SHORT NON-REFEREED PAPER

QUANTIFYING YIELD LOSS TO YELLOW SUGARCANE APHID IN POTTED SUGARCANE

MADIOPE, KW[1,2], KEEPING MG[2,3] AND FOURIE DV[1]

[1]*Department of Zoology and Entomology, University of the Free State, Bloemfontein, 9300, Free State*
[2]*South African Sugarcane Research Institute, Mount Edgecombe, 4300, South Africa*
[3]*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, 2050, South Africa*

2011037765@ufs4life.ac.za malcolm.keeping@sugar.org.za FourieDV@ufs.ac.za

Abstract

Crop damage by yellow sugarcane aphid (YSA) (*Sipha flava* (Forbes); Hemiptera: Aphididae) in southern African sugarcane has increased markedly over the past few seasons. In 2013, YSA was discovered on sugarcane at Mount Edgecombe (KwaZulu-Natal) in South Africa (Way *et al.*, 2014). However, its impact on commercial sugarcane production in African countries has not yet been quantified. This study considered the likely severe economic impact of YSA on southern African sugarcane, and aimed to quantify the biomass yield loss caused by YSA in potted sugarcane of a South African variety that is susceptible to YSA damage, as a proxy of potential loss in commercial fields. The experiment evaluated yield loss in potted sugarcane that was artificially infested with YSA, compared with uninfested plants, under caged conditions in a glasshouse environment.

The results showed that sugarcane dry leaf and stalk biomass yield were both significantly reduced by 44%, and that fresh leaf and stalk mass were reduced by 50% and 45%, respectively, in infested plants, compared with uninfested control plants. This demonstrates that YSA has the potential to greatly reduce yields, especially when infestations occur in young cane. The study highlights the likely severe economic impact of YSA infestation on commercial sugarcane production in South Africa.

Keywords: *Sipha flava*, Aphididae, Infestation, Leaf damage, Economic damage, Biomass yield.

Introduction

Growers have raised their concern over the effects of yellow sugarcane aphid (YSA), *Sipha flava* (Forbes) (Hemiptera: Aphididae), on cane and sucrose yields. Research in the United States indicates that yield reductions due to YSA feeding damage are usually as a result of infestations during the early plant growth stages (Wilson, 2019). Infestation within the first three months of growth and with two out of six leaves below the Top Visible Dewlap (TVD) having >50% damage, was enough to reduce sugar content at harvest by up to 6%, while more extensive damage with all six out of the six leaves below the TVD with >50% damage early in the season, reduced yields by 19% (Nuessly and Hentz, 2002). Hall (2001) found that the height of the primary shoot of young potted sugarcane plants infested with an average of 99.2 aphids was reduced by 36.2%, and in dry mass by 71.7%, compared with uninfested plants after a three-week period of exposure to YSA. The regeneration of shoots of infested plants after harvest was only 35.3%, compared to the 94.1% regeneration of uninfested plants (Hall, 2001). Yield losses due to a severe YSA outbreak in Puerto Rico during 1964 were estimated

at US$1,200,000, where 1600 to 2020 ha of young cane were destroyed by YSA and 20,200 ha were infested by the aphid (Gaud *et al.*, 1965).

There is no quantitative information on the effect of YSA on sugarcane yield elsewhere, or in South Africa. Due to the difficulties experienced in determining yield loss in field trials established during 2014 in the Pongola and Gingindhlovu areas (KwaZulu-Natal, South Africa) - principally as a result of the insect's patchy, unpredictable infestations - the present study, as in Hall (2001), used potted sugarcane that was artificially infested with YSA as a means of obtaining an estimate of yield loss.

Methods

Single seedlings of a YSA-susceptible sugarcane variety (N42) were planted in 6 L pots filled with a sand-and-compost mix and grown in a glasshouse inside insect-proof cages (bugdorm®, 47.5 x 47.5 x 93.0 cm, Megaview Science Co., Taiwan). After one month of growth, the plants were either artificially infested with YSA or left uninfested, and placed in a randomised design, with six replications (= a total of 12 pots). The infested plants were inoculated with ten late nymphal stadium aphids each, which were placed onto the upper surface of the lower leaves. When inoculating the plants, the largest and most active individuals were directly transferred from a petri dish stocked with aphids from a nearby sugarcane field, using a fine paint brush.

