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# TABLE GRAPE PRODUCTION INTEGRATED PEST MANAGEMENT GUIDELINES

Agriculture Directorate

AgriConnect

Agriculture Research & Innovation Hub

CIHEAM BARI

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# PLANT PROTECTION PRODUCT AUTHORISATION

Plant protection products (PPPs) need to be authorised by the MCCAA before they are placed on the Maltese market in accordance with the provisions of Regulation (EC) No 1107/2009 implemented in Malta through Subsidiary Legislation 430.07, Plant Protection Products (Implementation) Regulations, issued under the Pesticides Control Act (Cap. 430).

A list of authorised PPPs can be found on the MCCAA website:
https://mccaa.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 the purchase or application 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 PPPs listed in this publication but currently not yet authorized, the Agricultural Directorate encourages farmers, farmer representatives and commercial entities to contact AgriConnect, for 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

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# European Grapevine Moth

*Lobesia botrana*

*Lobesia botrana* is one of the main insect pests affecting grape production. Larvae cause damage by feeding on inflorescence, on unripe berries and inside ripe/ripening berries, the latter causing the most damage. There are several generations during a year.

The adult moth is around 6 to 8mm in length with a wingspan of 11 to 13mm.The forewing is tan/cream and mottled with tan-brown, dark brown and grey-blue botches. The rear wing is grey with a fringed border. Moth activity is commonly observed at dusk.

Females initiate oviposition on grapevine flowers or berries. Eggs are generally laid singly. Larvae in the initial stages of maturity are light yellow. Once mature, the larvae can reach a length of 10 to 15mm, and the body colour changes to light green or light brown, depending on nutrition.

## Control and Management

Place the pheromone traps (sexual confusion devices), two to three traps per homogeneous plot, during March and April and start monitoring during this period.

Intervene only on the second and third generation. For the second and third generation, the time of the intervention must be determined based on the flight curve recorded using the pheromone traps the pesticide chosen for the control and where it is available from the trend of the oviposition revealed with specific surveys and forecast models. The Directorate shall be assisting in the interpretation and generation of the model data.

***Bacillus thuringiensis*:** intervene 4–5 days after initial moth captures. Repeat the treatment after one week from the first intervention.

**Growth regulators:** intervene 3–4 days from when the first moth captures are recorded.

**Other insecticides:** Carry out sampling on 100 cluster per hectare for signs of moth infestation. Take action when the following threshold is exceeded: 3-4% of clusters infested with larvae or when presence penetration holes have been noted.

## PEST PROTECTION SUBSTANCES AND DEVICES

- *Bacillus thuringiensis*
- Sexual confusion pheromone
- Spinosad (3)
- Acetamiprid (2)
- Chlorantraniliprole (1)
- Emamectin benzoate (2)
- Etofenprox (4)
- Spinetoram (1) (3)
- Tebufenozide (4)
- Methoxyfenozide (4)

*Lobesia botrana adult moth* [1]

### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Do not exceed one intervention per year.

(2) Do not exceed one intervention per year regardless of disease or pest.

(3) Do not exceed two interventions per year.

(4) Do not exceed more than one intervention per year with pyrethoids regardless of disease or pest.

(5) Not more than three interventions per year using Spinetoram and Spinosad regardless of disease or pest. Spinetoram can be used only for orchards not yet in production phase.

*Larva feeding on grape* [2]

(6) Do not exceed two interventions per year regardless of disease when using Metoxyfenozide and Tebufenozide based products.

# Western Flower Thrips

*Frankliniella occidentails*

Western flower thrips are attracted to the vines during the blooming period when the inflorescence is formed. The adults are generally less than 1.5mm 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 appears yellow to brown. Populations of thrips are highest in the warm months, coinciding with peak vine growth.

The female adult oviposits in the berries during blooming or fruit set. Symptoms on the berry include the formation of a whitish halo around a scar which makes grape bunches unmarketable, especially white grapes. Suberised scars can cause grape berries to crack.

## Control and Management

Perform monitoring using a magnifying glass on the clusters from the onset of flowering the point when the ovary reaches around 0.5mm in diameter.

Sample 50–100 clusters per hectare and monitor using the shaking technique on the grape blossoms to observe the presence of thrips within cluster. Take action when the following threshold is exceeded: 2–3 thrips per cluster.

Eliminate and limit weeds within parcel before vines enter flowering stage.

### Chemical Interventions

Only intervene when the threshold of 2-3 thrips per cluster is exceeded and when at least 15% of plants are in the flowering stage.

Upon treatment, continue the monitoring from 3 days after treatment application and keep monitoring until when the berry size reaches at least 5mm in diameter.

## PEST PROTECTION SUBSTANCES AND DEVICES

- *Beauveria bassiana* ATCC 74040
- Potassium salts of fatty acids
- Azadirachtin
- Spinosad (2)
- Formetanate (1)
- Etofenprox (3)
- Spinetoram (2) (4)
- Tau-fluvalinate (3)

### LIMITATIONS OF USE AND SPECIAL CONDITIONS

**Pest-related Limitation**

Unless indicated below, apply a maximum of three interventions per year to counteract this pest from the list of recommended substances.

**Product specific Limitation**

(1) Do not exceed one intervention per year regardless of disease or pest.

(2) Do not exceed three intervention per year regardless of disease from Spinetoram and Spinosad based products.

(3) Do not exceed more than one intervention per year with pyrethroids regardless of disease or pest.

(4) Do not exceed one intervention per year regardless of disease or pest.

*Frankliniella occidentalis adult* [3]

*Frankliniella occidentalis adult* [4]

# Grape Thrips

*Drepanothrips reuteri*

Vine thrips or grape thrips are insects that cause leaf and shoot damage on grapevines, especially in spring. These parts of the plant, when bitten by the insect (both to feed and to lay eggs), impact its development, subsequently leading to necrosis, desiccation and blistering of the leaf. Inflorescences can also be attacked – punctures to the flower peduncles can cause desiccation and premature fall. The insect is small and cannot be seen well with the naked eye, with female adult size generally below 1mm. Body colour of adults is yellow to brownish-yellow.

## Control and Management

### Chemical Interventions

Only intervene in the event of a severe infestation (5–6 thrips per leaf).

