Prediction of coconut bug damage on avocados

PS Schoeman, T Grove and R Mohlala

Crop Protection Division,
Agricultural Research Council – Institute for Tropical and Subtropical Crops
Private Bag X11208, Nelspruit 1200, South Africa
E-mail: schalk@arc.agric.za

ABSTRACT

Results from the previous season suggest that the coconut bug prefer to feed on more mature avocados. Because of this relatively short susceptibility period, the practicality of degree-day models is limited. Previous researchers suggested that fruit phenology plays a pivotal role regarding the timing and severity of feeding by stinkbugs in general. With this in mind, fruit parameters (length, width, mass and moisture content) were measured in combination with the percentage coconut bug induced fruit damage for four cultivars ('Pinkerton', 'Fuerte', 'Hass' and 'Edranol') on two geographically distinct trial sites (Tzaneen and Nelspruit). All the fruit parameters, including moisture content, were significantly correlated with damage. Fruit mass was highly positively correlated with incidence of damage (r^2 = 0.97 – 0.98%). Phenological parameters of infested fruit did not differ statistically significant from uninfested fruit, which indicates that avocado orchards only become vulnerable to attack once the entire orchard has developed beyond a critical phase. Although the Nelspruit trial was not designed to demonstrate cultivar differences, 'Pinkerton' was most severely attacked, followed by 'Fuerte', 'Hass' and 'Edranol'.

UITTREKSEL

Resultate van die vorige seisoen dui daarop dat die kokosbesie verkies om op meer volwasse vrugte te voed. Weens hierdie kort periode waartydens die vrugte vatbaar is, is die praktiese toepassingswaarde van daggraadmodelle ongelukkig beperk. Onlangse buitelandse navorsing dui aan dat vrugfenologie 'n belangrike rol speel wat die aard en omvang van skade bepaal. Met dié gegewens in gedagte is 'n verskeidenheid vrugparameters (lengte, breedte, massa en vogpersentasie) gemeet in kombinasie met die persentasie kokosneutbesieskade vir vier kultivars ('Pinkerton', 'Fuerte', 'Hass' en 'Edranol'). Die proef is in twee geografies uiteenlopende persele uitgevoer (Tzaneen en Nelspruit). Al die vrugparameters, insluitend die voginhoud, was betekenisvol gekorreleer met skade. Vrugmassa was hoogs betekenisvol gekorreleerd met skade op die Nelspruit-perseel (r^2 = 0.97 – 0.98%). Fenologiese parameters van besmette vrugte het nie statisties verskil van onbesmette vrugte nie, wat aandui dat avokadoboorde vatbaar raak vir besmetting wanneer die hele boord tot op 'n sekere kritiese fase ontwikkel het. Hoewel die Nelspruit-proef nie uitgelê was om kultivarverskille aan te toon nie, was 'Pinkerton' die meeste beskadig, gevolg deur 'Fuerte', 'Hass' en 'Edranol'.

INTRODUCTION

Integrated pest management entails a variety of control options which normally incorporates biological, mechanical, chemical and physical methods. Practically on commercial avocado farms, the basis for such a programme is to monitor target pests and to spray only when threshold levels have been reached. Unfortunately this ideal has not yet been achieved for coconut bug control in the avocado industry of South Africa, because of the following reasons:

1. Due to the cryptic habits of the coconut bug, the magnitude of damage it causes as well as obvious difficulties in monitoring for this pest, threshold based insect control has not yet been achieved.
2. Due to the extreme heterogeneous distribution of these insects in an orchard, as well as the unpredictability of economic damage, the quantification of threshold values based only on insect counts are unreliable.
3. Avocados progressively become more susceptible to attack by the coconut bug during the late season. Orchards bordering riverine vegetation or alternative cultivated host plants are more prone to damage. While the stimulus luring the insects into the orchards is expected to remain high for a number of months, the residual activities of most synthetic pyrethroids are relatively short. Repeated applications of hitherto unregistered insecticides will be required to mitigate damage. This philosophy for insect control will probably cause more damage due to population increases of secondary pests,

which will then require even more sprays for effective control (pesticide treadmill). Clearly this is a solution that will have to be avoided at all cost.

