

The influence of plant volatiles on some indigenous heteropterans in avocados

FA Botha¹, BM Botha² and PS Schoeman³

¹SUBTROP

PO Box 866, Tzaneen 0850, SOUTH AFRICA

E-mail: andre@subtrop.co.za

²Tshwane University of Technology

Private Bag X680, Pretoria 0001, SOUTH AFRICA

E-mail: bothabm@tut.ac.za

³Pest Management Division,

Agricultural Research Council – Institute for Tropical and Subtropical Crops,

Private Bag X11208, Nelspruit 1200, SOUTH AFRICA

E-mail: schalk@arc.agric.za

ABSTRACT

Stink bugs have the ability to move around freely between the different crops and orchards and poses a threat to the subtropical industry. They have a high damage potential and utilise a wide variety of host plants in an eco-system, therefore they are considered as generalist feeders. They are difficult to monitor and even more difficult to control in a commercial environment.

A survey was done in the Nelspruit area on indigenous and exotic host plants to determine the presence of stink bugs and the preference of the insects during certain times or phenological stages of the plants, whether they are attracted by food, seeking shelter or for mating.

The volatile profiles of the different plant species were then quantified and compared to determine when the stink bugs are most attracted to the plants. The compounds that were found were then subjected to electro-antennographic studies at Tshwane University of Technology (TUT) for responses to either single or a blend of compounds on live insect antenna. The volatile profiles were taken over a whole season at all the critical stages when the insects were either in the avocado orchards or not.

INTRODUCTION

The data collected represents a whole season from when the flowers emerged to harvest, as well as an orchard profile. Some local information is currently available regarding the migratory habits of stink bug populations between limited numbers of commercial host plants. Although it appears cursorily that the availability and/or shortage of food is a major driver of this process, the chemical basis in host plant recognition is poorly understood. These factors can be instrumental in attracting the insects to a specific host which is in a desired phenological stage for the insect to satisfy its needs for survival. Undoubtedly migration of hemipterans between the various hosts is chemically mediated but these processes in a subtropical fruit tree environment are currently not well studied. It is therefore the main aim of this project to study aspects of factors affecting migration of

hemipterans between various host plants and to manipulate the process to the detriment of phytophagous insect populations.

MATERIALS AND METHODS

The monitoring of the insects were done with a thermal fogging machine. The insects were collected on plastic sheets that were placed under the trees. All specimens of insects were kept, even if they did not belong to the heteroptera species. The whole biomass present in the trees could give a better understanding of biological control through parasites in the orchards. The different species will be identified at a later stage by a taxonomist at Agricultural Research Council – Plant Protection Research Institute (ARC-PPRI). The volatiles were collected by placing a foil bag over the plant material for two hours and extracting the volatiles by pulling a vacuum through





Monitoring with fogger



Vacuum pump and filters



EAD

a carbon filter with a vacuum pump. The filters were analysed at TUT with GC-MS which creates chromatograms from which the different compounds can be identified. The compounds are then placed on a GC-EAD to determine if there are any responses on the live antenna of the insects.

