Monitoring and damage of stink bugs on avocados

PS Schoeman

Agricultural Research Council – Institute for Tropical and Subtropical Crops
Private Bag X 11208, Nelspruit 1200, SOUTH AFRICA
E-mail: schalk@arc.agric.za

ABSTRACT
A stink bug population survey with a thermal fogging machine was initiated on the premises of the Agricultural Research Council – Institute for Tropical and Subtropical Crops (ARC-ITSC) on unsprayed 'Pinkerton' avocados on the 7th of February 2013. Approximately 157 specimens of bugs belonging to 17 species of the Coreidae and Pentatomidae families were recovered during this period. The coconut bug represented only 9.55% of these insects and was particularly numerous during September/October. A hitherto unidentified bug, *Anolcus campestris*, was found in large numbers and represented 68.63% of all bugs that were recovered. These bugs were mostly recovered when developing fruit was present on the tree. Approximately 90% of the insects were recovered from September to the end of April. Approximately 27% were recovered during the early part of the production season when the fruit were still small, while approximately 62% were recovered from January to April. This seasonal distribution pattern is also very similar to the seasonal distribution of damage that was recorded previously on avocados. *Coenomorpha nervosa*, *Pseudatelus raptoria* and *Cletus* sp. were also found in considerable numbers on litchis, mangoes and macadamias, as well. *P. wayi* overwintered in litchis during July and could be managed in this crop when no fruit is available, which should significantly facilitate the sustainability of an integrated pest management (IPM) programme in subtropical crops during this period. Damage assessment studies with *A. campestris* should be done as matter of urgency, as the outcome could have a major influence on current studies relating to the chemical ecology of stink bugs in avocados. In order to verify results, this study should be expanded during 2014/15 to include other commercial estates as well.

INTRODUCTION

Because of difficulties regarding monitoring, the relative seasonal abundance of the coconut bug (*Pseudotheraptus wayi*) in avocado was initially inferred by making use of the occurrence of damage symptoms. However, an assortment of damage symptoms ranging from small hairline horizontal lesions to large lesions producing copious amounts of sugary exudates, was evident. Some symptoms manifested as water soaked lesions while other were only discernible after the epidermis was removed. During the previous season an attempt was made to sort out this array of confusing symptoms by confining a number of lesser important bugs on the fruit (Schoeman & Grove, 2013). Although some internal symptoms were duplicated, none of the external symptoms could be duplicated, which clearly indicated that we were looking in the wrong place and that the culprit was possibly still unidentified. The following series of trials were therefore designed with the aim of sorting out the species complex as well as concomitant damage symptoms.

MATERIALS AND METHODS

Population survey

Population levels of stink bugs occurring in avocados (cv. Pinkerton) were monitored with a thermal fogging machine (model Superhawk, Dyna Fog Africa). The trial was initiated on the 7th of February 2013 and lasted until the 6th of February 2014. Six randomly selected trees at the Nelspruit Research Farm of the ARC-ITSC were monitored every fortnight by placing plastic sheeting (±5 m^2) underneath each tree. Trees were fogged between 07:00 and 08:00 to ensure limited disruption of the smoke cloud due to air movement. Dead insects were collected ±1 hour after treatment.

Migration patterns of stink bugs

According to Panizzi (1997), stink bugs often use a sequence of host plants during a season for oviposition as well as feeding. The main aim of this series of trials was to quantify the host status of various subtropical fruit for important stink bug species, but with particular emphasis on the coconut bug. With this knowledge in hand, Panizzi (1997) suggests that the migration patterns could be disrupted chemically to the detriment of the pest complex.

Trees that were surveyed with the fogging machine, included mango (cv. Sensation), macadamia (cv. Nelmak 2) and litchi (cv. Mauritius). No insect management occurred on the litchi and mango trees for the duration of the trial. The macadamia orchard was managed commercially and very few stink bugs were recovered. Insect counts regarding macadamia was therefore based on a parallel study (Schoeman & Mohlala, 2013) where the branch shaking method was used.

