The Plant Protection of the Grapevine

In Europe, the grape is cultivated from the prehistory. The botanists believe that the origin of the cultivated grape in Europe is in the region of the Caspio Sea. The dispersion of the seeds for the birds, the wind and the water diffused the plant toward the west, until the Asian costs of the Mediterranean.

The vine is cultivated now from all over the world in warm regions, especially in western Europe, the Balkans, California, Australia, South Africa, Chile and Argentina. It was introduced in the east coast of America by the colonial time, but the intent failed as a consequence of the parasites and the illnesses attacks. Later resistant varieties were obtained.

1. MORPHOLOGY

The vine is a woody plant with flowers, this is, an angiosperm, of the class of the dicotyledoneous ones, of the subclass with simpler flowers (Choripetalae), but in the group endowed with chalice and corolla (Dyalypetalae), that is to say, the most advanced.

These twisted shrubby climber, belonging to the Rhamnales order, Vitaceae family, has a very long life in general (it is easy to find a centennial vine). The development of the vine requires a long time, so these plants are most demanding in climate and fertilization condition. The flowers are small and green colour, and they hang in clusters. Sometimes, only masculine or feminine flowers are present in the plant.

TThe slapped **leaves** with very jagged lobes appear opposed on the branches. Most of the varieties present tendrils in opposed position each two or three successive leaves.

The **fruit** (grape) clusters are small, spherical greenish or black-purple berries arranged in a raceme. They may be consumed fresh (table grapes) or as dried fruit, although a large part of the crop is used in the production of wine.

The **grape grain** divided in three parts skin, pulp and seeds
- The **skin** contains most of the colouring and aromatic components.
- The **pulp** contains a great amount of sugars that will become to wine in the fermentation process.
- The **seeds** are inside the pulp and they differ in size, shape a number according to the varieties. They contain tannins.

2. GROWTH AND DEVELOPMENT OF THE CROP

The viticulture year begins at budburst, around the middle of March. This usually signifies the end of the harsh winter weather, during which time the vines have lain dormant, and the beginning of the milder spring.

Weeping

Weeping is the first sign of the vine awaking after a winter of relative dormancy.
The roots starts to collect water and the sap of the vine rises, oozing out of the cane ends which were pruned in winter, in a manifestation called "Weeping".
Weeping occurs suddenly, rapidly increasing in intensity and then decreases gradually.
Weeping is the signal to prune for the spring growth.

Bud-break

In the spring, some 20 - 30 days after the vine starts to weep, the buds open.
Different varieties bud-break at different times: there are early bud-breakers and the same variety can bud-break at different times in different years due to climatic changes.
The type of soil can also affect the timing: clay, which is cold, will retard the process, while sand, which is warm, will promote it.

Emergence of Shoots, Foliage and embryo bunches.

Following bud breaks, foliage develops and shoots are sent out, in mid April (Mid Oct).
After the fourth or fifth leaf has emerged, tiny green cloisters form. These are the flowers which when they bloom will develop into grapes, commonly called embryo bunches, they are the first indication to the potential size of the crop.

Flowering of the vine

The embryo bunches break into flowers after the 15th or 16th leaf has emerged on the vine this is normally about eight weeks after the bud-breaks and involves pollination and fertilization and lasts for about ten days.

The weather must be dry and frost free, but temperature is the most critical requirement a daily temperature of at least 15ºC is needed in order for a vine to flower.

Flowering is a 3-step process:

(i) Formation of Anlagen ("uncommitted primordia") by apices of specialized lateral buds (latent buds) on shoots of the current season

(ii) Differentiation of Anlagen either as tendril primordia or as inflorescence primordia

(iii) Formation of flowers from the inflorescence primordium

Fruit Set.

The embryo bunches develop into real cloisters rapidly after flowering. The berries evolve into grapes - they are the first visible signs of the crops, of which wine is to be made. These grapes are called fruit set. The number of grapes per embryo bunch differs for every variety as does the percentage of berries that actually set into grapes.

When the vine develops its fleshy fruits, only a few chemical changes take place inside the single berries, until their skins start changing colour. This process is known as veraison. In the green stage of the grapes' development sugar and acid content does not change. When the skin of the grapes changes its colour, usually in August, the process of ripening has begun. Ripening is characterized through a dramatic increase in sugar content, diminishing hard malic acid content and the appearance of the riper tartaric acid. Although the amount of the latter starts to decrease after about two weeks, it remains the main acid of the grapes.

Ripening is also the period when the tannin of the grapes is gradually hydrolysed. The hydrolysis is essential, because this is what enables tannin to soften the wine throughout the process of maturation. Care has to be taken not to remove too much foliage, as it is the effect of sunlight upon the leaves, not the grapes, that causes the grapes to ripen.

Grape Harvest.

The Harvest usually starts at the beginning of autumn depending on the weather and the different regions.

At this time the grapes are usually ripe enough to pick, with high sugar levels having been achieved due to a combination of good ripening together with the concentration effect of mild dehydration.

White grapes ripen before red grapes and must in any case, be harvested that little bit early to achieve a higher acidity balance.

Shortly after harvest, the vines begin to translocate carbohydrates from the leaves to the roots in preparation for dormancy, during which time the foliage turns a brilliant red color. When all the useful nutrients have been recovered, the leaves turn brown, die, and the vine enters into dormancy. During this period pruning is carried out, which is necessary to maintain the balance between vegetative growth and fruit production in the following season. The pruning level depends upon the variety and vigor of the vines, but a typical crop load would be achieved by leaving around 12 buds. The later

the pruning is carried out, the later the bud burst, so areas with a high risk of frost are pruned as late as possible (middle of winter).

