Stink bug control in avocados: The past, the present and the future

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Very little was known in South Africa about stink bug infestation in avocados before the start of this project. Initial work focussed on a survey in Mpumalanga to determine the severity of stink bug incursions. One of the primary conclusions during this phase of the project was that the original stink bug damage symptom description was incomplete. This contributed to a general underestimation of the severity of the problem. Also, similar orchards appear to be infested during subsequent production seasons. Relative seasonal occurrence of stink bug damage followed a typical sigmoidal curve and the susceptibility of fruit to stink bugs throughout the season was not homogeneous. Typically, early mid-season fruit is most susceptible and it would appear as if older out of season fruit is not susceptible at all. Spraying with registered contact insecticides during the early season (Nov/Dec) provided poor results in commercial orchards consisting of large trees. Typically, pest numbers resurged 4 to 6 weeks after such a spray and the process of resurgence went on until early winter when most of the fruit were harvested. In some cases, four well-timed sprays could not prevent considerable economic damage. In contrast, an application of a contact insecticide during this period on small 'Pinkerton' trees proved to be very effective. Initially, it was assumed that *P. wayi* is very mobile and that individuals may migrate between various host plants throughout the season. When stink bugs migrate into avocados it was expected that prominent damage will first occur along orchard perimeters. Quite the opposite happened when commercial orchards were surveyed during 2015, as the majority of stink bug damage occurred deep inside the orchards. Currently, this finding points towards a stable bug population inside the orchards and poor bug control can be explained by the vertical operational limits of spray equipment linked with the affinity of these insects for higher tree portions. When various methods of pruning, as well as tree ages, were compared in adjoining commercial orchards, it quickly became clear that older and denser trees had significantly more stink bug damage. Old trees of approximately the same size harboured significantly fewer insects when one side of the tree was pruned back while stink bug damage was considerably reduced in younger and shorter trees. These findings suggest that some form of chemical control in avocados should probably always be necessary, but that pruning and tree rejuvenation should form an important equal part of stink bug management.

INTRODUCTION

Stink bugs are strongly K selected insects which mean that they produce relatively few offspring and generally occur in low numbers. During 1991 the loss of avocado fruit due to the coconut bug in South Africa already amounted approximately R1.37 million (Erichsen & Schoeman, 1992). This insect was recorded during 1977 for the first time in South Africa (De Villiers & Wolmarans, 1980) and was subsequently recorded on avocadoes approximately six years later by De Villiers and Van den Berg (1984). According to Van der Meulen (1992), mean damage ratings on early aborted avocados varied from 4.2 to 9.1% while it varied from 2.1 to 39.9% on mature fruit at harvest. On some farms damage levels as high as 76.2% were recorded.

According to Dennill and Erasmus (1991), the coconut bug was the biggest problem on avocados during the early 1990's and an infestation level of ± 4.7% was recorded. According to Bruwer (1999), this is very close to the 5% upper limit, which is generally used as a threshold value. Joubert and Claassens (1994) did a survey during 1993 and recorded damage levels of ± 1.21 – 3.14%. Bruwer (1996, 1999 & 2005) did a significant amount of work and mention infestation percentages ranging from 2.1% to approximately 13%.

Current research indicates that hemipterans (stink bugs) are normally heterogeneously distributed. Field observations on avocados indicate that this is certainly the case with the coconut bug as well. Hot spots are frequently found in and amongst large areas of extremely low infestation, which complicates scouting practices for this insect considerably. Significant variation in damage symptoms commonly occurs within one orchard and the only way to estimate the population of these insects accurately is to increase the sample size. Unfortunately, there is a practical limitation to this approach.

Despite various attempts at controlling the 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. Increases of secondary pests have also recently been noticed in some orchards. Whether this is due to increased frequency of foliar sprays against stink bugs is unsure at the moment, but the message to growers is clear: Any form of chemical control should be done with extreme circumspection.

Population survey of stink bugs and stink bug damage

At the inception of the project, a survey was undertaken in Mpumalanga to determine the severity of the stink bug problem. Because it was very difficult to monitor for the coconut stink bug, damage symptoms were initially used to determine the economic impact. This survey was done using photographs from the avocado industry handbook as a guideline. According to Table 1 with the exception of Farm 1, all damage levels were very low. However, it quickly became evident that the original symptom description was incomplete and that initial symptoms were confused with that of fruit fly damage. The damage levels reflected in Table 1 should therefore be regarded as a vast underestimation of the damage potential of this pest in the orchards that were surveyed.

Table 1. The severity of coconut bug damage symptoms in selected commercial avocado orchards in the Mpumalanga Province of South Africa.

