



GOVERNMENT
OF MALTA



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CITRUS PRODUCTION INTEGRATED PEST MANAGEMENT GUIDELINES

Agriculture Directorate



May 2024

PLANT PROTECTION PRODUCT AUTHORISATION

Plant protection products (PPPs) need to be authorised by the MCCA to be placed on the Maltese market in accordance with the provisions of Regulation (EC) No 1107/2009 implemented in Malta through Legal Notice 284 of 2011, Plant Protection Products (Implementation) Regulations, issued under the Pesticides Control Act (Cap. 430).

A list of authorised PPPs can be found on the MCCA website:
<https://mcca.org.mt/Section/Content?contentId=1158>

It is the legal obligation of all farmers and professionals making use of PPPs to consult the list prior to purchasing or applying of any products to ensure their authorisation, even if they are listed in this publication. If assistance is required one can contact AgriConnect for further assistance.

For PPP substances which are listed in this publication and are currently not authorised, the Agricultural Directorate encourages farmers, farmer representatives and commercial entities to contact AgriConnect which will provide information and assistance in the authorisation process of products containing such substances.

Colour code for substances listed in this guideline:

- Authorised for use in the Maltese Islands.
- Can be authorised for use.

🌿 Organic

🐝 Beneficial insect



+356 21804981/+356 21804982/+356 21804984
agriconnect.mafa@gov.mt

AgriConnect FAS, Government Farm Ghammieri,
Marsa, Malta.

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California Red Scale

Aonidiella aurantii

Red Scale is a pest found mainly on citrus trees. The reddish scale insects have a circular, flattened and leathery scale body measuring around 1.5 to 2 mm in diameter. It may be present on the stems, leaves and fruit.

The females give birth to live offspring in the form of young crawlers that emerge from under the scale and search for a suitable spot on which to settle permanently. The crawlers are mobile and settle around a metre away unless they are dispersed by wind, insects, birds or human activity. Crawlers are strongly attracted by light and tend to move to new growth, young shoots, the upper surface of leaves and green fruit, but can also settle on older branches and mature fruit.

After settling, the crawlers insert their mouthparts to start feeding on the sap of the plant and secrete a white, waxy, cottony covering. The females moult into a stage when their shield is a grey colour. Mating occurs at the start of this stage before the female finally matures. Males are slightly smaller in size and emerge as winged adults. After mating, each female produces 60-150 nymphs every 6 to 8 weeks. Four generations can be present in a single year. Overwintering may happen at any stage of development. Births are concentrated in May-June, August-September and October-November.

Continuous sap feeding of nymphs and adult females exposes the plant to the toxic saliva of the insect. Symptoms include discolouration of leaves and fruit, including yellow spotting. Distortion of leaves and shoots and dropping of leaves may occur. Branches can be affected and die back, and young trees can suffer greatly due to branch losses.

○ Control and Management

○ Agronomic Interventions

- Limit pruning activities.
- Reduce the presence of dust on the foliage.
- Work and turn over the soil to disturb the ants' nests.

○ Biological interventions

- Release the beneficial parasite *Aphytis melinus* during late summer of the previous year when not more than 50% of the pest is seen on the tree. It is recommended to continue the releases even after unfavourable conditions for the beneficial insects (e.g. frosts, high temperatures, non-selective chemical treatments, etc.).
- The dose of this beneficial parasite should be 50,000 to 200,000 per hectare. The maximum amount of 200,000 per hectare is not to be exceeded.
- *Aphytis melinus* should be released gradually. In spring, one should release 50% of the total number of the beneficial insects over the entire plot every two weeks (start releasing upon the first catches of wintering males and stop releasing when eventually there are no more catches of this insect). The remaining 50% must be released only when there is an outbreak of this scale insect.

○ Chemical Interventions

Intervene when any of the below thresholds is reached:

- 10% of infested fruit in summer

OR

- 20% of infested fruit in autumn

OR






- when there is one or several pest specimens per infested fruit showing no signs of parasitisation by the beneficial insect.

To determine whether the threshold has been reached or exceeded, monitoring should be done on 4 fruits per plant (on 4 different exposures) based on a sampling of 10% of the trees present in the orchard.

It is recommended to place yellow or white pheromone traps in sizes of 13 x 18 cm at the rate of two per plot.

If the threshold is exceeded, intervene every 2-4 weeks after the peak males captured using the traps.

PLANT PROTECTION SUBSTANCES AND BENEFICIAL INSECTS

- *Aphytis melinus*  
- Orange oil (Sweet orange essential oil) 
- Paraffin oil 
- Potassium salts of fatty acids 
- Acetamiprid (2)
- Pyriproxyfen (1)
- Spirotetramat (2)
- Sulfoxaflor (3)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

With the exception of paraffin oil, do not exceed one intervention per year.

- (1) At most one intervention per year regardless of adversity; can be used only during the summer-autumn period.
- (2) A maximum of two interventions per year regardless of adversity.
- (3) A maximum of one intervention per year regardless of adversity.



Two adult
Aonidiella
aurantii ¹

Infested lemon fruit with *Aonidiella aurantii* ²



Citrus Mealybug

Planococcus citri

The Citrus Mealybug is a highly polyphagous and adaptable insect that can feed on many host plants including citrus. Mealybugs are sap-feeding, soft-bodied, segmented scale insects that are coated with a powdery, white, wax secretion. Adult females are 3 to 4 mm in length and have elongated bodies, a flattened appearance, and are mobile. Males are short-lived and, unlike the females, can fly, having two pairs of wings. Fertilised females lay hundreds of eggs in cottony sacs. Once the first instar nymphs – the crawlers – emerge, they disperse along the plant.

Citrus Mealybugs feed mostly on the aerial part of the plant, including the leaves and fruit, but can occasionally feed on roots. The pest prefers well-shaded groves and can be predominantly found on the most shaded part of the plant.

Adult females and nymphs extract the sap from the plant, stunting growth and causing deformation, yellowing of leaves and eventually defoliation. Feeding causes the excretion of honeydew that may lead to sooty mould that further damages the foliage and fruit. Mealybugs can be often found in colonies that would have various insect stages, including adults, nymphs and eggs. Infestations can be identified by observing white, waxy clusters. In warm climates, the pest completes 4 to 6 life cycles a year, with the largest infestations occurring during the summer months. Plant-to-plant dispersal of the mealybugs can occur either by the first instar nymph being blown by the wind or by the moving of the developed nymphs and adult females by other agents, such as ants.

○ Control and Management

○ Agronomic Interventions

- Aerate the tree crown by carrying out appropriate pruning.
- Work and turn over the soil to disturb the ants' nests.
- It is recommended to place delta white traps with a pheromone inside at the rate of one per plot to capture the male adults.

○ Biological interventions

- Upon the first capture of the mealybugs, release the beneficial insect *Cryptolaemus montrouzieri*. Carry out 1 to 2 releases up to a maximum of 800 individuals per hectare.
- Another beneficial insect/parasitoid is *Leptomastix dactylopii*. This can be used instead of *Cryptolaemus montrouzieri* upon the capture of the first mealybugs. Apply at a dose of 5,000 individuals per hectare with a maximum of 2 to 3 interventions. Releases should be applied when the average temperature is at a minimum of 18°C.

○ Chemical Interventions

Intervene when the below thresholds are exceeded:

- 5% infested fruit for the summer period and 10% during the autumn period.
- When monitoring of fruit results in one or more non-parasitized living mealybug individuals per fruit.

PLANT PROTECTION SUBSTANCES AND BENEFICIAL INSECTS

- *Leptomastix dactylopii* 🌿
- *Cryptolaemus montrouzieri* 🌿
- Sweet orange essential oil 🌿
- Paraffin oil 🌿
- Potassium salts of fatty acids 🌿
- Acetamiprid (1)
- Spirotetramat (1)
- Sulfoxaflor (2)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

With the exception of paraffin oil, do not exceed one intervention per year.

- (1) A maximum of two interventions per year regardless of adversity.
- (2) A maximum of one intervention per year regardless of adversity.

