Innovations for the control of the coconut bug in avocado

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ABSTRACT

Where coconut bug is a problem, damage levels normally increase nearly exponentially from late December until harvest. Spraying during this time, typically reduce damage for a few weeks but invariably 3 – 4 weeks later damage increase again. Increased spray frequency late in the season is particularly undesirable because of pesticide residues. On the other hand, without spraying, damage levels are often unacceptably high. Solutions to this conundrum are currently being sought and this includes the development of fungal pathogens which can be used closer to harvest and which will not have a detrimental effect on possible exceedance of MRL levels. The Achilles heel of these pathogens is UV radiation. The addition of reflectants such as aluminium silicate were tested to determine if the environmental persistence of these organisms can be extended. Trees along a commercial 'Pinkerton' orchard/natural bush interface were treated with Thiamethoxam SC 240 g/kg early in the season to act as a barrier to invading bugs. Feedback is also provided regarding the effect of pruning on coconut damage. The mechanism of seasonal succession in macadamias was investigated over four years. The two-spotted bug pushed out all other bug species while it competed for its preferred food resource. The current explanation for this seasonal variation in dominance points towards semio-chemicals and possibly defensive pheromones secreted by the dominant stink bug. It has conclusively been determined in the past that the two-spotted bug cannot smell its own defensive volatile compounds but the ability of other bugs (such as the coconut bug) to smell these compounds needs clarification and will be investigated further.

INTRODUCTION

Despite various attempts at controlling stink bugs chemically, long term sustainable success has not yet been achieved. Main problems appear to be poor coverage due to tall trees, lack of a reliable monitoring method as well as continuous immigration from surrounding vegetation, especially during the second part of the season.

Chemical control currently forms the backbone of the South African industry and according to Schoeman (2016) this strategy is not very successful. A great deal of work regarding aspects of the behaviour and biology of these bugs were carried out over the past few years (Schoeman, 2016) and this information should now be used for the drafting of a workable Integrated Pest Management (IPM) programme.

Aspects such as distribution, immigration patterns as well as overwintering behaviour and host plants are key issues, which could ultimately hold the key for the long term sustainable control of this pest.

Very little work on biological control of coconut bugs on avocados was done so far. The coconut bug is an indigenous pest and it is therefore assumed that its complement of natural enemies will also be indigenous. Conservation agriculture where disruptive orchard sprays are limited to the absolute minimum may be the best practical biological control option available for South African avocado growers at the moment. There is fortunately a plethora of environmentally friendly products available for the control of other avocado pests, which will make Integrated Pest Management (IPM) and ultimately Integrated Avocado Production (IAP) practical realities.

MATERIALS AND METHODS

Pruning trial

The trial was carried out on an avocado estate on the outskirts of Nelspruit (25°25' 24.98S; 30°56' 36.32E). Because of expected differential susceptibility rates of avocado cultivars to bugs belonging to the family Coreidae (Waite *et al.,* 2003), mostly orchards consisting of the cultivar Hass were selected. The young cv. Pinkerton trees were included in the trial because according to Waite *et al.* (2003) this cultivar is particularly susceptible to coconut bug and would therefore represent a worst-case scenario. Four orchards with differing levels of canopy management were selected (Table 1).

All mature orchards had a history of severe coconut bug infestation dating back at least 15 years. All orchards are also surrounded by very dense riverine indigenous subtropical forest. This habitat has also been implicated in severe coconut bug infestations elsewhere in South Africa (Schoeman, 2016).

From the fifth of January 2016, 250 fruit in each orchard were inspected *in situ* every month over the next five months (50 fruit/tree x 5 replicate trees x 5 monitoring sites x 5 observations = 6 250 fruit).

Due to the commercial nature of the trial as well as to the patchy distribution pattern of this pest, this layout could unfortunately not be completely randomised.

Table 1. Level of canopy management as well as maturity of trees that were investigated for stink bug damage.

Parameter	Orchard				
	1	2	3	4	
				Top	Bottom
Cultivar	'Pinkerton'	'Hass'/'Fuerte'	'Hass'	'Hass'	
Age (years)	5	32	5	31	
Tree density	357	208	357	278	
Pruning status	Unpruned	Lateral 50% of each tree pruned	Unpruned	Unpruned	
Surrounding host plant	Subtropical forest	Pecans/forest	Subtropical forest	Subtropical forest	

In all orchards, data was collected along the forest/host plant/avocado interface, as it is well known that the distribution patterns of this insect form well defined edge effects (Schoeman, 2014). To standardize treatments as much as possible, only fruit from the apical parts of the trees were selected. Fruit occurring in the bottom 2 m of orchard 4 was also included as a comparison. In the two older orchards a 6 m ladder was used to gain access to the tree tops. Chemical insect control was the same in all four orchards and consisted of Beta cyfluthrin 125 SC @ 6 ml/100 L at flowering followed by a soil application of Thiamethoxam SC 240 g/L @ 9 ml/tree. Acephate 750 WSP @ 75 g/100 L was applied during February in an attempt to control the coconut bug. All survey data was subjected to an analysis of variance with SAS version 9.3 statistical software (SAS, 1999).

