Indigenous heteropterans and related volatile secondary metabolic compounds occurring on a range of indigenous trees in South Africa

FA Botha[1], PS Schoeman[1] and BM Botha

[1]Pest Management Division
Agricultural Research Council – Institute for Tropical and Subtropical Crops,
Private Bag X11208, Nelspruit 1200, SOUTH AFRICA
E-mail: andreb@arc.agric.za

ABSTRACT

Stink bugs are normally considered as generalist feeders. Their intrinsic ability to move with ease between various host plants in an eco-system, linked to their cryptic nature and high damage potential, ensures that they are notorious pests which are difficult to monitor and even more difficult to control. Even though a fair amount of general information is available worldwide, very little specific host plant relative information is available locally regarding economically important stink bugs.

The objective of this study is to quantify the volatile profiles of avocados during periods of peak attractiveness to stink bugs. Electro antennographic studies with compounds which could act as possible phagostimulants for *Pseudotheraptus wayi, Bathycoelia distincta, Nezara viridula* and *Chinavia palidoconspersa* were conducted. The relative seasonal abundance of various hemipterans in relation to basic phenological plant milestones were recorded and will hopefully assist in the prediction of insect movement and ultimately with the control of the pests. Certain host plants that were identified beforehand were treated with a thermal fogger. All insects were collected underneath treated indigenous fruit trees on plastic sheets that were placed out prior to the fogging treatment. Data have only been collected until mid- to end-season and will therefore not reflect the entire production season. A more complete picture is envisaged once all plant volatiles from the entire phonological cycle have been analysed.

INTRODUCTION

This report deals with the results of a two year project jointly sponsored by SAAGA and SAMAC. The project has only been running for less than a year and a whole season's data has not been collected yet. The main aim of this study is to determine the factors affecting migration of some hemipterans between various host plants, and the influence of plant volatile blends on them.

A number of host plants were surveyed in the Nelspruit region for the occurrence of stink bugs and to quantify and compare the volatile profiles of each host species during periods when the stink bugs are most attracted to specific crops. Electro antennographic studies were then subsequently done with some of the compounds. Monitoring of these insects are very important as they do not only feed on one kind of crop alone (monophagy), but are able to use a vast range of hosts for food, shelter and mating. Knowledge obtained by this study could be used to control these insects at certain critical periods in a crop to prevent emigration. If this is successfully done, the seemingly continuous migration cycle between various hosts could be broken which will lead to better control.

MATERIALS AND METHODS

The stink bugs were collected by using a thermal fogging machine. Plastic sheets were placed on the ground to collect all the falling insects. All the specimens were kept for later identification. Due to the taxonomy of these insects not being sorted, all specimens were forwarded to the national collection at the Plant Protection Research Institute (ARC-PPRI)

Table 1. The total number of hemipterans that were collected from the different indigenous and exotic trees.

Indigenous and exotic fruit trees that were evaluated.	Total number of Hemipterans
Antidesma venosum (Tassel berry)	35
Artocarpus heterophyllus (Jackfruit)	1
Averrhoa carambola (Starfruit)	1
Carissa edulis (Num-num)	0
Casimiroa edulis (White sapote)	1
Dillenia indica (Elephant fruit)	0
Diospyros nigra (Black sapote)	0
Dovyalis caffra (Kei apple)	2
Eriobotrya japonica (Loquat)	1
Garcinia livingstonei (Mangosteen)	0
Kigelia africana (Sausage tree)	6
Manilkara zapota (Sapodilla)	1
Mimusops zeyheri (Moepel)	1
Morus spp (Mulberry)	0
Punica granatum (Pomegranate)	0
Rapanea melanophloeos (Boekenhout)	8
Solanum mauritianum (Luisbos)	1
Syzygium cordatum (Waterberry)	2
Trichilia emetica (Natal mahogany)	8

for accurate identification. Most of the monitoring was conducted on the research farm of the Institute for Tropical and Subtropical crops (ARC-ITSC). Plant species may be added or removed from the list if new plants become available or if certain plants are merely not attractive to hemipterans.