Six randomly selected trees of each cultivar were monitored at the ARC-ITSC every fortnight by placing plastic sheeting (±5 m^2) underneath each tree. Trees were fogged between 07:00 and 08:00 to ensure limited disruption of the smoke cloud due to air movement. Dead insects were collected ±1 hour after treatment.

Measurements of mouthpart lengths and lesion depths

The mouthpart lengths of *Bathycoelia distincta* (previously *Bathycoelia natalicola*), *Coenomorpha nervosa*, *Pseudotheraptus wayi* and *Anolcus campestris* were determined by using a stereo microscope fitted with an ocular eyepiece and a stage micrometer. The mouthparts were measured from where the four stylets (two mandibular and two maxillary) enter the labrum to the point where they end in the labium. Approximately 15 mouthparts were measured for each species.

Fruit with lesion types normally observed in the orchards (cracks, bumps, water soaked lesions and craters) were harvested and the depth of approximately 20 lesions were measured for each lesion type with a hand held digital micrometer.

RESULTS

Population survey

Approximately 19 different heteropteran species (stink bugs) were recorded on avocado. According to Table 1, *P. wayi* comprised only ±12% of the total numbers of the five most numerous stink bug species recorded on avocados. This compared favourably with the study of Van den Berg *et al*. (2000) where *P. wayi* contributed only 6.1% of all stink bugs that were recovered in the Nelspruit area.

During the study of Van den Berg *et al.* (2000), the powdery bug *Pseudatelus raptoria* (formerly known as *Atelocera raptoria*) made up 30.5% of the individuals that were recovered. Although a small number of these stink bugs were recovered from avocados, relative large numbers of a hitherto unknown bug, *Anolcus campestris*, were found in avocados. According to Table 1, *A. campestris* made up nearly 70% of the individuals that were recovered during this study. This insect was also considerably more prolific when fruit was available on the trees during summer.

C. nervosa made up less than 1% of the individuals recovered in the study of Van den Berg *et al.* (2000), but this insect was the second most abundant species recovered during the present study and contributed ±16% of all individuals that were recovered.

Cletus sp. was only recovered during flowering and its economic status is currently undetermined. Large aggregations of this bug are normally observed on *Amaranthus* sp. weeds. This bug cursorily resembles

Table 1. Numbers and seasonal occurrence of dominant heteropterans recovered from a 'Pinkerton' avocado orchard at Nelspruit between February 2013 and February 2014 with the thermal fogging method.

Season		Dominant Heteroptera species collected					Total number of insects collected
		Pseudotheraptus wayi	*Anolcus campestris*	*Coenomorpha nervosa*	*Cletus* sp.	*Bathycoelia distincta*	
Summer 2013	n	3	52	1	0	0	56
	%	5.36	92.86	1.79	0	0	
	AR	2	1	3	4	4	
	SO	Feb/March	Feb - Apr	March			
Winter 2013	n	5	10	8	5	1	29
	%	17.24	34.48	27.59	17.24	3.45	
	AR	3	1	2	3	4	
	SO	May, Jun & Aug	May - Aug	May, Jun & Aug	Jun - Aug	May	
Summer 2013/14	n	10	43	15	0	0	68
	%	14.71	63.24	22.06	0	0	
	AR	3	1	2	4	4	
	SO	Sept, Oct & Jan	Sept - Jan	Nov, Jan & Feb			
Total	n	18	105	24	5	1	153
	%	11.76	68.63	15.69	3.27	0.65	
	AR	3	1	2	4	5	
	SO	Jan-March; May - Oct	Jan - Dec	Jan - March, May, Jun, Aug & Nov	Jun - Aug	May	

n = total number of individuals; % = percentage of grand total of individuals caught;
AR = Abundance ranking; SO = Seasonal occurrence