Possible solutions to this conundrum include:

1. Quantification of phenological parameters to predict critical periods when fruit become susceptible for the coconut bug. Mizell *et al*. (2008) proved conclusively that fruit phenology and stinkbug induced damage are interrelated.
2. Evaluate biological alternatives such as the pathogen *Beauveria bassiana*. These products are usually ephemeral but sub lethal doses of standard insecticides combined with the pathogen have proved to be effective in some cases.
3. Evaluate the effect of alternative hosts, not only for trap crops but also for monitoring.
4. Study the chemical ecology of this stinkbug with the long term aim of monitoring and possibly control in mind.

This report must therefore be regarded as a first step to gain some insight into this complex situation.

MATERIALS AND METHODS

The trial was carried out on a commercial farm near Tzaneen (23° 49′ 18.55″S 30°10′ 31.04″E) and on an unsprayed orchard at Nelspruit (25° 26′ 55.73″S 30°58′ 09.77″E). Fruit mass, length and diameter were determined fortnightly. In Nelspruit the survey started on the 11th of October 2010 and concluded on the 26th of January 2011. At Tzaneen the survey started on the 12th of October 2010 and concluded on the 4th of February 2011.

Ten fruit were randomly picked from five randomly selected trees (10 fruit x 5 trees = 50 fruit) at each trial site. Fruit mass, diameter and length were determined immediately after picking. Fruit moisture content was also additionally determined at the Nelspruit site, according to the standard recommended rate of Swarts (1976).

Coconut bug damage was determined by visually examining 50 fruit on five randomly selected trees every fortnight (50 fruit x 5 trees = 250 fruit). At Tzaneen observations were made on 'Hass', 'Pinkerton' and 'Fuerte' while only 'Pinkerton' and 'Fuerte' were studied at the Nelspruit locality.

RESULTS

Although statistical differences were observed between infestation status and various phenological parameters (**Table 1**), none of the relationships were consistent. Uncharacteristic large or small fruit were not specifically more attractive to this insect, which indicates that the stimulus required for infestation probably originates from the entire orchard. For this reason, infestation and concomitant prediction of coconut bug feeding on smaller amounts of out of season fruit will be different. Out of season fruit will also be the only source of food for stinkbugs during the winter, which also explains high damage levels on small and relatively immature fruit.

According to **Figure 1** and **2** significant positive relationships were observed between various fruit phenology parameters and coconut bug infestation. Infestation levels were significantly higher at the Nelspruit trial site, which probably increased the reliably of the data. The Tzaneen trial site formed part of a commercial farm and the orchard was sprayed on a number of occasions.

Figure 1 and 2 reconfirm the observations of Mizell *et al.* (2008) which states that phenology plays a pivotal role in the relative seasonal susceptibility of fruit for stinkbugs in general.

Table 2 portray the magnitude of various fruit parameters when damage levels reached the value of 5%. Edwards and Heath (1964) suggested this as the general maximum level of insect damage that can

Table 1. Seasonal relationship between infestation status of the coconut bug and various fruit parameters for 'Pinkerton' fruit at the Nelspruit trial site.

