
Integrated Pest Management for Citrus

2 Citrus Pest Monitoring

Learner Guide



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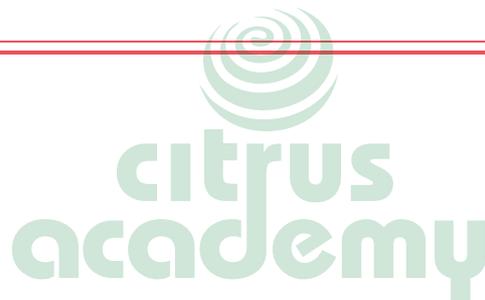


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Second Edition

The first edition of the Integrated Pest Management for Citrus learner guides were exact transcripts of the audio-visual modules which they accompanied. This second edition has been updated with additional information and new developments. The changes are in *italics and underlined*.



Introduction

Monitoring is the cornerstone of integrated pest management (IPM). It is impossible to implement a successful IPM programme without reliable and efficient monitoring. This consists of either trapping for certain pests, or in most cases and for most pests it will be visual scouting on the tree for the occurrence of the pest itself. In addition to the pest, one can also look for the presence of natural enemies.

All of this helps one in accurate decision-making. Not only does it enable one to determine exactly when to spray and what to spray for, but almost more importantly, it helps one to determine when not to spray. Monitoring can thus result in significant cost saving. Monitoring helps with decision-making in three ways:

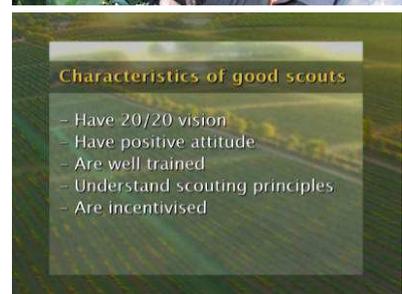
- ❖ It helps with **immediate decision-making** where there is a threshold associated with that particular pest or that pest natural enemy combination.
- ❖ It also helps one to **track pest trends** during the season and make a decision on whether intervention is required depending on how that trend might fluctuate.
- ❖ Thirdly, it enables one to **compare data from one season to the next** and to decide whether intervention is necessary based on historical outcomes.

Therefore, it is very important to record data and to keep records of one's monitoring from season to season so that one can develop a history of pest and natural enemy levels in the orchards and be able to make more and more educated decisions as time goes by.

Pest Scouts

In order to have an effective monitoring system on the farm, the correct person or people need to be appointed to do the scouting. Farmers need to realise that they need to appoint their most reliable labourer into the position of scout. There are certain requirements for a scout:

- ❖ He must have 20/20 vision
- ❖ He needs to have a good attitude towards his job
- ❖ He needs to be well-trained
- ❖ He needs to understand the principles of scouting. Why is he doing the job? For what purpose is it?
- ❖ Lastly, it would be a good idea for the farmer also to incentivise the scout for good performance



Scouting Tools

The scout requires certain tools in order to do the job.

Firstly, he needs a good **magnifying glass** or a head loop, then he needs a **pocketknife**, he needs a **scouting form** with a clipboard on which to place it, often tied to a string which he can loop around his neck.

Lastly, he needs a **scouting booklet** which is available from the CRI and has good quality pictures and descriptions of all of the pests and the important natural enemies, where to look for these pests and what sort of symbol to use when filling in observation of this pest into the scouting form. *The scouting booklet is now also available in PDF format, which can be accessed from a smartphone.*

It is very important that scouts complete the scouting form correctly. They need to familiarise themselves with the abbreviations which occur in the CRI identification manual for citrus pests and to use the correct acronyms for each pest that they observe.

On each day that they scout, they need to fill in the date, and the orchard number and the cultivar where they are scouting, and they need to ensure that they scout at least five data trees per each hectare of orchard.

A farmer should appoint more than one scout on the farm to minimise the chance of errors creeping into the work and scouts can double check one another. In addition to this, the farmer should check on the scouts regularly to ensure that what they are recording on the form is indeed what they are finding.

A screenshot of a scouting form on a smartphone. The form is titled "CRI" and has fields for Name, Pest, Orchard, Date, and Unit. The pest is "Thrips" and the unit is "Fruit". Below these fields is a table with 10 rows and 10 columns. The rows are labeled "Tree" and the columns are labeled "Unit". The table contains various letters and numbers, representing pest findings.

	1	2	3	4	5	6	7	8	9	10	L	A
1				L				A				
2	A		A				L					1 2
3		L	A		L							2
4									A			1
5						L						1
6				A								1
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Data Trees

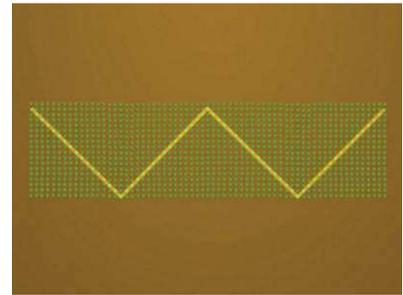
Data trees should be marked throughout an orchard. There should be a minimum of five data trees used per hectare of citrus and the same data trees should be used week in and week out.

The reason for using the same data trees is that data becomes more reliable. Any variations in pest findings, one can know are not simply because one is using different trees, but are genuine fluctuations in pest levels. This also enables the farmer to return to the exact trees that were monitored by the scouts and check that they did indeed find what they had written on those forms.



Data trees should be positioned in a diagonal formation through the orchard or, if it is a large orchard, in a V-formation or in a very large orchard even in a W-formation.

Data trees should be clearly marked with hazard tape or something similar so that scouts can easily return to the same trees that they scouted previously and to ensure that no one else fiddles with these data trees.

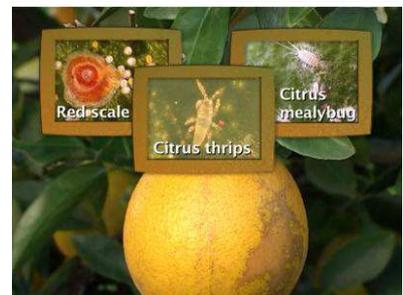


Inspection Points

Depending on which pest one is scouting for, one would look at different part of the tree. These are called inspection points.

For example, if one is scouting for bollworm one would inspect blossom or small fruitlet clusters. If one is scouting for red mite one would inspect leaves. If one is scouting for red scale or thrips or mealybug, one would predominantly scout on the fruit.

There need to be 10 inspection points on each tree. So if one is scouting five trees per hectare, each with 10 inspection points, that is 50 inspection points per hectare.



Scouting Procedures

Sweep Surveys

In addition to scouting specific data trees, there should also be periodic sweep surveys conducted. Farmers can assist in these. The reason for this is that pest infestation may not be even throughout the orchard, particularly for certain pests which tend to have a clumped distribution.

