Indian J. Plant Prot. VII (2)

A SIMPLE APPROACH TO THE IDENTIFICATION OF SHOOT-FLY TOLERANCE IN SORGHUM

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ABSTRACT

Approximately 8000 lines of world sorghum germ plasm collection were screend for seedling trait resistant to short fly *Atherigona soccata* Rond—a serious pest of sorghum. Most of the genotypes having resistance to shoot fly showed the presence of trichomes on abaxial surface of the leaf. These trichomed cultivars had distinctive characteristics, which were evident only in the first 3 weeks leaves tended to be more errect and narrower, with a yellowish green glossy appearance, which is termed as 'glossy trait'. These two traits are good tools in selecting germ plasm for shoot fly resistanc e.

The sorghum shoot fly *Atherigona soccata* Rond. is an important pest of sorghum in India and Africa. The female fly lays eggs on the underside of sorghum seedling leaves. The larvae migrate down the leaf, enter the whorl and feed on the shoot apex. Affected plants can be recognised by the death of the expanding leaves in the whorl, called the "dead heart". Insecticidal control of shoot fly is not fully effective (Davies 1966, Jotwani 1972) and too costly for the subsistence farmer. Efforts in many parts of the world (House 1980) to identify and use genetic resistance to the shoot fly have had only mixed success. This paper reports on two, apparently additive mechanisms of resistance to this pest, which should significantly improve the prospects for development of cultivars with increased resistance.

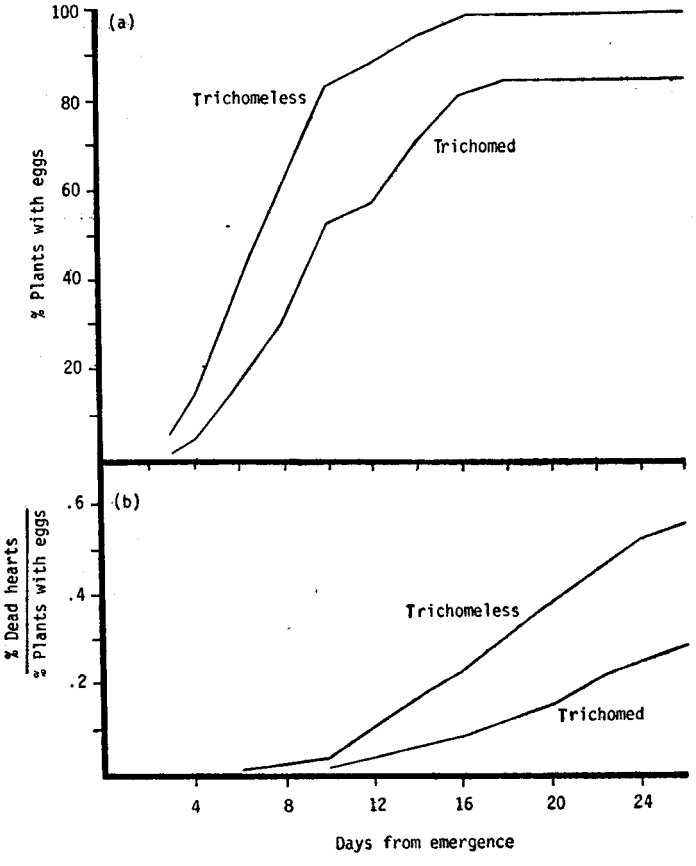
Our earlier observations indicated that many lines having some field resistance to shoot fly had trichomes on the abaxial leaf surface (ICRISAT Annual Report 1977-78). Two earlier mentions have been made of the presence of 'prickle hairs' on the leaf sheath in resistant genotypes, but it was not clear if trichomes were being described (Blum

Approved as Journal Article No. 127 of ICRISAT

1968, Langham 1968). Further experiments with a wider range of materials (germplasm and breeding lines) have confirmed our earlier observations. In a susbstanial number of comparisons, ranging from low (20% dead hearts) to very severe (90+% dead hearts) levels of shoot fly pressure, trichomed lines suffered lower incldence of dead hearts than trichomeless lines.

The presence of trichomes on the leaf surface appears to confer an advantage in two ways : i) by a reduction in egg laying on the leaf, and ii) by a reduction in the frequency with which the presence of eggs result in the death of the shoot. Data from a set of 67 lines (32 of which are trichomed) that were field evaluated for shoot fly resistance under natural levels of infestation illustrate these effect (Fig. 1).

Figure 1. Changes with the effect of 'time' on the mean percentage of plants with eggs (a) and the ratio of percent dead hearts to percent plants with eggs (b) for trichomed (n=32) and trichomeless (n=35) lines.



The percentage of plants with eggs was less in the trichomed lines throughout the experiment. There were also differences between the two types in the percentage of plants with eggs that actually developed dead hearts. The final percentage of plants with dead hearts (the product of the above two parameters) was 24 and 54 for the trichomed and trichomeless lines, respectively.

It was observed that many trichomed lines had distinctive characteristics, which were evident only in the first three weeks after seedling emergence : leaves tended to be more erect and narrower, with a yellowish green, glossy appearance; This seedling type, which we have called "glossy trait" can be easily recognised.