Date	Measured fruit parameter							
	Length		Diameter		Mass		Moisture content	
	Infested ± SD	Uninfested ± SD	Infested ± SD	Uninfested ± SD	Infested ± SD	Uninfested ± SD	Infested ± SD	Uninfested ± SD
29 Nov	7.23a ± 0.87	8.1a ± 1.63	3.93a ± 0.22	4.23a ± 0.41	54.8a ± 11.24	70.01a ± 22.48	89.03a ± 4.29	86.8b ± 0.90
	t = 1.05 P = 0.298		t = 1.50 P = 0.138		t = 1.33 P = 0.19		t = 3.08 P = 0.003	
14 Dec	10.3a ± 0.86	9.6a ± 1.24	4.87a ± 0.29	4.86a ± 0.48	107.31a ± 17.33	103.24a ± 27.37	86.3a ± 0.52	86.54a ± 0.51
	t = 1.44 P = 0.156		t = 0.046 P = 0.963		t = 0.38 P = 0.71		t = 0.64 P = 0.53	
11 Jan	11.41a ± 1.37	11.38a ± 1.47	5.91a ± 0.49	5.45b ± 0.54	173.45a ± 42.36	155.41a ± 44.91	84.56a ± 1.15	84.23a ± 1.36
	t = 0.064 P = 0.949		t = 2.25 P = 0.029		t = 1.05 P = 0.29		t = 0.64 P = 0.53	
26 Jan	11.22a ± 1.43	12.30b ± 1.87	5.67a ± 0.65	5.90a ± 0.64	154.81a ± 44.56	186.84b ± 56.99	82.82a ± 1.83	83.35a ± 1.44
	t = 2.13 P = 0.038		t = 1.05 P = 0.29		t = 2.087 P = 0.04		t = 1.14 P = 0.26	

Means for monitoring dates of the various fruit parameters followed by the same letter are not statistically different