Farm	Damage on tree (%)	Number of fruit examined	Damage on aborted fruit (%)	Number of fruit examined	Total damage (%)	Total number of fruit examined
Farm 1	127 (3.53)	3600	8 (14.55)	55	135 (3.69)	3655
Farm 2	72 (1.64)	4400	5 (1.11)	450	77 (1.59)	4850
Farm 3	117 (3.66)	3200	1 (0.05)	200	118 (3.47)	3400
Farm 4	30 (0.77)	3900	1	400	31 (0.72)	4300
Total	346 (0.6)	15100	15 (1.36)	1105	361 (2.23)	16205

Relative seasonal abundance of stink bug damage in avocado orchards

For optimal timing of control, it is necessary to know when the target insects are most active in the orchards. According to Figure 1 a small amount of damage did occur on fruit early in the season, but damage levels generally increased significantly from December onwards. Consequently, it was decided that an initial corrective treatment against stink bugs on 'Pinkerton' avocados should occur during approximately week 47 in a normal year.

However, because different cultivars mature at different times and seasons, as well as plant responses to various abiotic factors vary considerably, it was necessary to be more precise. Mizell *et al*., 2008 mentioned that plant phenology plays a pivotal role regarding fruit infestation by stink bugs in general. When fruit maturity (moisture %) was plotted against coconut bug damage and if 5% damage was selected as the uppermost damage level that can be tolerated, Figure 2 indicated that some form of control should be initiated before the fruit reached a moisture content of just below 86%.

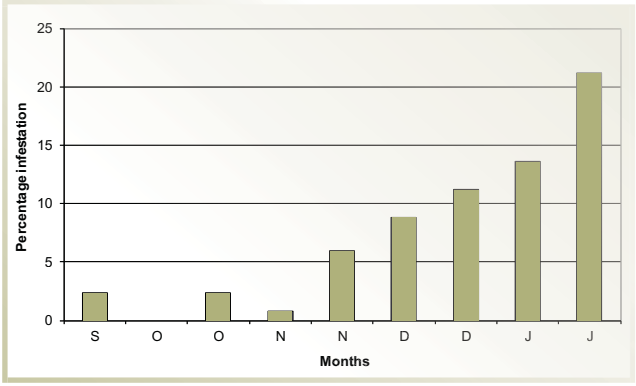

Figure 1. The relative seasonal abundance of stink bug damage to avocados during a typical season in an unsprayed 'Pinkerton' orchard.

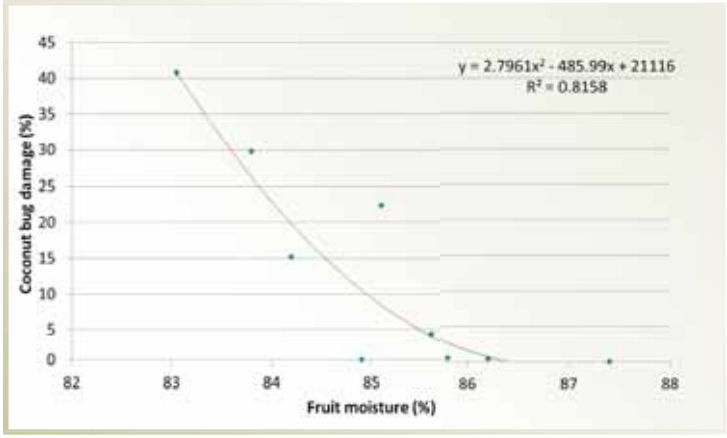

Figure 2. The relationship between fruit maturity (moisture %) and stink bug infestation in unsprayed 'Pinkerton' trees.

EFFECTS OF SPATIAL DISTRIBUTION OF FRUIT AND TREES IN ORCHARDS ON THE INCIDENCE OF STINK BUG DAMAGE

Effect of position of fruit in a tree

Despite spraying at the correct time, some growers still reported poor results. A subsequent survey revealed that statistically significantly more damage occurred in the upper portions of infested avocado trees (Fig. 3). Drew (2003) reported that the vertical operational limit of most air assisted orchard sprayers are in the region of 5.5 to 6 m. The combination of the preferred habitat of the insects combined with technical limitations of spray equipment explained poor results achieved by some growers.

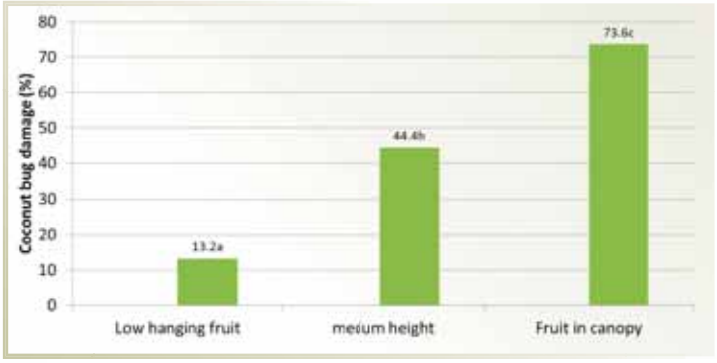

Figure 3. The relationship between the vertical distribution of 'Pinkerton' fruit in unsprayed trees and increased stink bug damage.