An unsprayed 'Pinkerton' block on the ARC-ITSC research farm was used to take the samples. Fruit or foliage was covered with an aluminium foil bag for 2 hours. The volatiles were then taken using carbon filters and a vacuum pump. One end of the filter was inserted into the bag and the volatiles were drawn through to the other side by using a vacuum pump. The filters were then analysed with a GCMS machine at Tshwane University of Technology (TUT). The antenna responses will then be done on an Electro antennographic (EAG) detector at TUT.

RESULTS AND DISCUSSION

A number of host plants (70) have been surveyed for stink bugs. The targeted species were difficult to locate because of the broad spectrum of host plants that may accommodate them during the months when they are not found in the orchards. Trees not bearing any fruit, or have any leaves during certain times, were not monitored. A fair amount of bugs (68) have been collected, but they are not always economically im-

Table 2. Volatile organic compounds in avocados taken on the 17th of October 2014 when the fruit were still small.

Nr	Time	146635 – 17 October 2014	Quality	MW
1	1.57	Methyl isocyanide	47	41.02
2	1.88	Hexane	46	86.11
3	1.95	Acetic acid	68	60.02
4	2.29	Benzene	94	78.04
5	3.59	Toluene	94	92.06
6	4.78	Cyclotrisiloxane	91	222.05
7	5.50	Urea	4	60.03
8	7.24	Butanal, 2-ethyl	27	100.08
9	8.45	1R-alpha-Pinene	97	136.12
10	9.66	Benzaldehyde	97	106.04
11	18.43	Nonanal	96	142.13
12	22.86	Benzenecarboxylic acid	96	122.03
13	23.36	Decanal	91	156.15
14	30.56	5,9-Undecadien-2-one, 6,10-dimethyl	80	194.16
15	36.04	Phenol	64	150.10
16	36.72	Tetradecanoic acid	99	228.20
17	37.57	Isopropyl myristate	96	270.25
18	38.06	Pentadecanoic acid	98	242.22
19	39.05	Oxacycloheptadecan-2-one	94	254.22
20	39.31	n-Hexadecanoic acid	99	256.24
21	39.36	Phthalic acid, hexyl tridecyl ester	95	432.32
22	39.63	Hexadecanoic acid, ethyl ester	96	284.27
23	39.97	Estra-1,3,5(10)-trien-17.beta.-ol	47	256.18
24	40.76	Octadecane	83	288.25
25	44.97	Hexanoic acid	70	368.36
26	45.86	1,2-Benzenedicarboxylic acid, diisooctyl ester	95	390.27
27	48.50	6,10,14,18,22-Tetracosapentaen-2-ol	46	506.31
28	48.58	2,6,10,14,18,22-Tetracosahexaene	96	410.39