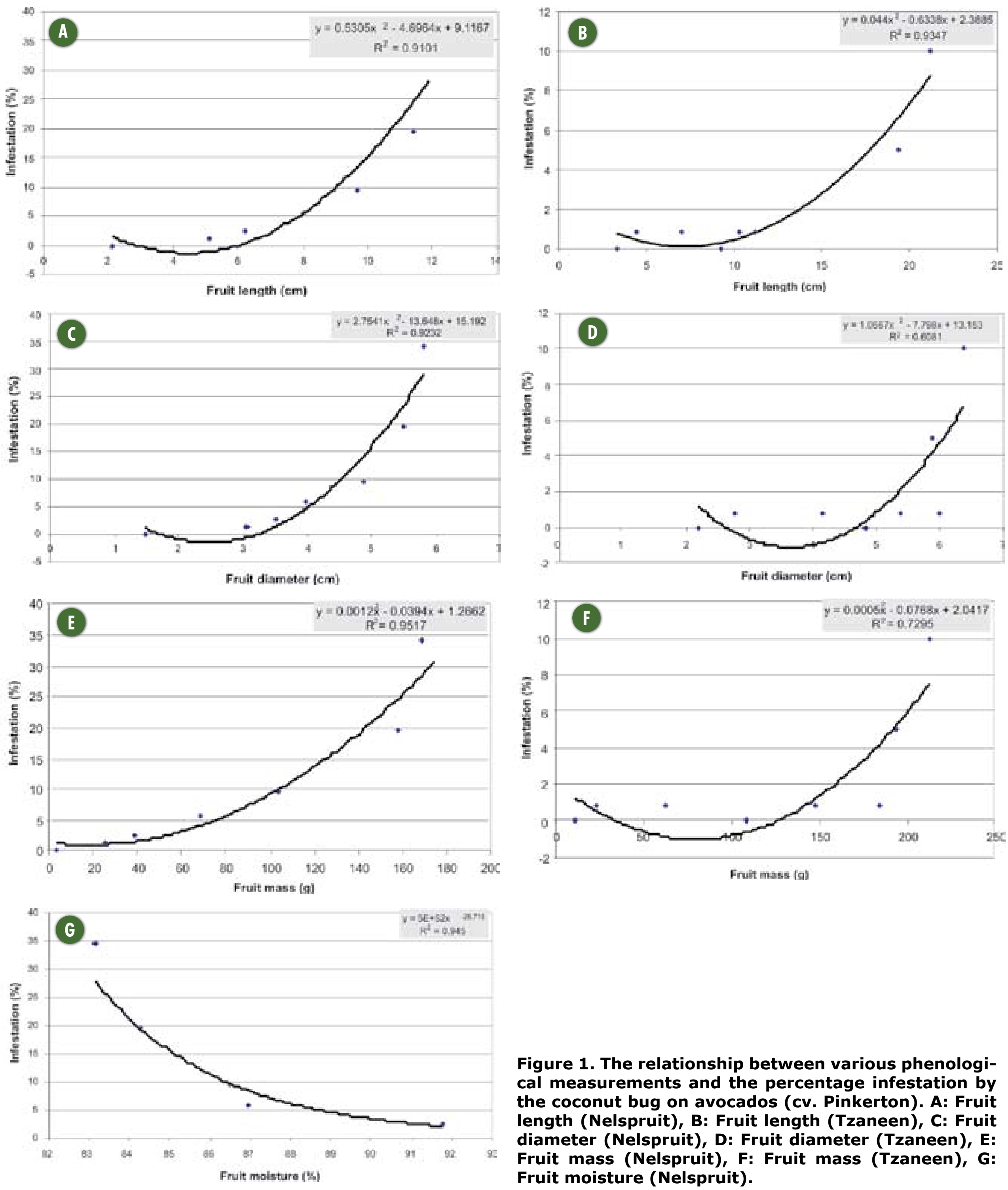

Figure 1. The relationship between various phenological measurements and the percentage infestation by the coconut bug on avocados (cv. Pinkerton). A: Fruit length (Nelspruit), B: Fruit length (Tzaneen), C: Fruit diameter (Nelspruit), D: Fruit diameter (Tzaneen), E: Fruit mass (Nelspruit), F: Fruit mass (Tzaneen), G: Fruit moisture (Nelspruit).

Table 2. Phenological parameters of avocado fruit (cv. Pinkerton & Fuerte) when 5% of the fruit were affected by the coconut bug (*Pseudotheraptus wayi*).

	Cultivar			
	'Pinkerton'		'Fuerte'	
Fruit parameter	**Nelspruit**	**Tzaneen**	**Nelspruit**	**Tzaneen**
Length (mm)	80	170	80	90
Diameter (mm)	40	60	44	63
Mass (g)	70	190	85	115
Moisture (%)	88.6	-	85	-

be tolerated before chemical intervention becomes necessary.

Cultivar effects

At Nelspruit 'Pinkerton' was most severely affected while it was the least affected cultivar at Tzaneen (**Figure 3**). At first glance this contradiction appears rather perplexing, but when the spatial arrangement of the cultivars are considered relative to each other and to the natural bush, things became a bit clearer. In Nelspruit all four cultivars are planted next to a mango orchard which acted as the primary source of