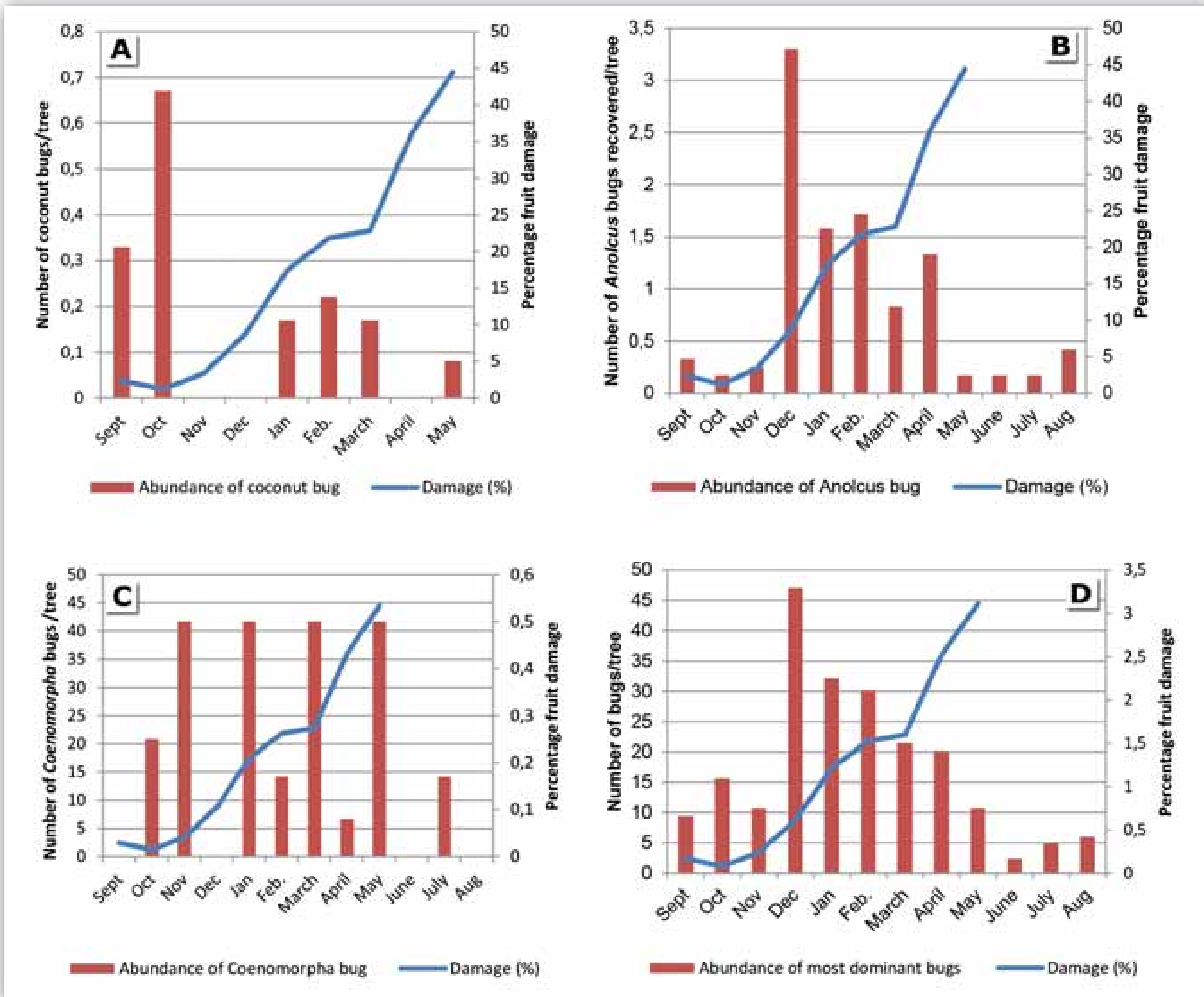

Figure 1. Relative seasonal abundances of (A) – the coconut bug, (B) – *Anolcus campestris*, (C) – *Coenomorpha nervosa* and (D) – pooled data of the three most dominant bugs in relation to stink bug induced fruit damage (cv. Pinkerton).

Table 2. Numbers and seasonal occurrence of dominant stink bugs recovered from mango and litchi orchards at Nelspruit with thermal fogging method from May 2013 to February 2014 and on macadamias from October 2010 to March 2014.