*Adult citrus mealybugs*³



*Beneficial insect
Cryptolaemus
montrouzieri eating
Planococcus citri*⁴

Scale Insects

(a) Mediterranean black scale (*Saissetia oleae*)

This blackish scale insect is normally found on twigs and shoots. In case of a heavy infestation of this pest, the shoots and the leaves wither and fade. A heavy coating of sooty moulds may also develop on the leaves and the fruit. One single female is able to lay an average of two thousand eggs, the laying period lasting 2 to 4 weeks. The colour of the eggs is white turning into brown. After hatching, which takes 15 to 20 days, the crawlers start feeding within a few hours. The nymphs prefer to feed on shoot tips and the underside of the leaves, but the adults prefer shoots and twigs. The nymphal development takes about 2 to 3 months. If conditions are not favourable the nymphs may go into diapause; in this state they are very difficult to kill. The males are winged and are not very common. Normally, under Mediterranean conditions, there are two generations, with a duration of 3 to 4 months each.



*Saissetia oleae*⁴



Saissetia oleae
and sooty mould
on an orange
tree leaf⁶

(b) Fig Wax Scale (*Ceroplastes rusci*)

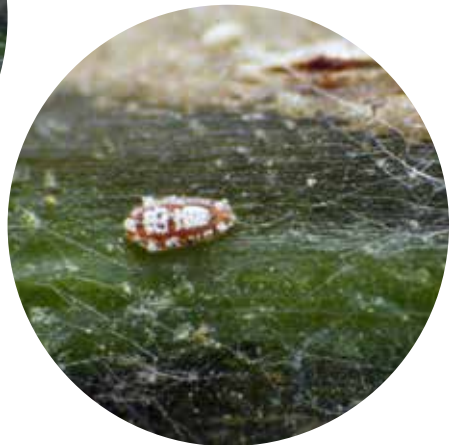
This scale is mostly common on fig trees and other hosts, including wild ornamental plants. The adult female grows up to 5 mm long, 4 mm wide and 3 mm high. It is barnacle-like, formed from eight fused plates, whitish-marble and variably marked with brown. The male is around 2.0 to 2.2 mm long and reddish. The eggs are 0.32 by 0.23 mm, oval, pale brownish yellow when laid but by time they become reddish brown. The first instar nymph (the crawler) is 0.3 mm long, oval-bodied, with a rusty red colour.

The females are able to deposit hundreds of eggs over a period of several weeks, normally from May onwards. The female sits on her eggs, which take 3 to 4 weeks to hatch. Before reaching adult stage, the nymphs go through three instars. As other scale insects do, this pest excretes large quantities of honeydew which attracts ants.

The infested trees are weakened and, if heavily infested, leaves and shoots may die. Due to the honeydew produced by this pest, mould can develop on the leaves.



Ceroplastes rusci adults ⁷



Ceroplastes rusci nymph ⁸

(c) Chinese Wax Scale (*Ceroplastes sinensis*)

The Chinese Wax Scale is normally associated with citrus trees but it can also be found on other hosts. The adult female (the scale) is 5 to 6 mm long, barnacle-like, rectangular in outline and strongly convex. When young it is pinkish white in colour but later it changes to red. The first instar nymph (the crawler) is purplish red, and has an oval-shaped body.

This pest is observed mostly on branches and stems. The eggs are deposited in thousands during late spring. The first instar nymphs will move over to the leaves, normally attaching themselves to the upper surface, and start feeding on the leaves. Later, the third instar nymphs move back to the stem and the branches, where they become sedentary, overwinter, and eventually reach adult stage.

The infested branches and shoots can be weakened, however the infestation is generally localised and only of minor significance.



Ceroplastes sinensis adults °



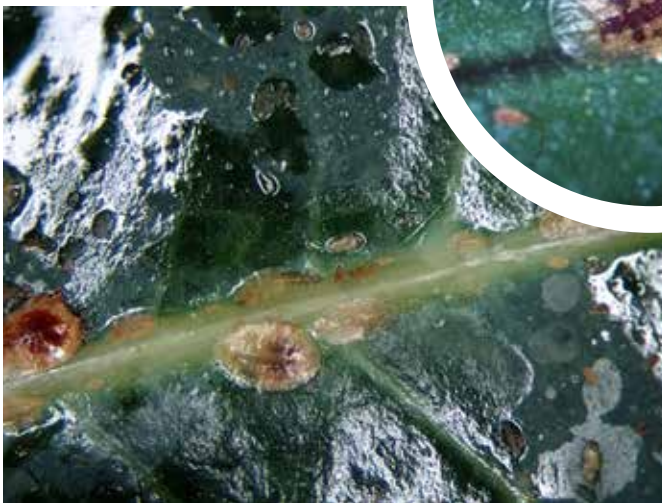
Ceroplastes sinensis nymphs °

(d) Common Shield Scale (*Coccus hesperidum*)

This is a common scale insect that is found on citrus trees but which can also be found on other host trees. The adult female (the scale) is usually 3.5 to 5 mm long. It is very flat and elongated and oval in shape, translucent yellow to brown in colour, with a distinct median longitudinal ridge and horizontal rib-like ridges.

Each female produces about one thousand nymphs within 2 to 3 months. The first instar nymphs move within the host tree for a few days then they settle down to feed on the leaves. After this they group along the midribs and other leaf veins. Usually, the scales overlap and form dense colonies on the leaves. Breeding occurs continuously in ideal conditions, which include temperatures of 25°C to 30°C, and lasts about 2 months. Due to the amount of honeydew that this insect excretes it is often accompanied by ants.

Brown soft scale ³



Coccus hesperidum, various life stages and honeydew ¹⁰

(e) Citricola Scale (*Coccus pseudomagnoliarum*)

The mobile first instar nymphs are yellow and have short legs. When they settle on the leaves, the first instar nymphs are flat, translucent and barely visible. Then, by late summer, the first instar turns yellowish and plump. In autumn the nymphs become mottled brown second instar on leaves or twigs. In winter, the second instar becomes mottled grey. The females' colour is a mottle of dark brown and grey; they are convex, oval-shaped, about 6 mm long.

The females usually lay their eggs on twigs. After 2 to 3 days the crawlers start to hatch and settle to feed mostly on the underside of the leaves, although when the infection is severe some crawlers may also settle on the surface. The growth of the first instar occurs during summer. In autumn nymphs change into second instars and move to the twigs. Maturation of the second instar normally starts in late winter when they enlarge and mature into adult females.

Due to the amount of honeydew that this insect excretes it is often accompanied by ants and sooty mould.



Coccus pseudomagnoliarum, multiple life stages on twigs ¹¹

(f) Mealy Shield Scale (*Protospulvinaria pyriformis*)

The Mealy Shield Scale, also known as Pyriform Scale, is 5 to 7 mm long, light brown in colour, with a distinctly fan-shaped outline. This scale insect normally has two generations in a single year. Its dense colonies can be found on the underside of leaves and tend to form a cluster within the leaf midrib. This pest is known to extract an abundant amount of honeydew, as a result of which the plants may become extensively blackened by sooty moulds, rendering the fruit unmarketable.



Protospulvinaria pyriformis adults³

(g) Chinese Wax Scale (*Ceroplastes sinensis*)

The adult females of *Ceroplastes sinensis* are reddish brown, coated with thick off-white dry wax. The adult female scales are oval when seen from above and dome-shaped when viewed laterally. Females lay up to 2,000 eggs in a chamber under their scale body, out of which crawlers hatch in July-August and disperse onto the upper surface of leaves. The birth of the nymphs occurs around July and August. The insect is mobile in all stages of maturity, but dispersal to neighbouring plants occurs during the first instar phase. As the nymphs mature they move to the stems and the branches. Nymphs and adults feed by sucking sap from the host plant. Severe infestations are accompanied by sooty mould. The insect overwinters on branches as an immature adult female, or as a third instar nymph, and completes one generation per year.



