Thresholds and guidelines for intervention against citrus pests

SEAN MOORE¹, TIM GROUT, VAUGHAN HATTINGH & HENDRIK HOFMEYR

Citrus Research International, P.O. Box 20285, Humewood, 6013, South Africa e-mail: seanmoore@cri.co.za

ABSTRACT
Thresholds and guidelines are given for intervention against 23 of the most important arthropod and molluscan pests occurring on citrus in southern Africa. Some of these thresholds are very specific, whereas others are no more than guiding principles. In order for these thresholds and guidelines to be used, reliable monitoring systems need to be in place. The thresholds and guidelines in this article can not only assist in significantly reducing pest damage but can also help to avoid unnecessary control measures. Good implementation will therefore enable a farm to become more financially viable.

INTRODUCTION
Periodic requests are received from citrus growers for a list of intervention thresholds for important citrus pests. It must be remembered that these insect pests are living organisms within a dynamic ecosystem, full of variables. Therefore, even though thorough studies can be conducted to determine when it is necessary to control a pest and when its levels spell no impending danger, thresholds can never be absolute. They must therefore always be seen as guidelines or as suggested thresholds. Some of these thresholds are more accurate than others. For some pests, it has not been possible to determine thresholds and no more than guidelines are possible. It is imperative that growers use all of these proposed thresholds and guidelines with educated caution.

Importantly, thresholds are only as reliable as the monitoring systems used. In order for these to be trusted, not only must the correct trapping systems be employed, but recommendations for their use must be closely adhered to. Scouts must be properly trained, instructed, equipped and incentivised.

The vast majority of information used here, has been gleaned from Citrus Research International's Production Guidelines for Integrated Pest Management (Grout et al., 2003). No background is given on the pests themselves and minimal information is given on the monitoring systems referred to. The intention was to keep this text focused on thresholds and guidelines for intervention against the most important pests occurring on citrus in southern Africa.

ANTS (Pheidole megacephala, Anoplolepis spp. and others)
If more than 30% of the trees in an orchard are infested with ants, then all trees in the orchard should be treated. Where less than 30% of the trees are infested, only those particular trees should be treated.

APHIDS (Toxoptera spp. and Aphis gossypii)
Light aphid infestations on cultivars other than grapefruit are usually left untreated. Infestations producing large amounts of honeydew should be treated. During spring this will apply particularly in orchards where sugar-containing baits are the primary treatments used for thrips control. Grapefruit trees less than eight years old should be treated at the first sign of aphid infestation in order to limit the spread of the Tristeza virus.

AUSTRALIAN BUG (Icerya purchasi)
When regular inspection indicates an increase in Australian bug, ensure that ant control is adequate in infested trees. In addition, surveys should be conducted to ascertain whether the vedalia beetle is preying on the population. The combination of ant control and beetle is likely to ensure commercial control of the pest. If beetles are absent and a noticeable increase in pest presence is recorded with a resulting increase in sooty mould, then chemical treatment can be applied.

BOLLWORM (Helicoverpa armigera)
An increase in egg presence on blossoms will provide an indication of the extent of the larval attack to come. A treatment should be applied when more than 20% of blossom clusters are infested with larvae or mature eggs. The more lucrative a market, the greater the financial losses would be for any fruit culled. In such cases, a lower intervention threshold for bollworm would be appropriate. Enlarged navel end problems in navel oranges can be further exacerbated by bollworm attack. In such an instance, a threshold of 11% of clusters infested should be used. When more than 40% of blossom or fruitlet clusters are infested, a significant reduction in yield may occur.

BUD MITE (Accria sheldoni)
Treatment is recommended when orchard inspection reveals the general presence of malformed blossoms. The need for treatment will be confirmed if comparison with previous survey data also indicates there has been a noticeable increase in blossom malformation.

FLAT MITE (Brevipalpus spp.)
A treatment should be applied when an average of one mite is noted per fruit or stalk.

FALSE CODLING MOTH (Tinutomatibia leucotreta)
The Lorelei trap system is recommended for monitoring false...
codling moth (FCM) (Fig 1). For the first few years the monitoring system should preferably not be used exclusively as a basis for control programmes. As experience with and confidence in the system is accumulated, control programmes can be based increasingly on trap results.

Trap catches must be counted weekly to determine the threshold value. It is therefore important that counts are conducted on the same day every week. Trap surveys must be initiated during November/December and must be continued until harvest time.

The threshold value for trap catches is currently fixed at 10 males per trap per week. This threshold is exceeded for a few weeks consecutively, subsequent FCM infestation can cause damage that will economically justify the application of control using a registered product. It is unlikely that regular weekly catches of less than 10 males per trap will lead to damage that will exceed the cost of a chemical control programme.

Having said this, it is important to point out that this threshold is only an indicator of the threat of pre-harvest economic fruit losses and has no bearing on the post-harvest risks of FCM infestation. Due to the high phytosanitary pest status of FCM, even sub-threshold levels of the pest should be treated if fruit is destined for an export market. This will ensure optimal control of FCM.