This also enables or maximises one's chances of finding these pests elsewhere if they don't occur on the data trees. For example, close to windbreaks, thrips levels are often higher.



Timing

Scouting should be conducted weekly at least until after mid-summer and should be started in spring.

Pests such as thrips need be scouted for at least on a weekly basis and sometimes twice-weekly. As fruit grows and hardens up it becomes less susceptible and scouting can become less frequent.

Other pests such as red scale would normally only appear on fruit in about December, so scouting for red scale is usually not necessary before December, *unless infestation is at a high level*. Pests such as red mite only needs to be scouted for every second week. Other pest such as fruit fly only become a problem once the fruit start to colour up, so monitoring for fruit fly is only necessary in the second half of summer.



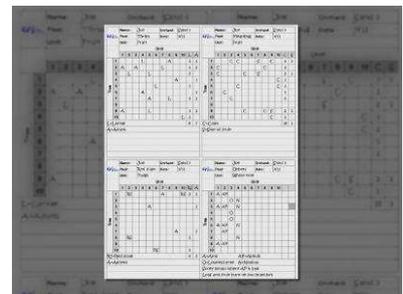
Red scale



Mediterranean fruit fly

Scouting for Multiple Pests

A scout should not look for too many pests simultaneously. A standard scouting form has four block matrixes, which enables scouting for four different pests simultaneously. This is the maximum that a scout should look for during one scout, otherwise he could lose focus. An inexperienced scout may need to look for fewer pests at a time.



At the end of a day, the scout should immediately report his findings and take his recording forms to the farm manager so that, if any urgent decisions need to be made, the farm manager can do so immediately.

Citrus Pests

Thrips

Possibly the most important pest to monitor for is citrus thrips. Because it occurs for the most protracted period during the season, it can cause damage to flush and to fruit from spring or even before fruit set right up until past midsummer.

It can cause damage in a very short period of time and this damage is irreparable. It is a cosmetic pest so it does not damage the internal quality of the fruit but it does cause the fruit to be blemished so that it can be downgraded from export standard.



Citrus thrips

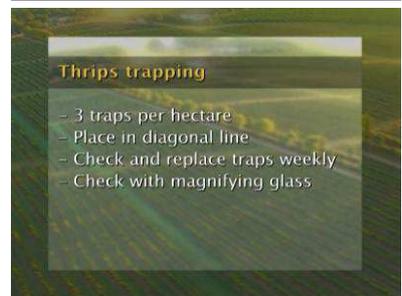
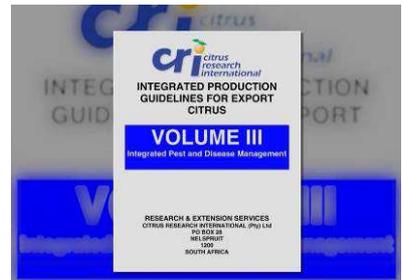
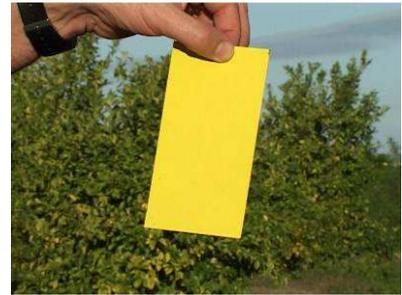
Trapping

The first way that thrips can be monitored is by use of sticky yellow traps. There are specific dimensions for these traps and one needs to consult the CRI volume III production guidelines for IPM to determine exactly what these measurements are.

The traps then need to be hung out in a density of three traps per hectare in a diagonal line. They are sticky on both sides and they are inspected after a week. One would need a good magnifying glass or even a microscope to see what is on the trap.

This is not a simple way of monitoring for thrips, because there are species other than citrus thrips which can also be attracted to those traps, such as onion thrips and blossom thrips. One therefore needs to be able to differentiate between the different species.

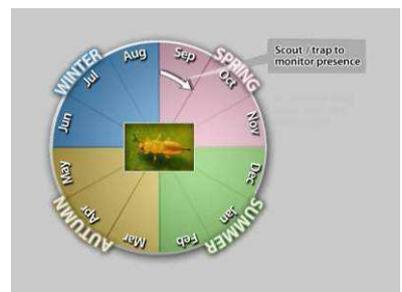
In addition, the catches on these traps can be influenced by climate and by cloud cover. These traps should therefore never be more than supplementary to the more accurate means of scouting, which is visually inspecting fruit and leaves for the occurrence of thrips. *These traps probably have their greatest value when used before blossoms open, in order to give an early warning of thrips pressure and to enable one to decide whether a pre-blossom spray is necessary.*



Scouting

One would begin by scouting on leaves or using sticky yellow traps in September on the flush which precedes fruit set to determine whether there is any thrips present at all. There is no threshold for finding thrips on flush, but this is something that should be recorded and reported, and is an indication of what thrips pressure could be on the fruit once fruit has set.

When one monitors on the fruit, it is important to do so on a sunny day. Thrips is very inactive if temperatures are cool or if it is a cloudy day, so one does need to wait for a sunny day. Thrips then become more active and moves out from underneath the calyx and is more easily visible on the fruit.



Despite this, one also needs to scout underneath the calyx. This is where the sharp knife comes in handy in order to be able to lift up the points of the calyx and inspect underneath the calyx with a hand lens.

When scouting for thrips on the fruit it is important to be able to differentiate between adult thrips and thrips larvae, the reason being that thrips larvae tends to feed more than adults do and are therefore responsible for more of the damage than the adults are. So scouts need to be trained in the difference between the two life-stages and to record them separately on the recording form.

Immediately after petal drop one needs to start scouting for thrips on the fruit and underneath the calyx.

One needs to be very careful that one doesn't select fruit which have any open blossoms nearby, because those blossoms have nectar in them which can be attractive to other species of thrips, such as blossom and western flower thrips, and one then risks confusing citrus thrips with these other thrips.

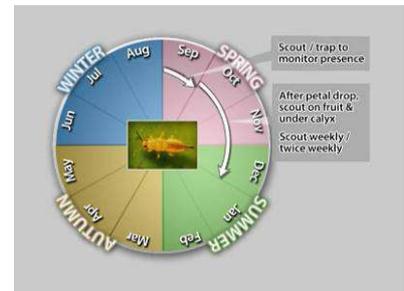
It is easy to avoid this confusion, not only by staying away from fruit which has blossoms near them, but also by specifically recording larvae on the fruit. Blossom thrips larvae are very unlikely to occur on the fruit as they have no business being there.

One needs to scout at least weekly from after petal drop, even twice-weekly would be better, and continue with that right up until December or early January. Thereafter the fruit becomes pretty hardened and into January thrips damage becomes rare.

Natural Enemies

Citrus thrips has a very effective natural enemy in the predacious mite.