Juvenile *Ceroplastes sinensis* on citrus¹²



Female
*Ceroplastes
sinensis* on
citrus¹²

(h) Oleander scale (*Aspidiotus nerii*)

The Oleander Scale, also known as the White Lemon Cochineal, is very polyphagous. It mainly infests lemon, lime and bergamot. This scale insect at various stages can be white to light brown, flat and oval. Adult females measure around 2 mm in length. Females lay eggs which hatch into crawlers that disperse to find an appropriate feeding site. Nymphs and adults can be present on all vegetative parts, including the branches, the leaves and the fruits. Infested leaves turn yellow and drop, and green spots may appear on the fruits; these spots remain present when the fruit becomes ripe. Eggs are minute in size, oval in shape and yellow-coloured. The crawler too is pale yellow in colour. It usually completes three generations a year, with the births of nymphs occurring in April-May, in June-July and August-September. As other scale insects, this species also excretes honeydew on which sooty moulds develop.



Aspidiotus nerii, adult female ¹³

Aspidiotus nerii, multiple life stages ¹⁰

○ Control and Management

○ Agronomic Interventions




- Aerate the tree crown by carrying out appropriate pruning. This is mostly effective against lecanoids, such as the Mediterranean black scale, the fig wax scale, the Chinese wax scale, etc.
- Minimize the presence of dust on the foliage.
- Work and turn over the soil to disturb the ants' nests.

O Chemical Interventions

Intervene when the threshold of 3-5 nymphs (nymphs which are at the beginning of the first nymphal stage, that is, when the scale insect is at the crawling stage) per leaf and/or 4 specimens per 40 cm a branch.

The monitoring observations must be done on a minimum of 4 twigs, length circa 10 cm per tree, and/or on 10 fruits per tree on a 5% sample of trees in the orchard (circa 200 fruits per plot, if possible).

PLANT PROTECTION SUBSTANCES AND DEVICES

- Sweet orange essential oil 
- Paraffin oil 
- Potassium salts of fatty acids 
- Pyriproxyfen (1) (3)
- Spirotetramat (2) (4)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

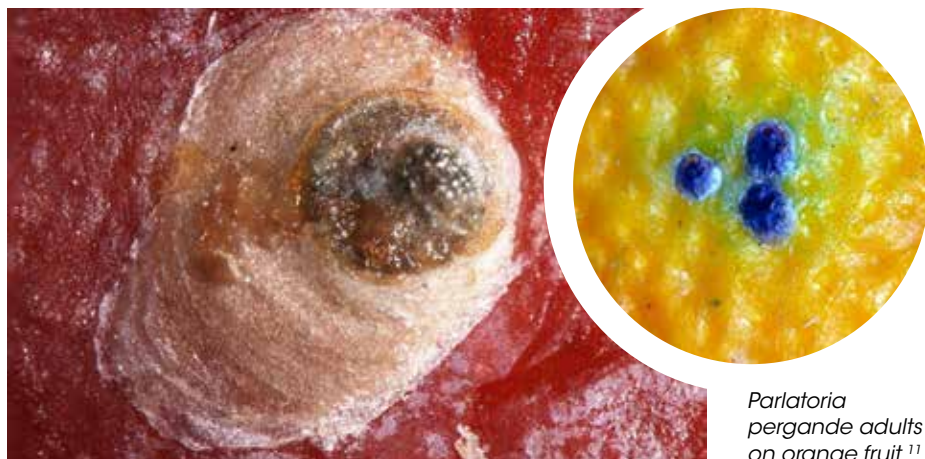
With the exception of paraffin oil, do not exceed more than one intervention per year against this adversity.

- (1) A maximum of one intervention per year regardless of adversity.
- (2) A maximum of two interventions per year regardless of adversity.
- (3) Authorized only on *Saissetia oleae*.
- (4) Authorized only on *Saissetia oleae* and *Ceroplastes rusci*.

Chaff Scale (*Parlatoria pergandei*), Black Scale (*Parlatoria ziziphi*), Aucuba scale (*Aspidiotus nerii*), Citrus mussel scale (*Lepidosaphes beckii*), Glover's scale (*Lepidosaphes gloveri*)

(a) Chaff Scale (*Parlatoria pergandei*)

The Chaff Scale is an armoured scale insect that is polyphagous. It is a pest on citrus as well as ornamental plants. The adults are 1 to 2.5 mm in length, oval-shaped and grey, yellow or brownish in colour. The eggs are minute, oval-shaped, with a purplish colour. The colonies develop on the upper surface of the leaves. They are normally found scattered over the leaf, although they tend to cluster along the midrib. This scale insect can also be found on branches and fruit. Symptoms on fruit include discolouration, in which case the fruit, once mature, remains speckled with light yellow spots. The mature females begin to oviposit in mid-winter and continue until early spring. Four different generations can be present in a single year, with an overlap of various stages of development. The life cycle from egg to adult normally takes about 2 months, depending on environmental and climatic conditions.



Parlatoria pergandei adults on orange fruit ¹¹

Parlatoria pergandei adult ¹³

(b) Black Scale (*Parlatoria ziziphi*)

The adult Black Scale's size varies from 1 to 2.5 mm. Its colour is mainly black to brownish white, and it has an elongated shape. The eggs of this pest are minute, oval in shape and violet-coloured. Each female can deposit around 20 eggs; these are sheltered under the mother's body until they hatch. This pest normally has one generation per year. It causes heavily infested branches to weaken, making the fruit unmarketable.



Parlatoria ziziphi adults ¹³

(c) Cottony Cushion Scale (*Icerya purchasi*)

Icerya purchasi is a scale insect that feeds on many trees and plants, most notably on citrus. The mature females (actually hermaphrodites) are easily recognisable from their large size; they are 4 to 10 mm long, oval-shaped, with a light brown to brick red colour. The adults have dark brown to black legs and 11 segmented antennae. The eggs are minute, oval and reddish. The nymphs are about 0.5mm long, flat, oval, and reddish with a waxy coating and long waxy tubules projecting from their hind end. The hind end of the nymphs also has three pairs of long black legs, an antenna, 6 segmented and clubbed, and black legs.

This scale normally overwinters as a third instar nymph. The life cycle begins with the female depositing several hundred eggs within a large white ovisac. The ovisac pushes the female away from the substratum and is characterized by the presence of a series of longitudinal grooves which gives it a fluted appearance. The egg takes a minimum of 3 months to develop into an adult. Usually, there are 2 to 3 generations in a single year.

The adult female usually inhabits the twigs or the branches, but the nymphs move away to feed on the foliage. During their final stages, the nymphs resettle on the twigs or branches.

The Cottony Cushion Scale extracts sap from the host plant, causing the plant to weaken from sap depletion. Symptoms include stems drying up, defoliation and branch dieback. Secondary damage is caused by honeydew extraction which results in a sooty mould that reduces the photosynthetic capability of the plants.



Icerya purchasi on a lemon tree twigs and branches⁵

(d) Citrus Mussel Scale (*Lepidosaphes beckii*), Glover's Scale (*Lepidosaphes gloveri*)

Lepidosaphes beckii females are about 2.5 to 4.5 mm long, mussel-shaped, and purplish brown. The male is similar to the female but more elongated. The eggs are minute, oval and white. The first instar nymph, also known as the crawler, is 1.3 mm long, with an elongated oval shape and brownish to white in colour.

Lepidosaphes gloveri females are 3 to 4 mm long, brown, mussel-shaped but long and narrow. The eggs are also very small, oval and pinkish.

After mating, the female deposits a batch of 50 to 100 eggs beneath the shelter of her test (a part of her body), following which it dies. After this, the final instar nymphs move to other parts of the tree, such as branches and fruits, where they will settle and feed until they mature. The life cycle normally takes 2 to 4 months, with several generations in a single year.

As with other scales, symptoms of the presence of this pest include stems drying up, defoliation and branch dieback. All of these reduce the market value of the fruits.



Lepidosaphes gloveri, adult³



Lepidosaphes beckii on a citrus leaf⁶

○ Control and Management

○ Agronomic Interventions




- Minimize the presence of dust on the foliage.
- Work and turn over the soil to disturb the ants' nests.

○ Chemical Interventions

Intervene when the below threshold is reached:

- 1 adult female per cm of the branch and/or 2 to 4 individuals per fruit.
- The monitoring observations must be done on a minimum of 4 twigs (about 10cm long) per tree and/or on 10 fruits per tree on 5% sample of the trees in the orchard.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Sweet orange essential oil 
- Paraffin oil 
- Potassium salts of fatty acids 
- Pyriproxyfen (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

With the exception of paraffin oil, do not exceed more than one intervention per year against this adversity.