Approximately 8000 lines of the world sorghum germplasm collection were screened for this seedling trait (glossy trait); only 70 such lines were found and those were largely of penninsular Indian origin. Of these, 85% had trichomes on the leaves, confirming earlier observations of the high frequency of association between these two traits. This supports other reports that this seedling type is associated with field resistance to the shoot fly (Rao *et al* 1978, Blum 1972). However, no direct evaluations of this characteristic as a source of resistance have been reported, or the mechanism by which it confers resistance studied.

Table 1. Frequency of glossy lines in groups showing statistically different levels of shoot fly damage

Experiment/cluster	Mean % dead hearts	Number of lines	
		Total	Glossy line
Experiment I	59.5		
Group 1	25.4	34	34
Group 2	44.9	30	25
Group 3	71.2	35	18
Group 4	92.4	36	5
Experiment II	83.5		
Group 1	62.0	17	17
Group 2	76.4	34	32
Group 3	87.6	36	24
Group 4	97.4	33	8

A set of lines and cultivars with and without the 'glossy' trait (including 'glossy' lines found in the germplasm) was assembled and tested for degree of resistance/ susceptibility to shoot fly, under variable shoot fly populations in the field. Different shoot fly pressures were obtained by varying the dates of planting. A cluster analysis procedures (Gates & Bilbro 1978) was used (Teble 1) to group lines with statistically differnt levels of dead heart incidence. The frequency of glossy lines in each group was calculated. In both experiments (and in others not reported here) there was a predominance of glossy lines in the groups with the lower mean percentage of dead hearts, although there were a few glossy lines in each case which fell into the more susceptible groups.

Approximately 85% of the lines in the above experiments with glossy lines were also trichomed ; because of this, it was not clear whether the glossy character itself was responsible for the reduced incidence of dead hearts or whether it simply appears to be so because of the association of the glossy trait and the presence of trichomes. To investigate this possibility, a subset of 40 lines from the orginal set were selected, in which equal numbers of all combinations of .he presence and absence of both the glossy trait and of trichomes were represented. The results of field tests of this subset suggest that the presence of trichomes and the glossy trait have independent and apparently additive effects in reducing the incidence of dead hearts, even under heavy shoot fly pressure

Table 2. Mean percentage of dead hearts for all combinations of the glossy trait and the presence of trichomes

Class	% dead hearts
	Mean ± Se
1. Trichome glossy	60.7 ± 3.2
2. Trichomeless glossy	70.9 ± 3.6
3. Trichome non-glossy	83.5 ± 2.9
4. Trichomeless non-glossy	91.3 ± 1.6
Entire set	76.6 ± 2.4
t test 2 vs. 4	5.17 (p < .01)
3 vs. 4	2.35 (p < .05)
1 vs. 2+3	7.02 (p < .01)

(Table 2). The glossy trait alone (mean of 71% dead hearts) seemed to be more effective than trichomes alone (84% dead hearts) in reducing dead hearts. The combination of both characters however (61% dead hearts) was significantly superior to the mean of the two traits taken singly (Table 2)

We conclude that the incorporation of trichomes and the 'glossy' trait into sorghum breeding lines will improve field resistance to shoot fly. The glossy trait can be easily incorporated as its presence is visible in the seedling stage. Selection for the presence of trichomes requires more effect, as leaf samples must be first cleared by boiling in ethanol and lactic acid, followed by microscopic observation.

REFERENCES

Blum, A. 1968. Anatomical phenomena in seedlings of sorghum varieties resistant to the sorghum shoot fly, *Atherigona varia soccata Crop Sci.* 8. 388-390.

Blum, A. 1972. Sorghum breeding for shoot fly resistance in Israel. In *Control of sorghum shoot fly* (eds. Jotwani, M.G. and Young, W.R.) 180 - 191 (Oxford and IBH, New Delhi).

Davies, J.C. and Jowett, D. 1966. Increases in the incidence of *Atherigona indica infuscata* Emden Diptera (*Anthomyiidae*) on sorghum due to spraying. *Nature* 209. 104 - 105.

Gates, C.E. and Bilbro, J.D. 1978. illuslration of a cluster analysis method for mean separation. *Agron J.* 70: 462 - 465.

International Crops Research Institute for the semi-arid Tropics, Hyderabad, India. Annual report, 1977-78.

Jotwani, M. G. 1972. Seed treatment of sorghum for the control of shoot fly. In *Control of Sorghum Shoot Fly* (eds. Jotwani, M. G., and Young, W. R. 262-273. (Oxford and IBH., New Delhi)

Langham, R. M. Unpublished M.Sc. thesis (Ahmahdu Bello University, Zaria, Nigeria, 1968).

Rao, N. G. P., Rana, B. S. and Jotwani, M. G. 1978. Host resistance to major insect pests of sorghum. In Plant breeding for resistance to insect pests : considerations of the use of induced mutation, 63-78 (International Atomic Energy Agency, Vienna).

Authors wish to acknowledge the encouragement received from Dr. J.S. Kanwar and Dr. L. R. House and thanks to Messrs G. Anjaih, P. S. Raju, K. E. Prasad Rao and Dr. K. V. Sheshu Reddy.