



Research Article

Correlation studies for shootfly resistance traits in sorghum (*Sorghum bicolor* (L.) Moench)

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Abstract :

A field experiment was conducted to study the relation of different plant characters and shoot fly resistance in sorghum. Leaf glossiness showed high positive correlation with shootfly oviposition and dead hearts. The oviposition percentage on 14th and 21st days after seedling emergence exhibited significant positive correlation with dead hearts. Leaf trichome density on adaxial and abaxial leaf surfaces showed significant negative correlation with shootfly dead hearts. The leaf trichome density revealed higher magnitude for resistance due to non-preference for oviposition. Seedling vigour recorded weaker association with dead heart percentage. Genotypic correlation confirmed that the number of trichomes on both surfaces of lamina and leaf glossiness contributed resistance to shoot fly. Thus these characters can be used as selection criteria for breeding shootfly resistance genotypes.

Key words:

Sorghum shoot fly, correlation, trichome density, oviposition, leaf glossness, resistance

Introduction

Sorghum shoot fly (*Atherigona soccata* Rondani) is an important seedling pest (Sherwill *et al.* 1999) attacks sorghum crop upto 30days from sowing leading to losses estimated as 5% in India (Jotwani 1983), but the infestations at times may be over 90% (Rao and Gowda 1967). The shoot fly females lay 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 resulting in drying of the central leaf called dead heart. It is estimated that an increase in 1% of dead hearts would result in loss of 143 kg grain yield per hectare (Chundurwar and Karanjkar 1979).

Adoption of chemical methods for insect control in staple food crops is not economically feasible for resource poor farmers of the semi-arid tropics (SAT) as the low crop value per acre precludes the use of insecticides for control of insects (Dhams, 1943). Therefore host plant resistance combined with timely sowing is the most realistic approach to minimize grain and stover yield losses due to insect pests such as sorghum shoot fly. The resistance to shoot fly appears to be a complex trait. Recent reviews on

shoot fly resistance reveals that four components governing resistance to this pest *viz.*, non preference for oviposition, antibiosis, seedling resistance and recovery resistance. The traits leaf glossiness, seedling vigour, trichome density on leaf surface, silica contents, lignifications and thickness of cell wall of the cells enclosing the vascular bundles of leaves and some biochemical factors are reported to be associated with shoot fly resistance. To find out the contribution of each character for governing the resistance, it would be necessary to study their correlations. Such investigations would depict a reliable scenario regarding characters associations and criteria for selecting characters for genetic improvement of sorghum for shoot fly resistance.

Materials and methods

A set of 78 F₁ hybrids were planted along with parents and three checks, *viz.*, susceptible variety (PVK 801), resistant source (IS 18551) and commercial hybrid (CSH 16). The materials were raised in randomized block design with two replications. Maintainer lines (B lines) were also raised to evaluate their susceptibility or resistant reaction to shoot fly. Each parental line and F₁ hybrids were planted in a single row plot (4m) with row to row and plant to plant spacing of 45 and 15cm, respectively. The sowing was carried out on 22nd September, 2006 for screening in early *Rabi* (post rainy) season. Each replication consisted of 106 entries, which were divided into two tiers to reduce

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soil heterogeneity and entries within the replication were randomized.

Six border rows with susceptible genotype (PVK 801) were sown around experimental plot 20 days before sowing of main experiment. To attain uniform shoot fly pressure under field condition the interlard fish meal technique (Soto 1974) was followed for screening. After every ten rows of test entries one row each of susceptible (PVK 801) and resistant checks (IS 18551) were sown. Ten days after seedling emergence polythene bags containing moistened fish meal were kept in test entries at uniform interval covering the entire area to attract the emerging shoot flies from infester rows (PVK 801). Plant protection measures were avoided until the shoot fly infestation period (up to one month after sowing) was over.

Observations recorded

Data were recorded in each row excluding border plants on leaf glossiness, seedling vigour, oviposition percentage, dead heart percentage and trichome density on upper and lower surface of lamina. Evaluation for leaf glossiness was performed according to the scale given by Sharma and Nwanze (1997). Seedling vigour (a combination of height, leaf growth, and robustness) was evaluated on a 1 to 5 scale at 9 Days after emergence (DAE) according to Sharma *et al.* (1997b). Oviposition percentage was calculated at 14 and 21 DAE by multiplying with 100 the ratio of number of plants with eggs to total number of plants. Similarly, the dead heart percentage was calculated by calculating the ratio of number of plants with dead heart to total number of plants and multiplying with 100 at 21 and 28 DAE. The rating scales were 1 = \leq 10% infestation (highly resistant); 3 = 10 to 20% infestation (resistant); 5 = 20 to 35% infestation (moderately resistant); 7 = 35 to 50% infestation (susceptible); 9 = \geq 50% infestation (highly susceptible). The observations on oviposition and dead hearts were angular transformed for statistical analysis. Trichome density was recorded at 12 DAE on central portion of the fifth leaf (from the base) of three random seedlings from each genotype in each replication. The leaf pieces were cleared in acetic acid-lactic acid (2:1) and leaf sections were mounted on a slide in a drop of lactic acid and observed under a microscope at a magnification of 10x. Number of trichomes per microscopic field was recorded. Trichome density was calculated in adaxial (upper) and abaxial (lower) surfaces of the leaves according to Maiti *et al.* (1980) and Dhillon (2004).