Effect of position of tree in an orchard on stink bug damage

It has always been assumed that the coconut bug is very mobile and move from host plant to host plant when fruit has reached the desired stage. It was also assumed that prominent edge effects will occur with most bugs occupying niches in perimeter trees before moving deeper into the orchards. However, when fruit from perimeter trees in a mature commercial 'Hass' orchard were compared to fruit occurring deep inside the orchards during the early season, quite the opposite was observed according to Figure 4. Although differences were not quite statistically significant, the majority of the damage occurred inside the orchard, highlighting the possibility that the bug population may be more sedentary than previously anticipated. The presence of out of season fruit in most orchards probably facilitated this distribution pattern.

Figure 4. The relationship between the distribution of 'Hass' trees in a commercial orchard and increased stink bug damage (t = 1.84, p = 0.076, df = 15).

Effect of pruning on stink bug damage

When the occurrence of stink bug damage was determined in 'Hass' and 'Pinkerton' orchards of varying sizes and ages, Table 2 revealed that considerably more damage occurred on tall, unpruned trees than on similarly aged trees that were pruned on one side. Furthermore, younger and therefore less dense trees had considerably less damage than older trees.

CHEMICAL CONTROL

When a contact chemical was sprayed either as a programme or as a single application from week 47 onwards, Figure 5 indicates that relative good control was achieved. This level of control was achieved because the trial orchard was relatively isolated from alternative host plants (in the desired stage) which could have acted as a source of re-infestation.

Table 2. The relationship between tree age, density and pruning on fruit damage on a commercial estate.

	Hass (unpruned)	Hass & Fuerte (half of tree pruned)	Hass (unpruned)	Pinkerton (unpruned)
Spacing (density trees/ha)	6 x 6 (278)	8 x 6 (208)	7 x 4 (357)	7 x 4 (357)
Planting date (age)	1984 (31)	1983 (32)	2010 (5)	2010 (5)
Tree height	7 m +	7 m +	3 m	2 m
Mean (%)	42 (28)	15 (10)	10.2 (6.8)	13.6 (9.06)
Number fruit examined	750	750	750	750

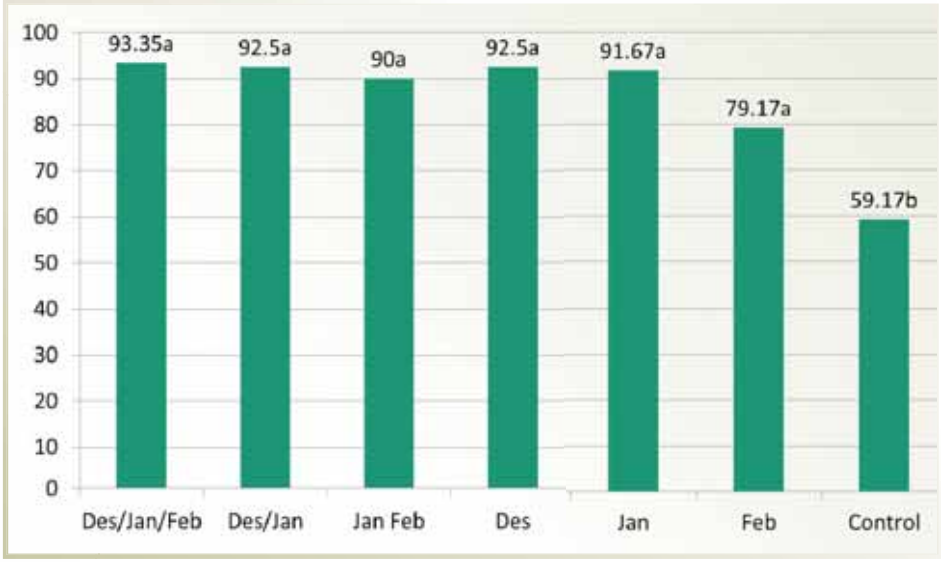

Figure 5. The effect of applying contact insecticides to small 'Pinkerton' trees in terms of percentage clean fruit.

CONCLUSIONS

Although avocado was not a good host for stink bugs in general, damage when it occurred was severe and required corrective chemical treatments. More than one species of stink bug were recovered from avocado, which also explains the myriad of stink bug-like damage symptoms commonly observed in avocado orchards. Stink bugs are not a general problem for the South African avocado industry, but the same farms are infested year after year, indicating that surrounding host plants may affect the severity of the attack. The year-round presence of fruit in mature orchards could induce bugs to become residents if trees are sufficiently big and dense. The absence of higher infestation levels along the perimeters of these orchards support this assumption.

Stink bugs also prefer higher portions of the trees which in big trees are notoriously difficult to spray. In time, repetitive applications of contact insecticides linked with poor spray coverage could lead to a plethora of problems (such as resistance and outbreaks of secondary pests), which should be avoided at all cost. Pruning and attention to proper spray coverage are key factors that will have to be sorted if this group of insects is to be controlled successfully.

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