GRAPE PHENOLOGYCAL STAGE	
1. Winter dormancy	Winter buds pointed to rounded, bright or dark brown according to cultivar, bud scales more or less closed according to cultivar.
2. Bud swelling	Buds expand inside the bud scales.
3. Wool stage	Brown wool clearly visible (doeskin).
5. Bud burst	Green shoot first clearly visible.
7. First leaf unfolded and spread away from shoot	
9. Two to three leaves unfolded	
12. Five to six leaves unfolded	Inflorescence clearly visible.
15. Inflorescence swelling	Flowers closely pressed together
17. Inflorescence fully developed	Flowers separating
19. Beginning of flowering	First flowerhoods (calyptra) falling.
21. Early flowering	25% of flowerhoods fallen.
25. Late flowering	80%of flowerhoods fallen. (
27. Fruit set	Young fruits begin to swell; remains of flowers lost (shatter). (
29. Berries bb-sized	Bunches begin to hang.
33. Beginning of berry touch	
35.beginning of ripening	Veraison.
38. Beginning ripe for harvest	

VIRUS DISEASES

1. Name of the Disease: GRAPEVINE YELLOWS (Flavescence dorée and Bois noir)

Causal Organism: *Phytoplasmas*

Grapevine Yellows are diseases caused by a complex of phytoplasmas (formerly called a mycoplasma-like organism)

Host range:

Phytoplasmas are known causal agents of hundreds of diseases in various plants.

Occurrence and importance:

Grapevine Yellows are known worldwide and are dangerous diseases of wild and cultivated vines that are associated to phytoplasmas. Bois noir is present in all French viticultural areas. All varieties of *Vitis vinifera* are susceptible, although in different grades. The quality of vines is decreased by high acid and low sugar contents of infected clusters.

Symptoms and changeable diseases:

Phytoplasmas reside in the phloem tissues of the vine, and it may be their blocking of phloem sieve tubes that leads to some of the observed disease symptoms.

Symptoms of Flavescence doree and Bois noir are similar. **Leaves** show discoloration and down rolling of laminae, turning yellow (fig 41) in white-berried cultivars and red in red-berried cultivars.

The quality and quantity of crop is reduce by **flower** withering and **berries** shrivelling.

Woody canes are poorly ripened, resulting in a strong weeping aspect of the affected branches.

Stocks decline rapidly.

Disease Cycle

Grapevine Yellows involves susceptible hosts, an insect vector, and the disease causal agent itself.

Phytoplasmas are transmitted naturally by phloem-feeding insects such as leafhoppers. **Flavescence dorée** spreads epidemically and reaches a high incidence within a few years, because its major vector, *Scaphoideus titanus*, feeds only on grapes and completes the whole life cycle on grapevine. The vector for the **Bois noir** is unkown,

The area affected by Flavescence dorée is linked to the occurrence of *Scaphoideus titanus*, and it is limited by climatic parameters because this insect requires cold winters to break the diapause of eggs, whereas warm summer temperatures are required to complete the life-cycle.

Adults are extremely mobile and effective vectors. Young instar larvae as well as adults may feed-acquire the Flavescence dorée phytoplasma in spring at the moment of quick growth of young vine shoots. A latency of four weeks is required before feeding transmission occurs. Insects are infective until they die in September.

Control:

To control grapevine yellows it is necessary make a control of its vectors.

The first treatment occurs one month after beginning of hatching, to prevent feeding inoculation by individuals which would have acquired along with their very first meal after hatching. One or two additional monthly treatment may be recommended.

Indeed, some cultural management as pruning of infected canes (which would act as important phytoplasma reservoirs for the vector) may help, providing that an efficient control of S. titanus is insured..

Reservoir plants should be identified and suppressed. In the case of Flavescence dorée uprooting of infected stocks and of abandoned vine plots is mandatory.

As it is known that Grapevine phytoplasmas belong to very different groups, care should be taken whenever vine planting material is shipped to different regions, because phytoplasma vectors already present might act as new vectors for a particular Grapevine yellows if contaminated material was planted on the site.

2. Name of the Disease: GRAPEVINE LEAFROLL-ASSOCIATED VIRUSES (GLRaV)

Causal Organism: Clostereovirus

There are at least seven distinct putative closteroviruses reported to be associated with leafroll disease. These viruses are collectively referred to as grapevine leafroll-associated viruses (GLRaVs) and are designated GLRaV 1 through GLRaV 7.

Transmitted by *Pseudococcus longispinus, Planococcus ficus* (GLRaV-3). Grafting also transmits this virus.

Host range:

Grapevine.

Occurrence and importance:

Probably distributed worldwide.

Symptoms and changeable diseases:

These viruses cause poor color development and non-uniform maturation of fruit in *Vitis vinifera*.

Additionally, symptoms may include downward rolling of basal leaves followed by rolling of the leaves near the shoot tips, color change and necrosis in the interveinal portions of the leaves (reddening in red varieties and chlorosis in white varieties), and phloem disruption. (fig 42)

In mixed infections more severe symptoms occur and may cause vine death.

The symptoms of grapevine leafroll disease can resemble those caused by mechanical damage to the trunk, other diseases of the phloem tissue, and arthropod damage, thereby complicating visual diagnosis.