There are a couple of different species of predacious mite which occur in different regions of the country, but they look very similar. They are small, round, pear-shaped, shiny mites that occur on the fruit and occur on the leaves inside the tree.



If one is to scout for them, one would select leaves on the inside of the tree, older leaves that are in a horizontal position. One would pick those leaves and one would inspect for those mites on the underside of the leaf.

Although there isn't a threshold for finding predacious mites which would determine whether one sprays for thrips or not, it is always encouraging to know that this natural enemy is there and is definitely capable of assisting in suppressing thrips, particularly late in the season as a means of preventing late thrips scribbling.



information

Thresholds for Predacious Mites

Although we say that there is no threshold, this is only partly true. Although there is no level of presence which will alleviate the need to spray if thrips levels surpass the threshold, if an average of one predacious mite per leaf is recorded, it means that predacious mites will significantly assist in thrips suppression.

Red Scale

Red scale is also extremely important and was at one time considered to be the key pest in the citrus industry as it can be devastating. Fortunately, current red scale control measures are very effective.

However, if red scale is left unattended it can still be extremely harmful. Not only can it be a cosmetic pest, blemishing the fruit and causing it to be un-exportable, but if red scale infestation is allowed to increase too high, particularly on the woodwork, it can actually cause the tree to go into decline and affect the yield and even cause die-back of the tree itself.

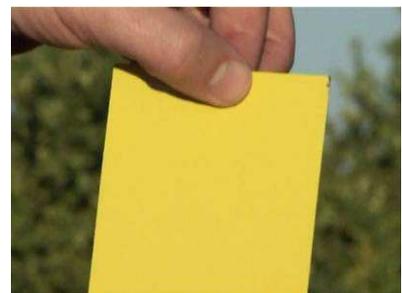


Trapping

As with thrips, sticky traps can also be used for monitoring red scale. These can either be white or transparent traps or the same yellow traps that are used for thrips.

However, in the case of red scale, one needs to place a pheromone dispenser onto the trap, and that pheromone dispenser needs to be replaced every few weeks.

Traps should be hung at a density of one per hectare and should be inspected weekly.



Elsewhere in the world, such traps are used successfully for determining whether it is necessary to spray or not, in other words, they have a threshold value associated with them.

Unfortunately, in South Africa it has been shown that this is not possible and all that these traps can be used for is determining when to spray, particularly if one is using an insect growth-regulator where the spray works most effectively against the younger life-stages of the insect and *accurate* timing of the application of the spray is very important.

Also, it is important if one is releasing parasitoids for red scale, such as the *Aphytis* parasitoids, that timing of these releases are well synchronised with the young life-stages.

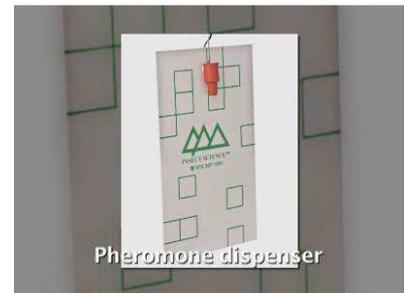
Although California red scale is known as a sessile insect which sits motionless on fruit, stems, and leaves, in fact the adult male life-stage is flighted and it is this life-stage which is attracted to the traps. By monitoring and counting these males that are caught on the trap on a weekly basis, one can determine timing of spray applications.

Scouting

Although traps can be used for red scale, it is far more important and far more accurate to scout on the fruit, so the fruit is the inspection point for red scale. One would select, as with thrips, 10 fruit at random per data tree and one would record whether there is any red scale present on that fruit and on the stems leading up to that fruit.

Red scale tends to move very slowly and so normally red scale will only appear on the fruit for the first time in December. Therefore inspections for red scale on fruit should only start in early December and should continue until fairly late in the season, until the grower is satisfied that there is a sufficient decline in red scale in order for it no longer to be a threat to the crop.

Because red scale numbers build up very slowly, and because red scale moves slowly, it is not necessary to scout weekly as in the case of thrips. Scouting every two weeks is more than adequate with red scale.



Pheromone dispenser

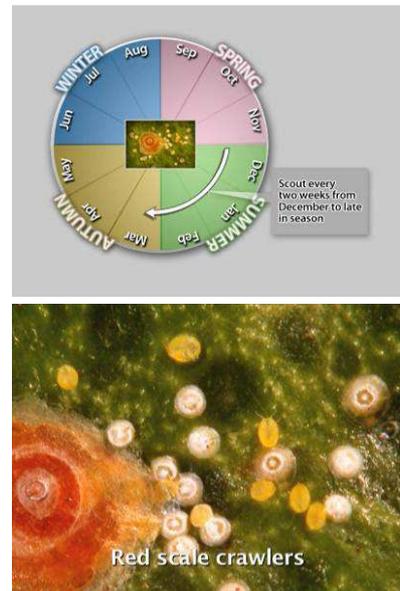


Red scale male



When scouting for red scale the scout should take 10 fruit at random without looking first to see whether there is anything on the fruit, and he should turn the fruit around *while inspecting*.

He may need a magnifying glass to inspect for *all* life-stages of red scale. The smallest life-stage of red scale is the very small yellow crawlers, whereas the larger life-stages are very easy to see. Not only would he look around the entire fruit, but he would look on a portion of the green stem leading up to that fruit.



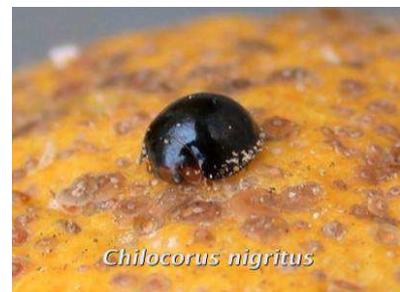
Natural Enemies

Natural enemies are also very important for red scale control. There are a few species of parasitoids or wasps which are important to parasitize red scale. They are very small, mostly microscopic and not that easy to see.

However, to the trained eye one can begin to recognise what a parasitized red scale looks like. In addition, one can collect red scale infested fruit from non-data trees, take them back to the office and inspect under the microscope whether these red scale are parasitized or not.

This can assist greatly in the decision-making on whether it is necessary to spray or not.

In addition to the parasitoids, in certain regions of the country, particularly the northern regions, certain ladybird predators are very important, such as *Chilocorus nigritus*, which is a round, black lady beetle about 5mm in diameter.



Mealybug

Mealybug is primarily a cosmetic pest. Mealybug can cause raised shoulders of the fruit by feeding on young fruitlets underneath the calyx. Mealybug can also cause honeydew which leads to the growth of sooty mould, which causes unsightly blemishes on fruit. It can also cause little pink scarring blotches on the fruit.



Mealybug can also be a precursor to certain secondary pests and diseases, such as carob moth and *Alternaria* navel-end rot, which is associated with mealybug infestation.

