Componental Analysis of the Factors Influencing Shoot Fly Resistance in Sorghum (Sorghum bicolor (L.) Moench)

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The sorghum shoot fly, *Atherigona soccata* (Rondani) is an important pest of sorghum in India and Africa. The resistance to sorghum shoot fly in sorghum appears to be a complex character and depends upon the interplay of a number of componental characters, which finally sum up in the expression of shoot fly resistance. In obtaining a clear picture of the contribution of each of such componental characters in building up the total genetic architecture of the resistance, it would be necessary to discriminate them and study their correlation and causation. Such a study would provide a realistic basis for allocation of weightage to each of these attributes in deciding upon a suitable selection criteria in genetic improvement of sorghum. As pointed out by Wright(1921)[5] and Li(1956)[2] this could be obtained by path analysis. The present investigation deals with the extent of the direct effect of the componental characters on the expression of resistance to shoot fly in sorghum.

Materials and methods

The investigation was carried out on two different experimental sets of material. The first experiment comprised 20 genetically diverse sorghum shoot fly resistant sources obtained from the various eco-geographical regions of the world. The second experiment had 32 genotypes selected from the sorghum world germplasm collection for varying glossiness (shiny yellowish green leaf surface) intensities. The first experiment was conducted twice, one in 1980 *Kharif* (rainy season) and the other in 1981 *Kharif*, while the second experiment was done only once in 1981 *Kharif* season. Both these experiments were conducted in a simple randomized block design with minimum of 3 replications under heavy natural shoot fly pressures. Each entry was grown in a single row plot of 4 m length in each replication. The rows were spaced 75 cm apart. The plant to plant distance within a row was kept 10 cm. Fourty seedlings were maintained in each plot for recording observations on shoot fly resistance traits. The characters studied were, trichome (microscopic hairs on abaxial leaf surface) intensity, glossiness intensity, number of eggs/plant and percentage of shoot fly dead hearts. The number of trichomes per mm^2 was counted on the abaxial surface of the 4th leaf under ordinary microscope, using ten plants/plot. The glossiness intensity was visually scored four times on a 1 to 5 scale (1: non glossiness, 3: intermediate, 5: maximum glossiness) during the second to fifth leaf stage of seedlings. Later on, the actual trichome counts and the percentage of shoot fly dead hearts counts were transformed to logarithm and arc sine scales for final statistical analysis.

The associations between shoot fly resistance and its components, and among the components themselves were computed in terms of genotypic and phenotypic correlation coefficients using genotypic and phenotypic variance and covariance components in all three experimental sets. The causal role in building up these correlations was analysed by path-coefficient analysis as suggested by Dewey and Lu (1959),[1] taking shoot fly resistance (percentage of shoot fly dead hearts) as the effect, and other characters as the all possible causes.

Table 1. Genotypic correlation coefficients between factors contributing resistance to shoot flies

Factors	Expt. No.	Trichome intensity	Glossiness intensity	No. of eggs/plant	% of dead hearts
Trichome intensity	1(a)	1.000	0.8330**	-0.6973**	-0.8174**
	1(b)	1.000	0.8279**	-0.7427**	-0.7768**
	2	1.000	0.8159**	-0.7529**	-0.7305**
Glossiness intensity	1(a)		1.000	-0.8255**	-0.9351**
	1(b)		1.000	-0.7479**	-0.8655**
	2		1.000	-0.8245**	-0.8115**
No. of eggs/plant	1(a)			1.000	0.9971**
	1(b)			1.000	0.9217**
	2			1.000	1.000 **
% of dead hearts	1(a)				1.000
	1(b)				1.000
	2				1.000

Note: Experiment No. 1(a) — Conducted during 1980 *Kharif*, 20 genotypes.
Experiment No. 1(b) — Conducted during 1981 *Kharif*, 20 original genotypes + 2 susceptible checks.
Experiment No. 2 — Conducted during 1981 *Kharif*, 32 genotypes.
* : Significant at 5% probability.
**: Significant at 1% probability.

Table 2. Phenotypic correlation coefficients between factors contributing resistance to shoot flies

Factors	Expt. No.	Trichome intensity	Glossiness intensity	No. of eggs/plant	% of dead hearts
Trichome intensity	1(a)	1.000	0.8289**	-0.4946*	-0.7190**
	1(b)	1.000	0.7865**	-0.5542**	-0.6156**
	2	1.000	0.7797**	-0.3342	-0.5708**
Glossiness intensity	1(a)		1.000	-0.5848**	-0.8177**
	1(b)		1.000	-0.5397**	-0.6666**
	2		1.000	-0.3469	-0.6025**
No. of eggs/plant	1(a)			1.000	0.7334**
	1(b)			1.000	0.7051**
	2			1.000	0.5296**
% of dead hearts	1(a)				1.000
	1(b)				1.000
	2				1.000

Note: Experiment No. 1(a) — Conducted during 1980 *Kharif*, 20 genotypes.
Experiment No. 1(b) — Conducted during 1981 *Kharif*, 20 original genotypes + 2 susceptible checks.
Experiment No. 2 — Conducted during 1981 *Kharif*, 32 genotypes.
* : Significant at 5% probability.
**: Significant at 1% probability.