Disease Cycle

These viruses are acquired by the pseudococcid (*Planococcus*, *Pseudococcus*) and coccid (*Pulvinaria*, *Neopulvinaria*, *Parthenolecanium*) mealybug vectors.

This is related to the life cycle of the viral mealybug vectors, which hide and hibernate under the bark of the grapevine

Control:

Chemicals cannot effectively kill viruses. The application of pesticides is therefore limited to the control of possible insect vectors.

The practice of sanitation seems currently the most effective. Sanitation measures include the use of virus-free propagation material, insect control (to eliminate possible vectors) and weed control (to eliminate possible alternative virus hosts).

3. **Name of the Disease: GRAPEVINE FANLEAF VIRUS (GFLV)**

(Virus, Comoviridae, Nepovirus)

Causal Organism: nepovirus

Host range:

It has a wide host range among perennial plants and trees.

Occurrence and importance:

Important and widespread virus disease of grapevine, occuring in all vine growing regions, probably spread by the main vector, the nematode *Xiphinema index* and by infected plant material.

Symptoms and changeable diseases:

Causes wide range of symptoms on grapevine:

- Shortening of internodes,
- The shoots growth in zigzag
- The leaves present acute indentation, asymmetry of the blade, resembling a fan.

Chromogenic strains of the virus induce various patterns of yellow discoloration (yellow mosaic form).

Fruit set is poor, fewer and smaller bunches with aborted berries.

Yield is reduced in more than 50% and longevity of the plant is low.

Disease Cycle

Infected nematodes are present in deep parts of the soil, contaminating it and making the recovery of the soil difficult. Infected propagating material is responsible for long distance spread of the virus and of the vector.

Control:

Through selection and production of virus free stocks by heat therapy and or meristem culture in order to use healthy scion and rootstock plant material. Avoid using contaminated soils to eliminate virus reservoirs and to diminish nematode population.

3. DISEASES

BACTERIAL DISEASES

1. Name of the Disease: CROWN GALL

Causal Organism: *Agrobacterium tumefaciens*

The bacterium transfers part of its DNA to the plant, and this DNA integrates into the plant's genome, causing the production of tumors and associated changes in plant metabolism.

Host range

Agrobacterium tumefaciens causes crown gall disease of a wide range of dicotyledonous (broad-leaved) plants, especially members of the rose family such as apple, pear, peach, cherry, almond, raspberry and roses.

Occurrence and importance: *V. vinifera* cultivars are more susceptible to crown gall than *V. labrusca* cultivars.

Symptoms and changeable diseases:

The main symptom consists of galls or overgrowths formed on the roots, crowns and/or trunks.

Galled vines frequently produce inferior shoot growth, and portions of the vine above the galls may die.

Current-season galls are first apparent in early summer as white, fleshy, callus growth. Galls turn brown by late summer and in the fall become dry and corky.

When galls are numerous or when they are located on major roots or on the root crown, they disrupt the translocation of water and nutrients, leading to poor growth, gradual dieback, and sometimes death of the vine.

Disease Cycle

The bacterium survives for long periods of time in soil, within galls and within infested vines.

Agrobacterium tumefaciens is found commonly on and around root surfaces, the region termed the rhizosphere, where it seems to survive by using nutrients that leak from the root tissues. But it infects only through wound sites, either naturally occurring or caused by transplanting of seedlings and nursery stock.

Control:

Chemical control:

Because the bacterium lives in the soil chemical sprays cannot control it.

Cultural control:

- BEFORE PLANTING:

It is necessary to examine new plants and discard any that have galls.

- IN THE VINEYARD:

Remove large galls on the upper parts of the trunk or on the arms by pruning the arm or trunk below the affected tissue and renew the vine by means of a shoot from the base of the vine.

Therefore, management practices that minimize the risk of cold injury are currently the only practical technique for managing the disease. When infected vines are pruned, disinfect shears between cuts.

2. Name of the Disease: BACTERIAL BLIGHT

Causal Organism: *Xylophilus ampelinus*

Host range:

X. ampelinus causes disease on grapevines only.

Occurrence and importance:

The severity of this disease in affected vineyards may vary strongly from year to year. This disease is responsible for progressive destruction of vine shoots, leading to their death.

Symptoms and changeable diseases:

The capability of *X. ampelinus* to survive for several years inside plants without inducing symptom development may result in a latency period, which depends on many factors including climatic conditions.

The bacteria entered the plant through all types of natural and artificial wounds. They were then observed in the sap and in the xylem vessels, where they found favorable environmental conditions for their development.

The symptoms on **leaves** are small black spots with marginal necrosis

In early spring the **shoots** develop dark brown streaks, chlorotic and stunted.

On **brunches** can be observed dark longitudinal cankers develop on the peduncle and the rachis

This bacteria can produce **berries** fail to mature fully.

Disease Cycle

X. ampelinus is a gram negative and aerobic bacteria that only survives on alive wood and pruning wood for 5 o 6 months.

The bacteria penetrate in vine wounded tissues and develop in the intercellular tissues affecting the cellar functions.

This is a diseases associated to humid climates. The dissemination is favored by rain-irrigation.

Control:

Chemical control:

Bordeaux or copper sprays after pruning and up until half leaf expansion can be effective to control this disease.