Spray trial

The main aim of this study is to investigate environmentally friendly alternative control products that can be used late in the season for the management of stink bugs on avocado. This spray trial was carried out on recently pruned 'Fuerte' avocados in an unsprayed mixed cultivar orchard at the ARC-TSC in Nelspruit and the following treatments were applied:

1. Untreated control
2. Lamda-cyhalothrin 50 g/L EC @ 10 ml/100 L (standard reference)
3. Screen Duo™ (Aluminum silicate) @ 1.25 kg/100 L
4. Broadband (*Beauveria bassiana* PPRI 5339) @ 1000 ml/ha
5. Screen Duo™ @ 1.25 kg/100 L & Broadband @ 1000 ml/ha

All products were applied with an experimental sprayer mounted on a LDV, equipped with hand lances. Approximately 2500 L spray mixture was applied per hectare. All treatments were replicated five times and each replicate consisted of three trees. Data was only taken from the central tree of each replicate and the trial was laid out as a complete randomized block. At least 100 fruit/replicate were rated for stink bug damage at the end of the season.

Aluminum silicate was selected for this trial as previous research by Dr Piet Joubert against the coconut bug on mangoes proved that the product was able to reduce coconut bug damage statistically significantly. The product was also mixed with *Beauveria bassiana* to investigate any potential synergistic effect.

Evaluate the viability of a perimeter treatment to prevent immigration of the coconut bug into avocado orchards

Local as well as overseas research results concur that prominent edge effects occur when stink bugs invade an orchard. Research in avocados and macadamias in South Africa point towards higher incidence of bugs in the outer five rows while researchers from the USDA work on a distance of 20 m from the perimeter of various plantings in perennial crops (Mizell *et al.,* 2008; Schoeman, 2014).

If the distribution patterns of stink bugs are predictable regarding their affinity for orchard perimeters, then clearly it does not make any sense treating an entire orchard both in terms of cost to the grower but more importantly in terms of environmental cost. To test this assertion, the following treatments were applied in a commercial 5-year old 'Pinkerton' orchard in the Nelspruit region.

1. Single application of Thiamethoxam @ 7 ml/tree during the 31st August 2016
2. Untreated control

Each replicate consisted of 25 trees and both treatments were replicated five times. Data was only taken in the centre row of each replicate from November up to harvest.

RESULTS

Pruning trial

According to Figure 1, significantly more damaged fruit were encountered in the apical regions of the unpruned orchard than any of the other orchards. Interestingly, although the trees in orchard number 2 (where the lateral 50% of the trees were pruned) were equally tall, the damage appeared to be considerably reduced. Opening up the trees resulted in a dramatic increase in sunlight penetration and probably also facilitated the penetration of insecticides into inner parts of the trees. According to Figure 1, fruit damage in the small 'Hass' and 'Pinkerton' orchards did not differ significantly from the fruit in the older taller orchard, indicating that pruning older trees had a beneficial effect.

Subtropical trees are generally vigorous growers and if no canopy management is carried out, tree height often exceed 12 – 15 m and canopy volumes often surpass 60 000 m^3/ha. Moreover, these trees gradually become unproductive as the production front also continuously shifts upwards, out of reach

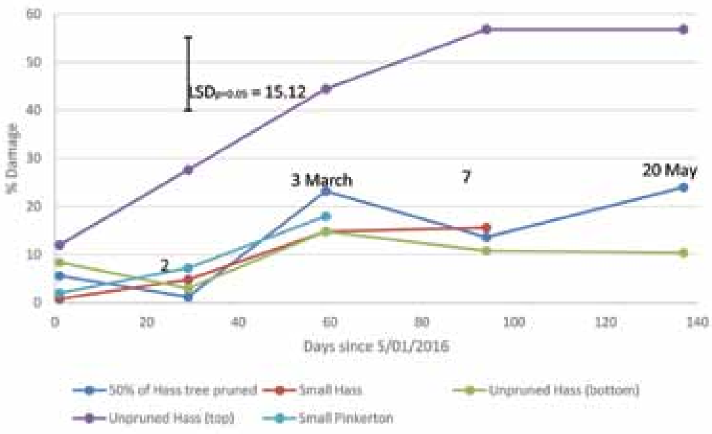

Figure 1. The effect of pruning on the percentage coconut bug induced fruit damage in 'Hass' and 'Pinkerton' orchards.

