
Monitoring and Inspection for Phytosanitary Markets

Citrus
False Codling Moth and
Fruit Fly

Learner Guide

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P.O. Box 461, Hillcrest, 3650
(031) 765-3410



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Scripted by:

Jacomien de Klerk

Visual material production:

Sagritex (Pty) Ltd

Information sources:

Citrus Research International

Project coordinator:

Citrus Academy (Jacomien de Klerk)

Special thanks to:

Peter Stephen

Luke Cousins

Aruna Manrakhan

Claire Love

Paul Cronje

Sean Moore

John-Henry Daneel

Glorious Shongwe

Rookie Beck



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Introduction

The false codling moth, commonly known as FCM, is a citrus pest unique to Africa, as are some of the species of fruit fly found in Africa. These pests do not occur in most countries to which South Africa exports its fruit. These countries don't want to risk the pests spreading to their countries. For this reason, they don't tolerate any infestation of FCM or fruit fly in fruit coming to their countries. It is very important that we do everything we can in South Africa to prevent fruit infested with FCM or fruit fly from being exported to these countries.

If we fail to do this, these export markets may close down and citrus farming in South Africa will lose a lot of money.

Monitoring fruit in the orchard and inspecting fruit in the packhouse for FCM and fruit fly infestation is extremely important to prevent the export of infested fruit. As the person responsible for monitoring and inspection, you have one of the most important jobs on the farm or in the packhouse.

If you fail to identify infested fruit and actions are not taken to correct the situation, it is likely that infested fruit will be exported. This fruit may then be rejected in the export market, and that country can then refuse to take any further fruit from South Africa. If this happens, citrus farms will close down and jobs will be lost.

Monitors and inspectors must be smart, have a good attitude, have perfect eyesight, understand the importance of their work, and be properly trained to perform their tasks. You must also be certified as a qualified monitor or inspector and should also be tested often.

In this module, we will firstly look in detail at FCM and fruit fly, the two pest insects for which you have to be on the lookout when inspecting export citrus. You need to know exactly what they look like, what their lifecycles are, and what you are likely to see when looking for them in fruit, in the orchard and at the packhouse. After that we will take a look at the right way to monitor orchards and to do packhouse inspections. Here we will then also describe other pests that you may find during inspections and that you might confuse with false codling moth and fruit fly.

Biology and Life Cycle

False Codling Moth (FCM)

The moth is only active at night and lays its eggs on the fruit after mating. The egg, which is small and difficult to see, hatches and produces a tiny larva that is just over one millimetre long. The larva enters the rind of the fruit and starts feeding on the pulp. Once inside the fruit, the larva grows through five larval stages. While growing, it keeps feeding on the fruit, and this causes the fruit to eventually drop from the tree.

Once the fruit has dropped, or even before it drops, the larva exits the fruit and goes into the soil, where it turns into a pupa. The pupa develops in the soil until a moth eventually comes out of the pupa, restarting the life cycle. Depending on the season and the temperature, the life cycle from egg to egg can take between five weeks to three months, being shortest in the summer.

Fruit Fly

Like FCM, the fruit fly also has four major life stages, which are the egg, the larva, the pupa and the adult fly. The adult female fruit fly pierces the rind of the fruit with her

ovipositor and lays eggs in small pockets just under the rind. Once the larvae hatch, they bore deeper into the fruit and feed on the pulp. The fruit starts rotting and at a later stage of rot can drop from the tree.

When the larvae are mature, they leave the fruit and turn into pupae in the soil. Eventually adult flies will emerge from the pupae and come out of the soil to continue the life cycle. The fruit fly life cycle takes anywhere from three weeks to three months, depending on the weather, being the shortest in mid-summer.

Monitoring, Inspection and Grading

There are three tasks involved in monitoring and inspecting for FCM and fruit fly infestation on the farm and in the packhouse. The first task is orchard monitoring, which involves checking and keeping record of the level of FCM infestation in the orchards. The second task is packhouse delivery inspections, which is where a sample is taken from the fruit of each orchard as they arrive at the packhouse, and the fruit in this sample is checked for FCM and fruit fly larvae. The third task is online grading and sorting, which involves checking the fruit on the packing line for FCM and fruit fly infestation symptoms and removing such fruit.

