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A PACKHOUSE SURVEY OF INSECT DAMAGE TO AVOCADOS IN THE NELSPRUIT/HAZYVIEW AREA DURING 1990

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ABSTRACT

*In a packhouse survey of insect damage to avocado fruits, 16 265 avocado fruits in 36 samples from 32 orchards were examined. Coconut bug [*Pseudotheraptus wayi *(Brown)],thrips* /Heliothrips haemorrhoidalis *(Bouche)] and* Selenothrips rubrocinctus(Giardi), fruitfly/Pterandrus rosa *(Karsh)] and stink bugs [including* Nezara viridula *(L)] were the most significant pests, respectively causing culling of 4,7%, 2,1% 1,9% and 1,8% of the fruits. Total crop loss due to insects is estimated at 10%. Nine insect taxa that cause lesions on the fruits were identified, and this number illustrates a threefold increase in these pests since 1982. The increasing pest complex and altering status of the pests is explained in terms of a recruitment theory, according to which further insect pest problems must be expected in the future.*

INTRODUCTION

Avocado orchards in South Africa comprise about 800 ha which generate R100 million and R30 million pa on the export and local markets, respectively. Of the exported fruits, 70% are marketed in Europe, especially in France where the preferred fruit is of the Haas cultivar. Fruits of the Fuerte and Edranol cultivars are second and third most popular, being marketed mainly in England and locally.

South African avocados have relatively few serious insect pests. In Annecke & Moran's (1982) comprehensive review of the insect and mite pests of cultivated plants in South Africa, only five sporadic pests are mentioned and only greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouche) and red-banded thrips, *Selenothrips rubrocinctus* (Giard), are discussed in any detail.

During the last decade there has been an increase in the number of insect pests and their impact on the avocado industry. While Annecke & Moran (1982) listed five sporadic pests, De Villiers & Van den Berg (1987) list 18 potential insect pests. The pests that are regarded as most troublesome are those that mark the fruit surfaces, and in this regard, De Villiers & Van den Berg (1987) name fruitflies, false codling moth and coconut bug. Thrips have been known to feed on avocado fruit surfaces, but have not been regarded as serious enough to warrant control measures (Annecke & Moran, 1982; De Villiers & Van den Berg, 1987). However, during 1989, thrips caused up to 80% culling of fruits in some orchards in the Hazyview area. Coconut bug, not mentioned by Annecke & Moran (1982), has subsequently (Viljoen & De Villiers, 1986;

Viljoen, 1986) been regarded as having the potential to cause serious losses. In addition, pentatomid bugs, notably green vegetable bug *Nezara viridula* (L), have become increasingly important despite as yet being unrecorded as pests of avocado.

In 1985, 3,64% of the 1,8 million cartons of avocados destined for export were rejected. Insect damage, caused by fruitflies, coconut bug, *Pseudotheraptus wayi* (Brown), and false codling moth, *Cryptophlebia leucotreta* (Meyrick), accounted for 2,6% of the rejections (Pieterse, 1986). In 1988 and 1989,3,81 % and 3,63% of the export cartons were rejected, and insect damage accounted for at least 0,42% of the 1989 rejections (Burmeister, 1990). These figures, however, concern fruit that have already been washed, sorted and packed, and the relative importance of the various insect pests was not examined. Losses due to insect damage could be expected to be greater if fruits were examined after picking on arrival at the packhouses.

In view of the enlarging pest complex and changing status of the avocado pests, a survey of insect damage to avocado fruits was conducted in the Nelspruit/Hazyview area during 1990.

METHODS

From June to August 1990, various packhouses were visited on four occasions, namely 7 — 8 June, 3 — 6 July, 30 July — 1 August and 20 — 22 August. In total, seven packhouses were concerned, namely Avalen, Burpak, Hall's & Sons, Pienaar Packers, Tropicado, Vos Pakkery and Wayland Green. At each packhouse, a sample of five lugs from each orchard that was being harvested and packed at the time was randomly selected from the trailers on arrival at the packhouse. Only fruits from orchards of the economically important Haas, Fuerte and Edranol cultivars were sampled.

The fruits in each sample were individually examined to identify and record the incidence of damage caused by the various insects that mark or infest the fruit surfaces. A total of 16 265 fruits in 36 samples (of which 18 were Hass, ten Edranol and eight Fuerte) from 32 orchards were examined. With the exception of stink bugs, weevils and ants, the damage caused by the various pests has previously been described and illustrated (Schwartz, 1978; Du Toil *et al,* 1979; De Villiers, 1980; Annecke & Moran, 1982; Viljoen, 1986; Viljoen & De Villiers, 1986; De Villiers & Van den Berg, 1987; De Villiers, 1990; Du Toit & De Villiers, 1990; Robertson, 1990).