However, mealybug can also be a phytosanitary pest. There are seven species of mealybug which occur on citrus in South Africa and some of those species don't occur in some of our export countries and we therefore need to make sure that they are not on the fruit at the time of export.

Fortunately, most of these are the less common species of mealybug and the most common species is citrus mealybug which is a cosmopolitan pest.



Scouting

As with red scale, the primary decision or the first decision on whether it is necessary to spray mealybug or not, is made on the basis of the pre-harvest blemish analysis from the previous season.

However, this must not prevent one from starting with inspections in winter, leading into spring. One starts by inspecting the woodwork, the trunks and the branches, in winter and if there is any obvious infestation of mealybug, then one would intervene.

As spring approaches, one inspects leaves, blossoms and small forming fruitlets. Any obvious infestation at this early stage of the season should be recorded and action should be taken.

The inspection point for mealybug is the fruit, and, just as with red scale and thrips, one would look around the tree and randomly select fruit and inspect underneath the calyx.

Primarily one would need a sharp knife to lift up the calyx. Try not to break the fruit off because that would eventually diminish the number of fruit available for inspection on the data trees.

Carefully lift the calyx with the knife and inspect underneath the calyx with a magnifying glass to determine whether there is any mealybug infesting underneath the calyx. This could be anything from large adult life-stages to very small brown crawlers which would need a magnifying glass to see.



A well-trained scout should also be able to differentiate between the different species of mealybug that can occur on citrus. It is important that, if he finds the adults of mealybug, he is able to write down on his form what species he observed.

For the first six weeks after petal drop, inspections should be conducted weekly. This is the high risk period and because the calyx is only just closing onto the fruit during this time, if a spray is applied during this first few weeks after petal drop one can more easily get good penetration of spray underneath the calyx.

After the first six weeks post petal drop one can reduce scouting to once every two weeks.

Apart from under the calyx, mealybug can also occur on the cheeks of the fruit and inside the navel-end of navel oranges, so one must also inspect there.

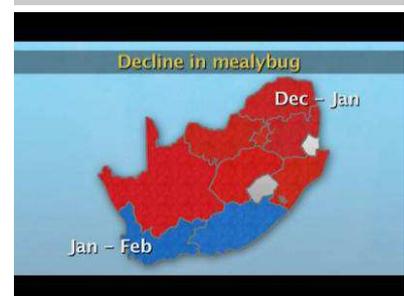
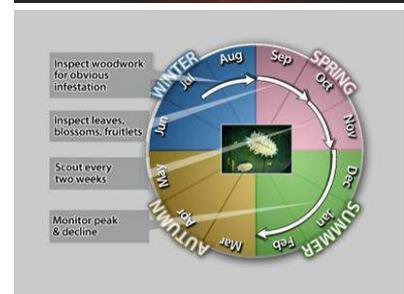
Scouting for mealybug should continue at least until February. This is very important because decision-making is now based on tracking the trend. Mealybug levels ought to build up to a peak in December or January, at which time natural enemies get on top of mealybug, and one should see a significant decline in the northern areas from December to January and in the Cape areas from January to February.

One is only able to determine whether this decline occurs if one is scouting regularly. If this decline does not occur, the farmer is in a position to immediately make a decision whether intervention is necessary or not.

Natural Enemies

Mealybug has a very effective biological control complex, almost more effective than most species that occur on citrus. However, it is not that easy to observe this complex. If mealybug is parasitized, the parasitized life-stages will often drop off the fruit and won't be easy to detect.

However, there are certain parasitoids which will be easy to see such as *Anagyrus*, which has distinct white antennae, and then a couple of the beetle predators of mealybug such as *Nephus* and *Cryptolaemus* beetles.

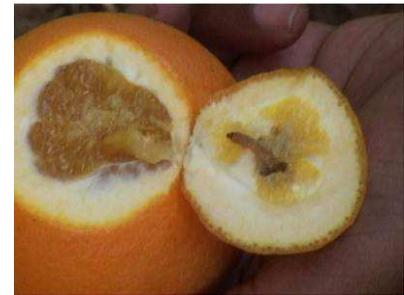


Although it is not possible to attach a threshold to the occurrence of these natural enemies, finding them in the orchard is a good sign and can fill the scout and the farmer with confidence that biological control is playing a significant role in the suppression of mealybug levels.



False Codling Moth

False codling moth is also a major pest. The female moth lays her eggs on the fruit, the larva hatches out of the egg and penetrates into the fruit and causes the fruit to decay and drop off the tree. This can cause significant crop loss. If infestation occurs shortly before the fruit is picked at harvest time, the fruit can then decay on the way to the market.



Most importantly, false codling moth is a pest that only occurs in sub-Saharan Africa and therefore our markets do not want that pest. This is a major reason why we need to rid our orchards as far as possible and certainly our fruit of false codling moth infestation.

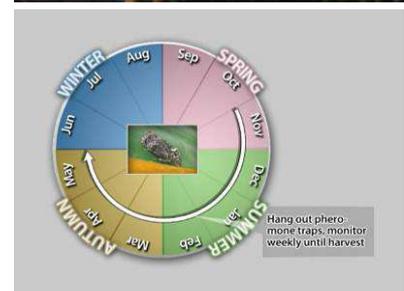
Trapping

Firstly, false codling moth is monitored through the use of pheromone traps. These traps are loaded with the pheromone of the female moth which attracts male moths to the trap.

Preferably delta traps should be used, however, PVC pipe traps are also an option. Both of them have a sticky lining at the bottom and these traps are inspected weekly to find out what has been caught in the trap.

Traps should be hung out at latest in early November and should be monitored all the way through until harvest.

One trap should be used per four hectares. The positioning of the trap is extremely important. The trap should be hung in approximately the fifth row of the orchard and approximately five trees in the orchard. The trap must be hung on the southern or shady side of the tree and it must be hung high up in the tree, at least at head height.



The trap must be hung on the upwind upside of the orchard so that the wind can blow the pheromone into the orchard. Male moths fly against the wind so they can detect the pheromone of female moths.

It is very important that the traps should be free-swinging and that there is no hindrance to the trap. Therefore, the scout when hanging the trap should use a pair of pruning shears to cut away any branches or leaves or twigs which could obscure the accessibility of the trap to the moth.

