Fruit-feeding moths in the Eastern Cape: experiences and control options

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ABSTRACT

There are two general categories of fruit-feeding moths: fruit-piercing and fruit-sucking moths. Only fruit-piercing moths have the ability to damage healthy fruit, as they have a modified proboscis. Fruit-sucking moths can only feed on fruit which have already been damaged, very often by fruit-piercing moths. The most common species of fruit-piercing moth occurring in the Eastern Cape is *Serrodes partita.* Epidemic outbreaks in the citrus producing regions of the Cape, occur every 5-10 years after heavy summer rains in the Karoo. Usually around two months later moths can migrate hundreds of kilometres to attack early ripening mandarins, particularly Satsumas. *Achaea lienardi* is the most common fruit-sucking moth in the Eastern Cape. The trigger for its outbreak is the same as for *S. partita,* hence inundation of orchards by *A. lienardi* often follows that of *S. partita.* This was recorded in 1999 in the Eastern Cape, leading to devastating losses of mandarins, and appeared to happen again in 2009. Currently, the only effective way of controlling fruit-piercing moths is by deterring them with lights. Growers are advised to regularly inspect their early mandarin orchards at night from the middle of February, for the presence of fruit-feeding moths. No action is justified against fruit-sucking moths, unless they are causing a nuisance in packhouses.

INTRODUCTION

Two general categories of fruit-feeding moths exist. These are fruit-piercing moths and fruit-sucking moths. Jack (1922) originally made this distinction, based on the morphology of the moth's proboscis. Only fruit-piercing moths have the ability to cause primary damage i.e. to damage healthy fruit, as they have a modified proboscis. Fruit-sucking moths can only feed on fruit which has already been damaged, very often by fruit-piercing moths.

Johannsmeier (1976) recorded the behaviour of fruit-feeding moths in orchards, tested their ability to penetrate with their proboscises either skin or flesh of fruit of varying hardness, and studied the morphology of their proboscises. He was able to correlate proboscis structure with the ability to pierce intact fruit.

FRUIT-PIERCING MOTHS

Johannsmeier (1998) lists 11 species of fruit-piercing moths, which have been recorded on citrus in South Africa. These are *Eudocima fullonia* (Clerck), *E. divitiosa* (Walker), *E. materna* (L.), *Oraesia provocans Walker, O. triobliqua* (Saalmüller), *O. emarginata* (F.), *Serrodes partita* (F.), *Egybolis vaillantina* (Stoll), *Pericyma atrifusa* (Hampson), *P. mendax* (Walker) and *P. scandulata* (Felder & Rogenhofer). Hofmeyr (2003) lists a sixth genus, *Plusiodonta.* All of these species belong to the family Noctuidae, or at least to the superfamily Noctuoidea, which means that they are night-flyers. In general the moths are large with a wingspan that varies from 20 to 90 mm according to species (Hofmeyr, 2003).

Fruit-piercing moths tend to be migratory. They have an acute sense of smell, being able to detect ripening fruit over a distance of 10 km and possibly much further, especially downwind from orchards (Johannsmeier, 1998). Greatest moth activity occurs during the first three hours after dark, followed by a decrease in numbers around midnight. Whitehead & Rust (1971) found that less than 5% of marked fruit-piercing moths *(S. partita)* returned to the same orchard on subsequent nights.

By far the most common species of fruit-piercing moth recorded in citrus orchards in the Eastern and Western Cape is *S. partita* (Fig. 1). The three black spots, forming a triangle near the base of the forewing, are characteristic. Epidemic outbreaks in the Eastern Cape and southern part of the Western Cape occur every 5-10 years after heavy summer rains in the Little Karoo and parts of the Great Karoo (Rust & Myburgh, 1986). This induces the wild plum, *Pappea capensis,* which is the larval host plant, to flush profusely. The larvae feed at night on the young leaves and shelter on and under the trees during the day. On completion of the developmental cycle the moths leave these trees and seek wild or cultivated fruit to feed on. Generally around two months after these heavy rains, millions of moths can migrate up to 500 km, often finding early ripening mandarins, particularly Satsumas.

