FRUIT-FEEDING MOTHS

Johannsmeier (1998) lists 11 species of fruit-piercing moths, which have been recorded on citrus in South Africa. These are Eudocima fullovia (Clerck), E. divitiosa (Walker), E. materna (L.), Oraesia provocans Walker, O. trioblita (Saalmüller), O. emarginata (F.), Serrodes partita (F.), Egybolis vaillantina (Stoll), Pericyma atrifusa (Hampson), P. mendax (Walker) and P. scandulata (Felder & Roggenhofer). Hofmeyr (2003) lists a sixth genus, Pluosiodonta. 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-SUCKING MOTHS

Nine genera of moths have been listed as possible fruit-sucking moths on citrus (Johannsmeier, 1998). By far the most common is Achaeta lienardi (Boisdouval) (Fig. 2), which like the fruit-piercing moths is a noctuid moth. 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 orchards 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.
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 Mari-sol 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 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,
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 (Johansmeier, 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. Shortcuts 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 vrugvoedingsmote: vrugsteekmote en vrugsuigmotte. Net vrugsteekmote 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 vrugsteekmote veroorsaak. Die mees algemeenste spesie van vrugsuigmote 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 rywordende Mandaryne, veral Satsumas, aan te val. *Achaea lienardi* is die mees algemeenste spesie van vrugsuigmote 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 geleë het. Dit wil voorkom afsoek die patroon hom in 2009 herhaal het. Tans is die gebruik van ligte as ’n afweringsmiddel 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 vrugvoedingsmote te ondersoek. Geen aksie word teen vrugsuigmote geregverdig nie, behalwe as hulle in pakhuise ’n probleem raak.

REFERENCES