Statistical analyses: The data were subjected to analyses of variance. The parents were classified as

resistant and susceptible on the basis of their reaction to shoot fly. Correlation between shoot fly resistance as defined by oviposition and dead heart percentage with shoot fly resistance attributing traits like leaf glossiness, seedling vigour, trichome density on adaxial (upper) and abaxial (lower) surface of lamina were estimated and significance was tested using SPSS ver. 13.0.

Results and discussion

Resistance to shoot fly was found to be highly correlated with the shoot fly resistance contributing traits (Table 1). Leaf glossiness mainly acts as non-preference mechanism. The intensity of leaf glossiness at the seedling stage is positively associated with level of resistance to shoot fly (Sharma and Nwanze, 1997). It was ranged from $r = 0.77^{**}$ to 0.78^{**} ($**P = 0.01$) and $r = 0.78^{**}$ to $r = 0.79^{**}$, respectively. Seedling vigour revealed positive association with shoot fly damage parameters (Oviposition and dead hearts) which ranged from $r = 0.39^{**}$ to 0.43^{**} and $r = 0.47^{**}$ to 0.49^{**} . Although it recorded significant positive correlation but the magnitude was low as compared to other shoot fly resistance traits. Anandan *et al.* (2009) also noticed the weaker correlations of this trait. Highly significant and negative association was observed for trichome density at adaxial surface of leaf lamina and shoot fly damage parameters (oviposition and dead hearts) was ranged from ($r = -0.74$ to -0.75^{**}) and ($r = -0.68^{**}$ to -0.75^{**}). While, at abaxial surface of leaf lamina recorded correlations were ($r = -0.71^{**}$ to -0.75^{**}) and ($r = -0.68^{**}$ to -0.75^{**}). Raina (1985) reported that trichomes may contribute to the expression of antibiosis to shoot fly in sorghum as trichomed cultivars hinder the movement of newly hatched larvae to the base of the whorl. Trichomes can act as an insect resistance mechanism by limiting the insects' contact with the plant. Such trichome can act as a physical barrier to insect movement. In addition, glandular trichomes can contribute to insect resistance by producing toxic compounds, which poison the insect through contact, ingestion, and/or inhalation, and by producing gummy, sticky or polymerizing chemical exudates, which impede the insect movement (David and Easwaramoorthy, 1988).

Dhillon *et al.* (2005) studied mechanism of resistance to shoot fly and stated that dead hearts, plants with eggs, leaf glossiness, trichomes on the abaxial surface of the leaf can be used as a marker traits to select for resistance to shoot fly. Genotypic correlation confirmed that the number of trichomes on both surfaces of lamina and leaf glossiness portrayed resistance for shoot fly (Karanjkar *et*

al.1992). Oviposition and dead heart recorded a significant positive correlation (Sharma *et al.*, 1977; Halalli *et al.*, 1982; Patel and Sukhani, 1990; Sajjanar, 2002).

From these studies it holds that, trichomes on both the surface of lamina and leaf glossiness played important role in shoot fly resistance. Therefore, magnitude of resistance by two or more resistance characters together is higher than the magnitude of resistance by the single trait alone. Thus these characters can be used as selection criteria for breeding shootfly resistance genotypes.

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**Table 1. Correlation between shoot fly resistance contributing traits**

	Leaf glossiness	Seedling vigour	Trichome density (Adaxial)	Trichome density (Abaxial)	Oviposition (14DAS)	Oviposition (21DAS)	Dead hearts (21DAS)	Dead hearts (28DAS)
Leaf Glossiness	1	0.61**	-0.77**	-0.76**	0.78**	0.77**	0.79**	0.79**
Seedling vigour		1	-0.43**	-0.54**	0.43**	0.39**	0.47**	0.49**
Trichome Density (Adaxial)			1	0.90**	-0.75**	-0.75**	-0.68**	-0.75**
Trichome Density (Abaxial)				1	-0.75**	-0.71**	-0.67**	-0.73**
Oviposition (14DAS)					1	0.94**	0.90**	0.87**
Oviposition (21DAS)						1	0.92**	0.90**
Dead hearts (21DAS)							1	0.91**
Dead hearts (28DAS)								1

** $P = 0.01$