Active ingredient	Activity	Rates
Copper hidroxide	Contact	0'15-0'55 %
Metalaxil + Copper oxychloride	Contact	0'4-0'5 %
calcium Copper Oxychloride	contact	0'4-0'6 %
Copper oxychloride + calcium copper sulphate	Contact	0'55-0'77 %
Copper oxychloride	Contact	0'15-0'25 %
Copper oxide	contact	0'2-0'3%
calcium copper sulphate	Contact	0'6-1 %

Cultural control:

Sanitation management is essential

- Use always plant disease free stock
- Infected branches and canes should be pruned and burned

FUNGAL DISEASES

WOODY DISEASES

1.- **Name of the Disease: EUTYPA DIEBACK**

Causal Organism: *Eutypa lata*

(Ascomycotina, Diatrypales, Diatrypaceae)

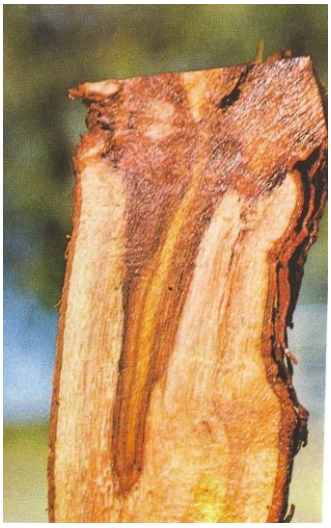
Host range: This fungus has a wide range of host, which includes at least 80 species. Most of the hosts are tree species

Occurrence and importance:

This disease affects a great number of vineyards all around the world and is one of the most destructive diseases on woody tissue of grapes.

Symptoms and changeable diseases:

There is usually a delay of several years between infection and the appearance of symptoms.



The earliest symptoms are cankers formed around pruning wounds that were infected several years ago. A cross section of the sapwood often reveals a wedge shaped zone of necrotic tissue.

The fungus toxins cause the secondary symptoms and they are.

- Shoots with short internodes
- Crinkled and cupped leaves with necrosis and tattered margins
- Aborted flowers and clusters.

Disease Cycle

The fungus over winters, resisting to the adverse conditions, as perithecia that develop in the dead branches. The fungus is never found in young wood.

Perithecia occur on stromatic tissue on the surface of dead wood and maintain activity for 5 or ore years.

Spores are dispersed by the wind and infection takes place when they penetrate the xylem tissue through pruning wounds, and then propagate into the cambium and phloem in the vein trunk and arms.

Control

Chemical control:

No grape cultivars are known to be immune to this disease, and any chemical used to control other grape diseases provide protection.

Cultural control:

Cultural and sanitation practices are essential:

1. Remove other host species such as old apricot trees from vicinity
2. Infected arms and trunks should be removed in late spring when wounds are less susceptible.
3. Pruning should be far enough below the canker, where healthy wood is evident.
4. Apply fungicide paint wound protection of large pruning cuts to mature wood.
5. Any infected wood or stumps should be removed and destroyed

Rain is necessary for the spread of this disease.

In winter, during rainfall or snow melt, fungal spores are released from fruiting structures on dead infected wood.

2. Name of the Disease: ESCA (BLACK MEASLES)

Causal Organism: *Stereum hirsutum*

(Basidiomycotina, aphyllophorales, stereaceae).

Host range:

Wide range of crops, mainly grapevine.

Occurrence and importance:

Esca is one of the most destructive diseases of woody tissues in grapevine

The esca diffusion through the country reaches all grape-growing.

Symptoms and changeable diseases:

The xilem presents dark necroses, starting at the medullar tissue and presenting, in transverse section, a black limiting line with a whitish and spongy central part.

As secondary symptoms, the vegetative vigor shows a progressive reduction with occurrence of chlorotic spots (in white varieties) and reddish spots (in red varieties), together with necrotic area in leaves that cause drying premature defoliation.

Disease cycle:

The fungus survives for several years in the infected xylem spongy tissues under the form of endoconidia, macroconidia and sclerotia; these are released after decomposition of the tissues.

The infection takes place through the wounds by the inoculum carried by the wind.

The mycelium penetrates through the medulla and xylem, after the tissues being degraded by precursor fungi (*Eutypa lata* and others) that destroy cellulose, hemicellulose and phenolic compounds.

Later, the fungus may produce fructifications (basidiocarps) at the surface of the plant and branches affected or dead. Infection can rarely occur from basidiospores of the surface fructifications, which are usually sterile.

Control:

Since the recent sodium arsenite ban, there is no other chemical means of controlling wood diseases.

Nowadays, the only solution consists in sanitation methods:

1. Remove of all infected wood.
2. Protect with a biological agent preparation or fungicide the large pruning wounds.

3.- Name of the Disease: ROOT ROT

Causal Organism: *Armillaria mellea*

(Basidiomycotina, Asidiomycotina, Agaricales, tricholomataceae)

Armillaria is a wood-decay fungus.

Host range: *Armillaria mellea* occur on a wide range of angiosperms and gymnosperms. Hosts include fruit trees (citrus, peaches, almonds, avocado, cocoa, coffee, kiwifruit, etc,) vine, shrubs, and shade and forest trees.

Occurrence and importance:

Armillaria root disease is worldwide in distribution. The disease occurs most often when a vineyard replaces an infected orchard, or when a vineyard site has recently been cleared in a forested area. *Armillaria* infects vine roots and can eventually kill the vine. Damage usually occurs in small patches of vines, rather than entire vineyards.