- (1) A maximum of one intervention per year, regardless of adversity.

Aphids

Aphis citricola, *Aphis gossypii*, *Toxoptera aurantii*

Aphids that attack citrus include *Aphis gossypii* (cotton aphid), *Aphis spiraecola* (spirea aphid) and *Toxoptera aurantii* (black citrus aphid), amongst others. They are sap-sucking insects and can also cause damage by being vectors for disease and spreading viral pathogens. Aphids are soft-bodied, generally globular with a pear-shaped body. Colours range from translucent-yellow to green or black. They can be fully winged or completely wingless. Various stages of maturity are generally present on one plant. These pests can attain high density, and severe infestations may lead to weakened plants due to abundant feeding. Aphids feed on flowers, leaf buds, shoots and leaves, causing the leaves to curl toward the stem. Secondary diseases, including sooty mould fungus, can develop due to honeydew as well as to viral diseases.

○ Control and Management

○ Agronomic Interventions

- Keep the application of nitrogen fertilization to a minimum and avoid excessive pruning.
- Work and turn over the soil to disturb the ants' nests.


○ Chemical Interventions

Before carrying out any chemical interventions, assess the activity of aphid antagonists. If such organisms are present, do not apply non-selective plant protection products.

Intervene when these thresholds for the individual pests are exceeded:

- for *Aphis citricola*, 5% of infested shoots for clementines and mandarin, and 10% infested shoots for other citrus trees;
- for *Toxoptera aurantii* and *Aphis gossypii*, 25% of sprouts infested.

PLANT PROTECTION SUBSTANCES

- Potassium salts of fatty acids 
- Acetamiprid (1)
- Flonicamid (2)
- Spirotetramat (1)
- Sulfoxaflor (2)
- Tau-Fluvalinate (3)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) A maximum of two interventions per year regardless of adversity.
- (2) A maximum of one intervention per year regardless of adversity.
- (3) Allowed on orange and mandarin and only on young plants not for fruit production purposes.



Aphis citricola
attended by ants ¹⁴



Aphis gossypii adults
and nymphs ¹⁵



Toxoptera
aurantii ¹⁶

Trivial Plant Bug

Calocoris trivialis

Calocoris trivialis is a species of plant bugs belonging to the family Miridae. Adults can reach a length of approximately 7.5 mm. The colour varies, depending on whether the insect is male or female and on the different stages of development. The females are mostly green in colour with yellow features and two dark dots on the pronotum, while males are darker in colour with hues of red and black. This species overwinters as an egg in the crevices of barks, and completes only one generation per year. Hatching generally occurs from the end of January to the beginning of April. When the vegetative season restarts, the nymphs and the first adults feed on young shoots and prick flower buds which, if they drop, hinder fruit development. In case of heavy infestation and on plants with little flowering the damage can be severe.

○ Control and Management

○ Agronomic Interventions

Pruning of the citrus trees must be carried out in years considered for, or estimated to coincide with, high-volume production. This is evaluated by monitoring the fruit harvest cycle throughout the years and the peak and low volume production years determined by the farmer.

○ Chemical Interventions

Intervene when the threshold is reached:

- 20% infested buds during the flower bud stage.

PLANT PROTECTION SUBSTANCES

- Acetamiprid (1)
- Etofenprox (2)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) A maximum of two interventions per year regardless of adversity.
- (2) Apply a maximum of one intervention per year when using Etofenprox against green bug and *Empoasca decedens*.

Spray at a rate of one row every three using the mist-blower sprayer. Do not intervene in the presence of flower buds of diameter greater than 6 mm.



Calocoris trivialis ¹⁷

Green Leafhopper

Empoasca decedens

Empoasca decedens is a species of leafhoppers. The adults are pale green in colour. If disturbed, they will fly or hop. This species of leafhopper is small, 3 to 4 mm in length. The nymphs are light green and wingless. The pest is normally found on herbaceous plants. Towards the end of summer it moves to citrus groves to overwinter. Leafhoppers feed on fruit by puncturing the rind cells. This produces yellow spots on the oranges, mandarins and clementines, reducing their commercial value.

Control and Management


Monitor the presence of this pest during autumn by using the yellow sticky traps.

Chemical Interventions

Intervene when the following threshold is exceeded:

- 2% of damaged fruit.

PLANT PROTECTION SUBSTANCES

- Sweet orange essential oil 
- Etofenprox (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

At most one intervention a year against this adversity and only in case of low flowering.

- (1) A maximum of two interventions per year regardless of adversity.



*Empoasca decedens*¹⁷

Woolly Whitefly

Aleurothrixus floccosus

Woolly Whiteflies are small insects, yellow in colour, with white wings that are covered with a waxy coating. Adult females lay eggs in a circle or semicircle on the underside of leaves; each egg is less than 0.2 mm long. The eggs can be identified from their white waxy dust covering. During the pupa and other immature nymph stages, woolly whiteflies are covered with woolly, curly, white, waxy filaments. Nymphs are generally more similar to scale insects than to mature Woolly Whitefly adults. This insect can be found on the underside of leaves. The adults and nymphs feed on leaf sap with their piercing sucking mouthpart. During severe infestations the feeding can result in the yellowing of leaves and weakening of plants. They produce honeydew, as a consequence of which the affected vegetation is often covered with black sooty mould. Whiteflies, like aphids, can also be vectors for secondary pathogens that cause viral diseases. Four to five generations of the woolly whitefly can be present, with one generation following the other almost continuously throughout the year, slowing down development only during the coldest months.

○ Control and Management

○ Agronomic Interventions

Work and turn over the soil to disturb the ants' nests.

○ Biological Interventions

The beneficial insect *Cales noacki* or *Amitus spiniferus* should be released when the parasitisation levels of the Woolly Whitefly (by beneficial insects) are below 5%.

○ Chemical Interventions

Take action when the following threshold is exceeded:

- 30 Woolly Whitefly nymphs during the first to the second stage of the nymph life cycle. Sample size must take into account 8 leaves per tree and 5% of trees from the whole plot.

PLANT PROTECTION SUBSTANCES AND BENEFICIAL INSECTS

- *Cales noacki* 🌿
- *Amitus spiniferus* 🌿
- Paraffin oil 🌿
- Potassium salts of fatty acids 🌿
- Acetamiprid (1)
- Spirotetramat (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) A maximum of two interventions per year regardless of adversity.

Aleurothrixus floccosus adults ¹⁸



Infestation by *Aleurothrixus floccosus* ¹⁰

Citrus Whitefly

Dialeurodes citri

Dialeurodes citri is another species of whitefly that affects citrus plants. Adults are creamy-yellow with white wings. The females lay pale yellow eggs scattered singly on the underside of leaves; the eggs hatch in 8 to 24 days. Once they hatch, the nymphs disperse to find feeding grounds and settle on the leaf underside, after which they become sedentary. They can be identified from the pupa which is the fourth instar change. It is 1 to 1.5 mm in length and has a distinct Y-shape when viewed from above. Symptoms of the presence of an infestation by the Citrus Whitefly include vegetation that is turning yellow as well as an abundance of sooty mould due to honeydew excretion. Two to three generations of this species are present in a single year. White adults can be sighted from April to May and August; in the case of a third generation they are sighted towards the end of autumn.

○ Control and Management

○ Agronomic Interventions




- Avoid excessive nitrogen fertilization.
- Carry out appropriate pruning to allow ventilation to circulate within the tree crown.

○ Chemical Interventions

Intervene when the following thresholds are exceeded and if the presence of *Encarsia lahorensis* (a beneficial insect, a parasitic insect which feeds on citrus whitefly) is low:

- Orange and lemon: 30 citrus whitefly nymphs at the first to the second stage of the nymph life cycle per leaf;
- Clementine and mandarin: 5 to 10 citrus whitefly nymphs at the first to the second stage of the nymph life cycle per leaf.
- Sample must be taken from 100 leaves taken from 10% of the trees. Check the activity rate from the parasitic beneficial insect *Encarsia lahorensis*.