Each week on the same day the scout should approach the trap and remove the sticky floor counting the number of moths that have been caught in the trap *and removing the moths so that they are not recounted the following week.*

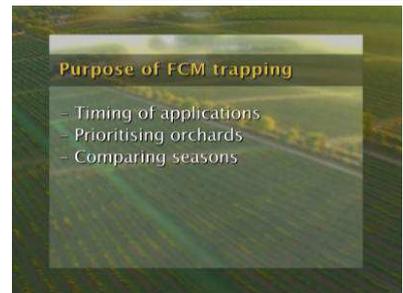
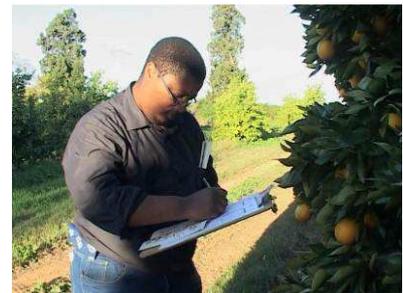
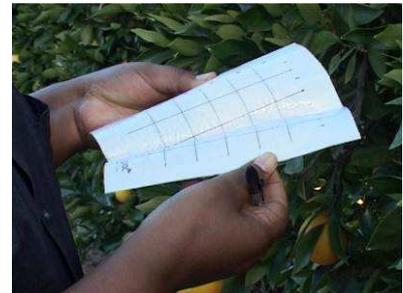
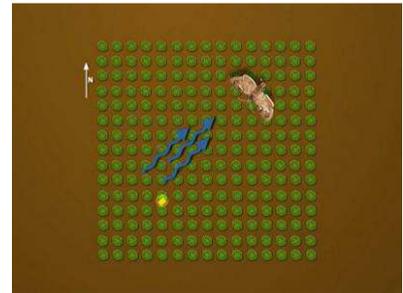
If he is unclear as to what is a false codling moth, because other moths and insects are sometimes also inadvertently caught in the trap, he should consult the CRI scouting manual in order to get an accurate identification of the moth.

If the sticky floor is dirty or has been used for a few weeks and a lot of moth residue remains on the sticky floor, the scout can replace the sticky floor with a clean one.

The scout should also bear in mind how long the pheromone dispenser lasts. There are *at least two* pheromone dispensers that are currently commercially available on the market. Each one lasts for a different duration of time, so the scout or the farm manager must be familiar with that.

As the season progresses, fruit grows and becomes heavier and begins to weigh branches down. The position of the trap is therefore likely to drop lower and lower. The scout needs to be aware of this and reposition the trap higher into the tree and to again prune away branches that might be hindering access to the trap.

Previously, traps use to be used for threshold purposes, in other words determining whether it is necessary to spray for false codling moth or not. False codling moth has now become such an important pest that all growers need to take some sort of action to control false codling moth, so those thresholds have fallen away.



So what then is the purpose of the trap?

- ❖ The traps are used for accurate **timing of application**, particularly if a virus spray is being applied
- ❖ The traps are also used for **prioritising one orchard** against another – whichever orchard is showing the highest catches the grower will know he has to intervene there first
- ❖ In addition, growers are able to **compare one season** with another

Fruit Infestation Inspection

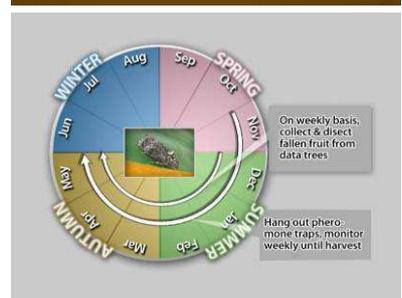
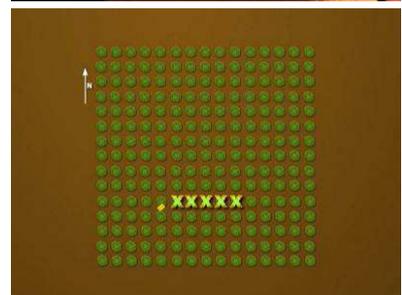
Another form of monitoring is inspection of fruit infestation. This is in fact even more important than monitoring traps for false codling moth. The reason is that what one really wants to know is: what is the risk of my fruit being infested or if it is infested at all?

In order to do this, one needs to mark out a certain number of data trees. One can use the same data trees that one is using for scouting; however, it might be easier to mark out five fresh data trees which are adjacent to the trap tree.

The data trees should be clearly marked and it needs to be ensured that no one other than the scout ever picks up fruit from those data trees. On a weekly basis, on the same day the scout needs to collect all the fruit that had fallen underneath the data trees. Then he needs to dissect those fruit and determine what the cause of the drop is.

It is fairly easy to determine whether fruit has dropped as a result of false codling moth. Either a false codling moth larva needs to be found in the fruit, or signs that a false codling moth larva was in the fruit, in other words the frass granules of the larva, must be found in the fruit.

The scout must be made aware that there are other insects that can infest the fruit, such as fruit fly, so he needs to be clear about the identification of the larvae. False codling moth larvae can be very small, predominantly white in colour, to relatively large, about 1.5mm in length, and dark pink in colour.

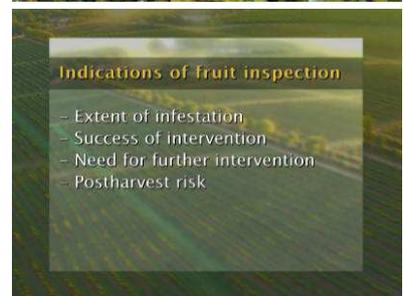


Although inspection of fruit infestation is an indication of damage that has already happened, the information that goes to the farmer is extremely valuable.

- ❖ It shows him the **extent** of the problem in the orchard,
- ❖ It shows him how well his **intervention programmes** are working
- ❖ It shows whether **further action** is required, and
- ❖ It shows him what his **postharvest risk** is likely to be



False codling moth larva



information

Fruit Infestation Inspection

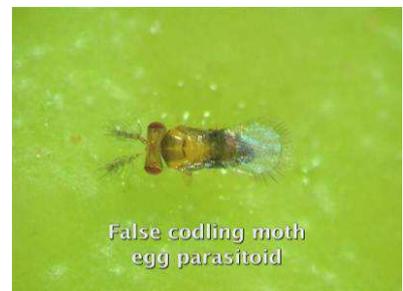
In addition to the points listed above, fruit infestation data also gives an indication of **other causes of fruit loss**, which is an important indication when deciding on control measures for other pests and diseases.

Natural Enemies

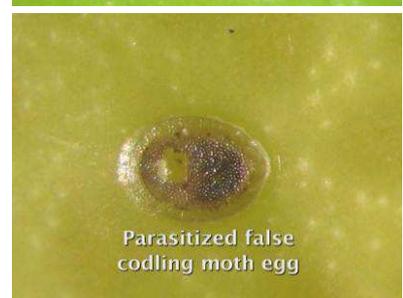
The most effective natural enemy of false codling moth is a very small egg parasitoid. Scouts can monitor for this too.

They would do so by using fruit as the inspection point and would randomly select 10 fruit per tree. On these fruit they can record false codling moth eggs, and the number or percentage of these eggs that are parasitized. A parasitized egg is very easy to differentiate from a healthy egg – a parasitized egg turns pitch black.

This parasitoid is extremely effective and can parasitize in excess of 80% of the eggs. Such a finding would be great encouragement to the farmer that his FCM levels would remain well suppressed until harvest.