Symptoms and changeable diseases:

The plants lost vigour and show:

1 Reduced growth
2 Weak wine shoots
3 Yellowish leaves in summer;
4 Premature defoliation,
5 Progressive drying of the branches,
6 Canker formation near the collar and rot
7 And death of roots with musty smell;

Eventually all the plant may collapse.

Under the bark of the affected roots, fan like plates of yellowish-white mycelium appear; outside the bark, however, rhizomorphs can be found.
After the first autumn rains and early winter, honey coloured mushrooms may appear on the basal part of the plants, but this may not occur on an annual basis. Therefore, absence of mushrooms does not mean absence of infection.

Disease Cycle

Armillaria mellea lives in soil but needs woody tissue on which to survive.
The infection results from the contact of the healthy plant roots with old Armillaria-infected root pieces, with the inoculum present in the soil or with the rhizomorphs or fragments of them.
The fungus penetrates through the roots, kills the cambium and destroys the xylem.
The infection may start from the basidiospores that germinate in the root wounds and dead tissues. The mycelium develops always under the bark, whereas the rhizomorphs may appear also surrounding the external part of the root.
The sexual fructification, basidiocarps, are honey-coloured mushrooms.
It may spread to neighboring vines forming distinctive clusters of dead vines.
It can live in decaying roots for up to 50 years, depending on their mass.

Control:

Cultural controls are more promising for long-term control of *Armillaria* than chemical controls, especially those that decrease soil moisture at the base of the vine.

Chemical control:

Fumigation is most effective if done on sites with thorough root removal and dry soil in the root zone.

Active ingredient	Activity	Rates
Cubiet	Contact	10-50 l/root

FOLIAGE AND FRUIT DISEASES

4.- Name of the Disease: POWDERY MILDEW,

Causal Organism: *Uncinula necator*
(Ascomycotina, Erysiphales, Erysiphaceae).

Host range: wide range of host including herbaceous and trees
Cultivars of the European grape (*Vitis vinifera*) are highly susceptible, and include the most popular wine and table grapes.

Occurrence and importance:
Powdery mildew, caused by *Uncinula necator*, is the most destructive disease of the grape anywhere that wine grapes are produced. It can have adverse affects on vine growth, yield, and winter hardiness. Wine quality can be affected when only 3% of berries are infected.

Symptoms and changeable diseases:
The fungus affects all green tissues and can be found mostly on the leaves and fruit stems.

The powdery mildew is visible under naked eye as a white-greyish downy grouth that may cover the leaves, young shoots and bunches.
In the **shoots**, brown spots with a white-greyish powder originating deformations in the younger ones, and yellow brownish spots with fibrous-looking edges in the mature ones.

In the **leaves**, light brown spots in the veins of the leaf (lower surface) originating deformations with wavy and crinkly aspect. Greyish-white dusty outer covering, on the leaf surfaces. . Severely diseased leaves may become puckered and distorted.

If **blossom clusters** are affected, the **flowers** may wither and drop without setting fruit. Infections on cluster stems often go unnoticed, but can be very damaging. Infected cluster stems may wither and dry up, resulting in berry drop

Affected **berries** may have spots on the surface similar to those on the leaves, or the entire berry may be covered with the white, powdery growth. Infected berries often are misshapen or have rusty spots on the surface.

Severely affected fruit often split open.

When berries of purple or red cultivars are infected as they begin to ripen, they fail to color properly and have a blotchy appearance at harvest. Berries are susceptible to infection until their sugar content (0Brix) reaches about 8 percent.

As spores are produced, the colony takes on a white, powdery appearance. On fruit and rachises the pathogen appears as white, powdery masses that may colonize the entire berry surface.

Disease cycle:

The fungus cannot be grown in artificial media, which means it is an obligate parasite.

The fungus overwinters resisting to the adverse conditions in two ways:

1) as dormant mycelium (asexual form) protected under bud scales
2) as sexual fructifications (cleistothecia) in the bark.

The infections take place from the mycelium, while cleistothecia release sexual (ascospores) that start new colonies (primary infections).

The superficial mycelia penetrate in the host epidermal cells through haustoria. The ascospores have a low range of dissemination (limited to places where the disease occurred in the previous year).

Infection usually starts soon after the blossom period and will continue on the foliage through the growing season. The favourable conditions to the attack of this parasite are temperatures of 25-28 °C. (optimal), after the bursting of the shoots. The fungus develops in dry conditions when the relative humidity is high.

Mildew colonies produce masses of white powdery secondary spores (conidia).

Conidia are wind-dispersed throughout the vineyard and do not require rain for release or infection. New colonies that result from these secondary infections produce additional conidia, which can continue to spread the disease.

In autumn, cleistothecia are formed from the subtle mycelia that covers the leaves and the immature tips of the shoots.

This repeating cycle of infection, spore production, spore dispersal, and re-infection can continue until there is no longer any healthy host tissue available for infection, until the onset of adverse weather conditions, or host dormancy.

Control:

Cultural control:

Cultural practices that promote good air circulation and light penetration should be followed. This promotes drying and lowers the humidity, which in turn should lessen disease pressure.

The excessive amounts of nitrogen will promote the production of succulent and susceptible tissue, thicken the canopy, and increase disease pressure.

Chemical control:

On susceptible varieties, control is based on the use of properly timed applications of effective fungicides.