Season		Dominant Heteroptera species collected					
		Pseudotheraptus wayi	***Anolcus campestris***	***Coenomorpha nervosa***	***Chinavia pallidoconspersa***	***Bathycoelia distincta***	***Pseudatelus raptoria***
Macadamia	n	48	0	3	279	1955	43
	%	1.93	0	0.12	11.22	78.64	1.73
	AR	4	8	7	2	1	5
	SO	Oct - Jul	-	May & Jul	Jan - Dec	Jan - Dec	Jan - Dec
Litchi	n	12	0	398	1	3	50
	%	2.5	0	82.92	0.21	0.63	10.42
	AR	4	7	1	6	5	2
	SO	May - Oct	-	Aug - Feb	Jul	Sept - Oct	May - Feb
Mango	n	47	1	7	1	3	2
	%	67.14	1.43	10	1.43	4.29	2.86
	AR	1	6	3	6	4	5
	SO	May - Jan	Sept	Nov - Jan	Sept	May - Aug/Sept	Oct & Jan
Total	n	107	1	408	281	1961	95
	%	5	8	2	3	1	6
	AR	3.52	0.03	13.44	9.26	64.59	3.13

n = total number of individuals; % = percentage of grand total of individuals caught; AR = Abundance ranking; SO = Seasonal occurrence the coconut bug, but is smaller and has thorn like projections on the thorax.

A single individual of the two spotted bug, *Bathycoelia distincta*, was also recovered during May when no fruit was available on the avocado trees.

Relative seasonal abundance

According to Figure 1A, the coconut bug was most abundant during September and October which corresponds well with the results of Van den Berg *et al.* (2000). Bruwer (1996) mentioned that peak occurrence of this insect was slightly later during November and December.

However, these abundance peaks do not correspond well with the incidence of stink bug induced lesions on the avocado fruit. Fruit damage is more prevalent during the late season and although some coconut bugs were recovered during this period, it is unlikely that these low bug numbers alone will be responsible for the observed damage.

A. campestris appears to have a single generation peak per annum and is prevalent at peak fruit damage (Fig. 1B). *C. nervosa* was present throughout the year, but low numbers were recorded during the period from June to September when little fruit is normally present on the trees (Fig. 1C).

When data from all three species were pooled, Figure 1D revealed that December appears to be the month with the highest incidence of stink bugs. These results support findings from the previous two seasons where acceptable results with chemical control were achieved during December (Schoeman & Grove, 2013).

Migration patterns of stink bugs

A total of 5 204 individual stink bugs from more than 25 species were recovered during this survey. Bugs of potential economic importance for avocado production are listed in Table 2.

According to Figure 2, litchi was the most important host for stink bugs in general, followed by avocado, mango and macadamia. Because stink bug numbers in macadamia was quantified with the branch shaking method, a direct comparison between this crop and the other in terms of species abundance is probably not valid.

According to Table 2, *P. wayi* was only the 5th most numerous pest recovered from all subtropical crops. It appears to breed successfully on macadamia, mango and avocado, as nymphs were recovered from these crops but not in litchi where only adults were recovered. Litchis could be a potential overwintering host because most individuals were recovered from this crop during July (Fig. 3) when no fruit were available.

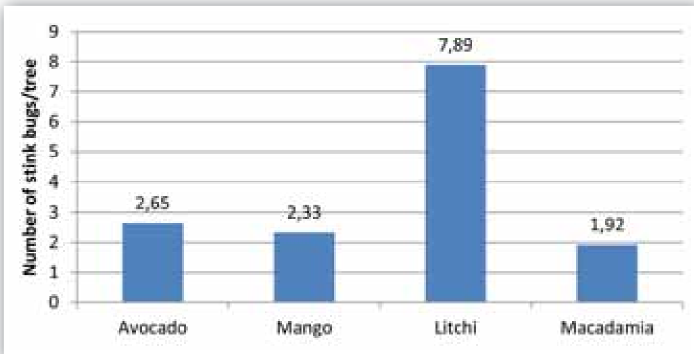

Figure 2. Abundance of stink bugs assessed with thermal fogging from February 2013 to February 2014 (avocado, mango and litchi) and with the branch shaking technique (macadamia) from October 2010 to March 2014 in the Nelspruit region.