PLANT PROTECTION SUBSTANCES

- *Encarsia lahorensis* 
- Paraffin oil 
- Potassium salts of fatty acids 
- Spirotetramat (1)
- Pyridaben (2)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) A maximum of two interventions per year regardless of adversity.
- (2) At most one intervention per year regardless of adversity.



Dialeurodes citri ¹⁹



Dialeurodes citri nymph ⁸

Ants

Linepithema humile, *Camponotus nylanderi*,
Tapinoma erraticum

There are various species of ants that affect citrus orchards. Ants feed on the honeydew that is extracted by other insects, including scales, mealybugs, whiteflies and aphids. As part of the relationship between ants and honeydew-producing insects, the ants provide protection against beneficial insects that feed on pests – thus interfering with biological pest control and enabling the occurrence of infestations.

○ Control and Management

○ Agronomic Interventions

- Carry out crown pruning especially on branches in contact with the ground (crown height should be 40 cm above the ground).
- Eliminate any weeds in contact with tree foliage.
- Work and turn over the soil to disturb the ants' nests.



Tapinoma erraticum ²¹

○ Chemical Interventions

It is advisable to intervene chemically when ants are observed in the same place where scale insects, or other parasites associated with ants, have been noted in at least 50% or more of the field.

PLANT PROTECTION SUBSTANCES AND DEVICES

Applications of hexane-based or polybutene-based adhesives to the main branch (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) In the case of young trees, glues are to be applied on special plastic stipes or aluminium clamps, not directly on the tree trunk.



Linepithema humile adult ²⁰

Curculio Beetle

Otiorhynchus cribricollis

The Curculio Beetle is a common pest found mostly on olive trees, however it may also be found on other fruit trees, including citrus. The adult beetle is 6.5 to 8.5 mm long, brown and shiny. Its thorax and elytra are deeply punctured, and the antennae and the legs are reddish. This beetle is parthenogenetic and is mostly active at night, visible mostly from May or early June onwards.

Its eggs, which are laid in the soil, hatch after about two weeks. The larvae then feed on the roots of various plants and become fully grown by spring. After they pupate in an earthen cell, adults will appear about a month later. The damage on the leaves can be noticed from the U-shaped notch formed in the leaves' margin by the adults.

○ Control and Management

○ Mechanical Interventions

Apply a band of glass wool around the stem to prevent insects from reaching the tree crown.

PLANT PROTECTION DEVICES

- Glasswool 



Otiorhynchus cribricollis beetle ²²

Citrus Leaf Miner

Phyllocnistis citrella

The Citrus Leaf Miner is a small white moth (adult) with a wingspan of 5 to 8 mm. The forewings are mainly white, partly suffused with yellowish orange, and have black or brown markings with a black spot on each wing tip. Adult females deposit 12 to 77 eggs on the under surface or sometimes on the upper surface of young leaves; the eggs hatch about one week later. The larva grows up to 3.5 mm long when fully developed and is a translucent green to yellow in colour. The pupa is about 2.5 to 3 mm long. It is golden brown, and its head has a distinctive horn-like projection. The adults are able to overwinter and re-emerge in spring. After this, the adults will lay the eggs, normally on expanded leaves or on succulent green shoots, usually near the midrib. During the larva stage it damages citrus plants by mining in leaves, especially the younger foliage. The pupation stage occurs at the end of the mine, typically with the leaf margin slightly folded over the pupal chamber. The leaf miner can have up to 8 generations per year. The development from egg to adult takes about 6 weeks.

The mines have a particular silvery appearance. Continuous feeding of the larvae leads to leaf deformation and reduces photosynthetic capacity. Occasionally, in addition to the leaves, shoots and young fruits may be affected too. Damage can be particularly serious, especially to young plants in nurseries. A heavy infestation can lead to premature leaf fall and death of young growth.

○ Control and Management

○ Agronomic Interventions

Maintain tree growth during the vegetative stage to an optimum by:

- avoiding water stress;
- reducing nitrogen inputs during summer;
- anticipating pruning annually and limiting pruning volumes.

○ Mechanical Interventions




Small trees can be protected with “anti-insect” nets or “non-woven fabric”.

○ Chemical Interventions

Take action when the following threshold is reached:

- 50% infested shoots.
- Since the citrus leaf miner normally attacks the newest/youngest leaves, make sure that the plant protection product used is applied well on these leaves.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Azadirachtin (Margosa extract) 
- Paraffin oil (1) 
- Acetamiprid (3)
- Chlorantraniliprole (2) (4)
- Milbemectin (6)
- Methoxyfenozide (5) (3)
- Tebufenozide
- Anti-insect net 

LIMITATIONS OF USE AND SPECIAL CONDITIONS

With the exception of Azadirachtin and Paraffin oil, use not more than four interventions against this pest per year and only on young plants (up to 4-5 years) or re-grafted trees.

- (1) Apply a dose of 0.4 to 0.8 kg / hl of active substance. Avoid treatments with temperatures above 32°C and relative humidity below 20-30%. Apply weakly during summer-autumn period.

Also useful as a synergist for other active substances as indicated.

- (2) Allowed on orange, lemon and mandarin.
- (3) A maximum of two interventions per year regardless of adversity.
- (4) A maximum of two interventions per year; allowed only on trees for non-production purposes.
- (5) Allowed on orange, clementine and mandarin.
- (6) At most one intervention per year regardless of adversity; only allowed on orange and tangerine.



*Leaf mines on lemon tree caused by Phyllocnistis citrella*⁵

Phyllocnistis citrella adult²⁴



Phyllocnistis citrella larva²³

Phyllocnistis citrella pupa²⁵

Mediterranean Fruit Fly

Ceratitis capitata

The Mediterranean Fruit Fly is a highly polyphagous pest. Adults are readily recognisable from their morphology and wing patterns, and are typically 4 to 5 mm in length. Their eyes are bright emerald green clouded with reddish brown. The thorax (the middle segment, behind the head of the insect body) is mainly black, suffused with greyish yellow. The scutellum is yellow and black; the abdomen is mainly yellowish orange with two silvery crossbands. The wings are clear, with black veins, black spots, and brownish yellow patches. The legs' colour is yellowish brown.

Females lay their eggs in small clusters in the fruit mesocarp. The eggs are 1 mm long, white and narrowly fusiform. A discoloured halo forms around the punctured holes left by the ovipositor which on ripe fruit remains as a brownish spot. The whitish larvae, that can reach up to 9mm in length, grow inside the fruit by feeding on the albedo (the white spongy material in-between the peel and the pulp) or on the pulp, leading to fruit decay and exposing the fruit to secondary pathogens. The larvae are fully fed in about two weeks. Within this period of two weeks the fruit may drop to the ground, following which, the larvae will be capable to move from the fruit and bury themselves in the soil, where they change into pupae and overwinter.

There can be a minimum of two generations or more each year, depending on the temperature. The ideal temperature for the development of this pest is 32°C. A full life cycle, from egg to fly, takes not more than two weeks. Around 6 to 7 generations can be present in a single year.

○ Control and Management




○ Agronomic Interventions

Place traps for monitoring (Attract & Kill traps) at least at the rate of one per plot, starting from July in the case of early citrus varieties. Increase the amount of these traps to minimum of 6 traps per tumolo after the first captures (always consult the product label to confirm the amount of traps one should install).

O Chemical Interventions

Intervene by applying poisoned protein baits (hydrolysed proteins as baits) with insecticides (Attract & Kill) in mid-July. Repeat the application every 25 days. Select one crown from every row and spray on the chosen crown every 3 to 4 rows. Once the number of flies caught (in individual monitoring traps) amounts to 20 adults per trap per week, and/or the first insect puncture marks on fruits are noted, apply these poisoned protein baits on the entire plot. Instead of applying these poisoned protein baits on the trees, one can use the same method by Attack & Kill traps/devices.