#### PEST PROTECTION SUBSTANCES AND DEVICES

- *Beauveria bassiana* strain ATCC 74040
- Sweet orange essential oil
- Potassium salts of fatty acids
- Azadirachtin
- Spinosad (1)
- Acetamiprid (3)
- Formetanate (2)
- Etofenprox (2)
- Spinetoram (1) (3)
- Tau-fluvalinate (2)

**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

(1) Apply a maximum of three interventions per year from Spinetoram and Spinosad regardless of disease or pest.
(2) At most one intervention per year regardless of the adversity.
(3) At most one intervention per year with Pyrethroids regardless of disease or pest.
(4) At most one intervention per year regardless of disease or pest.

*Close up of plant with leaves impacted by Grape thrips* [24]

*Palpita unionalis moth* [4]

# Phylloxera

*Daktulosphaira vitifoliae*

The grape phylloxera can cause significant economic damage to grapevines. The insect alternates between a root-feeding and a leaf-feeding form. Symptoms can be exhibited on the leaf surface in the form of small galls the size of half a pea. Numerous galls can be present on a single leaf. Gall formation on the leaves in severe infestations can cause leaves to drop. Knots can also form in the roots of grapevines, resulting in rotting leaves, yellowing of foliage, decreased vigour in the vines, and may lead to the eventual death of susceptible vines.The root-feeding stage of the grape phylloxera is what causes the most significant damage in vines, and hence, grafting on resistant rootstock significantly reduces the risk of infestation. In spring, when the leaves start to form, phylloxera sap-feeding nymphs and adults may be observed. These are yellow in colour, and adults are a bit larger than 1mm in length.

## Control and Management

### Chemical Interventions

Intervene at the appearance of the first galls.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- Acetamiprid (1)
- Spirotetramat (2)
- Flupyradifurone (1)

#### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Do not exceed two intervention per year regardless of disease or pest.
(2) A maximum of two interventions per year regardless of disease or pest.
(3) At most one intervention per year regardless of disease or pest.

*Galls formed on leaves* [5]

*Daktulosphaira vitifoliae apterae feeding on roots* [6]

# Grape mealybug

*Planococcus* sp., *Pseudococcus* sp., *Targionia vitis*

There are various Coccoidea scale insects that affect grape vines. *Planococcus* sp. and *Pseudococcus* sp. are mealybug species that include the grape mealybug (*Planococcus ficus*) and the long-tailed mealybug (*Pseudococcus longispinus*). Mealybugs are sap-feeding, soft-bodied, segmented scale insects that are coated with a powdery, white, wax secretion. Feeding causes the excretion of honeydew that may lead to sooty mould, damage the foliage and fruit. Mealybugs can often be found in colonies that would have various insect stages, including adults, nymphs and eggs. Adult females are flattened and do not fly. Infestations can be identified by observing white, waxy clusters on leaves, canes or grape bunches.

Coccoidea insects also include *Targionia vitis*, the grapevine black scale. It feeds on sap, causing a general deterioration, reduction of vegetative vigour and consequent reduction of production. *T. vitis* is able to have only one generation per year and overwinters as fertilized adult females, recognizable by the red colour of the body. In the spring, the nymphs emerge and within a month they fix under the rhytidome of the stem, on the young shoots, and in some cases also on leaves and shoots. Its control, made particularly difficult by the establishment of the insect in the smallest crevice of the bark and cracks of the lignified shoots, is based on the timeliness of the intervention.

## Control and Management

Sexual confusion (put dispenser in the field in March or April).

### Physical Interventions

Perform debarking and brushing of infested stumps to remove scale insects.

### Agronomic Interventions

Apply a balanced fertilization and irrigation. Never exceed the recommended nitrogen application to avoid instances of over-vigorous plants Light leaf pruning around the clusters must also be carried out.

## Chemical Interventions

In the presence of outbreaks, intervene promptly only on the infested plants. Only if cases of generalized attacks have been detected in the previous year, treat the entire plot surface.

### PEST PROTECTION SUBSTANCES AND DEVICES

- Sexual Confusion Pheromones
- Mineral oil
- Acetamiprid (2)
- Pyriproxyfen (3)
- Spirotetramat (1)
- Sulfoxaflor (2)
- Flupyradifurone (2)

#### LIMITATIONS OF USE AND SPECIAL CONDITIONS

**Pest-related Limitation**

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

**Product specific Limitation**

(1) A maximum of two interventions per year regardless of adversity; Active substance can also be used against *Planococcus ficus*.
(2) A maximum of one intervention per year regardless of disease or pest.
(3) At most one intervention per year.
(4) At most one intervention per year regardless of disease or pest.

*Pseudococcus longispinus* [7]

*Mealybugs in bark crevice* [7]

# Mediterranean Fruit Fly

*Ceratitis capitata*

The Mediterranean fruit fly impacts table grapes due to the oviposition of eggs in berries, followed by larvae feeding on the berries, creating galleries inside the fruit that lead to deformation and fruit drop. On white varieties, the infected berries start turning to light red. Punctures due to oviposition can result in secondary infection. Adult fruit flies are typically 3–5mm in length and have a recognizable morphology as indicated in images below.

## Control and Management

Use traps based on Trimedlure or other attractive substance for flight monitoring.

### PEST PROTECTION SUBSTANCES AND DEVICES

- Attract & Kill devices impregnated with:
  - Deltamethrin
  - Lambda-cyhalothrin
- Acetamiprid (1)

**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

(1) A maximum of one intervention per year regardless of disease or pest.

*Mediterranean fruit fly larvae* [10]

*Mediterranean fruit fly adult* [10]

# Black Vine Weevil

*Otiorhynchus* spp.

*Otiorhynchus* is a genus with several weevils which include the black vine weevil, *Otiorhynchus sulcatus* – a common weevil that affects grapevines. The adult is of a dark brown/black matte colour with small yellow patches, has fused wings and is unable to fly. The weevils are nocturnal and feed on the edges of leaves, leaving notched marks around the periphery, and can also feed on flowers. The larvae attack the roots.

*Otiorhynchus sulcatus adult* [11]

## Control and Management

### Agronomic Interventions

Use physical barriers positioned along the trunk (acrylic resin) to prevent adults from reaching foliage.

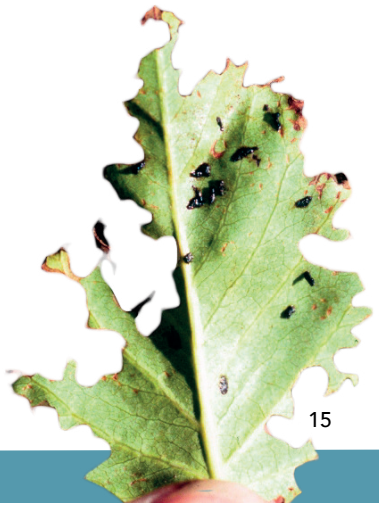
### Chemical Interventions

Intervene once adult weevils are spotted.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- Spinosad (1)

*Leaf damage by Otiorhynchus spp* [12]



**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

**Pest-related Limitation**

At most one intervention against this adversity.

