Project no. **M131/03**

Project title: **Screening South African sorghum cultivars for the sorghum aphid, *Melanaphis sacchari* (Zehntner).**

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Extended abstract:

A greenhouse trial was conducted to evaluate resistance to sugarcane aphid during the seedling stage under artificial aphid infestation. Fifty two percent of the 25 local commercial sorghum hybrids evaluated, have a level of resistant to sugarcane aphid. The same hybrids used in the greenhouse trial were evaluated on station at the Grain Crops Institute, Potchefstroom for resistance to aphids. Aphid damage ratings, yield and percentage yield loss were determined to differentiate between hybrids. Yield loss percentage was determined by splitting the trial in an aphid-infested and uninfested part by spraying the latter with insecticide. Aphid infestation was natural and high. The aphids did however not remain for a long period on the plants as a result of continuous rain. Yield loss as the tolerance indicator was therefore not reliable, but there were differences in aphid damage ratings which served as the antibiosis indicator. Aphid infestation did not remain for a long period of time on the different hybrids, yield losses may therefore be as a result of factors other than aphid infestation. Since trials were conducted under natural conditions, damage by other insects, for example sorghum midge was not excluded. Percentage yield loss calculated could therefore not be a true reflection of damage caused by aphids only and could be attributed to damage caused by feeding of the total insect complex present in the field. These factors hamper accurate conclusions from field trials where yield loss is used as a component to determine resistance. Exact data on yield loss as a result of aphid infestation could only be achieved under controlled

conditions where all insects except aphids can be excluded and rain during the period of aphid infestation avoided.

Introduction

Millions of rands are spend annually on chemical control of *Melanaphis sacchari* (Zehntner) in South Africa. Identification of aphid-resistant or tolerant sorghum hybrids will contribute to reduce yield losses as well as potentially negative effects of aphid damage on sorghum grain quality. It will also contribute towards optimization of input costs in sorghum production. The four important factors listed by Deutsch (1989) in determining farmers' need for resistant cultivars are:

i) yield loss of currently grown cultivars as a result of insect damage,
ii) frequency and severity of yield loss,
iii) other control measures that are affordable and
iv) effective short-term solutions.

The objective of this project was to determine the current levels of resistance to *M. sacchari* in South African sorghum hybrids.

Materials and methods

Greenhouse trial

Resistance to sugarcane aphid was evaluated during the seedling stage of sorghum under artificial aphid infestation. Twenty-five hybrids, the INTSORMIL line TAM 428 as well as Segaolane, a local Botswana sorghum genotype used as the resistant and susceptible checks, respectively, were planted in containers (0.5 m x 0.3 m x 0.1 m) with an inter-row spacing of 6 cm and with 2 cm space between seedlings. There were 15 seedlings per row. The trial was a randomized block design with three replicates. Plants were infested with aphids four days after emergence. Sugarcane aphids were reared on the hybrid Mr Buster in a greenhouse and were brushed from detached leaves of infested plants onto the rows of seedlings. Approximately 250 aphids of different instars were brushed onto each row (approximately 16 aphids per seedling). Plants were rated for aphid abundance and damage 21 days after infestation. The rating scale described by Teetes (1980) for evaluation of sorghum to greenbug, *Schizaphis graminum* (Rondani), proved applicable to rate aphid abundance as well as plant damage. Aphid abundance on plants as well as plant damage in each row were rated on a scale of 1 to 6, where 1 = 0-10 % leaf necrosis or plant tissue covered by aphids, 2 = 11-25 %, 3 = 26-50 %, 4 = 51 – 70 %, 5 = 71 – 90 %, 6 = 91 – 100 % leaf necrosis or plant tissue covered by aphids. Sorghum lines rated 1.0-2.0 were considered highly resistant, 2.1-3.0 resistant, 3.1-4.0 slightly resistant, 4.1-5.0 susceptible, and 5.1-6.0 highly susceptible.