Results and discussion

Genotypic and phenotypic correlation coefficients between shoot fly resistance and the characters contributing to it, and among the characters themselves are given in Table 1 and 2. As is apparent from these two tables, all four shoot fly resistance traits are highly significantly associated with each other at both genotypic and phenotypic levels over all three experiments, indicating that all are important for shoot fly resistance in sorghum. In general, the magnitude of these correlations are quite consistent over all experiments at the both levels. There are highly significant negative correlations between shoot fly resistance and trichome intensity ($-0.730<r<-0.817$) and glossiness intensity ($-0.811<r<-0.935$), which indicates that glossiness trait appears to be more important than trichomes for shoot fly resistance in sorghum. The shoot fly resistance is highly positively associated with the number of eggs/plant ($0.921<r<1.000$) which is rather quite an expected situation for a trait like shoot fly resistance since egg laying has its direct bearing on shoot fly damage. Similar results were reported by Sharma et al. (1977)[4].

There is a highly significant positive correlation between glossiness intensity and trichome intensity ($0.815<r<0.833$), indicating that in most cases glossiness and trichomes exist together. This is quite an interesting and important relationship from the viewpoint of shoot fly resistance. Shoot fly egg laying is highly significantly and negatively associated with trichomes ($-0.697<r<-0.752$) and glossiness ($-0.747<r<-0.825$) traits, indicating that both are working as deterring ovipositional non-preference of the shoot fly to sorghum varieties. The role of trichomes as a deterring factor was already suggested by Maiti and Bidinger (1979)[3]. The negative correlation observed between egg laying and glossiness intensity may be caused by the tight positive association of glossiness with trichomes, a deterring factor.

Path analysis (Fig. 1) clearly reveals that

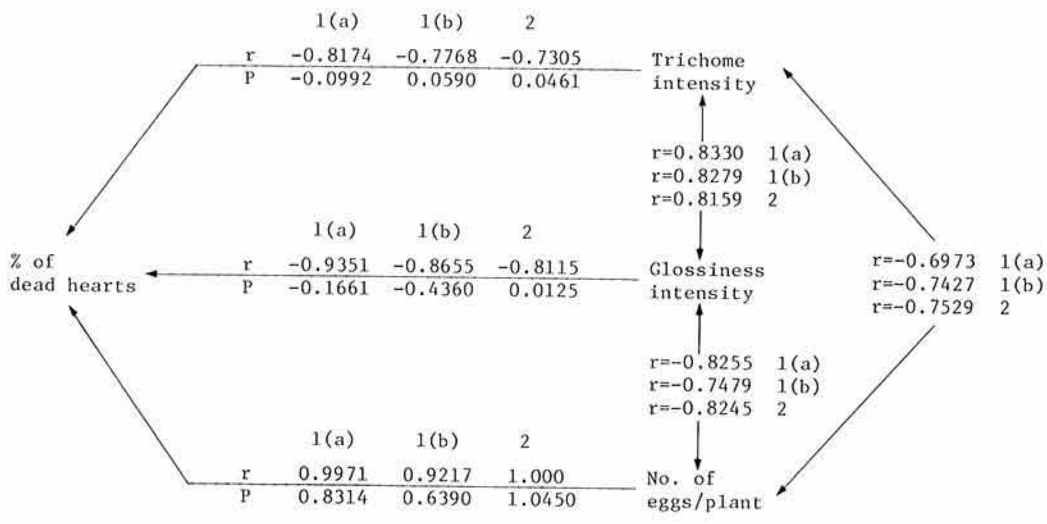

Fig. 1. Path analysis of factors contributing resistance to shoot flies at genotypic level

Note: Experiment No. 1(a) — Conducted during 1980 *Kharif*, 20 genotypes.
Experiment No. 1(b) — Conducted during 1981 *Kharif*, 20 original genotypes + 2 susceptible checks.
Experiment No. 2 — Conducted during 1981 *Kharif*, 32 genotypes.
r — Correlation coefficients.
p — Path coefficients.

the total variability present in shoot fly resistance is largely contributed by the variability present in the number of eggs/plant ($P \geqq 0.639$). Contribution of trichome intensity ($P \leqq 0.059$) and glossiness intensity ($P \leqq 0.012$) to shoot fly resistance is negligible. It appears that they do not play and direct role in building up the total variability in shoot fly resistance, although the correlations of these two traits with shoot fly resistance are very high.

In the present study, the correlations and the path analysis present rather different pictures regarding the major casual factors determining the final expression of shoot fly resistance, and indicate that highly efficient selection for shoot fly resistance could possibly be obtained by formulating selection indices based on the glossiness expressed in seedlings.

Based on both these analyses, it now appears that the high correlation observed between glossiness intensity and shoot fiy resistance is mainly the result of indirect influence of other traits, like trichome intensity and other unknown factors. It may, however, be interpreted from these results that glossy seedling expression in sorghum can be utilized as a simple and reliable selection criterion for the identification of shoot fly resistant plants.

This study is a part of the cooperative research project between ICRISAT and Tropical Agriculture Research Center, Japan, and this paper constitutes a preliminary report.

Acknowledgment

The authors wish to express many thanks to Dr. R. K. Maiti for his valuable advices given to this study.

Summary

Genotypic and phenotypic correlations between shoot fly resistance and three of its componental characters have been estimated in two different sets of material. Two of these componental characters, namely trichome intensity and glossiness intensity, showed negative and significant associations with the shoot fly resistance but do not play any direct role in building up the total variability in the shoot fly resistance. Both the correlation and path analysis showed rather dissimilar pictures of the causal system of the factors governing shoot fly resistance. It is also evident from the results of both these analyses that the major portion of the variability present in shoot fly resistance is contributed by the character: number of eggs/plant. The glossy seedling expression in sorghum can be utilized as a simple and reliable selection criterion for shoot fly resistant plants.

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(Received for publication, May 23, 1983)