PLANT PROTECTION SUBSTANCES AND DEVICES

- *Beauveria bassiana* ATCC 74040 
- Attract & Kill traps/devices impregnated with 
 - Deltamethrin or
 - Lambda-cyhalothrin
- Hydrolysed proteins + ● Spinosad (3) 
- Acetamiprid (1)
- Etofenprox (2)
- Deltamethrin (2)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) A maximum of two interventions per year regardless of adversity.
- (2) At most one intervention per year against this adversity between Deltamethrin and Etofenprox.
- (3) Use ready-for-use baits with hydrolysed proteins at a maximum rate of 8 applications per year.

Ceratitis capitata on orange fruit ⁵



Damage caused by *Ceratitis capitata* on an orange fruit ⁵



Adult emerging from its pupa ²⁶



Larva of *Ceratitis capitata* feeding on an orange fruit ⁸

Thrips

Heliothrips haemorrhoidalis, *Pezothrips kellyanus*,
Frankliniella occidentalis, *Thrips* spp.

The various species of thrips that attack citrus plants include *Thrips tabaci*, *Frankliniella occidentalis*, *Pezothrips kellyanus* and *Heliothrips haemorrhoidalis*. Adult thrips are generally less than 1.5 mm in length, having a narrow elongated body with fringed wings. The females are larger in size than the males. The colour of an adult varies but is generally light yellow to dark brown. Under ideal and favourable conditions, a female may be able to lay around 200 to 250 eggs. These are placed beneath the cuticle of new foliage, sometimes also, although less common, in green stems, twigs, buds and small fruits.

Thrips have two immature feeding stages: the first and the second instar. These are followed by another two non-feeding stages: the prepupa and the pupa. In these latter stages the pupae search for cracks or crevices within the tree to hide in or they drop to the ground during pupation.

A severe infestation can cause damage to young leaves due to feeding but the main damage is caused to developing fruit. Young leaves and stems may become thickened and distorted. Shoot apex turns black, dies and falls off. Injured foliage may have two thickened whitish-grey streaks on either side of the midrib on the upper side of the leaf, also characterised by mis-shapen and curled leaf margins. During feeding, thrips damage the fruit by leaving scabby scars on the rind. Thrips can also feed on the calyx end under the sepals of young fruit, resulting in rusty to silvery halos on the top of the fruit as it develops. A severe infestation by this pest may also lead to excessive drop of fruitlets. The damage generally occurs in sheltered areas.

○ Control and Management


○ Agronomic Interventions

Limit pruning activities as much as possible.

○ Chemical Interventions

- Install white sticky traps to monitor the presence of adult thrips and intervene one week (maximum two weeks) after the capture of the adult thrips.
- Apply chemical pesticides when the threshold of 5% infested fruits (10% for lemon) is exceeded between May and July.
- To sample, assess 5 fruits per plant every week from the stage when the flower petals fall to when the fruit reaches a diameter of 2.5 cm.
- It is recommended to sample not less than 50 fruit per plot.

PLANT PROTECTION SUBSTANCES

- Azadirachtin (Margosa extract) 
- Sweet Orange Essential Oil (2)
- Potassium salts of fatty acids
- Paraffin oil (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) Avoid treatments in the presence of temperatures above 30°C. Some anti-aphid products may act also against thrips.
- (2) Authorized only on *Heliothrips* spp.



Adults of *Frankliniella occidentalis*: one male (smaller) and two females²⁸



Multiple life stages of *Heliothrips haemorrhoidalis*¹⁰



Damage caused by thrips on an orange fruit²⁶



Pezothrips kellyanus adults on citrus flower²⁷

Citrus Flower Moth

Prays citri

The Citrus Flower Moth is a citrus pest mostly affecting lemons, lime and sweet oranges. It is a small brown-grey moth, with fringed and speckled wings with a wingspan of 10 to 12 mm. Its eggs are oval, opalescent and 0.20 by 0.15 mm. The larva is 7 mm long, with a whitish to light brown body colour, the head and the prothoracic plate marked with brown, crochets on the abdominal prolegs arranged in several concentric circles. The pupa is brown, about 5 to 6 mm long.

The adults appear from April to May. Females lay around a hundred eggs individually on flowers and sometimes on young fruit. The larva stage is the damaging stage of this pest. As they hatch, they bore into the flowers and, in the case of a severe infestation, also into small fruit (smaller than the size of a walnut) causing affected flowers and buds to wilt, resulting in yield loss. At a temperature of 25°C, a complete life cycle takes 20 days. Around 11 generations can be present in a single year with an overlap of various stages of development. In winter the population decreases due to temperatures and a lack of flowers.

○ Control and Management

○ Agronomic Interventions

Harvest of green summer lemons must be anticipated to reduce the risk of attack.

PLANT PROTECTION SUBSTANCES AND DEVICES

- *Bacillus thuringiensis* 🌿



Prays Citri adult³⁰

Red Spider Mite

Tetranychus urticae, *Panonychus citri*

The Two-Spotted Spider Mite, *Tetranychus urticae*, and the Citrus Red Mite, *Panonychus citri*, are two species of mites that affect citrus cultivation. Both mites are very small, about 0.5 mm in length. Females are globular in shape, with long dorsal hairs. The female Two-Spotted Spider Mite is usually of a pale greenish-yellow colour with two dark patches on its body. Overwintering adults can turn brown/orange-red. The Citrus Red Mite is dark red to purple red in colour. Females lay small eggs, 0.15 mm in diameter, on leaves. A complete life cycle in ideal conditions is 12 days or less, with many generations present in a single year. Infestations occur mainly in spring and autumn. The adults and the nymphs damage leaves by piercing through the cells to feed. In the case of the Citrus Red Mite this leads to widespread leaf depigmentation that is visible as stippling on the upper surfaces of leaves. In the case of the Two-Spotted Spider Mite, feeding results in yellowing and rosetting of leaves. Excessive feeding by either pest can lead to necrosis and defoliation. *Panonychus citri* can also cause silver or bronze stippling on unripe fruit that generally disappears when the fruit is mature unless mite populations are high and feeding is continuous. Fruit attacked by *Tetranychus urticae* may suffer from russetting and develop brown scabbing on the rind.

Tetranychus urticae females can overwinter in straw mulch or dead leaves, dry crevices in the soil, in pole and stakes cracks, and in other similar situations/ environments.

○ Control and Management

○ Agronomic Interventions

- Apply nitrogen fertilizer adequately and in a consistent way, do not over apply.
- Limit pruning activities.
- Avoid water stress.
- Work and turn over the soil to disturb the ants' nests.





○ Chemical Interventions

Sample 100 leaves or 100 fruits per plot between end of summer to harvest on a regular basis (weekly in autumn and every two weeks in winter).

Intervene when the following thresholds are exceeded:

- the infested leaves amount to 10% of mobile forms per leaf and when 2% of the fruits are infested with *Tetranychus urticae*;
- 30% infested leaves or 3 mites per leaf for *Panonychus citri*, when the ratio of females to *Phytoseiidae* (predatory mites which feed on mites and other insects) is higher than 2:1.

PLANT PROTECTION SUBSTANCES

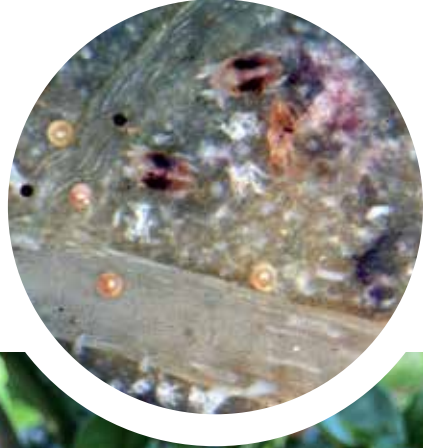
- *Beauveria bassiana* 
- Paraffin oil 
- Sweet orange essential oil 
- Potassium salts of fatty acids 
- Abamectin (1) (2)
- Acequinocyl (4)
- Bifenazate
- Hexythiazox
- Fenpyroximate
- Milbemectin (3)
- Tebufenpyrad
- Pyridaben (5)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) Allowed on orange, clementine, lemon and mandarin.
- (2) A maximum of one intervention per year regardless of adversity.
- (3) At most one intervention per year regardless of adversity; allowed only on orange and tangerine.
- (4) Allowed only on orange and mandarin orange.
- (5) At most one intervention per year regardless of adversity.