FRUIT FLIES (Ceratitis capitata and others)

Traps are not to be used to indicate when treatment is required but to indicate when a fixed control programme is inadequate and additional baiting is required. Treatment thresholds for use with the Sensus trap (Fig. 2) are four fruit flies per trap per week when Capilure is used. If Ceratitislure is used, the threshold is either zero female fruit flies or four male fruit flies, and when using Questarlure, one female fruit fly per trap per week. Higher numbers of flies per trap per week than the above thresholds indicate that control is inadequate and intervention is required.

FULLERS ROSE BEETLE (Pantomorus cervina)

For fruit that is destined for Japan there is almost no tolerance for Fullers rose beetle eggs so the beetles must be excluded from the trees. On trees with fruit for other markets where this pest is not a problem or on non-bearing trees it is usually not necessary to apply any treatments.

LEAFHOPPERS AND PLANTHOPPERS (Pentimioida bella – brown citrus leafhopper, Eusporus distinguenda and Epinotia natalensis – green leafhopper; Deciphla sp. – planthopper)

When using sticky yellow card traps the threshold for the mottled brown citrus leafhopper is in the region of 35/20 females per trap per week. However, practical experience has indicated that a realistic threshold might even be double this number (Johanna Mathewson pers comm.).

In autumn, the approximate treatment threshold for the two green leafhopper species is 8/trap/week. Alternately, after fruit colour break, treatments could be applied on presence of green leafhopper or the first appearance of damage on the fruit. Damage takes the form of irregularly shaped oleocellosis blemishes in the rind (2–7 mm diameter).

No treatment threshold has been set for planthoppers. However, as pest populations can rapidly build up to damaging levels, a treatment should be applied when unacceptable levels of honeydew are observed.

LEAFROLLERS (Tortrix capensis and Archips occidentalis)

No thresholds have been defined for the timing of treatments against leafroller larvae, however, experience indicates that a treatment should be applied before infestation of fruit reaches 10%. Orchards which are regularly subject to attack can be treated when larvae are detected. Alternatively, treatment can be applied when a potentially damaging population increase is noted.

LEMON BORER MOTH (Prays citri)

As this lemon pest is of minor importance or sporadic in nature, no thresholds have been defined for the timing of treatments. Treatments should be applied before fruit become infested with large numbers of LBM eggs or penetration marks (identifiable by gumming) on fruitlets. If infestation of LBM larvae and
pupae is noticeable on blossoms, intervention against LBM will be necessary.

**LOOPER** (*Ascotis selendaria*)

There are no formal infestation criteria on which to base the application of a special treatment for citrus looper (Fig. 3) control. The progressive, general occurrence of damaged young leaves, blossoms and/or fruit blemish symptoms will indicate the necessity for applying treatment.

**MEALYBUG** (*Planococcus citri and others*)

Severe mid-season infestations often come under good biocontrol before the end of the season and no chemical intervention is required the next season. Although there are no established thresholds for late-season evaluations, an obvious and widespread infestation in excess of approximately 10% of fruit with live mealybug shortly before harvest, is an indication that chemical intervention will be required the following spring.

Obvious mealybug infestation (of trunks, branches and leaves) during winter, on the new flush in spring, or on flowers and fruitlets during blossom, indicates the need for chemical intervention to protect the young fruitlets. An infestation level in excess of approximately 5% at petal fall, or up to 20% six weeks after petal fall, indicates the need for immediate chemical intervention.

There is little benefit to be derived from chemical intervention between six weeks after petal fall and the end of February. However, if during this period, there is extensive development of mealybug colonies with egg sacs on the cheeks of early maturing cultivars, and there is no sign of biocontrol activity, chemical suppression of the population with a short-residual treatment can be valuable.

If there is no decrease in the infestation level, with an associated increase in biocontrol activity, by the end of February, suppression with a short residual treatment is advisable on early maturing cultivars.

**ORANGE DOG** (*Papilio spp.*)

The smaller the tree the more damage a single larva (Fig. 4) can cause. In general no orange dog should be tolerated on trees less than four years old. As tree size increases, more larvae can be tolerated per tree, provided new growth clusters are not too seriously damaged.

**RED MITE** (*Panonychus citri*)

When inspection reveals mite numbers are progressively increasing, apply a treatment when an average density of five adult mites per leaf is noted. More mites per leaf can be tolerated if predatory mites or beetles are readily noted in infested areas and ongoing inspections indicate that no further infestation increase is taking place. This will also apply if a period of lethal temperatures is expected.

**RED SCALE** (*Aonidiella aurantii*)

It is important to accurately assess the scale population density in the planting concerned to ensure that any intervention is tailored to handle the scale pressure. This will be of particular importance in the case of early harvested cultivars where there is often comparatively little time between the establishment of fruit infestations and the harvest date.

The percentage fruit infested with red scale at the end of the season will give an indication of the approach required to control red scale in the following season. A light infestation with 0 to 5% fruit infested indicates commercial control. A moderate fruit infestation of 6 to 15% shows that commercial control is under threat. A severe infestation of more than 15% indicates an emergency situation.

The first scenario would probably require 0-1 treatments the following season. The second scenario would probably require 1-2 treatments the following season. The third scenario would probably require 2 treatments the following season.