**Product specific Limitation**

(1) A maximum of three interventions per year regardless of the disease or crop type.

# Vineyard Leafhoppers

*Jacobiasca lybica, Empoasca vitis*

Empoasca vitis and Jacobiasca lybica are both small leafhoppers, with the adult being around 3–4mm and 2.5mm respectively. They are green in colour. Adults fly or hop when disturbed. The eggs are laid in the veins on the underside of leaflets.

Leafhoppers cause damage to the foliage of grapevines. Adults and nymphs feed on leaves by puncturing cell walls. This results in small white/yellow spots appearing on the leaves, leaving a speckled effect due to the puncture marks. Leaves can become yellow at the edges. Severely affected leaves can drop prematurely. Leafhoppers can lead to a reduction of quality and quantity of harvest when defoliation and stunted growth occurs.

## Control and Management

### Agronomic Interventions

- Apply a balanced and even input of fertilizer and regimes irrigation throughout growth cycle;
- Carry out light leaf pruning around the clusters;
- Avoid excessive vegetative growth and hanging vegetation blocking airflow through the vines;
- Tie the shoots firmly around the trellis system, leaving enough gaps between each neighbouring vine to allow circulation to flow.

Detect the presence of adults using 3 per hectare of yellow chromotropic traps, from mid-May to October, positioned on the middle wire of the trellis. Traps are to be replaced every two weeks.

To assess the degree of leafhopper infestation, collect about 100 leaves per hectare and record the presence of juveniles and nymphs present on the bottom side of leaves around the central part of the plant during the summer period (July to August).

*Empoasca vitis adult* [13]

## Chemical Interventions

Green leafhoppers, especially in young plants and in the presence of more sensitive vines, can cause the total desiccation of the leaf parenchyma and lead to the incomplete lignification of the shoots and alteration to the reopening pattern of the cluster.

Intervene when the following thresholds are exceeded:
Average Green leafhopper (E. vitis), 1–2 nymphs/leaf

### PEST PROTECTION SUBSTANCES AND DEVICES

- Azadirachtin
- Sweet orange essential oil (2)
- Mineral oil
- Pyrethrins
- Potassium salts of fatty acids
- Acetamiprid (1) (2)
- Etofenprox (2) (3)
- Tau-fluvaliante (2) (3)
- Flupyradifurone (1) (2)
- Sulfoxaflor (1) (2)

*Jacobiasca lybica adult* [14]

#### LIMITATIONS OF USE AND SPECIAL CONDITIONS

**Pest-related Limitation**

Do not exceed one intervention against this adversity.

**Product specific Limitation**

(1) A maximum of one intervention per year regardless of disease or pest.
(2) To be used against *Empoasca vitis* only.
(3) At most one intervention per year with Pyrethroids regardless of disease or pest.
(4) At most one intervention per year regardless of disease or pest.

# European Red Mite

*Panonychus ulmi*

The European red mite affects a number of plant species, one of which is the grapevine. The adult female mites are around 0.4 mm in length, dark red and have long hairs at the base of which are white spots. The male mites are smaller and lighter in colour and have an elongated abdomen. Eggs are also reddish in colour.

The adults and nymphs damage leaves by piercing through the cells to feed, leaving small yellow/white spots on the undersurface of leaves. Under more severe infestations, the speckle spots coalesce to form a yellowing or bronzing appearance of grapevine leaves.

## Control and Management

### Chemical Interventions

Take action when the following threshold is exceeded:

30% of leaves infested with mobile forms coupled with insufficient presence of the predator *Stethorus punctillum* is observed.

When sulphur is used for other adversaries, it can also have an effect in controlling these mites.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- *Beauveria bassiana* strain ATCC 74040
- Potassium salts of fatty acids
- Bifenazate (1)
- Exitiazox (Also known as Hexythiazox)
- Fenpyroximate
- Formetanate (1)
- Tebufenpyrad

## LIMITATIONS OF USE AND SPECIAL CONDITIONS

**Pest-related Limitation**

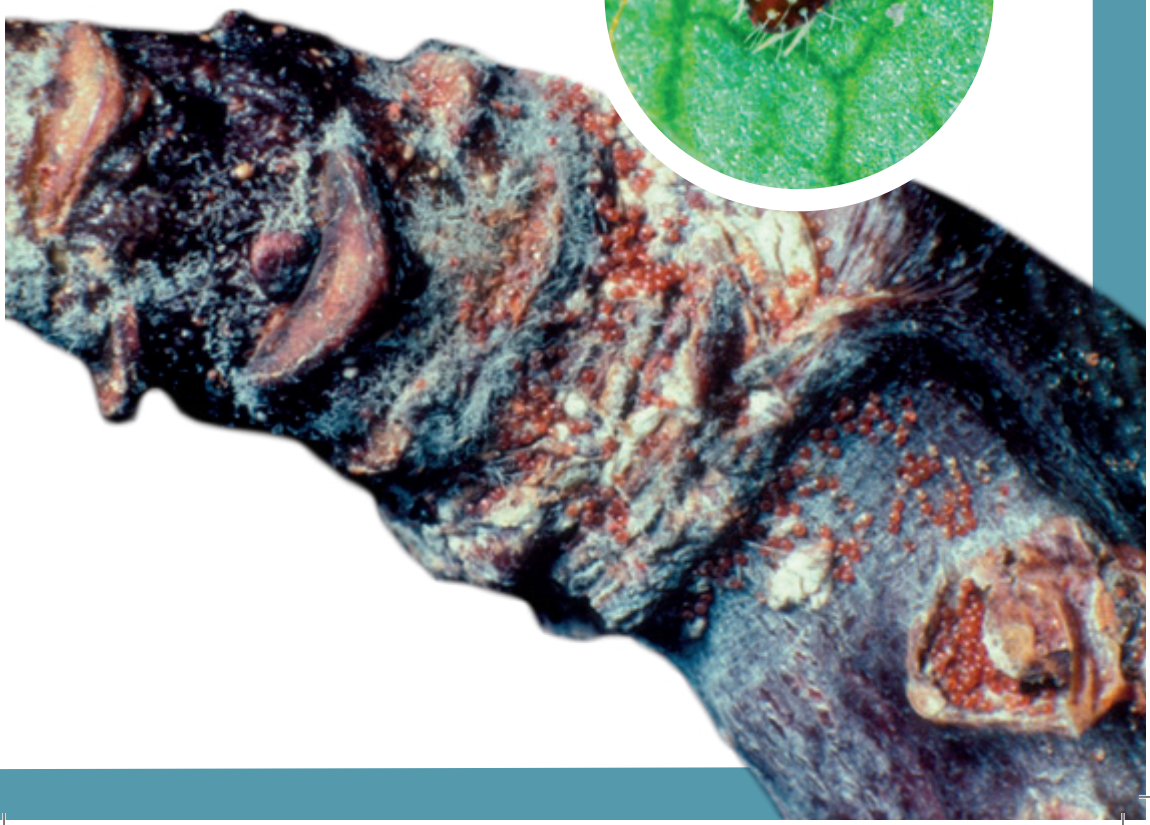
Do not exceed more than one intervention a year against this adversity.