Active ingredient	**Activity**	**Rates**
Azoxystrobin 25%	Systemic	0.08-0.10%
Sulfur 50% + Miclobutanil 0,8%	Contact/systemic	0.40-0.80%
sulfur 60% + Endosulfan 3%	Contact/ingest	20-30 Kg/ha
sulfur 70% + Cipermetrin 0,2%	Contact/systemic	15-25 kg/ha
sulfur 70% + Cipermetrin 0,2% + Maneb 4%	Contact/systemic	15-25 kg/ha
sulfur 72%	contact	0.20-0.60%
Sulfur 75% + Fenarimol 1,8%	Contact/systemic	0.10-0.15%
Captan 40% + Carbendazim 8%	Contact/systemic	0.30%
Captan 50% + Thiophanate Methyl 18%	Contact/systemic	0.20-0.25%
Carbendazim 2,5%	systemic	20-30 kg/ha
Carbendazim 8% + Folpet 40%	systemic	0.25-0.30%
Cyprocanazole 10%	systemic	0.01-0.02%
Diniconazole 5%	systemic	0.05-0.10%
Dinocap 18%	contact	0.06-0.10 %
Dinocap 0,7%+ copper oxychloride 4%	Contact	20-30 Kg/ha
Fenarimol 12%	systemic	0.02-0.05%
Flusilazole	systemic	0.01-0.05%
Propiconazole 10%	systemic	0.05%
Tebuconazole 25%	systemic	0.04-0.10%
Triadimenol 25%	sytemic	0.03-0.25%
Trifloxystrobin 50%	contact/systemic	0.0125-0.015%

5. **Name of the Disease: DOWNY MILDEW**

Causal Organism: *Plasmopara viticola*
(Mastigomycotina, Peronosporales, Peronosporaceae).

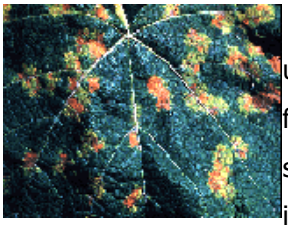
Host range: wide range of host including herbaceous and trees.

Occurrence and importance:

Downy mildew is the major disease of grapevine under humid conditions. Always present, in most parts of world where grapes are grown. However, in years with unfavorable conditions, the disease may appear only late, causing no or little damage.

Symptoms and changeable diseases:

Downy mildew occurs wherever it is warm and wet during the growing season and it develop most spectacularly and destructively on leaves, but they may also attack other non-woody parts such as shoots, petioles, flowers, berries and pods.



Leaf lesions appear as yellow or reddish brown areas on the upper leaf surface with corresponding white, downy or cottony fungal growth on the lower surface. Sometimes lesions are oily, somewhat angular and are located between the veins. Severely infected leaves often fall prematurely.

Young, infected **shoots** and **cluster stems** may curl and are frequently covered with a white, sporulating, fungal mass.
The fungus grows internally on these **berries** causing a condition referred to as brown rot and eventually shrivel. Young berrries are highly susceptible.

Disease Cycle

Free water is an absolute requirement for the development of this fungus.

Downy mildew fungi have a very short generation time. The number and duration of wetting periods are therefore critically important in downy mildew epidemiology, probably more so than with any other single group of plant diseases.

This fungus overwinters as dormant spores in fallen leaves on the vineyard floor. The fungus first becomes active in the spring about 2-3 weeks before bloom. This fungus has two types of spores, both germinating to give rise to swimming spores.

Primary infection occurs when these spores germinate and penetrate the host through stomata. The fungus becomes established as intercellular mycelium and then produces sporangia that exit host tissue through stoma on the undersides of leaves or lenticels on fruit.

Zoospores released from these structures causes **secondary infections**, entering the host through stomata or lenticels. As the season progresses, oospores are formed from mycelium within host tissue completing the life cycle.

Control:

Chemical control:

The most common way of controlling downy mildew is through the use of fungicides. Fungicides should be applied just before bloom.

Protectant fungicides such as cupric salts, dithiocarbamates containing Manganese and Zinc ions and Captan are used as preventatives. The systemic compound Metalaxyl can be used as a curative treatment.

Active ingredient	Activity	Rates
Azoxystrobin 25%	systemic	0.08-0.10%
Copper calcium sulfate	Contact	0.5-1%
Copper oxychloride	Contact	0.30-0.40%
Copper hydroxide 50%	Contact	0.15-0.25%
Captan 10%	Contact	20-30 kg/ha
Captan 40% + Carbendazim 8%	Contact/systemic	0.30%
Captan 50% + Thiophanate Methyl 18%	Contact/systemic	0.20-0.25%
Captan 50% + Triadimefon	Contact	0.15-0.20 %
Folpet 10%	Contact	20-30 kg/ha
Mancozeb 80%	Contact	0.20-0.40%

Maneb	Contact	20 kg/ha
Metalaxyl 25%	systemic	0.12-0.80%

Cultural control:

Indeed, some preventive management practices should be taken as:

- Make sure soils are well-drained
- Reduce the sources of overwintering inoculum (fallen leaves)
- prune out the ends of infected shoots.
- Any practice that improves air circulation and speeds drying within vine canopies will help to control downy mildew.
- Spring cultivation to bury fallen, infected leaves from the previous year will also help to reduce early season disease pressure.

6. **Name of the Disease: BOTRYTIS BUNCH ROT**

Causal Organism: *Botrytis cinerea*

Host range:

Botrytis cinerea infects numerous wild hosts and cultivated plants.