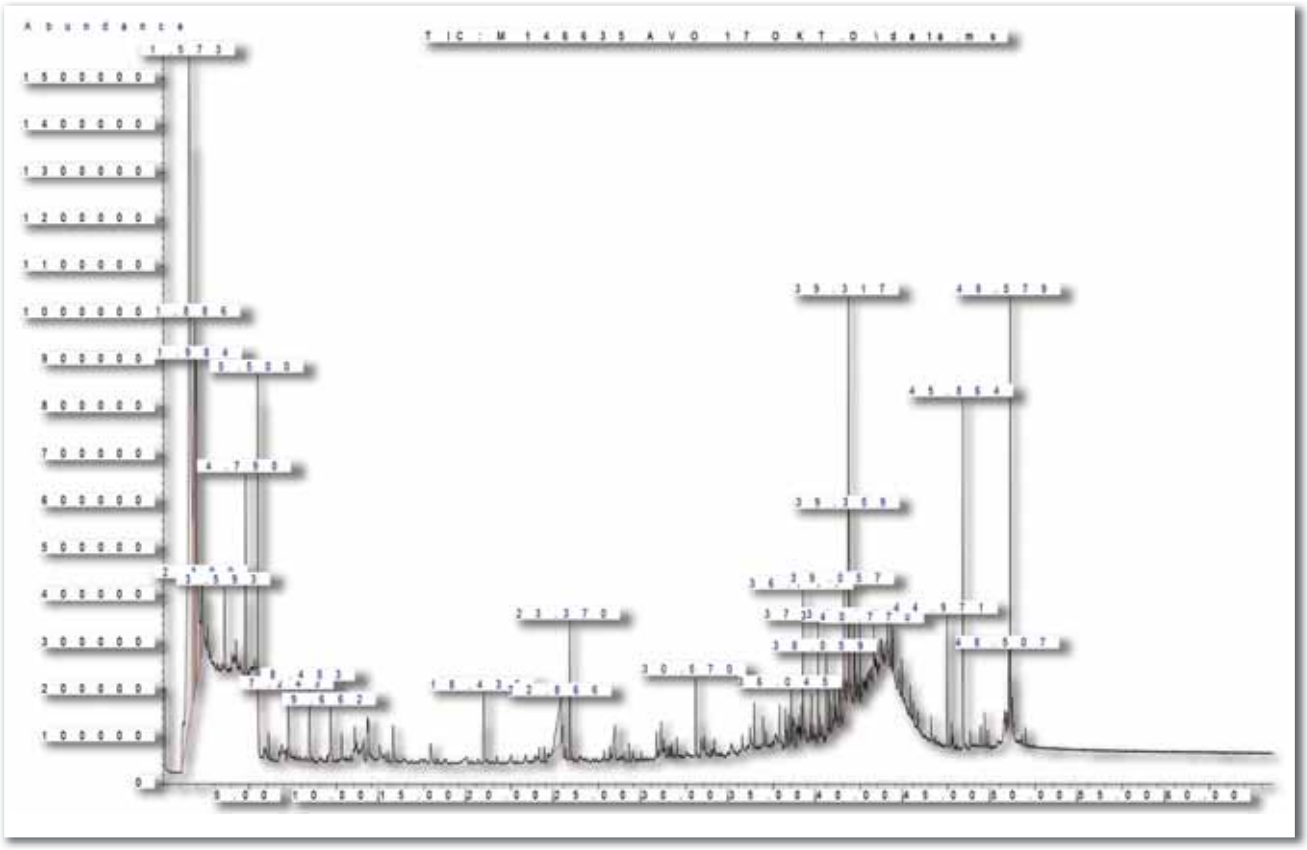

Figure 1. Chromatogram for 17 October 2014 (small fruit).

