

cage about 1 m wide, 1.5 m long, and 0.5 m deep. The cage, which prevented damage by birds or rodents but allowed full exposure to the environment, was placed on the ground in a field near Virginia, Nebraska, where ergot had been observed. The winter of 1997/98 was only slightly milder than normal. The average daily temperatures for January, the month with the lowest temperatures, were a low of -8°C and a high of 2°C. The extreme low temperature for the winter was -26°C. The panicles were exposed to rain, snow, sun, and repeated freezing and thawing. At intervals ranging from 2 to 4 weeks, samples of 8 to 12 panicles were brought into the laboratory and spores washed from the panicles were used to inoculate potted sorghum plants in the greenhouse. During several collections the panicles in the cage were found to be partially covered with ice and snow. The March sampling was missed because the cage was under a 1 m deep drift of snow. With the first samplings 10-15 florets with signs of ergot were removed from the panicles and after soaking in 15 ml of water for 1 h the spore suspension was filtered through cheesecloth and used to inoculate three to five panicles of a male-sterile forage sorghum, var Sweet Leaf 11, that had just begun bloom. With the later samplings, weathering had so damaged the appearance of the panicles that the infected florets could not be identified. For those collections, 8-10 whole panicles were soaked for 1 h in 300 ml of water in a graduated cylinder. After agitation the spore suspension was filtered and centrifuged to concentrate the spores. For all samplings an attempt was made to have a spore suspension of at least 10⁶ spores per ml. Nearly all of the spores from the early sampling were microspores, while the later samplings had a large number of all types of fungal spores, and identification and counting was difficult. Inoculation was accomplished by enclosing the panicle in a 4-L plastic bag and, after cutting a small hole to admit the nozzle of an atomizer, the spore suspension was sprayed over the florets. After 24 h the bags were removed and the plants maintained with supplemental light in a humidified greenhouse held at 23°C. At each sampling date a positive control, using macrospores from fresh honeydew at approximately the same concentration as the field sample, was included in the trial to test the effectiveness of the inoculation method.

Results and discussion

At each trial date the control panicles inoculated with the fresh macrospore suspension developed good levels of ergot infection as evidenced by 5-20 infected florets per panicle. Survival of viable spores in the field was

demonstrated by five or more infections per panicle from the samples tested in December and early January but the late January sample had only three infected florets on five panicles. The February, April, and May samplings were obtained by washing whole panicles and concentrating the spores by centrifugation. This led to a more concentrated inoculum and all of these samplings resulted in numerous infections indicating that the spores were still virulent until the end of testing on 20 May 1998.

These results only indicate that viable infectious spores did survive the winter of 1997/98 in Nebraska after full exposure to the elements of the weather. We have not proven that natural infection will occur from overwintering spores under field conditions, but we have demonstrated that it is possible. These trials will be repeated

Reference

Bandyopadhyay, R., Frederickson, D.E., McLaren, N.W., Odvody, G.N., and Ryley, M.J. 1998. Ergot: a new disease threat to sorghum in the Americas and Australia. *Plant Disease* 82:356-367.

Entomology

Association of Grain Size and Levels of Resistance to the Sorghum Midge

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There has been a commonly held concern that increased levels of resistance to the sorghum midge (*Stenodiplosis sorghicola* Coquillett) have resulted in decreased grain size. This assertion was examined in three separate situations.

1. Farmer deliveries

Screenings (this is a measure of grain size being the percent volume of grain passing through a 2 mm slotted sieve) and hybrid name data were collected on 3123

fanner deliveries of sorghum (*Sorghumbicolor(L.) Moench*) to four depots in Central Queensland in 1996. Percent screenings is routinely assessed for farmer deliveries. Samples with screenings above 11% are docked; so grain size is a significant farmer issue.

The level of resistance for each of the hybrids had been measured in a standardized test developed by the seed industry and the Queensland Department of Primary Industries (QDPI). The level of resistance varied from a Midge Tested Rating of 1 (i.e., susceptible) to 7 (i.e., an economic injury level seven times that of a susceptible hybrid).

The correlation between the level of midge resistance and percent screenings varied amongst the four depots, being 0.29, -0.16, -0.40, and -0.55. The reasons for this variation are unknown. The negative correlations (i.e., where the resistant hybrids had larger grains) may be due to the fact that the hybrids with the higher levels of resistance also had higher levels of stay-green. Dr Andrew Borrell (personal communication) has data from a set of recombinant inbred lines suggesting stay-green results in larger grain under terminal water stress conditions.

2. Tests involving experimental hybrids

Percent screenings was measured on a set of 200 experimental hybrids from the QDPI sorghum breeding program grown at four test sites in 1997. The midge resistance of these hybrids was measured in another two tests designed for the purpose. The results (Table 1) clearly show there is no correlation between percent screenings and midge resistance.

3. Tests involving recombinant lines

The level of midge resistance of a set of 160 random recombinant inbred lines from the cross QL41 x QL39 was tested as part of the molecular marker project. Grain

Table 1. Correlations between midge resistance and percent screenings of a set of 200 experimental sorghum hybrids in Australia, 1997.

Test site	Correlation
Bauhinia	0.17
Biloela	0.06
Dalby	-0.07
Bongeen	0.11

size for these same lines was measured in Dr Andrew Borrell's "Physiology of Stay-green" project and as part of the molecular marker project.

This data indicated no relationship ($r = 0.03$) between midge resistance and grain size. Correlations calculated from data on random recombinant lines are more likely to indicate the relationship between the midge resistance and grain size genes. This is because possible 'background' genes affecting grain size will be distributed more at random across the midge resistance genes than they would be amongst genotypes in which there may have been some selection for grain size and midge resistance.

Conclusions

There is clearly no relationship between the level of midge resistance and grain size in these test conditions and with the genetic backgrounds involved. The perception that there may have been, may be due to the fact that a number of the sources of midge resistance had small grain. It follows that it is possible to develop sorghums with high levels of midge resistance and large grain size.

Association of Sorghum Seedling Characters with Resistance to Shoot Fly, *Atherigona soccata* (Rondani)

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The sorghum shoot fly, *Atherigona soccata* (Rondani) (Muscidae: Diptera) is an important pest of sorghum (*Sorghum bicolor* (L.) Moench) causing substantial reduction in crop yield. Plant resistance to insect pests is an important component of integrated pest management. The relationship of various plant characters with shoot fly resistance has been studied earlier by many workers (Khurana and Verma 1985; Singh 1986; Patel and Sukhani 1990). The present investigations were undertaken to identify the stage and physical characters of sorghum seedlings that are associated with shoot fly resistance.

Materials and methods

Field trials were conducted at the Forage Research Area, CCS Haryana Agricultural University, Hisar, Haryana,