Feeding holes are round to oval and about 0.7-1.2 mm in diameter. The moth breaks up the fruit tissue and juice cells with its proboscis and subsequently sucks up the juice. This leaves an underlying dry area in the fruit tissue where the fruit juice has been removed. After a few days the damaged area turns yellow and can become infected by fungi (Fig. 3) and the fruit can drop within 4-10 days of having being pierced. Jack (1916) recorded up to 50% damage on Washington Navels in Zimbabwe. Gunn (1929) reported losses of 15-70% in the Eastern Cape.

FRUIT-SUCKING MOTHS

Nine genera of moths have been listed as possible fruit-sucking moths on citrus (Johannsmeier, 1998). By far the most common is *Achaea lienardi* (Boisduval) (Fig. 2), which like the fruit-piercing moths is also a noctuid. It appears to be endemic to Africa, the larvae feeding on the leaves of a number of tree species, including the same wild plum on which *S. partita* feeds, and certain *Acacia* and *Schotia* species, amongst others (Wagner *et al.*, 2008). The trigger for an outbreak of this fruit-sucking moth is the same

Fig. 1. The fruit piercing moth, Serrodes partita. *Note the diagnostic three black marks at the base of the forewing, forming a triangle.*

Fig. 2. The fruit sucking moth, Achaea lienardi. *There is great variation in the colouration of these moths. However, close inspection reveals characteristic wing patterns.*

as that reported for the fruit-piercing moth i.e. very good summer rains.

Outbreaks of *A. lienardi* appear to be far more protracted than those of *S. partita*, sometimes continuing for weeks. However, it is most probable that each night's infestation is a swarm of fresh moths. Johannsmeier (1976) found only a 7.6% return of marked moths to orchards the following night. It is because of this protracted presence of *A. lienardi* that growers can easily get the impression that it is this moth which is the primary cause of the damage to their fruit. However, it is not uncommon for fruit-sucking moths to feed on the damage caused by fruit piercing-moths (and other causes of primary damage). *Achaea lienardi* simply exacerbates the damage caused by *S. partita*, or anything else, enlarging the holes in the fruit and causing them to drop more rapidly (Fig. 4).

RECENT EXPERIENCES IN THE EASTERN CAPE

In 1999, there was a devastating outbreak of *S. partita* in the Eastern Cape, followed by an invasion of *Achaea lienardi*. This outbreak lasted for about six weeks, with low numbers of moths still tailing off for a week or two after that. It is not clear at what stage the fruit-piercing moth disappeared and at what stage the fruit-sucking moth appeared. Moths were first recorded in the Sundays River Valley and Gamtoos River Valley in the latter half of February. The outbreak occurred in Knysna at around the same time, and lasted for about five weeks. Early in March, the incidence of these moths was reported from the Kat River Valley and Uitenhage.

Only Miho Wase Satsumas were affected initially. However, damage was subsequently noted on Owari Satsumas and Marisol and Oroval Clementines, but to a much lesser extent.

The pre-harvest drop of Miho Wase Satsumas was estimated to be 20% of the crop in Sundays River Valley, 30% in Gamtoos River Valley, and 50% at the Citrus Foundation Block near Uitenhage. Only one orchard in the Knysna area was seriously affected, losing an estimated 50% of its fruit. Two orchards in the Kat River Valley each lost around 5% and 10% of their crop.

After ethylene degreening, a further 10-15% of fruit was culled by packhouses in the Sundays River Valley, 5-6% by a packhouse in the Gamtoos River Valley, and less than 5% by a Kat River Valley pack house. At the port of export, an additional 3-4% decaying fruit was detected in fruit from Sundays River Valley. An estimated 40-45% of the Satsuma crop from Sundays River Valley was eventually packed for export. Gamtoos River Valley orchards packed only around 30% of their Satsuma crop for export in the early portion of the season. The affected orchard in the Knysna area was not harvested for export at all, so as to avoid waste problems.

Relatively few growers (seven in the Gamtoos River Valley and three in the Sundays River Valley) were reported to have erected lights to deter the moths from orchards. Results were variable, but appeared to be dependent on the type and number of lights which were erected. Most growers who erected lights were observed to not have followed recommendations adequately, and therefore did not experience satisfactory control.