According to consultants and researchers in the subtropical fruit industry, *N viridula* is at least one species causing the symptoms ascribed to stink bugs (the present authors have collected this species in avocado orchards). Where the bugs have penetrated the pericarp with their piercing-sucking mouthparts, elevations develop which give the fruits a pimply appearance (Figure 1 a). If an elevation is severed from the body of the fruit, a dark central dot in the outer flesh of the fruit indicates where feeding took place (Figure 1 b). Unidentified weevils also feed on the fruit surfaces. The damage they cause differs from that of the smoother lepidopteran lesions by consisting of numerous distinguishable bite marks (Figure 1 c). Ants (Formicidae) feed on fruits that touch the ground and produce 'potholes' in the fruits which usually have the diameter of a pencil (Figure 1d). The ant species involved have not yet been identified.

The percentage of the total number of fruits examined that was damaged by each pest was determined in order to rank the pests in order of importance. To confirm this ranking of the pests, the top five pests of each of the three cultivars examined (Hass, Fuerte and Edranol), were scored from 5 to 1. The scores for the pests on each cultivar were then added and the pests were arranged in decreasing numerical order.

Although the number of fruits per sample of five lugs was high (n = 290 — 628), the reliability of the sampling technique was evaluated by comparing the incidence of damage of the four most important pests (coconut bug, thrips, fruitfly and stink bugs) in two independent samples taken from four orchards. Two pairs of samples were taken from two Hass orchards and the two remaining pairs were from a Fuerte and an Edranol orchard, respectively. Pairwise Chi-square tests were used to do the 16 comparisons.

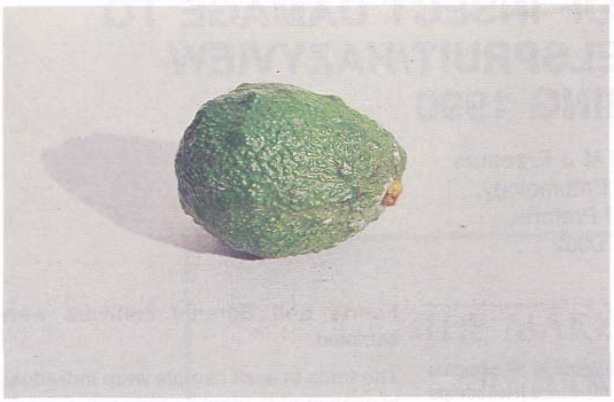

Fig 1 Feeding by stink bugs causes the fruit surface to have a pimply appearance (photo: A S Schoeman).

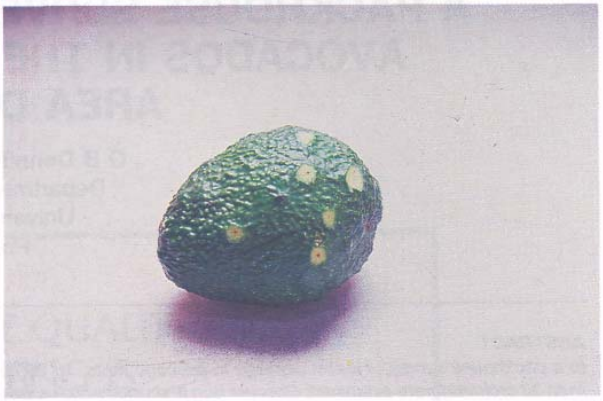

Fig 2 If the elevations caused by stink bug feeding are severed from the body of the fruit, the positions of the feeding holes are revealed (photo: A S Schoeman).

Fig 3 Lesions consisting of numerous bite marks on the fruit surfaces caused by unidentified weevils (photo: A S Schoeman).

Fig 4 'Potholes' in the fruit surfaces caused by unidentified ants which feed on fruits touching the ground (photo: A S Schoeman).

For Hass fruits damaged by coconut bug and green vegetable bug, the numbers of feeding marks per fruit were recorded, as were the number of fruitfly stings (oviposition sites) per fruit. Fruits of all cultivars damaged by thrips were scored from 1, 2, 3 ... to 10 according to the percentage of the fruit surface discoloured by thrips feeding. The latter

was done to determine the percentage of fruit culled due to thrips, since only fruits with > 30% of their surface damaged (i.e. a score greater than 3) are regarded as unfit for export. Fruits with scale infestations that were high enough to result in rejection were counted.