**Product specific Limitation**

(1) At most one intervention per year regardless of disease or pest.

*European red mite eggs on bark* [15]

*European red mite adult* [15]



# Grape Leaf Rust Mite

*Calepitrimerus vitis*

The grape leaf rust mite can cause a variety of symptoms depending on the growth stage of the vine. The mite attacks the buds and shoots and can result in leaf curling and distortion in early spring. Symptoms can also include shortening of internode and bunched foliage. Later in the season, in mid to late summer, the mite causes leaves to turn rust-brown. The pest can cause economic impact on a vineyard if there is a high population density, by reducing grapevine yield. The mite is not visible to the naked eye, with an adult being 0.15mm in length.

## Control and Management

### Chemical Interventions

Only intervene in case of a severe attack at the beginning of the vegetative restart if the presence of mites has been recorded in the previous year or in case of ascertained/prolonged presence on the leaves. This is important to avoid damage on the bunches.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- Potassium salts of fatty acids
- Sulphur
- Bifenazate (1)
- Formetanate (1)

#### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Do not exceed more than one intervention per year regardless of disease or pest.

Sulphur has anti-oidium activity and thus can also be applied also against mites.

*Leaf discoloration caused by C. vitis* [25]

*Adult on grapevine David G James* [25]

# Flea Beetle

*Altica* spp

Altica of the vine *Haltica lythri Aubé* var. ampelophaga (Guerin). *Haltica lythri* is a chrysomelid beetle native to central Spain (Andalusia) and is widespread in many vine-growing areas around the Mediterranean. The leaf beetle lives from the vine itslef. In spring, the adults attack the leaves and cause irregular erosion on the leaf parenchyma along the main veins. In the process, this can cause sometimes damage to the shoots. The larvae develop normally on the underside of the leaves, along the upper epidermis which then causes drying and perforation. Significant damage can occur in young vines under cultivation. Altica adults are of metallic green colour. The leaf beetle have characteristic small heads with filiform antennae reaching one third of the length of the elytra which are irregularly dotted. The total length of the insect ranges from 4.5-5mm. Their larvae are ellipsoidal yellowish in form. Larva are yellow at birth, later become blackish with tubercles bearing long hairs. The altica overwinters as an adult and completes three generations in one year. The leaf beetle tends to winter in the crevices of the bark and the dry leaves or other shelters present near the vine. At budding phase, the adults appear, feed and mate. When the average temperatures reach 15-16°C the females begin to lay their eggs on the underside of the leaves. Overall, an average of 150-200 eggs are laid in small groups of a few units or at most of a few dozen elements. The duration of embryonic development depends on the temperatures and can range from 19 days at 16°C up to 4 days at 32°C. The larvae live gregarious only the first age. When ripe, the larvae drop to the ground where they pupate in earthy cells at a depth of 2-5 cm. The adults of this first generation appear in June-July, those of the second at the end of August and those of the third generation in the first half of October. The latter, with the lowering of temperatures, take shelter to overcome the winterization phase.

## Control and Management

### Agronomic Interventions

Remove any spontaneous weeds growing within the vines.

### Chemical Interventions

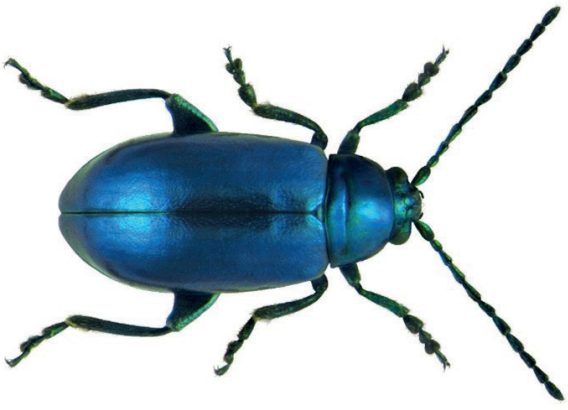
Only intervene in case of a severe attack.