A similar outbreak occurred in the Eastern Cape in March 2009, exactly 10 years later. This outbreak affected Sundays River Valley and the Kat River Valley most severely. Gamtoos River Valley and Knysna seemed to be relatively unaffected. Although a few reports of the occurrence of *S. partita* were received from individuals within the farming community, this was not confirmed and it is therefore not clear whether *S. partita* did lead the invasion again. However, A. *lienardi* was present in Satsuma mandarin orchards in particular in high numbers for several weeks. Large numbers of fruit dropped as a result and a lot of damaged fruit had to be sorted at harvest – both in the orchard and on delivery to the packhouse. Fortunately, the practice of ethylene degreening of fruit proved very helpful in highlighting wounds which were not initially visible.

RECOMMENDATIONS FOR MANAGEMENT OF FRUIT-FEEDING MOTHS

Growers are encouraged to inspect Satsuma orchards regularly after dark, from around the middle of February. It appears that infestations of *S. partita* probably don't last for more than a few days. It may therefore happen that growers can be oblivious to an invasion of this pest, until wounds begin to show, fruit begins to drop or a secondary infestation of *A. lienardi* occurs. However,

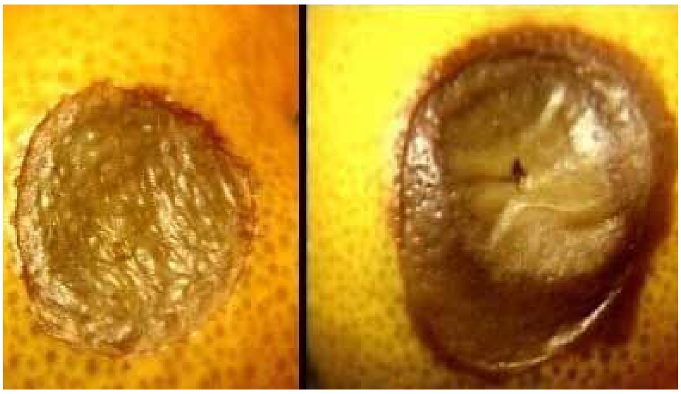

Fig. 3. Advanced damage on Satsuma mandarins caused by Serrodes partita *feeding.*

Fig. 4. Achaea liernadi *moths feeding on a damaged Satsuma mandarin.*

with regular evening inspections once fruit begins to colour up, the first wave of a fruit-piercing moth invasion can be detected. Consequently, it will be possible to implement control measures or at least be warned that there may be a high level of damage and post-harvest decay potential in the orchard.

It is very important to note that no chemical option is considered to be effective for use in orchards. These moths are extremely hardy to chemical pesticides (Kriegler, 1962). In 1999 the author personally witnessed moths being sprayed with an extremely high concentration of an organophosphate insecticide, without any apparent effect on the moths. In addition, fruit-piercing moths do not remain in an orchard for more than one night (Whitehead & Rust, 1971). Any subsequent infestation is therefore a result of a new wave of migrating moths. It would certainly be completely impractical, irresponsible and probably unaffordable to spray every night for several nights running.

Currently, the only way in which the fruit-piercing moth can be controlled is by the erection of a barrier of mercury-blended lamps on the down-wind side of the orchard, or preferably around the entire orchard. This can deter the moths. The success of this measure relies on the fact that the eyes of these night-flying moths change physiologically when exposed to light (Hofmeyr, 2003). Consequently, moths that fly into the light spiral upwards and away from the light barrier; and moths that settle on trees in the light become quiescent (as during the day) and do not feed. Specifications are as follows (Whitehead & Rust (1967, 1971, 1972):

- Use 160 W (300 to 350 candle power) mercury blended lamps (certain other types of lights may work too, however, some lights may even attract the moths).
- Illuminating cable and holder clips will also be needed for each lamp.
- Lights should be placed on the downwind side of the orchard (moths fly upwind), ± 20 m apart, ± 2 m from the border row, 1½ m above the ground.
- Bushveld should be cleared to lower than 1½ m for the 10 m preceding the lights, if possible.
- Lights surrounding the entire orchard/block would probably offer even more protection, but this may be prohibitively expensive.
- Lights should be switched on from dusk (before dark) to midnight. If lights are only switched on after moths have settled in the orchard and have begun feeding, they will have no effect.

These lights can work very well, but may not work at all if recommendations are not followed accurately. Although the erection of such lights may be expensive and laborious, they can be very effective in deterring fruit-piercing moths and may thus dramatically reduce losses. Remember that fruit-sucking moths are only responsible for secondary damage and thus the use of such lights against them is not justifiable.