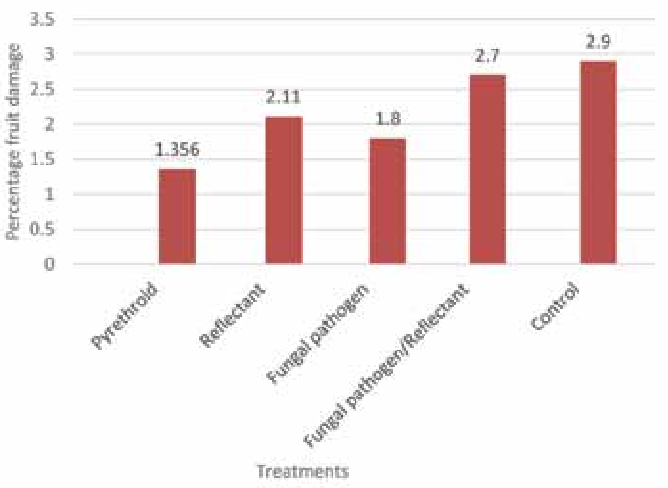

Figure 2. The effect of various environmentally friendly products on the percentage coconut bug induced fruit damage.

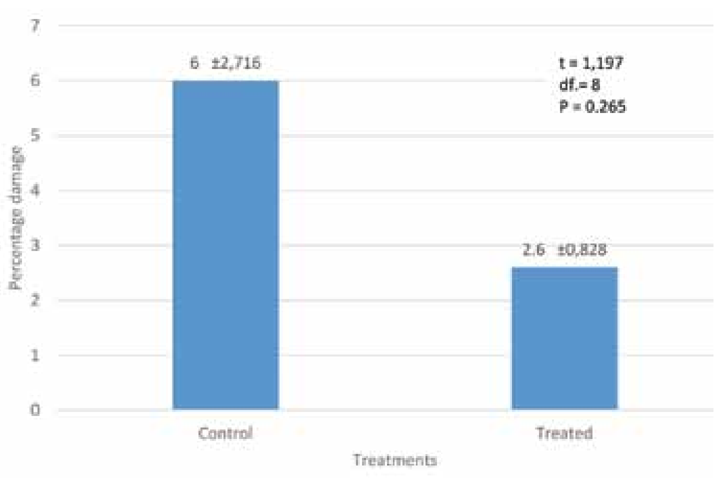

Figure 3. The effect of a soil drench of Thiamethoxam SC 240 g/L on the percentage coconut bug induced damage evaluated during January 2017.

of spraying equipment. This survey has demonstrated that pruning is probably a very important component of IPM in avocados.

Spray trial

Although this trial is ongoing, provisional results indicated that trees treated with the pyrethroid had the lowest percentage fruit damage while untreated trees had the highest damage. Damage percentages portrayed in Figure 2 were very low and it is expected that treatment effects will become more pronounced as the season progresses and infestation increases. Currently there is no demonstrable benefit of the fungal pathogen/reflectant combination (Fig. 2).

Evaluate the viability of a perimeter treatment to prevent immigration of the coconut bug into avocado orchards

The presence of edge effects are well documented in various crops (Mizell *et al*., 2008; Schoeman, 2014) and it has been quantified in South Africa avocados as well. It would therefore not be ecologically sustainable spraying entire orchards if only relative small areas are infested. A students' t test revealed no statistically significant differences between treatments, which is probably due to the extreme heterogeneous distribution of coconut bugs in the orchard.

CONCLUSION

The coconut bug is essentially a late season pest and invades orchards during late summer/autumn. Apart from the risks of applying chemicals during this time, the constant immigration of insects into the orchards meant that this strategy was not very effective.

Applying environmentally sensitive products containing entomopathogens late in the season may work, provided that the residual actions of these products are sufficiently long. Unfortunately, these products are known to be adversely affected by UV radiation and so far adding a reflectant to these products did not give a demonstrable advantage during the mid-season. Results from the late season should, however, provide more clarity on the matter.

Pruning had a drastic effect on the incidence of stink bugs. Previous research on macadamias indicated that tree height and density had a major influence on the occurrence of stink bug numbers (Schoeman, 2014) and current research confirms this observation. Pruning is also expected to optimise the penetration and coverage of insecticidal sprays.

Treating the edges on the 'Pinkerton' orchard did not completely reduce stink bug infestation inside the orchard but decreased it considerably. Although the residual action of thiamethoxam should have worn off when the trial was evaluated during January 2017, differences in infestation between treated and untreated trees nevertheless remain considerable. Even though these differences were not statistically significant, it nonetheless points towards the possible integration of this product in an IPM system.

None of these methods discussed above will give exclusive control for this pest and it is envisaged that an integrated method be followed which will encompass a number of control procedures.

Some exciting findings were however recently made during a related study in macadamias. The two spotted bug appears to outcompete and subsequently displace most stink bugs from macadamia orchards when developing green nuts are available. The true mechanism of this displacement is currently not known but it is very likely that semio-chemicals (defensive compounds) are involved. According to Botha (personal communications) defence compounds of the two spotted bug does not illicit any behavioural inter species response. While it is therefore clear that this phenomenon will have little practical value for macadamia IPM, it could potentially act as a general deterrent of stink bugs in avocado orchards and could be of considerable value in an IPM programme.

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