In order to achieve high fruit quality, corrective spray treatments should be applied before 60% of the fruit are infested with one or more live nymphs or adult red scale. Adherence to this treatment threshold, which was developed when virtually all spraying was manual, is important as most treatments are applied with mistblowers which have difficulty in meeting red scale spray coverage requirements on branches weighed down by fruit. Microscopic assessments of red scale infested fruit can assist greatly in corrective decision-making. A sample of at least 20 fruit from throughout the orchard, which is reasonably well infested with scale, should be used. Scale should be classified as alive, dead or parasitised. Parasitoids should also be identified to genus e.g., *Aphytis* sp. or *Camerella* sp. In the Eastern Cape, guidelines have been established for corrective intervention against red scale on navel and Valencia types. In February, at least 16% of red scale should be parasitised. At least 50% of the parasitoids should be identified as *Aphytis* spp. At least 30% of the scale should be dead in February and there should be around a 50% increase in mortality from February to March. In the warmer inland regions, these levels should be realised at least a month earlier than in the Eastern Cape. These thresholds cannot be used on early maturing easy-peeler varieties.
Table 1. Suggested intervention thresholds for citrus thrips on citrus fruit.
To prevent more than 1% yield loss, treatments should be applied when these numbers are exceeded.

<table>
<thead>
<tr>
<th>Damage risk period</th>
<th>Mean infestation over 1 week</th>
<th>Mean infestation over 2 weeks</th>
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<tr>
<td></td>
<td>Fruit with larvae (%)</td>
<td>Fruit with fruit with larvae (%)</td>
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<tr>
<td>PF-4 weeks</td>
<td>2</td>
<td>1</td>
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<td>5-6 weeks</td>
<td>3</td>
<td>2</td>
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<td>7-8 weeks</td>
<td>4</td>
<td>3</td>
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<tr>
<td>9-10 weeks</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>11-12 weeks</td>
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**RUST MITE** (*Phyllocoptruta oleivora*)
The first sign of rust mite presence in an orchard is frequently the presence of isolated blemished fruit. When this is noted during a particular season it must be regarded as a serious rust mite warning for the following season.

**SILVER MITE** (*Polyphagotarsonemus latus*)
Due to the speed with which silver mite populations can increase, the presence of mites on even isolated fruitlets in an orchard can be regarded as a threat that warrants treatment.

**SNAILS AND SLUGS** (*Helix aspersa, Theba pisana and others*)
Treatment should be applied when successive inspections indicate that the snail population has increased to an average of from two to five brown/dune snails or slugs per tree, depending on tree size.

**SOFT SCALES** (*Coccus hesperidum* and *Pulvinaria aethiopica*)
There are no fixed thresholds for the application of treatment. Where necessary, treatments must be applied to ensure that a build-up of sooty mould does not inhibit tree performance or cause crop loss. In the case of grapefruit the early control of soft scales is important to prevent the development of necrosioma blottches on fruit.

**THRIPS** (*Scirtothrips aurantii*)
Intervention thresholds based on percentage fruit infestation are described in Table 1. Thresholds are provided for mean infestation over both one- and two-week periods because low numbers of thrips present over a long period can still cause serious damage. The thresholds increase with time as the fruit becomes less susceptible to damage and may have to be fine-tuned for different cultivars and production regions. Only when the thresholds are exceeded are treatments justified. Once thresholds are exceeded, treatments should be applied as soon as possible. This is particularly important for the IPM-compatible treatments such as abamectin and tartar emetic plus sugar as they will not be effective once infestation levels exceed approximately 15%.

**WAXY SCALE** (*Ceroplastes spp.*)
There is no fixed infestation threshold to indicate the need for a treatment. The fairly general presence of infested twigs on trees can be regarded as a potential infestation hazard requiring treatment. The more frequently that treatments are applied for other pests in such an orchard, the greater the prospect that they will eliminate the natural enemies of the scale and enable it to multiply unchecked.

**CONCLUSION**
Before growers can begin to employ the thresholds and guidelines given in this article with confidence, absolute assurance must be made that monitoring systems are reliable, trustworthy and as accurate as possible. Proper employment of monitoring systems and interpretation of the data generated, with the aid of the thresholds and guidelines in this article, can not only assist in significantly reducing pest damage but can also help to avoid unnecessary control measures. Good implementation will therefore enable a farm to become more financially viable.

**OPSGOMING**
Riglyne en drempelwaardes en word gegee vir optrede teen 23 van die belangrikste geleedpotige en slakplae wat op sitrus in suidelike Afrika voorkom. Van die drempelwaardes is baie spesifiek, terwyl ander slegs as n riglyne kan dien. Om hierdie drempelwaardes en riglyne te kon gebruik moet betroubare monitoringstelsels in plek wees. Die riglyne en drempelwaardes in hierdie artikel sal nie net hydra tot 'n beduidende vermindering in plaagskade nie, maar kan ook help om onnodige bestrydingspraktike te voorkom. Nuusgesette toepassing sal derhalwe die gelegenheid vir 'n plaas skep om lewenswatbaarder te wees.

**REFERENCES USED**