	Nezara prunasis	*Nezara viridula*	Total number of insects collected
	122	36	
	4.91	1.45	2486
	3	6	
	Jan - Nov	Apr - Nov	
	16	0	
	3.33	0	480
	3	7	
	May - Nov	-	
	8	1	
	11.43	1.43	70
	2	6	
	May - Sept	Jul	
	146	37	
	4	7	3036
	4.81	1.22	

Table 3. Mean mouthpart lengths of dominant stink bugs occurring on avocado in South Africa in relation to lesion type, depth and abundance.

Lesion type	Lesion depth (mm)	Occurrence (%) (n = 100)
Horizontal cracks	5.2	75.24
Water soaked lesions	5.0	0
Bumps	7.7	0.95
Craters	14	4.76
Cracks & water soaked lesions		10.05
Cracks & bumps		9
Mouthpart length *P. wayi* (mm)	5.2	
Mouthpart length *A. campestris* (mm)	5.13	
Mouthpart length *C. nervosa* (mm)	7.7	
Mouthpart length *P. raptorial* (mm)	7.3	
Mouthpart length *B. distincta* (mm)	13.6	

The coconut bug is also prevalent on avocado and mango during the winter and spring, but macadamia should be regarded as a summer host as most of the individuals were only recovered from November onwards.

According to Fig. 4, mango appears to be the best host for the coconut bug. However, the branch shaking technique used to monitor for this insect in macadamias was probably inferior when compared to the thermal fogging which precluded a direct comparison.

On avocados, the majority of *C. nervosa* individuals were nymphs (±66%) which occurred intermittently throughout the winter and early summer/spring. Adults were only prevalent from November, presumably because of the availability of developing fruit from this period onwards. Litchi appears to be a favourite host for this insect, with adults occurring from September to March.

Although *P. raptoria* is listed by Haddad & Louw (2006) as the major pest of pistachio nuts, caged individuals of this species did not survive on mature avocado fruits. Van den Berg *et al*. (2000) mentions that *P. raptoria* is possibly a bark feeder and it may even be a facultative predator.

Measurements of mouthpart lengths and lesion depths

Figure 5 A–D highlights the various lesion types commonly observed in South African avocado orchards.

Coconut bugs confined in cages containing undamaged fruit induced typical water soaked lesions (Fig. 5B). After six weeks, these lesions gradually took on a deep sunken appearance but in many cases no cracking of the epidermis was observed. However, in some cases epidermal layers covering some of the lesions dried out and caused typical horizontal cracks (Fig. 5A). These lesions were ±5 mm deep which cor-

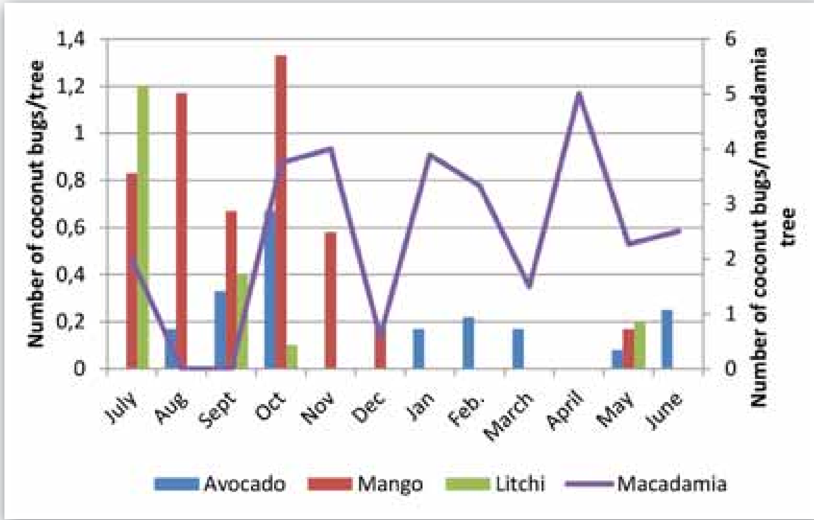

Figure 3. Seasonal succession of the coconut bug in four major subtropical crops in the Nelspruit area.