False codling moth egg parasitoid



Parasitized false codling moth egg

Fruit Fly

There are two species of fruit fly which are important on citrus. This is the Mediterranean fruit fly (*Med fly*) and the Natal fruit fly (*Natal fly*).

The female damages the fruit by attempting to oviposit or successfully ovipositing her eggs through the rind of the fruit. Even if there isn't a successful oviposition, the penetration hole which she makes is large enough to allow secondary infection to occur and to cause that fruit to decay and drop off the tree.

If the eggs are successfully laid underneath the surface of the rind, the larvae will hatch out and the maggots will develop into the fruit also causing the fruit to decay and drop off the tree.

Trapping

The only way in which fruit fly can be monitored is through the use of traps. There are two traps which are registered and commercially available for monitoring fruit fly in citrus. However, only one of these has a threshold value associated with it and this is the Sensus trap. The Sensus trap can be loaded with either Capilure or Questlure. There are other lures available but the use of either Questlure or Capilure, or preferably both of them, is even better. They should not be used together in the same trap and traps loaded with Questlure and Capilure should be separated by at least 50m of distance.

Traps should be hung at a density of between one per two hectares and one per six hectares, depending on the size of the farm. Capilure is red in colour, and is used mainly for catching male flies. Questlure is green in colour and is used mainly for catching female flies.

Traps should be monitored every week on the same day. The scout should remove the flies from the traps and should identify the flies to species, and should differentiate between male and female flies. Thresholds for Medfly and Natal fly and for males and females differ.

The lures and the dichlorvos tablet should be replaced every six weeks. The dichlorvos tablet kills any flies that fly into the trap.

Fruit only becomes susceptible to fruit fly once it begins to colour up. Fruit starts to colour up about two months before harvest, so these traps should be hung out about three months before harvesting begins. However, where fruit fly pressure is known to be very high, traps should be hung much earlier in the season.



Natural Enemies

There are no natural enemies of fruit fly that one needs to inspect for.

Oriental Fruit Fly

The Oriental fruit fly, also known as *Bactrocera dorsalis* (and previously known as *Bactrocera invadens*), is of Asian origin. It was first discovered in Africa, in Kenya, in 2004. Since then, it has dispersed north and south of the equator.

It was recently declared present in South Africa, with very limited distribution in certain northern parts of the country. Every effort should be made to prevent it from establishing elsewhere in the country. Therefore, it is important to monitor for the pest.

Trapping

To monitor for Oriental fruit fly, a bucket trap (there are four types) is loaded with a methyl eugenol dispenser (various are commercially available), and a dichlorvos tablet to kill any flies entering the trap.

This monitoring system is highly effective at attracting and catching adult male Oriental fruit fly. Between one and five traps must be hung per hectare, depending on whether Oriental fruit fly is present, under eradication or absent.

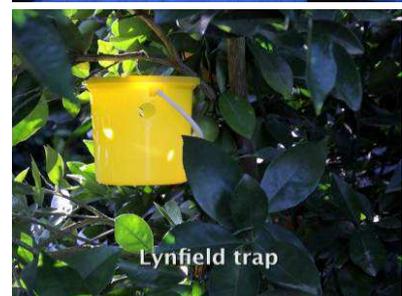
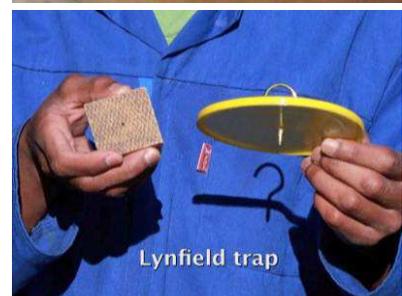
Traps must be hung on the shady side of the tree, within the tree canopy and as high as possible above the ground.

Traps are monitored weekly and catches must be recorded even if these are zero, which is important to demonstrate that the farm is free of Oriental fruit fly.

Lures and toxicant tablets must be replaced every six to eight weeks, depending on which lure dispensers are used.

Bollworm

Bollworm is only a pest in spring. The female moth is attracted to lay her eggs on the blossom, even before the blossom opens. The larva hatches out and begins to



feed on the blossom clusters. Once the fruit sets, the larvae move over to the fruit and start feeding on the small fruitlets.

Bollworm causes damage and losses in three different ways. Crop load can be reduced by heavy feeding on blossoms and fruitlets. Even if fruitlets don't drop off the tree and *develop to maturity*, they could carry an ugly scar and make them unfit for export. Finally, where there is an overlap of spring blossom with late hanging ripe Valencia fruit, the larvae can feed on these fruit.



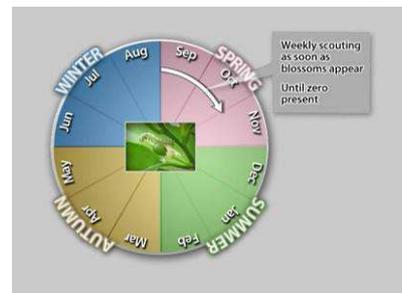
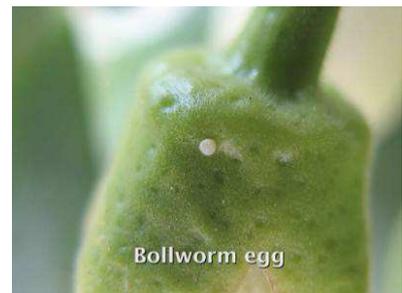
Scouting

Scouting for bollworm will start in spring, as soon as there is blossom on the tree.

The scouting units are blossom clusters, which eventually become fruitlet clusters. The scout will select at random 10 fruitlet or blossom clusters per tree and inspect these for any life-stage of bollworm. Eggs are small and round and are ridged from top to bottom. Larvae are initially small but grow into very large caterpillars measuring a few centimetres in length.

The scout doesn't need to record number of individuals per blossom or fruitlet cluster, simply whether it is infested or not. Life-stage recorded is also generally not important, unless the grower is planning to apply a soft option, such as *a baculovirus product or Bacillus thuringiensis*, which are only effective against small larvae.

Scouting must be conducted once a week and it must be continued either until there is no bollworm present any more, or until the grower has sprayed successfully for the pest.



Budmite

Budmite is a microscopic pest which infests the axial buds of developing new growth on a citrus tree. Ultimately what happens is that the fruit is damaged at the end of the day and the symptoms of this damage are ridging, protruding navels, particularly on navel oranges, and the flattening out of the fruit.

Because budmite is microscopic, it is very difficult if not impossible to find this pest on a citrus tree, so the only real way to look for this pest is to look for signs of damage.



Scouting

In spring one will inspect developing blossom on the tree and look for signs of blossom malformation on the tree.

The scout will select at random 10 blossom clusters on each data tree and will inspect these for any signs of malformed blossom. This is the most important time for inspection for bud mite.