## PEST PROTECTION SUBSTANCES AND DEVICES

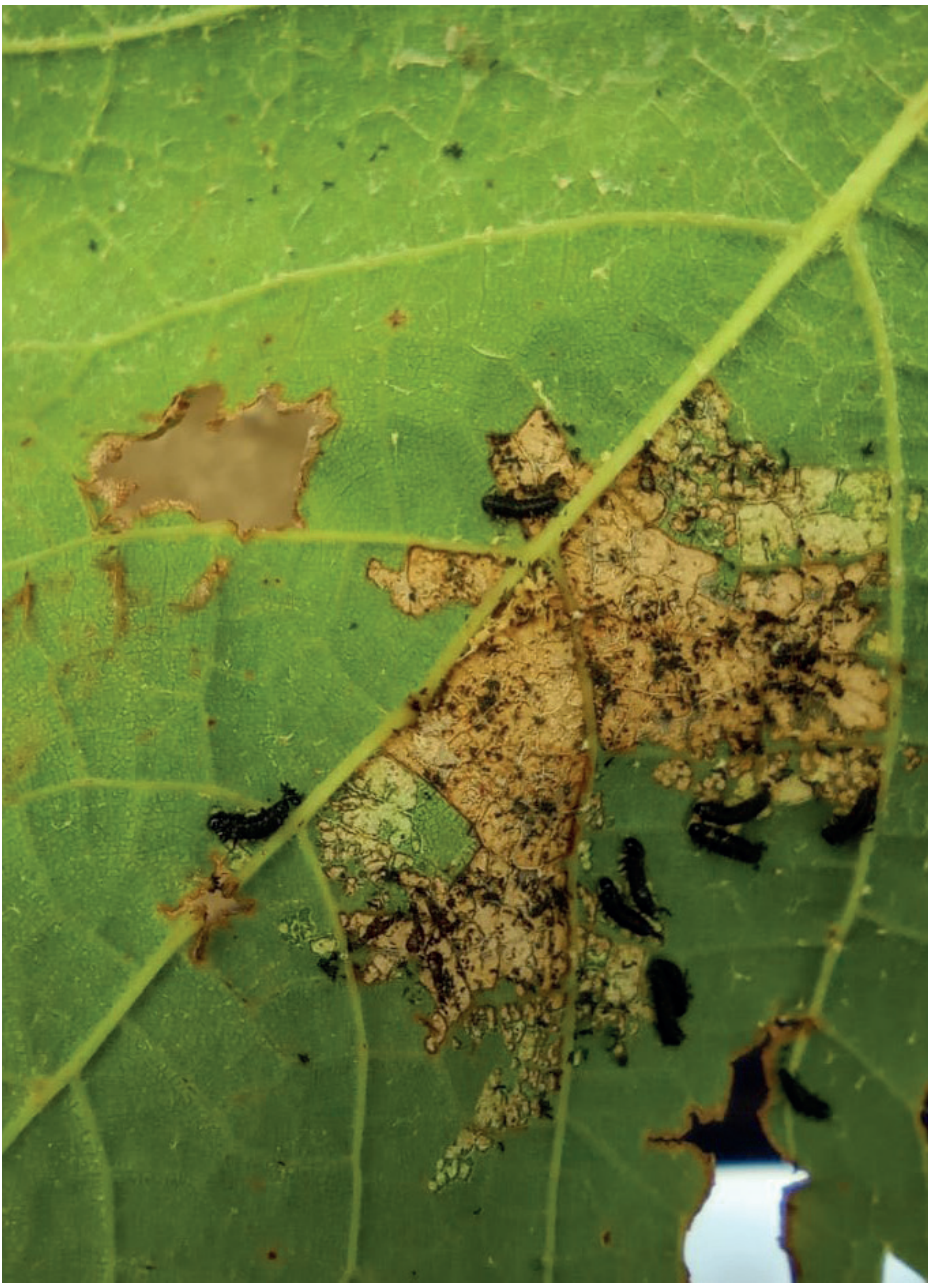
- Cypermethrin (1)
- Deltamethrin (1)
- Lambda-Cyhalothrin (1)

### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) At most one intervention per year with Pyrethroids regardless of disease or pest.



*Altica lythri adult insect* [27]



*Altica spp damage on vine leaf* [28]

# Powdery Mildew

*Oidium tuckeri*

Powdery mildew is the most widespread fungal vine disease.The fungal pathogen affects the green tissue of the grapevine, including leaves, shoots and berries. In the early stages of infection, leaves exhibit yellow blotching.This further develops to form conidia that appear like a white/grey powder on foliage. Green shots may exhibit brown patches. Berries can also exhibit white powdery growth and scarring on the skin. *Oidium tuckeri* thrives in environments with high humidity.

## Control and Management

### Agronomic Interventions

- Allow air circulation by tying the shots around the trellis system separately. Arrange shoots and tie them.
- Carry out light leaf pruning around the clusters.
- Apply a balanced and even input of fertilization and irrigations.

### Biological/Organic Interventions

Use *Ampelomyces quisqualis* in periods of lower disease pressure in alternation with other permitted fungicides. Do not mix this product with sulfur - containing substances as these reduce the effectivity of the *A.quisqualis.* Wait at least 5 days after treatment with *A.quisqualis* before application of chemical-based substances. In case of rainfall exceeding 6mm, it is recommended to repeat the treatment once more.

*Powdery mildew forming on grapes* [17]

## Chemical Interventions

High risk areas:

- up to pre-flowering: intervene in advance with covering products;
- from pre-flowering to veraison: intervene by alternating systemic and covering products.

Low-risk areas:

- take precautionary measures in the immediate pre-flowering stage and continue alternating systemic and covering products. Use sulfur compounds in the coolest hours to avoid phytotoxicity phenomena.

## PEST PROTECTION SUBSTANCES AND DEVICES

- *Ampelomyces quisqualis*
- *Bacillus amyloliquefaciens*
- *Bacillus pumilus*
- Potassium Bicarbonate
- Cerevisane
- COS-OGA
- Sweet orange essential oil
- Laminarin
- Sulphur
- (Eugenol + Geraniol + Thymol) (11)
- Azoxystrobin (1)
- Boscalid (2)
- Bupirimate (3)
- Cyflufenamid (5)
- Difenoconazole (4) (10)
- Fluxapyroxad (2)
- Meptyldinocap (6)
- Metrafenone (7)
- Proquinazid (3)
- Pyraclostrobin (1)
- Pyraclostrobin (1) + Metiram (8)
- Pyriofenone (3) (7)
- Spiroxamine (9)
- Trifloxystrobin (1)
- Tetraconazole (4)

### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Apply a maximum of three interventions per year between Azoxystrobin, Pyraclostrobin and Trifloxystrobin regardless of disease or pest;

(2) Between Boscalid, Isofetamid and Fluxapyroxad only apply a maximum of two interventions per year regardless of disease or pest.

(3) Do not exceed a maximum of two interventions per year between Bupirimate, Proquinazid and Pyriofenone;
(4) Do not exceed a maximum of three interventions per year with the azole-type sterol inhibitor compounds.
(5) Apply a maximum of two interventions per year.
(6) Apply a maximum of three interventions per year.
(7) Apply a maximum of three interventions per year Metrafenone and Pyriofenone.
(8) Apply a maximum of three interventions per year regardless of adversity; Product is to be used until fruit set. fruit set.
(9) A maximum of three interventions per year.
(10) At most one intervention per year.
(11) A maximum of four interventions per year regardless of disease or pest.

*Yellow blotching on grapevine leaf* [18]

# Grey Mould

*Botrytis cinerea*

*Botrytis cinerea* is a fungal pathogen that infects a variety of plant species, including the grapevines. Grey mould or bunch rot may reduce the quantity and quality of berries, resulting in poor quality wine due to changes in composition. The fungus also produces toxic compounds that affect the fermentation process. The fruit are most prone to infection when they are ripe and close to their harvesting period. Infected berries become soft and watery and under humid conditions are covered with grey mould.