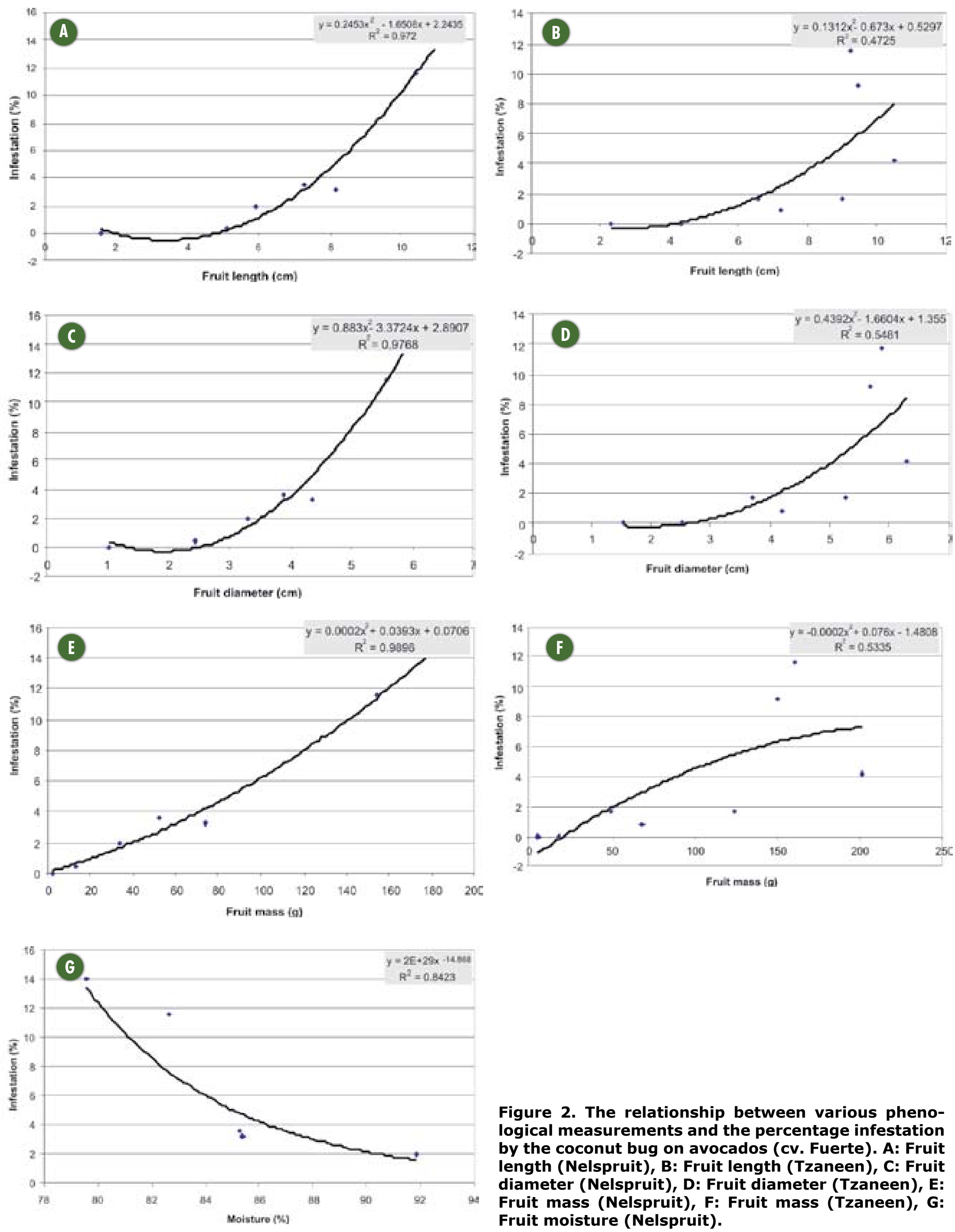

Figure 2. The relationship between various phenological measurements and the percentage infestation by the coconut bug on avocados (cv. Fuerte). A: Fruit length (Nelspruit), B: Fruit length (Tzaneen), C: Fruit diameter (Nelspruit), D: Fruit diameter (Tzaneen), E: Fruit mass (Nelspruit), F: Fruit mass (Tzaneen), G: Fruit moisture (Nelspruit).

infestation. The stinkbugs only had to fly a few metres and probably selected the most suitable cultivar. At Tzaneen 'Pinkerton' trees were planted close to the centre of the orchard with 'Fuerte' trees on the perimeter. Stinkbugs migrated into the orchard from the surrounding natural bush and landed on the first avocado trees. Because their need for food, shelter and mate location was satisfied, further migration deeper into the orchard was limited. This observation is corroborated by Todd (1989) who ascribed the extreme heterogeneous distribution of stinkbugs to limited movement in an orchard once all primary needs (food, shelter and mate location) have been satisfied.