Orchard Monitoring

Orchard monitoring is also referred to as pre-harvest infestation monitoring. The purpose of orchard monitoring is to measure the levels of false codling moth infestation in the runup to the harvest, so that action can be taken if the levels are too high. Fruit from a particular orchard can only be exported to phytosanitary markets if this monitoring data for that orchard is uploaded to the Phytclean system.

Orchard monitoring involves taking a sample from the fruit that is collected during orchard sanitation and dissecting the fruit to look for signs of false codling moth infestation, and then recording the number of fruit that are infested and the total number of fruit that was collected in that orchard during sanitation. This must be done for each individual orchard every two weeks for a period of twelve to sixteen weeks before harvest.

Orchard monitoring must start at least twelve weeks before picking starts, although it is best practice to start monitoring sixteen weeks before the projected harvest date, in case harvesting begins earlier than expected.

Monitoring, however, does not need to start before the 15th of January. So, if harvesting in an orchard is expected to start in or before the first week of April, you still don't have to start monitoring before the 15th of January.

Monitoring must preferably be done on the same day every second week. If for some reason you cannot do these tasks on the designated day, then do your monitoring as soon as possible after that day. Take note that there must be at least six monitoring records for an orchard, this being one every two weeks for a minimum twelve-week period, and that the gap between monitoring events must not be more than eighteen days.

Orchard Sanitation

Orchard sanitation is done regularly throughout the year to remove all fallen and out-of-season fruit from orchards. Sanitation must be done at least once per week, but should be done as often as possible. For more information and background, please watch the Orchard Sanitation video module on the Citrus Academy YouTube channel.

During the orchard monitoring period, orchard sanitation should continue as usual. On your orchard monitoring day, the sanitation teams must keep all the fruit they collect from that orchard. The fruit collected in an orchard should preferably all be pooled in one place and mixed together, although this may not be practical for very large orchards.

Calculating Total Collected Fruit

The first thing you need to do is to count, or at least accurately estimate, the total number of fruit that have been collected by the sanitation teams from that orchard. You only need to do this for the fruit collected on the day that you are doing monitoring, meaning, not for fruit that were collected on other days.

One possible method is to weigh all the collected fruit, then weigh ten fruit separately and calculate the average weight per fruit, and then divide the average weight per fruit into the total weight to get the number of fruit. If the fruit have been collected in bags, bins or crates, you can count the fruit in one bag, bin or crate and multiply that by the number of bags, bins or crates, provided that they are all filled to more or less the same level.

Ask the farm manager or team leader for their advice on how best to estimate the total number of fruit that have been collected from the orchard in your circumstances.

Taking the Fruit Sample

From all the fruit that have been collected from an orchard you now need to take a sample of 100 fruit. If fewer than 100 fruit were collected, sample all of the fruit.

The fruit for the sample must be selected at random, with no preference for fruit that seems less or more likely to be infested. Remember that the is to get a sample that is representative of all the fruit in the orchard.

If the fruit from the whole orchard have been pooled and mixed together in one place, you can simply collect 100 fruit at random from this pile. If the fruit have not been pooled in one place but is still spread around the orchard, you will need to drive or walk around the orchard and collect your fruit sample from the bags or piles of fruit. Make sure that you take the sample evenly throughout the orchard, so that the sample is as representative as possible.

Dissecting Fruit

Once you have collected your fruit sample, you need to carefully cut and inspect the fruit to see if they have been infested with FCM, or if there are signs of infestation.

Inspect the outside of the fruit carefully for any signs of FCM penetration. Where you find such marks, cut the fruit in this place. Cut thin layers of the fruit rind, stopping after each slice to see if there are any further signs of larval penetration or infestation. Once you reach the flesh of the fruit, and if there are no further signs of infestation, cut the fruit into quarters and do a final inspection for infestation.

If you are working with navel oranges and you find no signs of penetration on the rind, begin to cut at the navel end of the fruit and inspect the fruit in the same manner. For all other fruit, cut the ones with no external signs of infestation or penetration into quarters and inspect them for infestation.