The aphids were monitored by means of daily inspections, along with the damage caused, until such time as about 50-60% of leaf area had been damaged. At this stage, all the aphids were removed from the infested plants using a Craftsman Hand Vacuum (Craftsman, Illinois, USA), and they were later counted per plant in the laboratory. The date of removal of aphids from the plants varied because the rate of development of the infestation and the time taken to achieve equivalent leaf damage varied between plants. On average, aphids were left to feed on the plants for 37 days. Following aphid removal, all plants were returned to their original cages in the glasshouse, where they were left to continue growing for a further 100 to 120 days post-aphid-removal. Thereafter, the plants were harvested on the same day to measure the number of tillers, stalk fresh mass, stalk dry mass, stalk length, stalk diameter (at 30mm height from the base), green leaf fresh mass, green leaf dry mass, number of non-senesced (green and/or aphid-damaged) leaves, and number of dead leaves in infested and uninfested plants.

ANOVA was performed on the results to compare the above yield variables between the infested and uninfested plants

Results

A mean of 7226 aphids was collected per infested plant (range: 5992 to 9182, n=6 plants). Stalk fresh mass, stalk dry mass, green leaf fresh mass, green leaf dry mass, and stalk diameter were significantly reduced in the infested plants, compared to the uninfested plants (Table 1). There was a large percentage decrease in stalk fresh and dry mass, as well as green leaf fresh and dry mass in infested plants (Table 1), which demonstrates that feeding by YSA greatly reduced the shoot biomass yield.

Table 1: Mean values, ANOVA P values, and percentage decreases between uninfested and YSA-infested plants for sugarcane yield-related variables

Sugarcane Variables	Control	YSA-infested	P value	Percentage difference
Stalk fresh mass (g)	219.7	109.8	0.054	50.0
Stalk dry mass (g)	35.3	19.8	0.037	43.9
Stalk length (cm)	66.3	63.5	0.638	4.2
Stalk diameter (mm)	17.1	13.2	0.004	22.6
Total No. of stalks	3	2	0.374	27.7
Green leaf fresh mass (g)	548.3	300.8	0.035	45.1
Green leaf dry mass (g)	113.2	63.3	0.032	44.1
Dead leaf mass (g)	31.3	26.2	0.493	16.3
No. of non-senesced (green and/or aphid-damaged) leaves	41	32	0.311	21.5
No. of dead leaves	27	22	0.391	17.7
Total No. of leaves	68	54	0.176	19.9

Discussion and Conclusions

The results demonstrated that YSA feeding has the potential to greatly reduce yields where infestations occur in young cane. They also provide the first quantitative evidence for the negative effects of YSA damage on plant growth in South African sugarcane. In the USA, Hall (2001) recorded a substantial (71.7%) reduction in stalk dry mass in young YSA-infested potted plants, compared to uninfested plants, following three weeks of YSA feeding. Nuessly and Hentz (2002) subjected two-month-old potted sugarcane to YSA feeding for eight to ten weeks and then transplanted the plants into the field, where they were kept aphid-free for seven months. The authors found that YSA feeding resulted in thinner and lighter stalks, as in the present study, and a sucrose loss of up to 19% where the damage was excessive. Our study also showed that even after the aphids had been removed for three to four months, the sugarcane suffered a significant loss in shoot mass. A knowledge of yield losses to YSA is critical for developing management strategies against the pest, and further field-based studies are required. Such knowledge will incentivise farmers to adopt pro-active YSA monitoring and management, which will benefit their own operations in the long-term, as well as the industry, in general.

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References

Gaud SM, Martorell LF and Robles RB (1965). Notes on the biology and control of the yellow aphid of sugarcane, *Sipha flava* (Forbes), in Puerto Rico. *Proc Int Soc Sug Cane Technol* 12: 1307-1320.

Hall DG (2001). Notes on the yellow sugarcane aphid *Sipha flava* (Homoptera: Aphididae) and the lady beetle *Diomus terminatus* (Coleoptera: Coccinellidae) in Florida. *J Am Soc Sug Technol* 21: 21-29.

Nuessly G and Hentz M (2002). Feeding effects of yellow sugarcane aphids on sugarcane. *J Am Soc Sug Technol* 22: 126-127.

Way MJ, Conlong DE, Martin LA, McFarlane SA, Stranack R, Keeping MG and Rutherford RS (2014). First record of yellow sugarcane aphid, *Sipha flava* (Homoptera: Aphididae), in the South African sugarcane industry. *Proc S Afr Sug Technol Assoc* 87: 53-57.

Wilson BE (2019). Hemipteran pests of sugarcane in North America. *Insects* 10: 107.