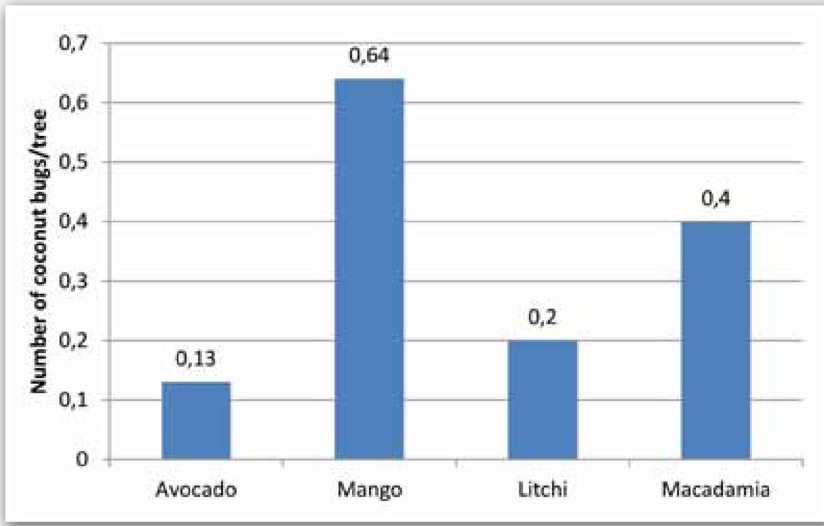

Figure 4. Abundance of the coconut bug assessed with thermal fogging from February 2013 to February 2014 (avocado, mango and litchi) and with the branch shaking technique (macadamia) from October 2010 to February 2014 in the Nelspruit region.

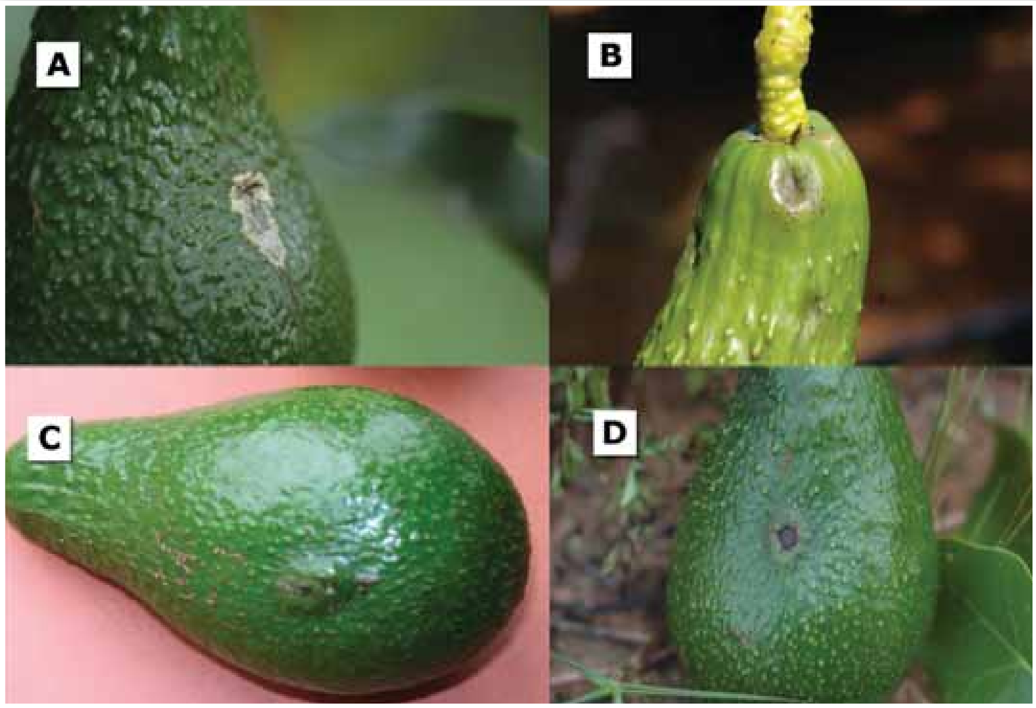

Figure 5. Various stink bug induced lesion types commonly observed in avocado: (A) – horizontal cracks; (B) – water soaked lesions; (C) – bumps and (D) – craters.

responds to the mouthpart length of the coconut bug listed in Table 3.

