MIDGE RESISTANCE AND HYDROCYANIC ACID CONTENT OF *SORGHUM BICOLOR*

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Sorghum midge (*Stenodiplosis sorghicola* [Coquillett]) is found in most countries where sorghum (*Sorghum bicolor* L. Moench) is grown (Doggett 1988). A number of sorghum lines resistant to the sorghum midge have been identified (Teetes 1985). Various mechanisms have been proposed for midge resistance, including cleistogamy, nonpreference, antibiosis, tannin content, and glume size and tightness (Doggett 1988 and Teetes 1985).

Dhurrin[p-hydroxy-(S)-mandelonitrile-$-D-glucoside] is the cyanogen of sorghum (Gorz et al. 1977) that is enzymatically hydrolyzed to cyanide and p-hydroxybenzaldehyde (p-HB) when cellular integrity is interrupted (Wajant et al. 1994). Gorz et al. (1977) reviewed studies that showed colorimetric methods can be used to determine cyanogen content or hydrocyanic acid potential (HCN-p) in plant tissue.

In an unrelated study in search for cyclic hydroxamic acids (e.g., DIMBOA), the second author (M. D. Richardson) found that midge resistant sorghum genotypes, Huerin and Tift MR88, produced 0.52 and 0.78 mg p-HB while midge intermediate (genotype 1821 cm) and midge susceptible (Tx623B) genotypes produced 0.18 and 0.15 mg p-HB per g fresh weight [LSD(0.05) = 0.10], respectively (unpublished data). The objective of this study was to determine whether resistance to sorghum midge may be related to HCN levels.

In this study, three replications (pots) of 10 genotypes (Table 1) of sorghum with varying levels of midge resistance were planted in 20 cm wide plastic pots in the greenhouse on 17 Nov 1993 in a randomized complete block design. Plants were thinned to six plants per pot at ten days after planting. Response of the genotypes to midge (Table 1) were determined in a previous unpublished study, where a rating of 0 = resistant and 9 = susceptible. These entries were part of a larger experiment arranged in a randomized complete block with four replications where genotypes were rated for midge resistance under natural midge infestation at Tifton, Georgia. All genotypes in this study were inbred lines except DeKalb E57, Hyperformer, AgraTech 712G and Pioneer 8333 which were F_1 hybrids. Plants were grown under uniform temperature (28 to 30E C) and moisture conditions in the greenhouse. Plants were fertilized with a complete water-soluble fertilizer to maintain healthy growth. HCN contents were analyzed by analysis of variance procedures (SAS Institute, Inc., 1985) to evaluate genotype effects. Differences between genotype means were separated by the least significance difference (LSD) test at the 0.05 probability level.

Leaf discs from non-expanded leaves of the six plants (50 days old) in a pot were cut with a #3 cork cutter and placed in 10 ml test tubes. Leaf tissue from each genotype in each replication weighed 0.07 g. No significant differences in dry weights of the leaf tissue were observed among replications and genotypes. Four drops of chloroform were added to each test tube. We used the colorimetric technique and standards described by Hogg and Ahlgren (1942). HCN content of the solutions were determined using a Milton Roy Company Spectronic 501 at 540 nm with Mr. Sipper.

TABLE 1. HYDROCYANIC ACID (HCN) CONTENT OF SORGHUM GENOTYPES WITH VARYING LEVELS OF MIDGE RESISTANCE.

Genotype	Sorghum	
	Response to midge[†]	HCN content (mg/g fresh weight)[‡]
DeKalb E57	9.0 a	0.11 ± 0.05 e
Pioneer 8333	8.3 a	0.19 ± 0.01 d
AgraTech 712G	8.0 a	0.19 ± 0.02 d
1821 cm	6.0 b	0.23 ± 0.05 cd
Hyperformer	5.8 b	0.19 ± 0.01 d
Tift 9110	3.3 c	0.26 ± 0.01 cd
Huerin	3.0 cd	0.39 ± 0.04 a
TAM 2566	2.5 cd	0.34 ± 0.04 ab
Tift MR88	2.0 d	0.26 ± 0.01 cd
PI383856 (AF28)	0.3 e	0.29 ± 0.01 bc

[†]Ratings from unrelated-unpublished study where 0 = resistant and 9 = susceptible.
[‡]Mean ± SE.
Means in each column followed by same letter are not different at P = 0.05.

The sorghum genotypes most resistant (with rating of 3.3 or lower) to the sorghum midge had numerically higher HCN content than the more susceptible (with ratings of 5.8 or above) genotypes (Table 1). The most midge-susceptible genotype, DeKalb E57, had significantly (P= 0.05) lower HCN content than the remainder of the genotypes. Midge-resistant genotypes TAM 2566 and Huerin had significantly higher levels of HCN than all of the more susceptible (rating of 5.8 or higher) genotypes. The HCN content of midge-resistant genotypes Tift MR88 and Tift 9110 was numerically higher but not significantly different from susceptible genotypes Hyperformer, AgraTech 712G, Pioneer 8333 or 1821 cm. It appears that HCN may be related to resistance in sorghum to the sorghum midge and that this resistance may be imparted at a certain threshold level of HCN. It may be argued that this study measured HCN in the leaves which may not relate to HCN levels in the panicle. We could not determine the HCN-p in the panicles of the test genotypes at the same time in this study because of the broad range in days to flowering among the genotypes. We did test the HCN level in the florets of 1821 cm and found it to be 0. 21 mg HCN per gram fresh weight which is slightly less than observed in the leaf tissue (Table 1).

It is known that cyanogenic compounds enzymatically release cyanide as a cell is damaged by a factor such as a feeding insect (Wajant et al. 1994). This localized release of cyanide at an injury site could produce the chemical barrier necessary to prevent further damage by the insect. Cyanogenic compounds are but one example of the many secondary plant metabolites that protect plants against various biotic pests. Further work is needed to determine the relationship of HCN and/or p-hydroxybenzaldehyde in sorghum panicles to midge resistance and to assess the variability for these compounds among a wide range of sorghum germplasms. The authors acknowledge the laboratory assistance of Jacolyn Merriman and Ellen Tucker.

SUMMARY

Two sorghum genotypes highly resistant to sorghum midge had significantly higher levels of hydrocyanic acid than a highly susceptible genotype. It appeared that sorghum midge resistance in sorghum may be related to a threshold level of hydrocyanic acid.

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