Occurrence and importance:

Botrytis bunch rot or gray mold is a disease that exists in all vineyards worldwide, displaying very different degrees of virulence toward one given host plant species. It causes the greatest economic losses especially on French hybrids and *Vitis vinifera* cultivars.

Symptoms and changeable diseases:

On **Shoots,** under favourable conditions, Botrytis infects young succulent shoot growth early in the season causing patches of soft brown rot, which often break at the nodes revealing a brown discoloration of internal tissues.

Shoot stems are usually girdled at the point of infection and their extremities either wilt and die or break off.

When **young leaves** are infected, the fungus usually grows from the edge of the leaf into the main veins producing a brown, V-shaped area of dead tissue.

Infected **inflorescences** develop patches of brown, mushy rot that spread along the main stalk (peduncle) until the inflorescence is completely rotted.

First signs of infection in mature grape **berries** are small circular water-soaked spots.

On colored grapes, these spots may be faintly clear and relatively indistinct. When berries are rubbed, the skin over these spots cracks and slips freely, revealing the firm inner berry pulp.

Disease cycle:

The pathogen overwinters on bark, in dormant buds and in debris on the vineyard floor or on the vine.

In the spring, spores are produced by the fungus and infect leaves and young grape clusters. Mainly air currents move about spores on decaying and dead vegetation.

Infections require free water for a definite period of time depending on temperature. Berries that have been damaged by insects, birds, machinery, etc. may become infected at any time after the fruit begins to ripen because the juice in the berry can provide the necessary water and nutrients for fungal growth.

The funguses can more easily attack injured or senescing tissue. Any break in the skin of ripening grapes provides an ideal entry point for the Botrytis fungus as well as a moist medium in which the spore can germinate.

Control:

Cultural control:

Control of Botrytis bunch rot can be achieved through the application of well-timed fungicide treatments integrated with vineyard sanitation and vine canopy management practices:

- Practices that improve air circulation and thereby reduce humidity in the canopy are beneficial.
- Removal of four to five basal leaves has resulted in significantly reduced incidence and severity of disease.
- Any practice that reduces skin cracking or skin punctures near harvest helps control ripe fruit rot.

Chemical control:

Well-timed sprays of an effective fungicide are important if weather is relatively wet between veraison and harvest.

Applications of protectant fungicides in spring may be necessary to reduce the incidence of shoot infection, the loss of inflorescences and the amount of young fruit infection.

Preharvest fungicide applications are also recommended.

Active ingredient	Activity	Rates
Captan 20% + Carbendazim 6% + Tiram 30%	Contact/systemic	0.20-0.30 %
Captan 40% + Carbendazim 8%	Contact/systemic	0.30%

Captan 50%	Contact	0.30-0.40 %
Carbendazim 2.5%	Systemic	20-30 kg/ha
Carbendazim 8% + Folpet 40%	Contact/systemic	0.25-0.30 %
Folpet 50%	Contact	0.25-0.30
Iprodione 50%	Contact	0.1-0.15%
Mancozeb 50% + Thiophanate Methyl 25%	Contact/systemic	0.2-0.4%
Maneb 50% + Thiophanate Methyl 25%	Contact/systemic	0.20-0.35 %
Pirimetanyl 40%	Systemic	0.15-0.20 %
Tebuconazole 25%	Systemic	0.04-0.10 %
Tiram 50%	Contact	0.35-0.50%

7.- Name of the Disease: BLACK ROT

Causal Organism: *Guignardia bidwellii*
(Ascomycotina, Dothideales)

Host range: grapevine

Occurrence and importance:

Black rot, a foliar and fruit disease, is one of the most common and serious diseases of wild and cultivated grapes in all areas where it occurs. The principal disease loss is the direct destruction of fruit.

The disease is most destructive in warm, humid areas. The fungus develops in every growing season, and, if left uncontrolled, it will destroy fruit on most cultivars.

Symptoms and changeable diseases:

The fungus attacks canes, tendrils, leaves, and fruit.

On **leaves**, the black rot disease appears in late spring on the upper surface as definite necrotic (dead) spots, which are at first circular and red . Later, the spots are visible on both sides of the leaf. As the spots enlarge, their margins become black and the red spots turn brown.

On **shoots**, lesions may appear as circular to oval shaped dark brown to black sunken cankers, larger.

Infected **berries** initially turn brown in color, and may remain as a cluster on the vine or fall to the ground as individual berries leaving only the rachis.

The final stage is a dark purple to black, wrinkled mummy.

Irregular necrosis of the tissues, spreading to the branches produces wilt

Reddish or brownish necrosis in the peduncle and main branching of the rachis produces bunches wilt.

Disease cycle:

The fungus persists in cane and tendril lesions and fruit mummies. In spring, spores of the fungus are carried to young tissue by splashing or wind-blown rain. After spring rains thoroughly soak the mummies, spore-bearing bodies (asci) in the perithecia forcibly release ascospores. Air movements carry ascospores to developing plant parts, which they infect under wet conditions. Some ascospores are also released during the summer when heavy rains occur and also infect tissues. Thus, there can be a continuous primary infection of tissues.

Fruit infections occur from midbloom until the berries begin to change color (véraison). Most serious fruit infections occur when the grape is pea-sized or larger. Mature leaves and ripe fruit are not susceptible.

Very few fruit or leaves are infected after late July and none are infected after the end of August.