However, the scout can also inspect each new flush which occurs throughout the season to look for shortened internodes, or any other signs of malformation on the leaves.



Red Mite

There are a number of other mite species that can be a pest on citrus. Most of these are fairly sporadic and many of them are fairly minor.

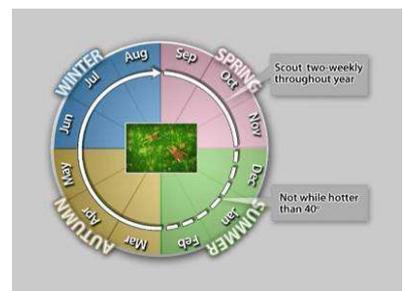
However quite important is the red mite. Red mite is a pest on both leaves and on fruitlets. It causes a greying of the leaves and can even cause a silvering of the fruit if infestation is severe. If infestation of the leaves is particularly severe, leaves can even drop off the tree.



Scouting

Inspection point for red mite is both fruit and leaves. The scout will take fruit at random, 10 per data tree, and count the number of mites on the fruit. He will also take leaves, 10 at random from the tree, and count the number of mites on the upper side of the leaves.

Red mite can be a pest throughout most of the year so scouting for red mite should be conducted at two weekly intervals throughout the year, except in the hottest months. Temperatures above forty degrees tend to be fatal for red mite.



Flat Mite

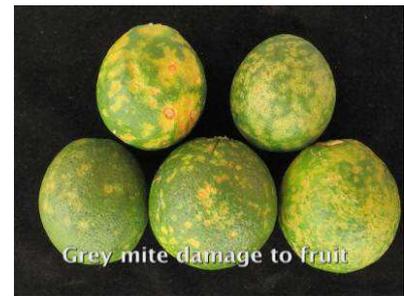
Another fairly important mite pest is the flat mite. Flat mite often feeds on the edges of other scars such as thrips scars and wind scars and even feeds underneath red scale, causing an exacerbation of the scarring. Flat mite should be inspected for on the fruit and can occur at any time during the summer.



Other Mites

There are a number of other species of mite which can be pests on citrus, both on the fruit and sometimes on the leaves too and these are species like:

- ❖ Grey mite
- ❖ Oriental or Lowveld mite
- ❖ Rust mite
- ❖ Red spider mite
- ❖ Silver mite



Citrus Psylla

Citrus psylla is the vector of greening disease, so particularly in areas where greening disease occurs, scouts must be vigilant in looking for citrus psylla. In other areas, psylla is nothing more than a cosmetic pest.



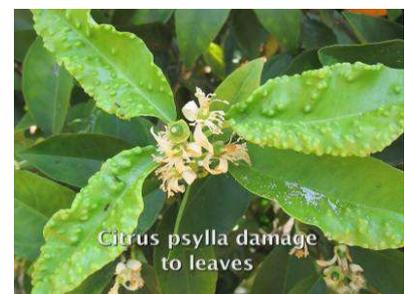
Scouting

Citrus psylla infestation is recognisable by the pockmarking that infestation from young stages results in on leaves.

However, in areas where greening occurs, scouts want to detect the presence of citrus psylla before these extreme symptoms on leaves show up.

The first signs of infestation would be the laying of eggs on the perimeter of leaves and the settling of juvenile stages on the leaves, so the inspection point for citrus psylla is leaf clusters. The scout should select 10 leaf clusters at random around the tree.

Citrus psylla will only infest new flush, so whenever there is a new flush on the tree, an inspection must be made for citrus psylla. While the flush is still soft, weekly inspections of this flush must be made. Once it has hardened up, it is no longer attractive to citrus psylla, and scouting for this pest can be put on hold until the next flush shoots.



Other Scales

Mussel Scale

Mussel scale is not normally a pest in citrus orchards, particularly where a conventional spray programme is being followed. Therefore, routine monitoring for mussel scale is not necessary.

However, if mussel scale is observed, then fruit must be monitored for mussel scale in a very similar way that would be used for red scale inspection.

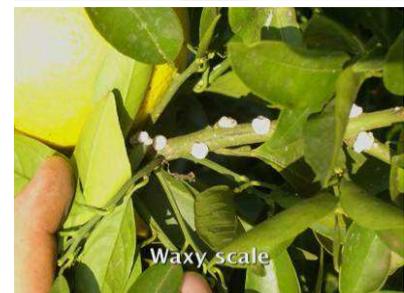


Waxy Scale

Waxy scale is also a fairly sporadic pest. Infestation by waxy scale can be on the green stems or on the leaves.

Waxy scale doesn't settle permanently on the leaves, but in its growing life-stages would settle temporarily on the leaves and then move back to the stalks.

Routine scouting for waxy scale is not necessary, but if the scale is observed, then the scout should inspect for waxy scale by using leaf clusters as the inspection points. Stems should be included in these inspection points.



Soft Scales

Soft scales, like waxy scales, *soft green scale* and *soft brown scale*, are sporadic pests. Normally one does not need to scout for soft scales but if their presence becomes obvious, then scouts should inspect for them too. The main problem with soft scales, like waxy scale, is the production of honeydew which leads to the growth of sooty mould, which can land up on the fruit and cause the fruit to be downgraded for export.

The inspection point for soft scales, is the leaves and the green stems leading up to the leaves.

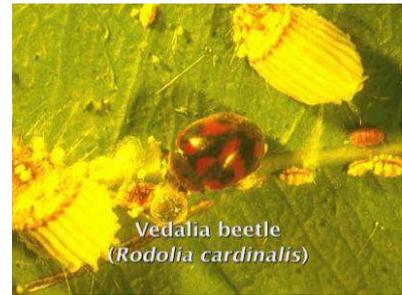


Australian Bug

Australian bug (*cottony cushion scale*) is also a sporadic pest. In fact, Australian bug should never be a pest. Australian bug has arguably the most effective predator of all citrus pests. This is the *Vedalia* beetle, which normally keeps Australian bug at levels which are not even detectable.

If Australian bug is present, it will be seen mainly on the tree trunk and on the scaffolding branches. There is no real scouting system for Australian bug, but the presence of the pest must be recorded.

Simultaneously it is very important to look out for *Vedalia* beetles. If they are present, then this will probably eliminate the need to spray for the pest. Additionally, one needs to look out for ants, as ants can disrupt the natural enemies of Australian bug. If ants are present, these need to be controlled immediately.



information

Rodolia cardinalis

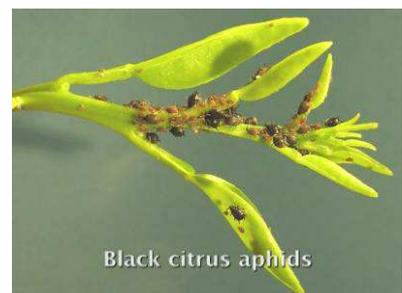
The scientific name for the natural enemy of Australian bug is *Rodolia cardinalis*. It is commonly known as the **Vedalia** beetle or cardinal ladybird.