## Control and Management

### Agronomic Interventions

- Carry out a systematic arrangement of the shoots around trellis system.
- Carry out light leaf pruning around the clusters.
- Balanced input of fertilizer and irrigation.

### Chemical Interventions

Carry out an intervention at verasion and one in the pre-closure of the cluster. For late-ripening varieties and for those covered agricultural management systems, action must be taken when the relative humidity is high.

In order to prevent resistance phenomena, it is recommended to alternate fungicides with different mechanisms of action.

### PEST PROTECTION SUBSTANCES AND DEVICES

- *Aureobasidium pullulans*
- *Bacillus subtilis* strain QST 713 (6)
- *Bacillus amyloliquefaciens*
- *Metschnikowia fructicola* strain NRRL Y-27328
- *Pythium oligandrum* strain M1
- *Saccharomyces cerevisiae*
- *Trichoderma atroviride* strain SC1
- Potassium Bicarbonate
- Cerevisane

- Eugenol + Geraniol + Thymol (6)
- Laminarine
- Boscalid (1)
- Cyprodinil (2)
- Cyprodinil (2) + Fludioxonil (3)
- Fenhexamid (4)
- Fenpyrazamine (5)
- Fluazinam (7) (5)
- Fludioxonil (3)
- Isofetamid (1) (5)
- Pyrimethanil (2)

**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

A maximum of three interventions are allowed per year for uncovered cultivation systems and four maximum interventions for grapes cultivated using covered systems. The latter applies only for instances where harvest occurs between November and December. Products allowed in organic farming are exempted from this limitation.

(1) Between Boscalid, Isofetamid and Fluxapyroxad, apply a maximum of maximum two interventions per year regardless of disease or pest.

(2) Between Pyrimetanil, and Cyprodinil at most one intervention per year independently from adversity.

(3) A maximum of two interventions per year regardless of disease or pest.

(4) A maximum of two interventions per year.

(5) At most one intervention per year.

(6) A maximum of four interventions per year regardless of disease or pest.

(7) Between Ditianon, Fluazinam and Folpet apply a maximum of three interventions per year independently from adversity.

*Botrytis cinerea mould forming on grapes* [19]

*Bunch affected with grey mould* [19]

# Downy Mildew of Grapevine

*Plasmopara viticola*

*Plasmopara* viticola is an oomycete that infects all green parts of a vine, but symptoms are first visible on leaves, causing discolouration, necrosis and distortion. Yellow circular spots (in some red varieties these spots are red) appear on young leaves with 'oil spots' with a chocolate-brown halo. These oil spots can grow and coalesce, and as they mature they dry and become necrotic. White, cottony, fungal-like growth may appear on the surface of the leaves.

Inflorescence or young berries turn yellow or grey if infected and may exhibit spores. The young berries may turn brown and wither. Two to three weeks after blossoming; the berries do not support sporulation but would still become discoloured, and shrivel.

## Control and Management

It is recommended to intervene through the application of contact products when the following conditions and stages ensue:

- Pre-flowering phase and;
- Climatic conditions predisposing infection (rain/high relative humidity).

In the presence of the first symptoms (oil spots) intervene with cytotropic active ingredients or systemic, alone or mixed with contact products. If the weather conditions remain favourable to the disease, intervene with longer-lasting anti-peronospora type products.

### PEST PROTECTION SUBSTANCES AND DEVICES

- Cupric products (11)
- Cerevisane
- Sweet orange essential oil
- Laminarine
- Ametoctradin
- Ametoctradin + Metiram (1)
- Amisulbrom (2) (14)
- Benthiavalicarb (9) (5)
- Benthiavalicarb (9) (5) + Copper
- Cymoxanil (4)
- Cyazofamid (2) + Disodium phosphonate (12)
- Dimethomorph (5)
- Dithianon (10)
- Fluopicolide (7)
- Folpet (10)
- Fosethyl Aluminum (12)
- Potassium phosphonates (12)

- Disodium phosphonate (12)
- Iprovalicarb (5)
- Mandipropamid (5)
- Metalaxyl – M (3)
- Metiram (1)
- Pyraclostrobin (6) + Metiram (1)
- Valifenalate (formerly Valiphenal) (5) + Folpet (10)
- Zoxamide (8)
- Oxathiapiprolin (13)

**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

(1) A maximum of three interventions per year regardless of adversity. Product is to be applied until fruit set developmental phase;

(2) A maximum of three interventions per year between Amisulbron and Cyazofamid;

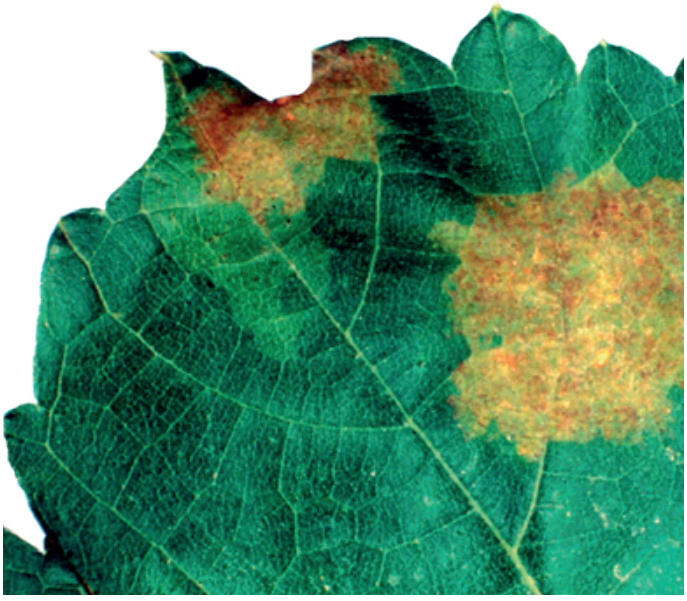
(3) At most one intervention per year;

(4) A maximum of three interventions per year;

(5) A maximum of four interventions per year between Benthiavalicarb, Dimetomorf, Iprovalicarb Mandipropamid and Valifenalate;

(6) A maximum of three interventions per year between Azoxystrobin, Pyraclostrobin and Trifloxystrobin regardless of adversity and crop;

(7) A maximum of two interventions per year.



*Yellowing and oil spot formation on leaves* [20]

(8) A maximum of four interventions per year.