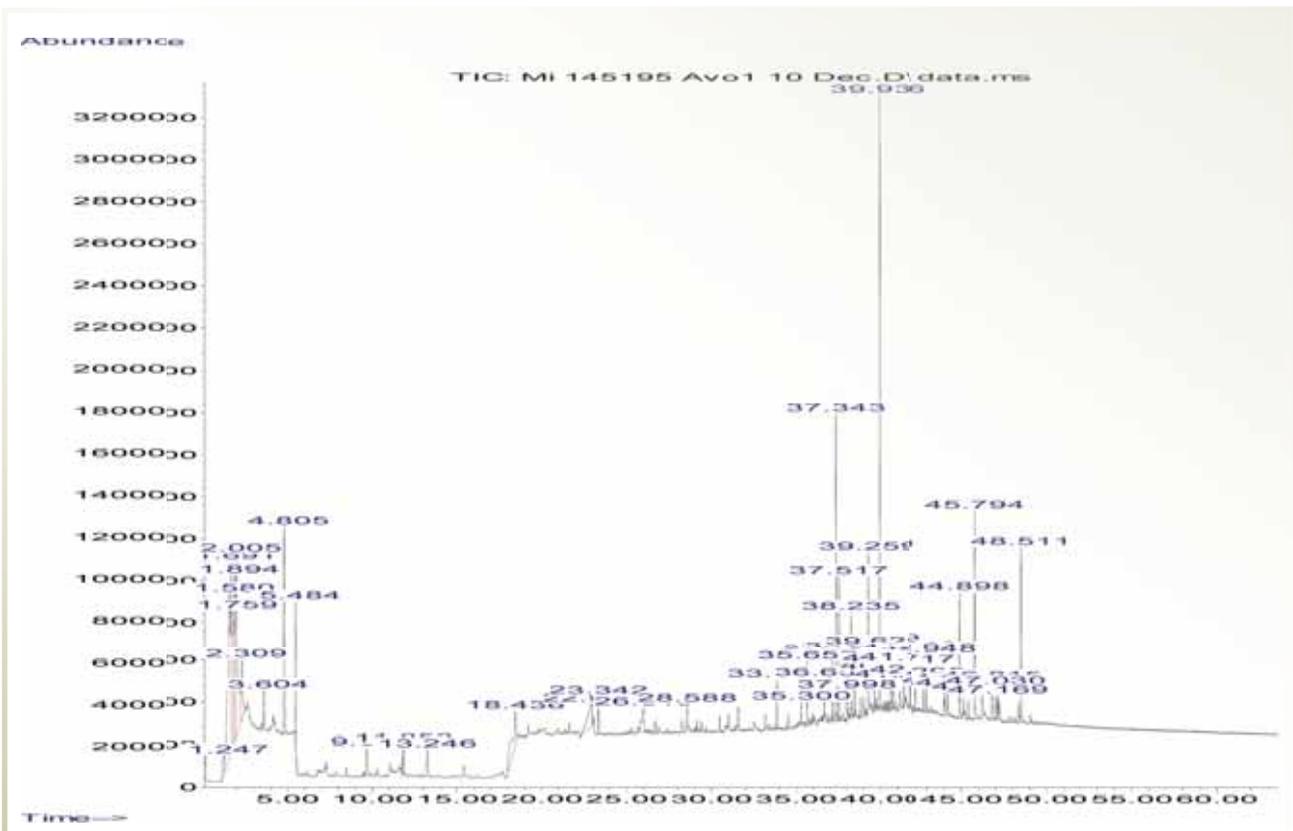
RESULTS AND DISCUSSION

Out of 78 different host plants (indigenous and exotic) that were surveyed, 68 stink bugs were collected, however almost all of them were of no economic importance for the main commercial crops in the area. The main culprit in avocados seems to be the coconut bug (*Pseudotheraptus wayi*) when it comes to damage, especially on the smaller fruit. When the fruit matures, the damage seems to be much less, although some literature suggests otherwise. Both the adults and nymphs are equally destructive by sucking the sap from the fruit, as well as the young stems and leaves, but the insect is presently described



GC-MS

exclusively based on the adults when all the instars can actually cause damage. Other species of *Coreidae* can be easily mistaken with the coconut bug, like some *Cletis* species, therefore the correct identification of the insects is important. The damage they cause is the malformation of younger fruit as well as lesions which become a ball like clot under the skin,



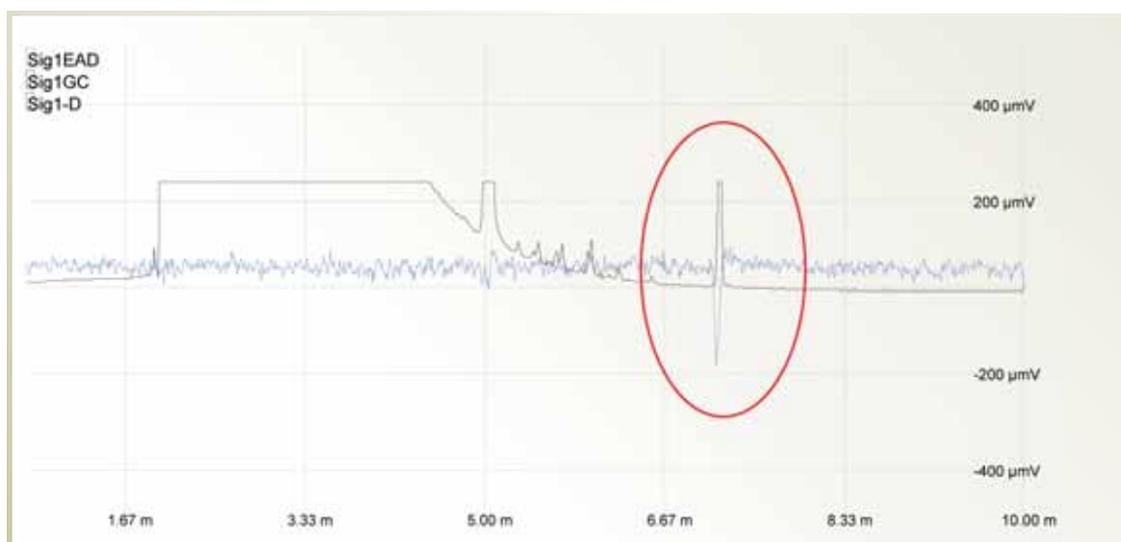
Chromatogram for avocado fruit in December