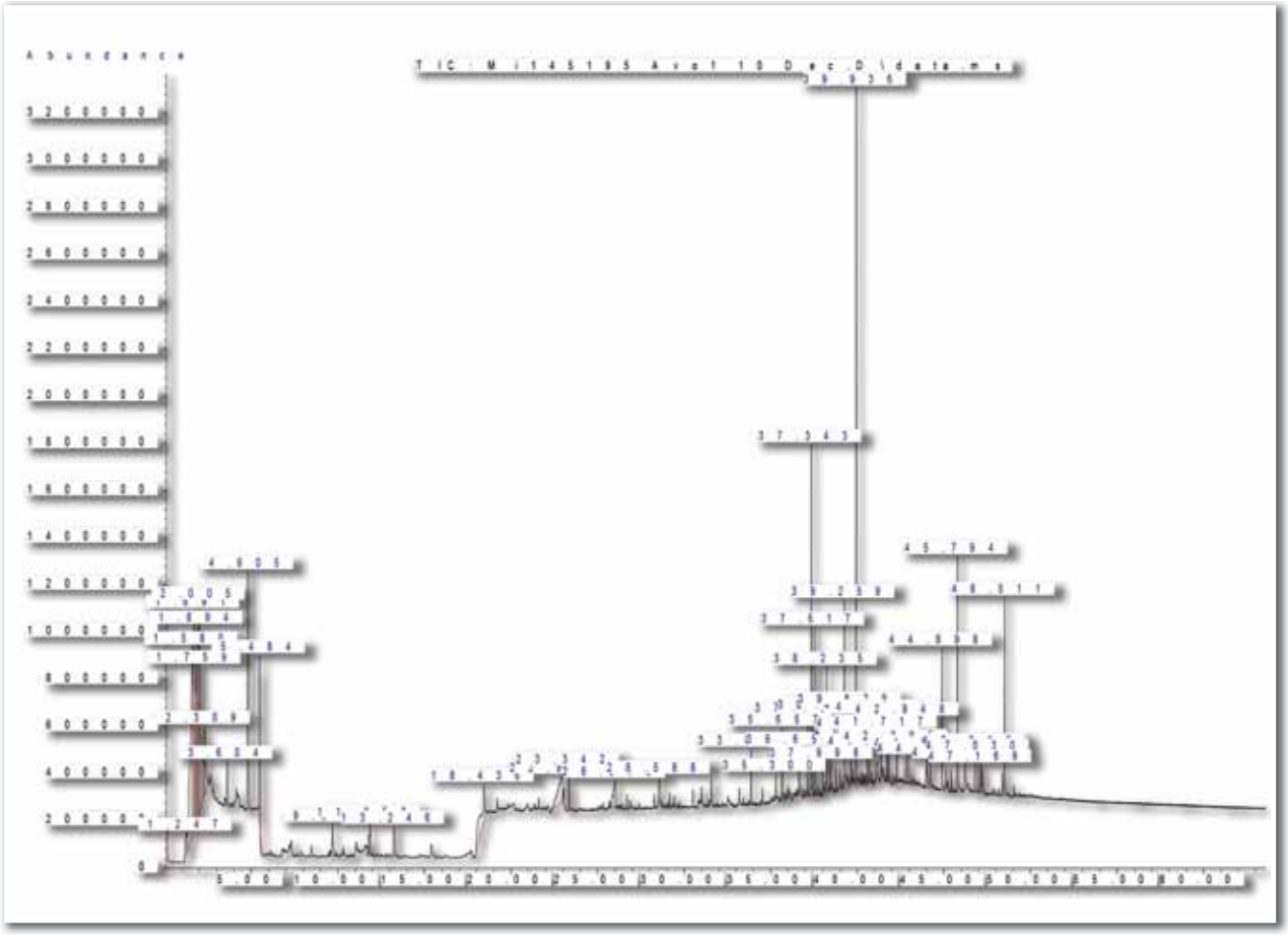

Figure 2. Chromatogram for 10 December 2014 (medium fruit).

portant for the four main crops, namely macadamia, avocado, litchi and mango. The hemipterans found are closely documented, and the by-catch is also collected for identification of possible beneficial insects.

The coconut bug (*Pseudotheraptus wayi*) seems to be the main culprit when it comes to damage in the avocado orchards. The insect prefers the smaller fruit which normally occurs during the beginning of the season. Damage seems to decrease when the fruit matures. Monitoring with the fogging machine also took place in the commercial crops, but results are not included in this report. The insects mentioned in Table 1 therefore represent only those which were found in the indigenous and exotic crops.

The volatiles were taken with the major phenological stages of the plants (avocados) in mind. The different stages when data were collected were on 17 October 2014 (small fruit), 10 December 2014 (medium fruit) and 2 March 2015 (mature fruit). To date 56 samples have been taken from eight different host plant species which included eleven samples on avocados. Metabolic products that may be involved in the recognition of a specific plant as a food source are of specific interest in this study.

Volatiles from the first two sampling dates were analysed on the GCMS machine at TUT, the chromatograms were analysed and different compounds have been identified. The last date (2 March 2015) still needs to be analysed. After harvest a new set of data will also be collected from the trees, when no fruit are present, to be compared with the samples taken when fruit were present. The chromatograms of the first two dates are shown in Figures 1 & 2.

When all these peaks were identified, differences in the single compounds were then compared. The highlighted compounds are the common organic chemicals found in almost all the different samples. Specific chemicals potentially acting as attractants or repellents will be identified when all the data have been collected and analysed.

CONCLUSION

Results portrayed in Figures 1 & 2 must be regarded as provisional as only the first portion of the season has been analysed. Only upon completion of the first season can the data be compared to identify possible compounds, or a combination of compounds that can possibly be used as kairomones for pest insect population monitoring. Antennographic studies will only begin once all the data has been analysed. The chances of finding a specific compound are slim, but a positive result with a blend of compounds will have a huge influence on monitoring and ultimately the effective control of these pests.

FUTURE RESEARCH

The search for host plants for the economically important species must continue. The identification of such a plant will be regarded as an important breakthrough, mainly for the control of the insects on alternative hosts when they are not in the orchards.

Volatiles will still have to be taken during the mature fruit and postharvest stages to complete one cycle. This work will also carry on in other commercial and suspected non-commercial host plants. This study has only been running for less than a year and a significant amount of data is needed to refine current knowledge regarding the identification of a possible usable compound or blend of compounds that can be used for insect monitoring.

ACKNOWLEDGEMENTS

The authors wish to thank SAAGA and the ARC for their financial support.