Field trials

Two field trials were conducted for evaluation for aphid resistance under natural infestation conditions at Potchefstroom during the 2005/2006 season with twenty-five sorghum hybrids each. Long growers were planted on 15 November 2005 and the short growers on 25 November 2005 (Trial 1). The planting dates for Trial 2 were 29 November 2005 (long growers) and 9 December 2005 (short growers) (Trial 2). Inter-row spacing was 1.0 m and intra-row 0.15 m. Single rows of 12 m were planted. The experimental design was a randomized block, split-plot with three replicates of each hybrid. One sub-treatment (split – plot) was sprayed with a systemic insecticide to prevent aphid infestation in order to serve as an uninfested control for the calculation of yield loss. Demeton-S-methyl EC was applied at a rate of 250 g a.i.ha^{-1} during the flag leave stage before the onset of aphid infestation. The application was repeated two weeks later. The other sub-treatment was allowed to become naturally infested by aphids. Aphid damage was evaluated when the majority of the hybrids were flowering. The severity of aphid damage was evaluated using a 1 to 5 scale where, 1 = no aphids present on plants, 2 = light infestation with aphids present on a few leaves (no dead leaves), 3 = moderate infestation with many aphids present on two or three leaves (one or two dead leaves may be present), 4 = high infestation with many aphids on nearly all leaves (many dead leaves) and 5 = majority of plants in plot dying. Plants with a rating of 1 or 2 were considered to be resistant to damage while a rating of 3 indicated intermediate levels of resistance. Plants with a rating of 4 and 5 were considered to be susceptible (Van den Berg, 2002).

Grain yield was determined for each hybrid by harvesting 10 m of each row. Data on yield of infested and uninfested plants were analysed by means of a factorial analysis of variance, with treatment (aphid infested vs. protected) and cultivar as main effects. Yield loss was calculated in relation to the insecticide-treated plots of each hybrid and expressed as a percentage.

Results and discussion

Greenhouse trial

There were differences in aphid abundance and plant damage ratings among sorghum hybrids, indicating the existence of resistance sources. The susceptible Segaolane scored 6.0 and TAM 428, the resistant check scored 1 in both categories (Table 1). Based on aphid abundance, 36 % of the sorghum entries rated 1 (highly resistant), 16 % rated 2 (also highly resistant), 8 % rated 5 (susceptible) and 40 % rated 6 (highly susceptible) for aphid abundance. In terms of plant damage, 52 % of the entries rated 1 (highly resistant), 12 % rated 3 (resistant), 8 % rated 5 (susceptible) and 28 % rated 6 (highly susceptible) in the greenhouse trial (Table 1). Thirteen of the twenty-five hybrids (52 %) had both aphid abundance and plant damage ratings that ranged from 1.0 to 4.0. All of those hybrids therefore, have a level of resistance to sugarcane aphid.

Field trials

Yield, percentage yield loss (calculated as the difference between yield of the sprayed control and those of aphid-infested hybrids) and levels of resistance of South African sorghum hybrids determined in the two field trials are provided in Table 2 (Trial 1) and Table 3 (Trial 2) respectively. There were significant differences in yield of uninfested South African sorghum hybrids ($P<0.05$) that ranged between 2.35 and 5.72 t ha^{-1} for Trial 1 and 2.55 and 5.17 t ha^{-1} for Trial 2. Percentage yield loss varied between an 0.78 % increase in yield and 22.33 % yield loss in Trial 1 and an 3 % increase in yield and 19.21 % yield loss in Trial 2. The hybrid NS5511 had a high yield in both trials, but scored the highest possible aphid damage rating as well. Although infestation levels of aphids were high, the infestation remained for a very short period of time (during which the ratings were done), before continuous rain commenced. Within days after the rain started, the aphids disappeared. This also explains the low percentage yield losses of the majority of the hybrids and in some instances an increase in yield of aphid-infested hybrids. Yield loss as the tolerance indicator for both trials, was therefore not reliable. Hybrids that had an aphid damage rating of 4 and higher in both trials were NS 5655, PAN 8648, OVERFLOW and NS 5511, indicating that they are susceptible to aphids (antibiosis indicator).

Summary

Sorghum cultivars were screened successfully for aphid abundance and plant damage during the seedling stage to indicate the existence of resistance sources. Aphid damage ratings were also conducted successfully under field conditions. Yield loss (indicator of tolerance) as a result of aphid infestations was not accurate under field conditions for both trials evaluated. The presence of an insect complex, including panicle-feeding insects under field conditions makes it impossible to attribute yield loss to aphids only. There may also be seasonal variation in yield response of grain sorghum to aphid damage. Rain reduces aphid numbers and will therefore influence field data negatively. These factors make accurate conclusions from field trials tough where yield loss is used as a determining factor for resistance. Exact data on yield loss as a result of aphid infestation could only be achieved under controlled conditions where all insects except aphids can be excluded and rain during the period of aphid infestation avoided.

References

Van den Berg, J. 2002. Status of resistance of sorghum hybrids to the aphid, *Melanaphis sacchari* (Zehntner) (Homoptera: Aphididae). *S. Afr. J. Plant Soil* 19, 151-155.