*Multiple life stages of
Tetranychus urticae*¹⁰

*Panonychus citri*³³



*Strong spider mite
infestation on a
young lemon plant*³¹



Panonychus citri (red colour) and mites feeding injury (white stippling) visible on leaf³²

Citrus Bud Mite, Pink Citrus Rust Mite, Citrus Silver Mite

Eriophyes sheldoni, *Aculops pelekassi*,

Polyphagotarsonemus latus

The Citrus Bud Mite is a pest on several citrus species but predominantly on lemon and grapefruit trees. It is a small, elongated straw-yellow mite, not visible to the naked eye (about 0.15 to 0.2 mm in length). It lives in the most protected parts of the plant, inside the buds, especially during the colder months. In spring it begins to multiply, damaging the flowers and, subsequently, the young fruits. It can cause deformation to leaves, flowers and fruit. Deformed fruit have a specific appearance as a consequence of the abnormal development of the carpels that grow apart. The mite completes several generations in a single year, following one another, only slowing down the development cycles during the coldest months.

The Pink Citrus Rust Mite affects mainly lemons but can also be found on mandarins, oranges and clementines. The mite is very small, around 0.14 to 0.15 mm in length. Its body is pink and fusiform. It is mainly found on new growth, normally concentrated near the leaf margins. The mites lay their translucent white eggs randomly around the leaves and fruits. On fruit with an orange skin, rust spots appear and remain on the rind of mature fruit. In lemons, a yellowish silver blemish appears while blackish russetting may appear on more mature fruit. It usually winters in the adult state and completes 10 to 15 generations in a single year. The most serious infestations occur from June to September.

The Broad Mite, also known as the Citrus Silver Mite, is a polyphagous species that is invisible to the naked eye, with adults reaching 0.2 mm in length. Infestations can occur on young leaves of citrus. The mite can cause damage to specific stems, flowers, tips of shoots, as well as fruit. The broad mite affects lemon fruits causing the appearance of widespread silvery blemishes on lemon rind. The mite lives on average 7 to 18 days, during which the female lays on average just under fifty eggs. Several generations follow one another during the season, each of which is completed in 5 to 8 days in the presence of optimal conditions of 70%-80% relative humidity and a temperature of 28°C.

○ Control and Management

○ Agronomic Interventions

- Apply nitrogen fertilizer adequately and in a consistent way.
- Limit pruning.
- Avoid water stress.
- Work and turn over the soil to disturb the ants' nests.

○ Chemical Interventions

Take action when the following thresholds are reached:

- 30% infested buds for *Eriophyes sheldoni*.

Sample one bud per plant out of 50 trees per plot. Assess the status using a small microscope or an adequate lens (20x) to determine the presence of the mite.

- In the event of infested fruit with *Aculops pelekassi* and *Polyphagotarsonemus latus*.

Sample 100 fruits per plot, selecting fruits from fruit set until they reach a diameter of 2.5 to 3 cm.

PLANT PROTECTION SUBSTANCES

- Paraffin oil 
- Potassium salts of fatty acids 

LIMITATIONS OF USE AND SPECIAL CONDITIONS

For *Eriophyes sheldoni*, it is advisable to intervene using plant protection products when buds are not present.

Polyphagotarsonemus latus adult ³⁶



Eriophyes sheldoni damage on lemon fruit ³⁴



Damage caused by *Aculops pelekassi* on lemon fruit ³⁵

Snails and Slugs

Snails cause damage in citrus orchards by feeding on ripe and ripening fruit, leaves of young trees and young tree bark. Affected fruits exhibit rough holes, making the fruit unmarketable. Feeding by snails leaves exposed wounds that can lead to other pathogenic diseases and secondary pests. Snails can also feed on the leaves of citrus leaving ragged holes in the foliage. Snails can be found during the rainy season and wet period of the year. Activity decreases in the summer months due to the harsh weather. Snails, similar to slugs, can also be detected from the presence of slime trails.

○ Control and Management

○ Chemical Interventions

Intervene close to the ground.

PLANT PROTECTION SUBSTANCES

- Ferric Phosphate 

*Common snail feeding on a leaf*³⁷



*Common snail feeding on an orange fruit*³⁸



Rodents (voles and rats)

Rodents are a common pest problem for all agricultural operations. They typically thrive in populations when food and nesting sites are plentiful. Rodents inflict damage to growing trees, stored crop materials such as fruit, and equipment, e.g. irrigation material and structures. They can also contaminate commodities or food and water supplies. Rodents are also carriers of diseases that may be harmful to humans and livestock. The most effective and economical long-term solution to get rid of a rodent problem is to use an integrated pest management (IPM) programme that focuses on the following elements: (i) rodent population management, involving consideration of the biology, population dynamics, and ecology of the pest rodent; (ii) habitat management, involving consideration of the physical and biotic environment; (iii) people management associated with the farm or plot.

○ Control and Management

○ Agronomic Interventions

- Work and turn over the soil to disturb the rodents' nests, and keep free from weeds especially if *Oxalis* spp. is present.
- Protect natural predators (birds that prey on rodents, snakes, Maltese weasel, etc.)
- Where possible carry out irrigation with the deep drench method especially for newly-planted citrus trees.

○ Chemical Interventions

Formulated baits acting as rodenticides can be used and only when utilized in dedicated storage compartments to avoid spillage and contamination of rodenticides to the environment or animals.



Damage on orange fruits by rats ³⁸

Wilt of Citrus / Mal Secco of Citrus

Plenodomus tracheiphilus sin. *Phoma tracheiphila*

Citrus Wilt is a disease caused by the fungal pathogen *Phoma tracheiphila* that can lead to the death of citrus plants, particularly lemons. The first symptoms usually appear at the end of winter or in spring as interveinal leaf chlorosis, which progresses to the fall of the leaves, followed by dieback of the shoots, twigs and branches. On the surface of infected twigs, black dots on silver-grey areas appear; these are the pycnidia (the fruiting body containing conidia). An infected host often responds by sprouting growth from under the affected branch or by releasing suckers from the rootstock. Gradually the pathogen spreads and infects the entire plant, leading to eventual death. The wood of infected branches, when cut, would show a salmon pink or red colour due to gum production within the xylem vessels. Plants are infected due to the dispersal of conidia by rain and wind that infect a plant through stomatal openings or open wounds. Temperatures above 30°C stop the mycelial from growing, however they do not kill the fungus in infected tree tissues. So far, there is no records of this disease in the Maltese Islands.

○ Control and Management

○ Agronomic Interventions

- Remove and burn infected parts, including stumps.
- Limit soil tillage to the uppermost layer to minimize the possibility of inflicting damage to the root system.

○ Chemical Interventions

- Intervene following tree damage in response to adverse weather events causing injury (wind, hail storms, etc.) or after other mechanical injuries (by machinery and pruning). Intervene within 24-48 hours after damage has been confirmed.

- Copper-based products (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

Interventions allowed only on lemon.

- (1) Do not exceed the cumulative application of 28 kg of copper per hectare over 7 years. It is recommended not to exceed the quantity average of 4 kg of copper per hectare per year.



Lemon tree (*Citrus limon*) infected by Mal Secco³⁹



(A) Longitudinal section of a lemon twig showing the typical salmon-orange stain of the xylem

(B) Comparison between acervuli of *C. gloeosporioides* (top) and pycnidia of *P. tracheiphila* (bottom) on a 2-3-year-old dried lemon twig

(C) Dried lemon twig with acervuli of *C. gloeosporioides*⁴⁰

Wood discoloration in a lemon tree infected by Mal Secco³⁹



First symptoms in a branch of a lemon tree infected by *Plenodomus tracheiphilus*⁴¹



Several adult branches with the typical infection in ring spots⁴¹



Lemon tree branches infected by *Plenodomus tracheiphilus*: comparison with other young branches free of this fungus (below).⁴¹



Lemon tree severely affected by Mal Secco³⁹

Root Rot and Gummosis

Phytophthora spp.