(9) A maximum of two interventions per year.

(10) Between Ditianon, Fluazinam and Folpet apply a maximum of three interventions per year independently from adversity;

(11) Do not exceed the cumulative application of 28kg of copper per hectare over 7 years and it is recommended not to exceed the quantity average of 4kg of copper per hectare per year;

(12) Apply a maximum of ten interventions per year between Phosphonates and Fosethyl Aluminum, excluding vines used for propagation purposes;

(13) A maximum of two interventions per year. Product is to be applied as a mixture of active substances with different modes of action;

(14) Should be mixed with contact fungicides.

*Fungal-like growth on leaf surface* [20]

# Secondary Fungal Disease

*Penicillium* spp., *Aspergillus* spp.

*Penicillium* spp., *Aspergillus* spp. cause secondary fungal diseases in grapevines. Penicillium rot is identifiable due to the presence of whitish powdery mould that is followed by the formation of dusty blue/green spores. Berries are infected generally due to skin damage or splitting from rains. *Aspergillus* fungus can cause different symptoms. *Aspergillus* niger is visible on berries in the form of brown/black sooty spore mass. The manifestation of these secondary fungal diseases on grapes may be different since the pathogens can either be on their own or in combination with other pathogens. These fungi produce toxins that are harmful to human health. These fungal agents cause rot even in the post-harvest stage.

## Control and Management

### Chemical Interventions

At veraison or pre-harvest.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- Cyprodinil (1) + Fludioxonil (2)

#### LIMITATIONS OF USE AND SPECIAL CONDITIONS

(1) Between Pyrimetanil and Cyprodinil at most one intervention per year regardless of the adversity;

(2) A maximum of two interventions per year regardless of disease and crop type.

*Penicillium rot on grape bunch* [21]

# Acid Rot

*Caused by yeast and bacteria*

Sour rot is caused by the joint action of naturally-occurring yeast and acetic acid bacteria, and results in berries emitting a vinegary odour. Symptoms in the early stage of infection and during ripening of the berries may be confused with Botrytis cinerea. Sour rot decreases the sugar content in the berries, resulting in a change of composition that would affect the final quality of the wine.

## Control and Management

### Agronomic Interventions

- Balanced input of fertilization and irrigation
- Carry out light leaf pruning around the clusters.
- Apply anti-parasite agents to prevent damage to the grape cluster.

### PEST PROTECTION SUBSTANCES AND DEVICES

- *Bacillus amyloliquefaciens*
- *Bacillus subtilis* strain QST 713 (1)

**LIMITATIONS OF USE AND SPECIAL CONDITIONS**

The use, if necessary, of copper-based fungicides helps in strengthening the cuticle of the berries which can prevent lesions.

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

*Acid rot on white grapes variety* [26]

# Phomopsis Cane And Leaf Spot

*Phomopsis viticola*

Phomopsis cane and leaf spot is a disease caused by a fungal pathogen. Phomopsis can infect most parts of the grapevine. Most prominent symptoms include dark spots of around 1mm diameter with yellow halos forming on the leaves. If badly affected, the leaves can turn yellow and fall off. On green shoots, black elliptical lesions appear on internodes. Cracks can appear on shoots giving a scabbing appearance. Infected canes may experience discolouration and bleaching in winter. Berries can become infected, but generally, this happens following previously mentioned symptoms exhibited on foliage.

## Control and Management

### Agronomic Interventions

- Always remove infected parts during pruning stage.
- Carry out light leaf pruning around the clusters;
- Do not store pruned shoots. Burn any vine shoots after pruning.

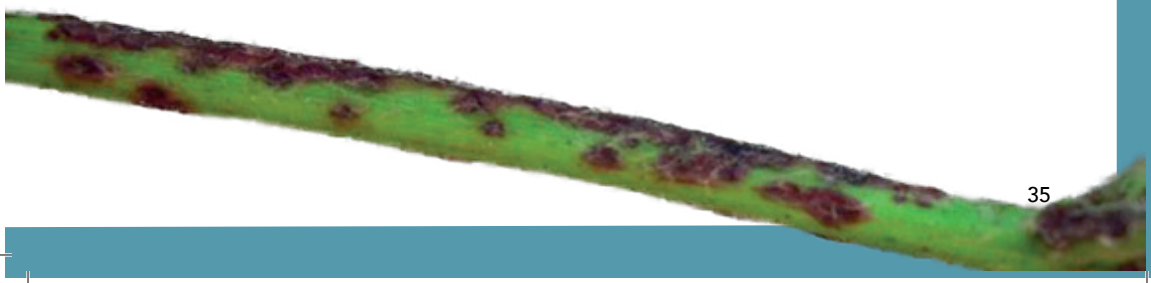
### Chemical Interventions

Chemical interventions are to be carried out in the following phenological phases:

- Beginning of budding (bud break) phase
- Leave at least 8–12 days before applying next treatment.

#### PEST PROTECTION SUBSTANCES AND DEVICES

- Cupric products (3)
- Azoxystrobin (1)
- Folpet (2)



*Phomopsis viticola lesions on shoot* [22]

## LIMITATIONS OF USE AND SPECIAL CONDITIONS

**Pest-related Limitation**

Application of chemical compounds must be restricted to sensitive cultivars only.

