naresh

ABSTRACT

The sorghum shoot fly, *Atherigona soccata* Rond. (Diptera: Muscidae), is one of the most important pests of sorghum [*Sorghum bicolor* (L.) Moench], and host plant resistance is an important component for the management of this pest. Most of the sorghum hybrids currently under cultivation are based on cytoplasmic male-sterility (CMS). To develop a strategy to develop sorghum hybrids with resistance to shoot fly, we studied the nature of gene action for resistance to this pest in F_1 hybrids derived from shoot fly-resistant and -susceptible CMS and restorer lines. The hybrids based on shoot fly-resistant CMS and restorer lines were glossy and trichomed and had lower proportion of plants with eggs (78.5% vs. 88.4 to 93.3%) and deadhearts (40.8% vs. 60.8 to 75.3%) than the hybrids based on other cross combinations, suggesting that resistance is required in both CMS and restorer lines for obtaining shoot fly-resistant hybrids. Proportional contributions of CMS lines for oviposition, deadhearts, leaf glossiness, and recovery resistance were greater than those of the restorer lines. The general (GCA) and specific combining ability (SCA) estimates suggested that inheritance for oviposition nonpreference, deadhearts, recovery resistance, and the morphological traits associated with resistance or susceptibility to *A. soccata* were governed by additive-type of gene action. The SCA effects and heterosis estimates indicated that heterosis breeding would not be rewarding in breeding for resistance to shoot fly.

Sorghum is an important crop in Asia, Africa, USA, Australia, and Latin America. It is grown on about 10.4 million hectares in India, with an annual grain production of 8 million megagrams (FAO, 2002). The productivity levels under subsistence farming conditions are quite low (500–800 kg ha^{-1}) mainly because of biotic and abiotic constraints. More than 150 species of insect pests damage the sorghum crop, of which sorghum shoot fly is most important in Asia, Africa, and the Mediterranean Europe (Sharma, 1993). Losses in grain yield because of shoot fly damage average about 5% in India (Jotwani, 1983). The shoot fly females lay white, elongated, cigar-shaped eggs singly on the undersurface of the leaves, parallel to the midrib. After egg hatching, the larvae crawl to the plant whorl and move downward between the folds of the young leaves until they reach the growing point. When they feed, they cut the growing tip and the result is drying of the central leaf called "deadheart."

M.K. Dhillon, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, India, and Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004, India; H.C. Sharma and B.V.S. Reddy, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, India; R. Singh and J.S. Naresh, Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004, India. Received 13 June 2005. *Corresponding author (m.dhillon@cgiar.org; mukeshdhillon@rediffmail.com).

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677 S. Segoe Rd., Madison, WI 53711 USA

A number of genotypes with resistance to shoot fly have been identified, but the levels of resistance are low to moderate (Sharma et al., 2003a). Plant resistance to sorghum shoot fly appears to be a complex trait and depends on the interplay of a number of component characters (Dhillon, 2004).

The discovery of CMS (Stephens and Holland, 1954) made it easier to incorporate desired traits into hybrids (House, 1985). Because more than 75% of the area under sorghum cultivation in India is planted to high-yielding hybrids, and most of these hybrids are based on milo-cytoplasm, it is important to transfer genes conferring resistance to sorghum shoot fly into cytoplasmic male-sterile (A-lines), maintainer (B-lines), and restorer (R-lines) lines to develop hybrids with high grain yield and resistance to this pest.

There is no information on the interaction between shoot fly-resistant and -susceptible A-, B-, and R-lines relative to the expression and inheritance of resistance to *A. soccata* in F_1 hybrids. Since future breeding efforts will largely focus on high-yielding, shoot fly-resistant hybrids, the present studies were performed to understand the nature of gene action for components that contribute to resistance or susceptibility to *A. soccata*. Such an information will be useful in developing an appropriate strategy to produce shoot fly-resistant hybrids for cultivation by the farmers in the semiarid tropics.

MATERIALS AND METHODS

Experimental Material

The experimental material consisted of 12 restorer, 12 CMS, and their maintainer (5 shoot fly-susceptible and 7 shoot fly-resistant) lines selected at random from germplasm and breeding material maintained in the gene bank at the International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India. The prehybridization evaluation of CMS, maintainer, and restorer lines for reaction to sorghum shoot fly (determined on the basis of percentage deadhearts) during the 2002 rainy season supplemented with an ex-ante inference was used to categorize the test material into shoot fly-resistant and -susceptible groups. The 144 F_1 hybrids were produced by crossing 12 CMS with 12 restorer lines in a line × tester mating design during the 2002–2003 post-rainy season.

The test material (12 A-, B-, and R-lines, and their 144 F_1 hybrids), along with shoot fly-resistant (IS 18551) and susceptible (Swarna) checks, was planted in a randomized complete block design (RCBD) in three replications during the 2003 rainy (July–November), early post-rainy (September–January), and late post-rainy (October–March) seasons using the interlard fish-meal technique (Soto, 1974). Each genotype was sown in four-row plots of 2-m row length; the rows were 75 cm apart. The seed was sown with a four-cone planter at a depth of 5 cm. The plants were thinned 1 wk after seedling emergence to maintain a spacing of 10 cm between plants.

Data were recorded in the central two rows on oviposition and deadheart formation at 14 d after seedling emergence