If fruit-sucking moths cause a nuisance in the packhouse, they can be controlled by baiting. This can be done by mixing decaying fruit with molasses and a non-pungent (non-repellent) toxicant, and placing these in trays on the floor in the pack house (although this is not a registered practice). Trays should be positioned where moths are most likely to congregate, possibly under lights. Great care should be taken to do this in as safe a manner (for workers and fruit) as possible. It is unlikely that such a bait will have any significant impact on fruit-piercing moths if used in the field. Gunn (1929) found similar baits to be effective against *A. lienardi* in the Eastern Cape, but not against fruit-piercing moths.

Due to the devastating levels of damage which fruit-feeding moths can inflict, and the possible delay in the appearance of this damage, it is important to afford all opportunity to detect any such injuries after harvest. Degreening of fruit is of great assistance in highlighting any such damage. Alternatively, fruit can be left to stand for two or three days, can be immersed in a hot bath to observe for the appearance of bubbles from puncture wounds, or can be treated with an indigo carmine dye to highlight the same. If it is impractical to test all fruit in such a manner, then a large representative sample can be tested to indicate the risk potential of the consignment. Inclusion of any damaged fruit in export cartons will result in decay.

Although it is believed that *S. partita* larvae can be attacked by a series of bacterial and viral diseases, wasps and tachinid parasitic flies (Swart *et al.*, 1975) and bats (Johannsmeier, 1976), this has little bearing on a grower's decision making on his management practices.

CONCLUSION

Although experience has shown that there is usually only an outbreak of fruit-feeding moths every 5-10 years, it would be better to be vigilant every year rather than be caught by surprise. This starts with inspection of orchards in which fruit are colouring up, from around mid-February (i.e. Satsuma mandarins). Inspections should take place after dark, preferably between 8 and 10 pm.

The erection of deterrent lights will be an expensive and laborious practice, but may well be worth the cost and effort, if one considers the potential losses which can be prevented – both pre- and post-harvest. However, in order for these lights to have the desired effect, they must be hung exactly as recommended. Short-cuts may lead to failure and a total waste of money and effort.

Although *A. lienardi* may appear to be the primary culprit in an orchard, it can even be argued that its activity may be a blessing in disguise. Fruit damaged by *S. partita* shortly before harvest may be packed as healthy fruit. However, once *A. lienardi* has been through an orchard, the damage is far more obvious and sorting of fruit may even be made easier.

OPSOMMING

Daar is net twee algemene kategorieë van vrugvoedingsmotte: vrugsteekmotte en vrugsuigmotte. Net vrugsteekmotte het die vermoeë om gesonde vrugte te beskadig omdat hulle 'n aangepaste suigorgaan het. Vrugsuigmotte kan net op vrugte wat alreeds beskadig is voed. Die skade word gereeld deur vrugsteekmotte veroorsaak. Die mees algmeenste spesie van vrugsteemot wat in die Oos-Kaap voorkom is *Serrodes partita*. Epidemiese uitbrake in die sitrusproduksiestreke van die Kaap vind elke 5-10 jaar plaas, altyd na swaar somer reën in die Karoo. Gewoonlik omtrent twee maande later kan motte honderde kilometers migreer om vroeë rypwordende Mandaryne, veral Satsumas, aan te val. *Achaea lienardi* is die mees algemeenste spesie van vrugsuigmot wat in die Oos-Kaap voorkom. Die oorsaak vir sy uitbraak is dieselfde as vir *S. partita*. Derhalwe vind *A. lienardi* aanvalle in boorde gereeld kort na *S. partita* uitbrake plaas. Dit het in 1999 in die Oos-Kaap gebeur wat tot groot mandaryn oesverliese gelei het. Dit wil voorkom asof die patroon hom in 2009 herhaal het. Tans is die gebruik van ligte as 'n afweringstegniek die enigste doeltreffende manier om die motte te beheer. Produsente word aanbeveel om hulle mandaryn boorde van middel-Februarie in die nag gereeld vir die teenwoordigheid van vrugvoedingsmotte te ondersoek. Geen aksie word teen vrugsuig motte geregverdig nie, behalwe as hulle in pakhuise 'n probleem raak .

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