Identifying FCM Infected Fruit

Carefully record the number of fruit infested with FCM. A fruit must be recorded as infested with FCM if you see any of the following signs:

- ❖ Live or dead FCM larva,
- ❖ Larval tunnelling,
- ❖ Frass, and
- ❖ Head capsules

Other Pests and Symptoms

It is important that you identify FCM infestation accurately, and that you don't mistake other insect infestation for FCM. The other insect larvae you may see in the fruit that you may mistake for FCM larvae, are:

- ❖ Fruit fly larvae,
- ❖ Vinegar fly and other fly larvae,
- ❖ Beetle larvae, and
- ❖ Carob moth larvae

It is not necessary for you to record vinegar fly larvae, other fly larvae and beetle larvae, as these are secondary infestors. This means that they will only infest fruit that is already damaged and so they are not identified as pests.

You need to be very good at identifying FCM larvae and distinguishing them from other insect larvae. The young FCM larva is white with a black head capsule and is just over one millimetre long. As they get older, larvae darken, first turning off-white and finally changing to pink. The mature larva is fifteen to twenty millimetres long.

Small young fruit fly larvae are see-through with pale mouth-hooks. The older larvae are creamy white with black mouth-hooks that stick out. At this point the larvae are at least five millimetres long. Fruit fly larvae do not have the hard head capsule which is so obvious in FCM larvae. The body of the fruit fly larva narrows to a point at the mouthparts and is flattened at the tail. If larvae are dark, they are dead.

Vinegar fly larvae look similar to fruit fly larvae, especially the young fruit fly larvae. The main difference is that vinegar fly larvae lack the flat stump rear-end of the fruit fly larva. Vinegar fly larvae also tend to be a bit smaller, at two and a half to four and a half millimetres long, and are often found in groups, whereas fruit fly larvae more often occur on their own.

Larvae of other fruit fly species, such as *Silba*, look a lot like fruit fly larvae in size and shape. They differ from fruit fly larvae in that their spiracles at the rear end are black in colour and sometimes stick outwards.

Sap beetles have a dark hard head capsule, like FCM, but they do look different from FCM because they have a speckled body, forked tail and no pink colour.

Carob moth larvae look like FCM larvae, but the smallest carob moth larvae are slightly pink, whereas small FCM larvae are white. Carob moth larvae stay this light pink colour, which is a paler pink than the mature FCM larvae. The carob moth larva also has a small dark hard patch in front of its first spiracle, which is not seen on the FCM larva. You will however need a magnifying glass or microscope to see this.

As part of your inspection, you can also record fruit fly larvae and carob moth larvae, as most of these larvae are clearly different from FCM larvae, especially if you are able to inspect them using a magnifying glass. You might still make a mistake and record a

carob moth larva as an FCM larva, but it is better to make this mistake rather than to record an FCM larva as a carob moth larva, because FCM infestation is far more common and the potential dangers far greater.

If you are not sure about the identification of a larva, keep the larva and take a photograph of it. Speak to someone who is more knowledgeable for a second opinion.

Fruit also drop from the trees for other reasons, such as Alternaria navel end rot, chemical burn, heat waves, budmite damage, and infestation by other pests, such as mealybug. Very often you will not be able to identify any obvious cause for the fruit drop, but it is important that you eliminate FCM infestation as the cause.

Recording and Reporting

Record your monitoring findings on a standardised form that allows you to capture all the relevant information. The form can be very simple, or more complicated, but it is essential that the form should at least contain the following information:

- ❖ The details of the person responsible for monitoring
- ❖ The details of the orchard being monitored
- ❖ The date of monitoring
- ❖ The date of the previous sanitation event in the orchard
- ❖ The total number of fruit collected from the orchard
- ❖ The number of fruit in the sample that are infested with FCM. Remember that this includes fruit where the larva is present, live or dead, and fruit where there are signs that the fruit was infested with a larva at some point.

The number of fruit dropped due to other pest insects, diseases or other causes may also be recorded, but this is not compulsory within the FMS.

Once the data from all orchards is collected, report the infestation levels to the farm manager and give him the completed recording forms.

Packhouse Delivery Inspections

After harvesting, fruit are delivered in picking bins or picking trailers to the packhouse. Several bins or trailers of fruit from a particular orchard can arrive at the packhouse at the same time. For fruit to be approved for export to Europe, a sample of the fruit from each orchard has to be thoroughly inspected for FCM and fruit fly infestation.

Selecting a Fruit Sample

Depending on the export option for the orchard, the sample size can vary from 800 to 2800 fruit. The inspector will be instructed by the packhouse manager on the size of the sample for every orchard. The fruit sample must be taken as evenly as possible from all of the bins delivered from the orchard to the packhouse. For example, if an 800 fruit sample is required and 8 bins of fruit are delivered to the packhouse, choose 100 fruit from each of the 8 bins.