Aphids

Aphids are generally not a serious pest, particularly on bearing trees. Trees can tolerate a low level of aphid infestation. On non-bearing trees aphids become important and the trees can tolerate less. The presence of aphids must be recorded.

There is no specific monitoring system for aphids, however. If it is noted that there is a general increase in the infestation level of aphids, and if there is an unacceptable level of honeydew and sooty mould developing, then this must be immediately reported by the scout to the farmer.

Aphids are vectors of tristeza disease, particularly the black citrus aphid, and grapefruit is particularly susceptible to citrus tristeza disease. Therefore, if an aphid infestation is detected on grapefruit trees this must be immediately reported to the farmer so action can be taken.



Leafhoppers

Leafhoppers are sporadic pests. In fact, in most areas leafhoppers never reach pest status level.

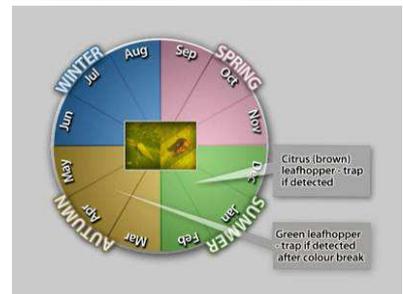
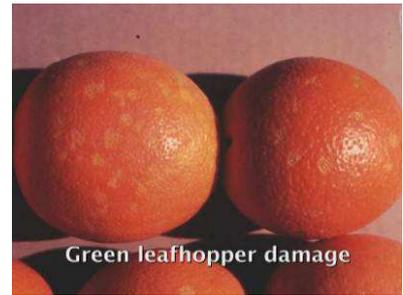
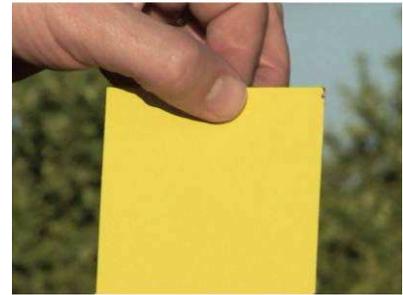
There are two species of leafhoppers which are of primary importance on citrus. This is the green citrus leafhopper and the citrus leafhopper, which is brown and larger than the green citrus leafhopper.

Monitoring for these pests is done mainly with the sticky yellow traps, similar to those used for citrus thrips. These traps should be checked and replaced on a weekly basis. As for citrus thrips, a density of three sticky yellow traps per hectare should be used.

The sort of damage that can be caused by leafhoppers is an oleocellosis type of blotching on the fruit, which can then be downgraded at time of harvest.

The brown citrus leafhopper generally becomes a pest earlier in the season than the green citrus leafhopper. The brown citrus leafhopper can be a pest in midsummer. If the pest is detected, then the sticky traps should be placed out in an orchard.

Only once fruit starts to colour up, is the green citrus leafhopper usually a problem. If this is noted, then traps should be placed in the orchard.



Citrus Butterfly

There are two main species of butterfly which are pests on citrus. They are large butterflies, which are generally yellow and black in colour. The female lays her eggs on young flush. The larva hatches out and the caterpillar feeds on this flush.

It is very rare that it is necessary to take any action on citrus butterflies on bearing trees. However, no infestation of citrus butterflies or their larvae can be tolerated on non-bearing trees. In a short period of time, the flush can be damaged by these.

Therefore, if a scout sees any larvae or eggs of citrus butterflies on non-bearing trees, these must be recorded and reported immediately.



Citrus Flower Moth

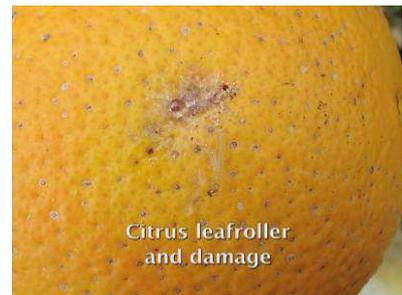
Citrus flower moth is generally only a pest on lemons. The female will lay her eggs on or near the blossoms, the larvae will hatch out, and they will begin to penetrate into and feed on the blossoms. If this generation is large and left to reproduce, the second generation can attack the fruitlets, the moth laying her eggs on the fruitlets and the larvae penetrating into the fruit and damaging the fruitlets.

Lemons should be inspected for citrus flower moth whenever there is a new blossom on the tree. This happens usually *three or* four times a year with lemons. Therefore, the blossom clusters form the inspection points. Scouts must determine what percentage of these inspection points are infested with citrus flower moth larvae or pupae.



Leafroller

There are two species of leafroller which occur on citrus, the most important being the apple leafroller. The larvae of the leafroller tend to roll leaves together using their webbing, hence their name. However, the damage that they cause is by feeding underneath the calyx of the fruit. As the leafroller occurs during the period that thrips occurs, as one is inspecting for thrips, one can simultaneously monitor for leafroller larvae.



Ants

There are a number of different species of ants that occur in citrus orchards. However, there are two species that are overwhelmingly more important than any other species. These are the brown house ant, which is by far the most important, and the pugnacious ant.

Scouts need to inspect both in the trees and on the ground for the presence of ants and they need to record the percentage of trees where they find ants to be present. Although ants are not direct pest to citrus, they are extremely important as they disrupt the natural enemies of many other pests. Sucking insects produce honeydew and honeydew is attractive to these ants.

As these ants want to feed on this honeydew, they protect these sucking pests against the attack by their natural enemies. As a result, biological control of these sucking insects is seriously compromised by the presence of ants.



Woolly Whitefly

Contrary to what the name suggests, *woolly whitefly is not a fly*, but is more closely related to scale insects and aphids.

The adults look like tiny moths and fly around rapidly, while the larval stage sucks onto the undersides of leaves.

The larvae produce honeydew, which leads to the growth of sooty mould, which can cause fruit to be unfit for export and can impede photosynthesis. Honeydew also attracts ants, which in turn protect the woolly whitefly from its natural enemies.

Scouts must be on the lookout for the presence of both adult and larval woolly whitefly, and report it to the farmer without delay.



Other Citrus Pests

A well-trained and observant scout should be able to detect pests which don't normally occur in the orchard. These could be pests such as:

- ❖ Looper
- ❖ Black scale
- ❖ Planthopper
- ❖ Leafminers
- ❖ Snails
- ❖ Tip wilters
- ❖ Fuller's rose beetle



Conclusion

In conclusion, the importance of scouting and the importance of the scout who conducts the work can never be over stated. This is arguably the most important function that can be performed on a day-to-day basis on a farm.

This practice will not only save the farmer money, but it can save him innumerable losses. It is an extremely important function and one which should never be neglected on the farm.