Table 1. Resistance ratings of sorghum hybrids and two lines used as checks, evaluated in a greenhouse trial.

Hybrid	Average leaf necrosis rating	Average aphid abundance rating
PAN 8816	1.0	1.0
PAN 8806	1.0	1.0
PAN 8609	1.0	1.0
PAN 8247	6.0	6.0
NS 5511	4.8	6.0
PAN 8446	1.0	1.0
PAN 8564	1.0	1.0
PAN 8123	1.0	1.0
PAN 8420	1.0	1.0
BANJO	1.0	1.0
PAN 8229	4.5	4.8
PAN 8706 W	6.0	6.0
PAN 8625	5.0	6.0
PAN 8648	6.0	6.0
NS 5655	6.0	6.0
PAN 8738	6.0	6.0
PAN 8534	1.0	1.5
OVERFLOW	3.3	5.0
PAN 8346	5.5	6.0
PAN 8141	2.5	6.0
PAN 8043	3.5	6.0
PAN 8250	1.0	2.0
PAN 8851	1.0	1.5
PAN 8353	1.0	1.5
PAN 8553 W	1.0	1.0
TAM 428	1.0	1.0
Segaolane	5.8	6.0

Table 2. Yield, percentage yield loss and levels of resistance of South African sorghum hybrids (Trial 1).

Hybrid	Yield (t/ha)	% Yield loss	Aphid damage rating
NS 5655	2.35 a	5.29	5.00
PAN 8706	3.08 ab	4.05	4.00
PAN 8141	3.56 bc	0.93	3.33
PAN 8250	3.58 bc	1.25	1.67
PAN 8420	3.69bcd	0.11	1.00
PAN 8346	3.76 bcd	-0.78	3.00
PAN 8043	3.79 bcd	1.02	2.00
PAN 8247	3.82 bcd	1.49	4.00
PAN 8738	3.86 bcd	9.87	4.00
PAN 8534	3.92 bcd	4.61	2.33
PAN 8229	3.99 bcd	0.37	4.00
PAN 8353	4.05 bcd	1.22	2.33
PAN 8123	4.07 bcd	8.11	2.33
PAN 8609	4.08 bcd	6.18	2.00
PAN 8851	4.10 bcd	5.57	1.33
PAN 8648	4.10 bcd	8.17	4.33
PAN 8816	4.14 cd	2.29	1.67
BANJO	4.35 cde	16.22	3.00
PAN 8553	4.47 cde	2.88	1.33
PAN 8446	4.50cde	0.00	1.33
OVERFLOW	4.55 cde	22.33	4.33
PAN 8564	4.56 cde	1.10	2.00
PAN 8806	4.61 de	4.33	2.00
NS 5511	5.23 ef	14.86	5.00
PAN 8625	5.72 f	8.23	3.00

Table 3. Yield, percentage yield loss and levels of resistance of South African sorghum hybrids (Trial 2).

Hybrid	Yield (t/ha)	% Yield loss	Aphid damage rating
PAN 8353	2.55 a	0.50	1.00
PAN 8250	2.78 ab	2.03	1.00
PAN 8706	2.86 abc	15.02	3.00
PAN 8553	3.10 abcd	2.56	1.00
NS 5655	3.13 abcde	18.39	4.00
PAN 8420	3.21 abcde	-3.00	1.00
PAN 8851	3.39 abcdef	10.85	1.33
PAN 8346	3.4 abcdef	1.74	3.33
PAN 8806	3.41 abcdef	5.00	1.33
PAN 8141	3.50 abcdef	4.47	2.33
PAN 8738	3.56 abcdef	10.21	3.33
PAN 8816	3.63abcdefg	-0.90	1.00
BANJO	3.74 bcdefg	5.12	2.67
PAN 8043	3.81 bcdefg	6.82	2.00
PAN 8247	3.82 bcdefg	1.11	3.67
PAN 8564	3.91 cdefg	2.47	1.33
PAN 8609	3.97 defg	6.12	1.33
PAN 8123	3.97 defg	4.89	1.33
PAN 8648	4.02 defg	19.21	4.67
PAN 8534	4.05 defg	5.65	1.33
PAN 8229	4.18 defgh	8.61	3.67
OVERFLOW	4.20 efgh	14.05	5.00
PAN 8446	4.31 fgh	0.54	1.00
PAN 8625	4.69 gh	1.00	2.00
NS 5511	5.17 h	14.81	5.00