Phytophthora spp. is a water mould (also known as oomycete) that is a fungal-like microorganism that causes various diseases in citrus plants, including Root Rot, Brown Rot, Collar Rot and Gummosis. This pathogen is able to survive for several months to 1-2 years in the soil as mycelium or chlamydozoospores on plant residues and decomposing matter. To be able to completely develop it requires water for production and the maturation of sporangia and zoospores.

Phytophthora root rot causes a slow decline in the vigour of the plant. In susceptible cultivars the leaves turn yellow and may drop, shoot die-back occurs, and the disease kills off the feeder roots of the plant. The pathogen infects the root cortex which becomes macerated and, if regeneration of roots does not occur, the plant would not be able to take up the required water and nutrients, resulting in poor growth. In infected plants, Gummosis and Collar Rot may also occur at the base of the trunk. The first symptom is the oozing of gum from cracks in the bark. Necrosis of the bark occurs with the bark splitting off from the trunk. Dark water-soaked lesions will be visible on the trunk where there is an active infection. Eventually, the entire bark may be girdled with lesions. The adversities occur mainly in citrus groves located in compact soils that do not drain well and in particularly rainy years due to the pathogen spread in moist conditions.

○ Control and Management

○ Agronomic Interventions

- Limit water stagnation upon irrigating by improving soil drainage.
- Carry out a balanced fertiliser application and moderate the use of nitrogen.
- Avoid long dry periods followed by abundant irrigation.
- Carry out crown pruning especially on those branches in contact with the ground (crown height should be 40 cm above the ground) to improve air circulation within the crown.
- Use tolerant rootstock, such as Sour Orange and Citranges.

- When grafting, the area to be grafted should be at least 30 cm above the ground so as to avoid or minimize contact with water.
- Avoid wounds, especially in the zone of the collar and the base of the trunk.
- When carrying out irrigation avoid water contact with the tree.
- The tree roots should not be damaged or exposed.

O Chemical Interventions

Chemical treatments must be only carried out after the start of the vegetative phase and on trees showing clear signs of symptoms.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Copper-based products (1) (3) 
- Fosethyl aluminum (2)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

With the exception of cupric products, limit application to one intervention per year.

- (1) Brush product to the trunk.
- (2) Allowed on orange, lemon, mandarin and grapefruit.
- (3) Do not exceed the cumulative application of 28 kg of copper per hectare over 7 years. It is recommended not to exceed the quantity average of 4 kg of copper per hectare per year.



*Phytophthora Gummosis on citrus tree*³⁸

*Stunted tree with Phytophthora citrophthora*⁴²

Fruit Rot

Phytophthora spp.

Phytophthora fruit rot symptoms appear on mature fruit as leathery, firm, tan or olive brown-coloured lesions that may eventually develop a water-soaked appearance. The rot makes the fruit susceptible to additional secondary infections. Brown rot leads to the fruit producing a pungent odour. Infected fruit eventually drop. Fruit harvested in the early stage of the disease may not exhibit symptoms but will eventually infect other fruit during storage. Post-harvest, the fruits rot similarly and may also be covered with a slight whitish mould. The infections are caused by the spread of zoospores which splash onto the lower leaves of the plant, with the rain leading to fruit near the ground being increasingly prone to the disease. Continuously wet conditions are required for an infection to develop.

○ Control and Management

○ Agronomic Interventions

Surrounding weeds during the autumn period can result in reduced infestation as spore dispersion decreases. In this regard it is recommended to retain the weeds during this period.

○ Chemical Interventions

Intervene during typical rain years or when harvest is prolonged due to adverse weather condition.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Copper-based products (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- (1) Do not exceed the cumulative application of 28 kg of copper per hectare over 7 years. It is recommended not to exceed the quantity average of 4 kg of copper per hectare per year.
- (2) When spraying, limit application to the lower part of the canopy using 1,200 l / Ha of solution. Do not mix with products based on Paraffin oil.



Fruit rot on oranges³⁸



Fruit rot (Phytophthora) on oranges³⁸

Citrus Sooty Mould

Sooty mould on citrus can be caused by the fungal agent *Capnodium citri* and a complex of other fungal pathogens that develop saprophytically on the emitted honeydew from scale insects, aphids, scales, whiteflies and other sap-sucking insects that infest the plant and extract honeydew. Covering the leaves, sometimes with a thick layer, the pathogen reduces the photosynthetic activity of the plant, reducing its vigour. Fruits blackened by sooty mould have a reduced market value.

○ Control and Management

In general, containment measures against insects that generate honeydew, such as whiteflies, aphids and scale insects, is enough to prevent the occurrence of sooty mould.

○ Agronomic Interventions

- Carry out appropriate pruning for the aeration of the tree foliage.
- Avoid excessive nitrogen fertilization.



Citrus Sooty Mould on orange fruit⁴³

Citrus Sooty Mould on citrus leaves⁴⁴

Alternaria

Alternaria alternata

Alternaria brown spots are caused by a fungal pathogen that can affect leaves, stems and fruit, reducing the overall yield and quality. On leaves, symptoms include small blackish brown lesions, often at the margins, that develop prominent yellow halos that expand into irregularly shaped necrotic areas. On fruit, lesions can appear on young fruit as sunken dark spots with yellow halos. On mature fruit, the lesions can either resemble small specks or form larger spots. The fruit produces a corky tissue over the lesions that can eventually fall off, exposing indented necrotic spots. Premature fruit drop can occur if the fruits were infected when young. Alternaria is spread by airborne spores after heavy rains, which aid in their dispersal and also create conditions of high relative humidity that favours infections.

○ Control and Management

○ Agronomic Interventions

- Avoid plantations with high tree density.
- Promote air circulation of the foliage.
- Avoid highly vigorous rootstocks.

○ Chemical Interventions

Intervene in the summer-autumn period.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Pyraclostrobin (1)

LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Do not exceed more than one application per year.



Alternaria alternata
on Nova mandarin⁴⁵

Fruit symptoms
of *Alternaria* on
mandarin fruit⁴⁵

Bacterial Blast (Citrus Blast)

Pseudomonas syringae

Bacterial Blast, also known as Citrus Blast, is a disease that develops on all species of citrus apart from mandarine, which is less susceptible. The infection appears as numerous small, dark brown/black lesions on the petiole and axil of leaves, stems and fruit. The affected leaves wither but remain attached to the branch. Lesions also appear on fruit as tiny dark spots with a halo on immature fruit, and as large reddish black, pitted spots on mature ones with a diameter of around 2 cm. The disease is most prevalent in the densest and shadiest parts of an orchard and emerges during spring and autumn due to optimal conditions of high relative humidity and lower temperatures. The bacterial agent enters the plant via stomata or wounds on the plant tissue.

○ Control and Management

○ Agronomic Interventions

It is advisable to adopt adequate defence measures against adverse meteorological conditions (e.g. windbreaks, anti-freeze fans, etc.).

○ Chemical Interventions

Intervene in autumn-winter immediately following adverse meteorological events known for promoting infections (e.g. thermal drops and prolonged rains).

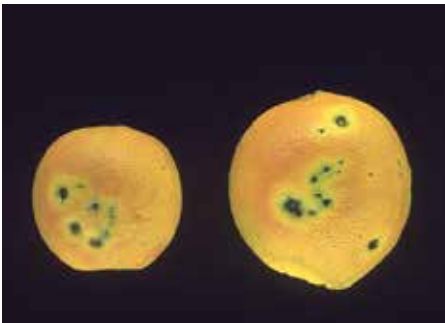
PLANT PROTECTION SUBSTANCES AND DEVICES

- Copper-based products (1) 

LIMITATIONS OF USE AND SPECIAL CONDITIONS

- 1) Do not exceed the cumulative application of 28 kg of copper per hectare over 7 years. It is recommended not to exceed the quantity average of 4 kg of copper per hectare per year.

*Infected stem with Pseudomonas syringae*³⁸



*Bacterial Blast, Citrus Blast, or Black Pit caused by Pseudomonas syringae on navel orange*³⁸



*Brown citrus leaf with a black petiole killed by Bacterial Blast or Citrus Blast, Pseudomonas syringae*³⁸

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