It is important that you select the fruit from across each bin, and not just from one spot in the bin, and that you choose fruit at random, and not just better-looking or more damaged fruit. Collect the fruit for your sample in a separate crate or bin, and record the details of the orchard and the date of sampling on your recording form.

Fruit Inspection

Carefully inspect the entire surface of every single fruit in the sample, by turning the fruit in your hand and looking at it from all angles, looking for any possible marks or blemishes that show you that the fruit might be infested. To help you, you may need a magnification device, such as a head loop or a hand-lens with a minimum of 2.5 times magnification. It is helpful to have charts put up in the inspection area with symptoms of fruit fly and FCM infestation, so that you are constantly reminded of what to look for.

All fruit that you think may be infested must be set aside to be dissected. If you are not sure that the marks or blemishes you see are signs that the fruit is infested, you must still set the fruit aside – it is much better to dissect a whole lot of clean fruit, than to let even one infested fruit through. Navel oranges with any split at the navel end, even if it is very small, must be set aside. Research has shown that when these external inspections are properly done, you can identify 80% of the infested fruit even before cutting the fruit. You must aim to reach this high standard of identifying infestation in the fruit you are inspecting.

After superficially inspecting the entire fruit sample, take another careful look at the fruit you have set aside, to make sure that you have correctly identified the fruit as being infested.

Dissection Procedure

Take each fruit that has been set aside in turn and start cutting it at the point where the fruit might be infested. Cut thin slices of fruit under this point, and inspect the fruit closely after every slice for FCM larvae and fruit fly eggs or larvae, and for other signs of larval infestation. Keep slicing the fruit this way until you have cut deep into the flesh of the fruit. If you don't find any infestation, cut the fruit into quarters, slicing down the middle of the fruit and inspecting each quarter for infestation.

For navel oranges, inspect the navel-end of the fruit, especially if there are signs of navel-end splitting. Cut thin slices as described before and inspect for infestation.

Signs of FCM and Fruit Fly Infestation

As you dissect the fruit, you may find signs of infestation. For FCM, these are larval tunnelling, frass and head capsules. You will however only record a fruit as infested with FCM if you find a larva, live or dead, in the fruit. The signs are merely helpful to show you where to look for the larva. For fruit fly, you will record infestation if you find live fruit fly larvae or fruit fly eggs.

Other Pests and Symptoms

As described in the previous section, you may find vinegar or other fly larvae, beetle larvae or carob moth larvae in the fruit, and may mistake these for fruit fly or FCM larvae. Please review the previous section where the differences between these species are discussed in detail. Also regularly consult the identification charts.

Recordkeeping and Reporting

Record the findings of your inspections on a standard form that contains all essential information, similar to the form used for orchard monitoring. Record FCM infestation

only if you find a live or dead FCM larva in the fruit, and separately record fruit fly infestation if you find live fruit fly larvae or fruit fly eggs. Report your findings to the packhouse manager immediately, providing him with the completed forms.

Packhouse Online Grading and Sorting

The purpose of a packhouse is to sort, grade, treat and pack fruit for export. Graders are responsible for finding and removing all fruit with unacceptable blemishes, including signs of disease or pest infestation. This includes fruit infested with FCM or fruit fly.

The sorting and grading table in the packing line should be accessible and well lit, so that a grader can inspect all the fruit, and identify and remove blemished fruit and fruit that might be infested. There should be charts up at the grading station that show the most prominent external infestation symptoms.

It is your responsibility to quickly and accurately inspect every fruit that passes on the line. Look at the fruit as it passes you on the grading table. If you notice any signs of infestation, pick up the fruit and inspect it more closely. If you find even the smallest mark that might indicate infestation, remove and discard the fruit. Navel oranges with even the slightest navel-end split, must also be removed and discarded. No such fruit may be packed for export.

Conclusion

The monitor, inspector or grader can sink or save the farm, depending on whether he or she does their work badly or well. As a monitor or inspector you must do everything you can to find and identify all FCM and fruit fly infestation of fruit you are inspecting. By identifying and removing infested fruit, you help lower the risk of infested fruit being exported, which is very important to the success of the South African citrus industry.