Although the number of samples for each cultivar was relatively low (n = 18,10 and 8 for Hass, Edranol and Fuerte, respectively), the proportions of fruits damaged by coconut bug, thrips, fruitly and stink bug and infested by armoured scales were averaged to compare between the cultivars. This was done as a preliminary check of the opinion of farmers and consultants that the fruits of the Hass variety are most damaged by insect pests.

RESULTS

According to the percentage of the total 16 265 fruits damaged by each pest, the five most important pests were coconut bug (4,70%), thrips (2,10%), fruitfly (1,86%), stink bugs (1,84%) and weevils (0,80%) (Table 1). The lepidopteran and ant pests together damaged 1,64% of the fruits examined. The top five pests together caused 87% of the damage, while coconut bug and thrips contributed 36% and 16%, respectively.

The ranking of the pests based on the scores for pest status per cultivar was similar: coconut bug (14), fruitfly (11), thrips (9), stink bug (6) and weevils (3) (Table 2). These results indicate that coconut bug is more than twice as important as the second most important pest, whether the latter is thrips or fruitfly.

TABLE 1 The percentage of a total 16 265 avocado fruits from 32 orchards in the Nelspruit/Hazyview area damaged by various insect pests during 1990

Pest	n	%	Rank
Coconut bug	764	4,70	1
Thrips	342	2,10	2
Fruitfly	302	1,86	3
Stink bug	300	1,84	4
Weevils	130	0,80	5
False codling moth	106	0,65	6
Other Lepidoptera	78	0,48	7
Looper	56	0,34	8
Ants	27	0,17	9

TABLE 2 **A ranking of the five most important insect pests of Hass, Fuerte and Edranol fruits (5 = most important to 1 = fifth most important) used as a scoring system to determine the five most important pests of the three cultivars combined (see Methods)**

Pest status* (score)	Cultivar Hass	Cultivar Fuerte	Edranol
5	coconut bug	coconut bug	fruitfly
4	stink bug	fruitfly	coconut bug
3	thrips	thrips	thrips
2	fruitfly	weevils	looper
1	weevils	stink bug	stink bugs/ants

* Cumulative scores: coconut bug — 14, fruitfly — 11, thrips — 9, stink bug — 6, weavils — 3, looper — 2 and ants — 1.

TABLE 3 **Chi-square comparisons of the proportions of fruits damaged by coconut bug (Cb), stink bug (Sb), thrips (Th) and fruitfly (Ff) in pairs (P1 & P2) of samples from four different orchards**

Sample cultivar	Pest	P1	P2	Chi^2	P
Fuerte	Cb	29/393	8/381	11,85	<0,001
	Sb	6/393	0/381	5,86	0,05>P>0,01
	Th	8/393	5/381	0,61	>0,05
	Ff	9/393	30/381	12,61	<0,001
Edranol	Cb	4/375	4/375	0,00	1,0
	Sb	3/375	1/375	1,005	>0,05
	Th	0/375	0/375	*	*
	Ff	2/375	1/375	0,334	>0,05
Hass (a)	Cb	86/364	48/380	15,21	<0,001
	Sb	103/364	32/380	49,44	<0,001
	Th	0/364	4/380	3,85	0,05
	Ff	1/364	5/380	2,52	>0,05
Hass (b)	Cb	18/471	15/503	0,52	>0,05
	Sb	8/471	2/503	4,05	>0,05
	Th	4/471	4/503	0,01	>0,05
	Ff	11/471	9/503	0,361	>0,05

* Although these proportions are identical, the statistical comparison could not be done because they are both zero.

TABLE 4 The average percentage of avocado fruits damaged by various insect pests in samples from 16 Hass orchards, seven Fuerte orchards and nine Edranol orchards

Pest	Average % (and variance) damaged/infested fruits					
	Hass (n = 16)		Fuerte (n = 7)		Edranol (n = 9)	
Coconut bug	6,59	(32,67)	3,33	(16,97)	1,64	(2,64)
Thrips	2,99	(11,31)	1,09	(1,24)	0,98	(0,86)
Fruitfly	1,42	(3,22)	2,41	(5,17)	2,53	(13,90)
Stink bug	3,00	(22,03)	0,22	(0,14)	0,06	(0,03)
Scales	7,61	(34,26)	32,56	(296,68)	7,73	(32,85)

Of the insects which infest the fruits, diaspidids were most abundant, infesting 1 874 (11,52%) of the 16 265 fruits examined. The diaspidid species were unable to be identified because of a high incidence of parasitism of the specimens collected for identification. Mussel scales occurred on 120 (0,74%) of the fruits, heart-shaped scales were positively identified on only 12 (0,07%), and long-tailed mealybugs on 159 (0,98%) of the fruits examined. Scale infestations were never high enough to cause culling of the fruits, probably a result of high levels of parasitism.