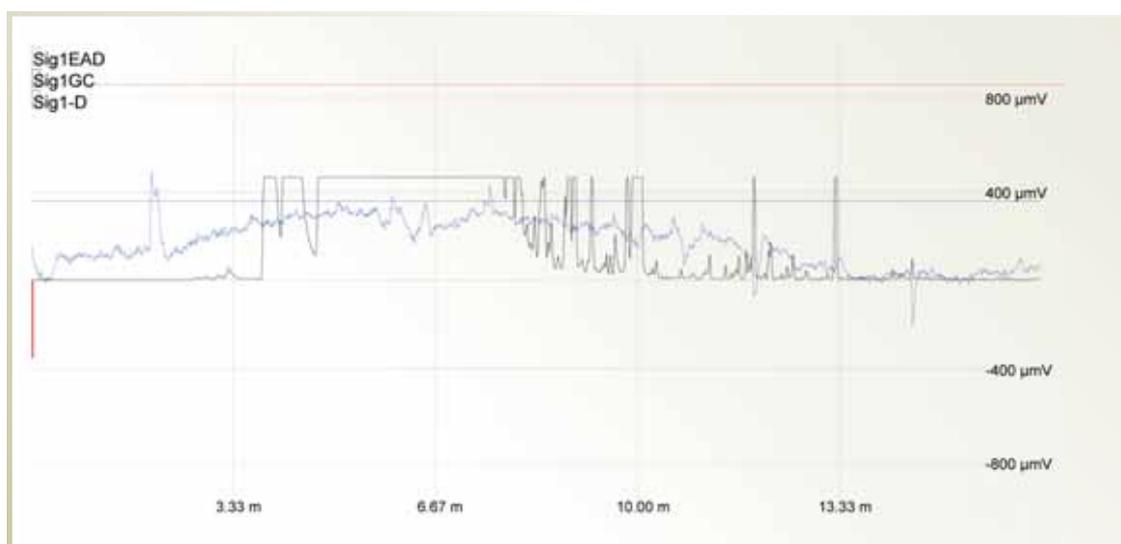
although they do not cause the fruit to rot. A few host plants have been documented in literature for *Pseudotheraptus wayi* (coconut bug): *Anacardium occidentale* (cashew), *Cocos nucifera* (coconut), *Averrhoa carambola* (carambola), *Carya illinoensis* (pecan), *Cinnamomum verum* (cinnamon), *Eriobotrya japonica* (loquat), *Psidium guajava* (guava) and *Theobroma cacao* (cocoa) (Egonyu *et al.*). This insect is extremely adaptive and can survive on a number of different food sources, thus it is found in all economically important crops in the subtropical areas.

The volatiles were taken with the major phenological stages of the plants in mind. The different stages when data were collected are on the 17 October 2014 (small fruit), 10 December 2014 (medium fruit), 2 March 2015 (mature fruit) and on the flowers for the avocados. The data in each different stage (replicates) are combined to have one profile for the time of the season. There are a lot of elements that correlates but there are natural differences, being the plant or the surroundings. The smallest change

can influence the sensitive analysis. Comparing these profiles and identifying different compounds at certain stages, may be the key to the substance responsible for luring these pests. The flower profile contained some floral compounds that are only found during that specific time of the season. Using the Pherobase site, known pheromones, allomones, kairomones and attractant semiochemicals can be screened. Compounds like beta-myrcene and alpha-pinene – monoterpenes used in flavouring additives in food, fragrances in cosmetics and scent in household products are then present, as well as Eucalyptol, Bicyclo (3.1.1) hept-2-ene, Oxirane, hexadecyl and Caryophyllene – Allomone for *Perillus bioculatus*, native to North America, which is the same species as some native bugs found on avocados (Pentatomidae). With fruit on the trees, different compounds are present. With small fruit, for instance, Nonane (pheromone for cucumber fruit fly) and Peridine (allomone for mosquitos) are present. With all the compounds found in all the avocado profiles, there



Graph A – Positive response



Graph B – Negative response

are very little in the literature that refers to the pests in South Africa and whether they respond to these compounds. Compounds identified were then either obtained or synthesized and were subsequently screened using a GC-EAD on live antennae from stink bugs. Graph A contains the results of a mixture of linalool, 2-Hexanal, 1-Hexanol and n-Tridecane. A positive response was visible for linalool. In Graph B no significant responses are visible using a different mixture of compounds.

CONCLUSION

Many more compounds identified from avocados will be tested for positive responses. If one of these compounds or a blend of compounds can be identified to which the insects respond to, or are attracted to, it can be used either as a monitoring tool or a means

of control. The ideal will be to move away from chemicals that are currently being used in the industry. The maximum allowed MRLs are being reduced and enforced a lot stricter. It is critical to move towards biological control in IPM strategies. The different profiles are now known for avocados and some of the compounds these insects responds to. Future research must include the following: To do some olfactometer work in the laboratory to confirm if the insect prefers the "smell" of the compound above just normal air passed over its antenna; and to investigate different traps to lure stink bugs – there are other traps available in the market, but not specifically designed for stink bugs. The traps and compounds should then be taken to the orchards in a commercial situation to evaluate the effectiveness of it and if it could be used commercially.