Feeding and damage symptoms of the coconut bug are very similar to two closely related species of *Amblypelta* bugs in Australia. According to Danne *et al*. (2013), feeding by *Amblypelta* sp. bugs in Australia entails injection of salivary sucrase into the fruit which increases the osmotic potential of the intercellular fluids. This then generate an osmotic driven outflow of cellular fluid which results in characteristic sunken lesions commonly observed on the fruit.

P. raptoria individuals confined in cages on the fruit did not cause any damage and died after a few days. *A. campestris* could also be responsible for some of the horizontal cracks (Fig. 5A) which constituted the majority of the damage symptoms, as their mouthpart lengths are similar to that of the coconut bug (Table 3). Mouthpart length of the second most dominant stink bug pest (*C. nervosa*) corresponded to the lesion depths of bumps portrayed in Fig. 5C. The crater like external symptoms had very deep lesions which may correspond to mouthpart lengths of *B. distincta*. However, lesions induced by *C. nervosa* and *B. distincta* still have to be properly studied to conclusively prove these assumptions.

CONCLUSION

1. During 2013/14, the coconut bug was only the third most numerous stink bug recovered from 'Pinkerton' avocado fruit in the Nelspruit region.
2. *C. nervosa* and a hitherto unknown bug, *A. campestris*, were the most abundant bugs and comprised nearly 84% of the individuals of the five most dominant bugs recovered from avocado during this survey.
3. Although no definite population peak could be distinguished for *C. nervosa*, the relative seasonal abundance of *A. campestris* could possibly be linked to the near exponential damage peak normally observed towards the end of the season in avocados.
4. Pooled data of all three dominant bugs listed in Figure 1 indicated a population peak during December which could possibly explain the reason why a spray during this time (Schoeman & Grove, 2013) significantly reduced damage in avocados.
5. Peak relative seasonal abundance of the coconut bug was during September/October which corresponded with the findings of Van den Berg *et al*. (2000).
6. The coconut bug was able to breed in macadamia, avocado and mango. On litchis only adults were recovered which seems to indicate that this crop could perhaps act as a temporary overwintering refuge. Disrupting migration patterns of this pest in subtropical orchards bordered by litchi orchards during July could be considered as an alternative method of controlling this insect.
7. Four main types of stink bug damage symptoms were identified and could possibly be linked to other stink bugs.
8. Although the coconut bug constituted a relative small percentage of the total number of phytophagous stink bugs recovered during this trial, it is important to quantify the feeding frequency of this and other stink bugs before a final verdict regarding the economic importance of each species can be made.

REFERENCES

BRUWER, I.J. 1996. Die Hemiptera-plaagkompleks op avokado's in die Kiepersol-gebied. *South African Avocado Growers' Association Yearbook* 19: 33-35.

DANNE, A.W., LIEWELLYN, R., HUWER, R.K. & FURLONG, M.J. 2013. Fruitspotting bugs, *Amblypelta nitida* Stal and *A. lutescens* Distant (Hemiptera: Coreidae): a review of the potential for integrated management practices. *Austral Entomology* 53: 2-23.

HADDAD, C.R. & VAN DER MERWE LOUW, S. 2006. Phenology and potential biological control of the stink-bug Atelocera raptorial Germar (Hemiptera: Pentatomidae) in pistachio orchards. *African Plant Protection* 12: 23-27.

PANIZZI, A.P. 1997. Wild hosts of Pentatomids: Ecological significance and role in their pest status on crops. *Annual Review of Entomology* 42: 99-120.

SCHOEMAN, P.S. & GROVE, T. 2013. Management of the coconut bug in avocados. *South African Avocado Growers' Association Yearbook* 36: 53-58.

SCHOEMAN, P.S. & MOHLALA, R. 2013. Prediction of ideal spraying dates for the stink bug and nut borer complexes. *Southern African Macadamia Growers' Association Yearbook* 20: 24-29.

VAN DEN BERG, M.A., STEYN, W.P. & GREENLAND, J. 2000. Hemiptera occurring on avocado trees in the Mpumalanga Lowveld of South Africa. *African Plant Protection* 6(1): 29-33.