Of the 16 comparisons of the proportions of fruits damaged by coconut bug, thrips, fruitfly and stink bugs in the four pairs of samples from four orchards, only ten were not statistically different, one was significantly different, four were highly significantly different and one comparison (for thrips on Edranol) could not be done because both proportions were zero (Table 3). The sampling method was thus 69% reliable at the 95% probability level.

On Haas fruits, the mean ± se number of coconut bug bites, fruitfly stings and stink bug bites per fruit were 1,88 ± 0,05 (n = 496), 1,46 ± 0,11 (n = 119) and 5,66 ± 0,33 (n = 280).

Of a total of 262 fruits of all cultivars damaged by thrips, the median score for damage was 1 (1 — 10% of surface area damaged). Only 11 fruits scored 4, and 5 was the maximum score recorded on only four fruits. Fruits with a score greater than 3 were culled so that the percentage cull was 5,72%. Of the total 16 265 fruits examined, thrips caused the rejection of only 0,09%, thus indicating that thrips were an insignificant pest during 1990 in the study area.

Comparisons between cultivars indicate that there was a higher incidence of damage by coconut bug, thrips and stink bugs on fruits of the Haas cultivar than on Edranol and Fuerte fruits (Table 4). No difference could be detected regarding the incidence of fruitfly damage (Table 4). On Fuerte fruits armoured scales were encountered about two and four times more frequently (33,00%) than on Edranol (16,00%) and Haas (8,00%), respectively.

DISCUSSION

The avocado pest complex has increased in size over the last decade: regarding only

insects causing lesions on the fruits, Annecke & Moran listed three taxa (thrips, false codling moth and fruitfly), De Villiers & Van den Berg (1987) listed six (fruitfly, coconut bug, thrips, loopers, leaf rollers and false codling moth), and in the present study nine taxa were implicated. Recruitment of pests onto crops is initially rapid and reaches an asymptote after 150 — 200 years. The number of recruited pests is related to the area under cultivation and the time since the introduction of the crop plant. (Strong, 1974; Strong *et al,* 1977; Banerjee, 1981; Strong *et al,* 1984). Although the avocado was introduced into South Africa during the Dutch colonisation of the eighteenth century, it began to be cultivated as a crop between 1920 and 1930 (Durand, 1990). Even at present the industry is relatively small in comparison with other crops, including other fruits (Garbers, 1987). However, the avocado industry is expanding rapidly; Kotzé (1990) reports an annual increment in exports of over 25% per annum for the last decade. The growing avocado pest complex is thus a result of the recent expansion of this young industry, and it is clear that this pest complex will only increase in numbers of species and severity of infestation in time to come.

The insects that contribute to the initial rapidity of recruitment of pests are usually highly mobile polyphagous insects (Dennill & Moran, 1990), and the present suite of avocado pests confirms this hypothesis (see Annecke & Moran, 1982). Such pests can be expected to be sporadic, since their mobility and polyphagy enable them to exploit a range of crops (and other plants) in the vicinity. These characteristics account for the high variance of the data collected during this study. Despite the large number of fruits per sample, the sampling technique was reliable for only 69% of the comparisons between samples taken from the same orchards. Statistical comparisons of the incidence of damage between different cultivars could not be done for the same reason. The high variance in incidence of damage by these pests is the result of their being sporadic, polyphagous insects, a feature that is going to complicate research on these pests in avocados.

This study was undertaken to determine the relative importance of the insect pests that damaged avocado fruits, and the four most important pests are undoubtedly coconut bug, thrips, fruitfly and stink bugs. Fruits damaged by more than one pest were not taken into account. However, while scale insects commonly occurred on fruits damaged by the other pests, fruits were seldom damaged by more than one of the insects that cause lesions (a result of the sporadic occurrence of these pests). The sum of the percentage of damaged fruits is 12,94% and the authors regard this as a slight overestimation of the total percentage of fruits damaged by insects, while the sum of the percentage of fruit damaged by coconut bug, thrips, fruitfly and stink bugs, namely 10,5%, is regarded as a minimum loss. Scale insect infestations were insignificant, probably because of the high incidence of parasitism (De Villiers *&* Van den Berg, 1987). If this figure is representative of the annual crop loss due to insects (this is to be confirmed by continuing this survey for two more years), the avocado industry is losing about R10 — R13 million per annum to insect pests. If one considers that the Californian avocado industry, after being relatively free of pests during its infancy (ca 1910), suffered from about nine mite and 40 insect pests by 1959 (Ebeling, 1959), the need for research on the South African avocado pest complex is clear.

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