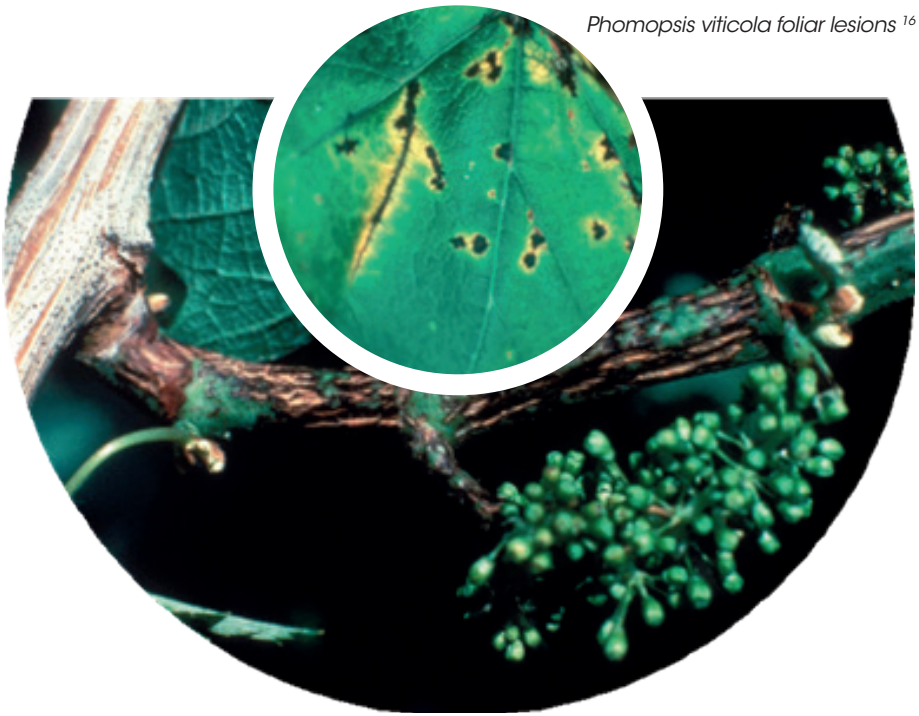
**Product specific Limitation**

(1) A maximum of three interventions per year from Azoxystrobin, Pyraclostrobin and Trifloxystrobin; regardless of disease or pest.

(2) Between Dithianon, Fluazinam and Folpet apply a maximum of three interventions per year regardless of disease or pest.

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

*Phomopsis viticola foliar lesions* [16]



*Elliptcal lesions at basal internodes* [16]

# Petri Disease and Esca

*Phaeoacremonium aleophilum*, *Phaeomoniella chlamydospora*, *Fomitiporia mediterranea*, etc.

Petri disease and esca are caused by fungal pathogens. Petri disease affects grapevines that are usually between 1 to 5 years. Symptoms are interveinal chlorosis and stunted growth. Esca affects more mature vines with symptoms depending on the severity of the infection. Leaves exhibit chlorosis like in the Petri disease, foliage wilts on the entire plant, necrosis occurs and early defoliation may occur. In chronic infections, the berries develop brown/purple spots on the surface. The trunk exhibits dark brown streaks and necrosis. Dissection of the vine would show that xylem vessels have turned brown due to gum formation and tylosis, and are partially blocked. This leads to water stress and insufficient nutrient supply throughout the plant.

## Control and Management

### Agronomic Interventions

- When symptoms appear, cut and burn infected plants.
- The surface where cutting will be effected must be smooth and sloping.
- Disinfect cutting and grafting tools with sodium hypochlorite or quaternary ammonium salts.
- Mark plants with symptoms and prune them separately from healthy plants.
- Avoid applying measures to accelerate the growth of young plants.
- Use healthy propagation material that does not contain browning spots in the interior at the point of cut.
- In the presence of partially attacked plants, remove the damaged parts and leave new growth around the cut area to sprout.
- Treat large pruning cuts with healing substances and waxes.

## PEST PROTECTION SUBSTANCES AND DEVICES

- *Trichoderma asperellum + Trichoderma gamsii*
- *Trichoderma atroviride*
- Boscalid + Pyraclostrobin (1)

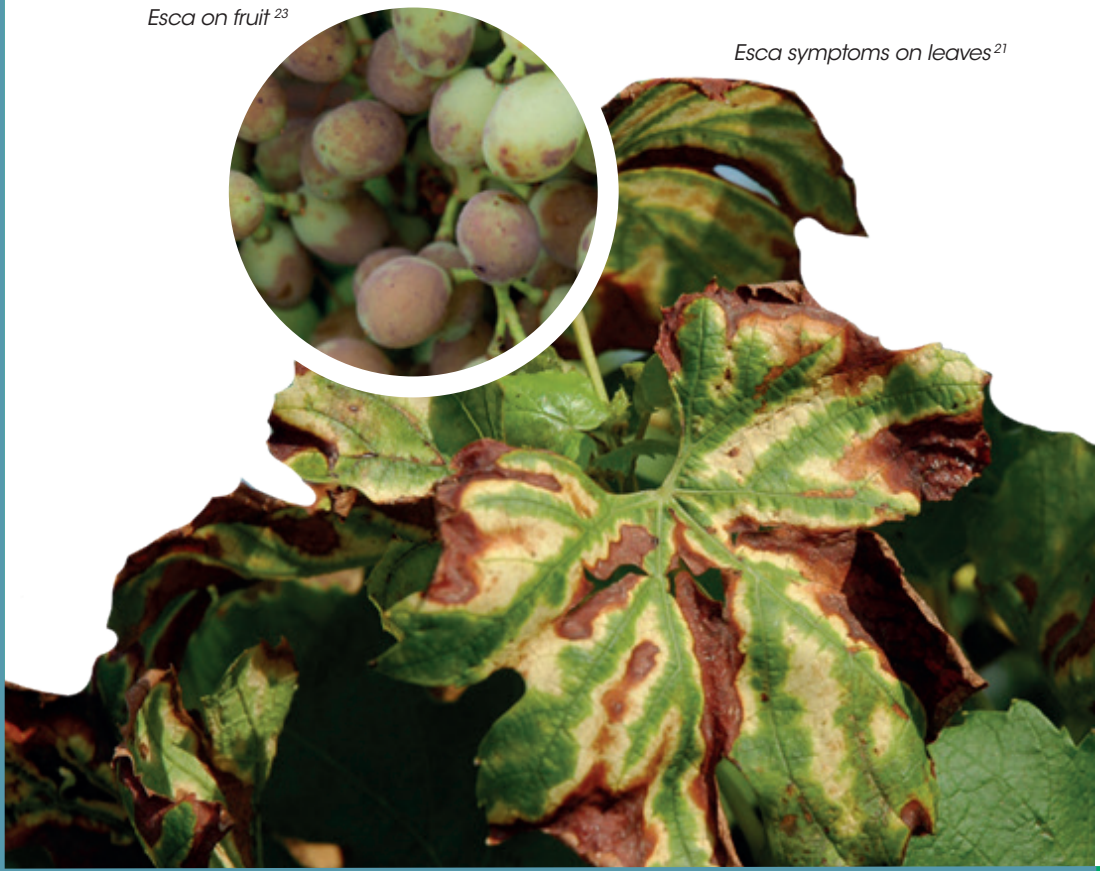
### LIMITATIONS OF USE AND SPECIAL CONDITIONS

Treatments involving copper-based products used against downy mildew of grapevine have a protective action against this disease. Consequently such products are considered effective against this disease.

(1) Apply pruning sealer on freshly pruned cuts.

*Esca on fruit* [23]

*Esca symptoms on leaves* [21]



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