CONCLUSION

1. Fruit phenology (maturity) is directly related to the severity of damage caused by the coconut bug. This observation supports the earlier findings of Mizell *et al*. (2008) in this regard.
2. Towards the end of the season there were such large numbers of stinkbugs in the orchards that small out of season fruit were also invariably affected. Additionally, when the food source (avocado fruit) was removed at harvest, the stinkbugs probably did not have an option but to feed on the small immature fruit. This theory is supported by an observation on the research farm of the ARC-ITSC where large numbers of coconut bugs converged on out of season mango fruit towards the end of the 2010/11 season.
3. Differing levels of management influences fruit size and fruit mass too much for a reliable recommendation. It is suggested that moisture content versus infestation levels be compared on a number of farms to determine if accurate predictions of coconut incursions into avocado orchards can be made.
4. Because damage escalated significantly towards the end of the production season, non-chemical control methods such as *Beauveria bassiana* should be investigated mainly due to the favourable residue profile of biological alternatives.
5. Cultivar preferences are difficult to quantify, as the configuration of bordering host plants play a large role in determining the eventual fate of fruit, especially towards the end of the season. It would, however, appear as if the cultivar 'Pinkerton' is predisposed to more severe damage.

LITERATURE CITED

EDWARDS, C.A. & HEATH, G.W. 1964. Principles in Agricultural Entomology*. Ed. Chapman and Hall, London*, 418pp.

MIZELL, R.F., RIDDLE, T.C. & BLOUNT, A.S. 2008. Trap cropping system to suppress stink bugs in the Southern Coastal plain. *Proceedings of the Florida State Horticultural Society,* pp 1 – 16.

SWARTS, D.H. 1976. 'n Praktiese avokado-oliebepalingsmetode vir produsente. *The Citrus and Subtropical Fruit Journal,* 5(11): 8-14.

TODD, J.W. 1989. Ecology and behaviour of *Nezara viridula. Annual Review of Entomology,* 34: 273-92.

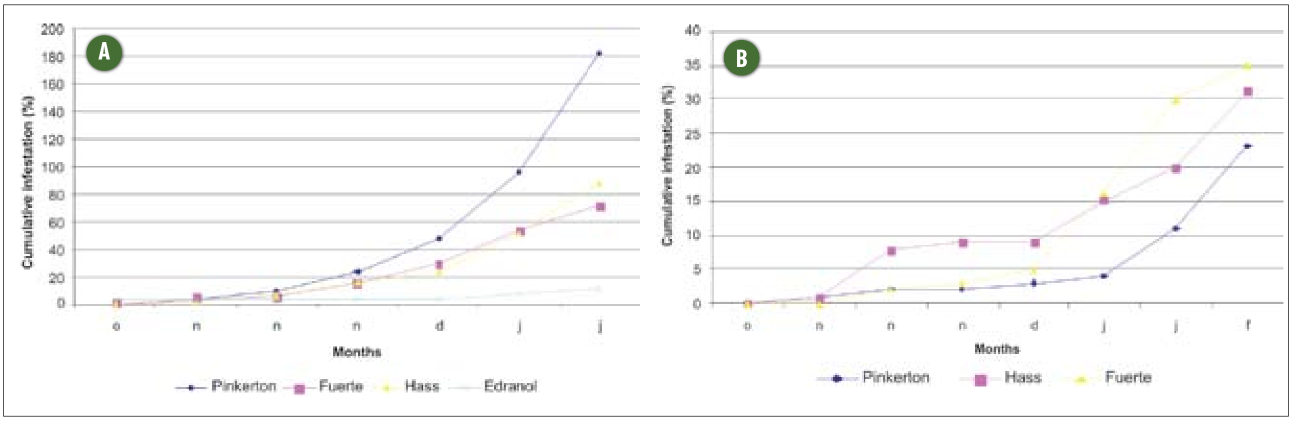

Figure 3. Cultivar preference of the coconut bug. A: unsprayed locality (Nelspruit), B: commercially managed orchard (Tzaneen).