Control:

Cultural control:

Sanitation is very important in the control of black rot.

- Destroy mummies,
- Remove diseased tendrils from the wires,
- When pruning, if possible, leave only fruiting canes without lesions.
- If only a few leaf lesions appear in the spring, remove these infected leaves because the disease spreads rapidly after a few infections become established.

When grapes are exposed to light and good air circulation, they are less likely to have black rot. Cultural practices that open the canopy are beneficial because they increase air circulation and improve spray coverage. Should infections become numerous, it is very difficult to protect against fruit rot later in the growing season.

Chemical control:

A fungicide spray program, especially early in the season, is required for adequate control of black rot. Certain fungicides are effective for preventing black rot if they are applied beginning early in the spring when the young shoots are developing and spraying is timed to anticipate a rainy period.

Active ingredient	Activity	Rates
Azoxystrobin 25%	Systemic	0.08-0.10 %
Folpet 25% +Fosetil-AL 50%	Contact/systemic	0.20-0.40%
Folpet 50%	Contact	0.25-0.30%
Mancozeb 45%	Contact	0.35-0.70%
Metalaxyl 5% + copper oxychloride 40%	Systemic/Contact	0.40-050 %
Propiconazole 10%	Systemic	0.05%

8.- Name of the Disease: PHOMOPSIS CANE, LEAF SPOT, AND FRUIT ROT EXCORIOSIS

Causal Organism: *Phomopsis viticola*.
(Ascomycotina, Diaporthales, Valsaceae)

Host range:

Grapevine (*Vitis* sp) and virginia creeper (*Parthenocissus quinquefolia*) species are the only known hosts.

Occurrence and importance:

Phomopsis cane, leaf spot is widely distributed in vineyards. The disease can weaken vines, reduce yields and lower fruit quality. This disease was often the first disease of the growing season to appear in the vineyard.

Symptoms and changeable diseases:

The fungus attacks canes, tendrils, leaves, and fruit.

The infected **young leaf** blades have small, light green or chlorotic, irregular to circular spots with dark centres (fig 33). Dark brown to black necrotic spots may also occur along primary and secondary leaf veins and petioles. Infected portions of the leaf may turn yellow, then brown

On **shoots**, small spots with black center occur usually on a basal portion of the shoot. After spots lengthen a few millimeters, the epidermal layers of the shoots usually crack at the infected parts.

On **clusters**, spots similar to those that occur on leaves and shoots occur on the flower cluster stems. Cluster stems can blight and become brittle if infections are high. These clusters usually break and the fruit is lost.

Lesions on leaves, shoots, and clusters become inactive during the summer heat but rain just before harvest can cause light brown spots on clean berries and spots quickly enlarge and become dark brown.

Berries may shrivel and become mummified.

Heavy infection usually results in a scabby appearance of the basal portions of the shoot.

Disease cycle:

The fungus overwinters in bark and leaf petioles. Black fruiting bodies of the fungus overwinter in infected canes and rachises.

During early spring rains, spores ooze from fruiting bodies and are rain splashed onto susceptible young tissue. The infection occurs after the bursting of the buds at the base of the stem, or in nearer internodes, after the germination of the pycnidiospores with favourable temperatures (8-10 °C.) and rain for at least 12 hours, penetrating afterwards in the internal tissues of the xylem.

Shoot and leaf lesions appear within 3-4 weeks after infection but do not form new spores until the following year.

Rachises are susceptible from the time they first become visible until after peas-sized fruit have formed.

Fruit infections occur primarily from bloom through shatter, then remain dormant until just before harvest. Thus, severe fruit rot can develop at harvest if the bloom period is very wet and fungicidal protection is not provided, particularly in high-risk vineyards.

Long distance spread occurs via the movement of diseased propagation materials such as budwood, cane cuttings and nursery stock.

Control:

Phomopsis becomes a problem when the fungus is allowed to build up on dead canes in the vines.

Diseased canes should be removed during pruning to reduce inoculum.

Cane blight and leaf spot can be controlled by a combination of sanitation and fungicide applications.

At pruning, remove dead and diseased wood.

The cane and leaf infections can be prevented by one, or two early-season fungicide sprays. The amount of new shoot infections the previous two years, combined with prolonged rainy periods the current year, are indications for the need of one or two fungicide applications.

The period from bloom through fruit set is a critical time to protect against fruit infection under wet conditions. Fruit and cluster stem infections occur from bloom until the fruit are pea size. Regular fungicide applications are necessary to prevent disease.

No registered fungicide provides post-infection control.

Active ingredient	**Activity**	**Rates**
Folpet 10% + Metalaxyl 8%+ Copper oxychloride 7’5%+ Copper calcium sulphate 7’5%	Contact/systemic	0.25-0.35%
Folpet 25% + Fosetil-AL 50%	Contact/systemic	0.20-0.40%
Mancozeb 75%	contact	0.25-0.70 %

9.- **Name of the Disease: ANTHRACNOSE (BLACK SPOT)**

Causal Organism: *Elsinoe ampelina*
(Ascomycotina, Dothideales, Elsinoaceae)

Host range:
All grapevine (*Vitis* sp.) species are more or less susceptible**:**

Occurrence and importance:
This disease reduces the quality and quantity of fruit and weakens the vine. Once the disease is established in a vineyard, it can be very destructive.

Symptoms and changeable diseases:
All succulent parts of the plant, including fruit stems, leaves, petioles, tendrils, young shoots, and berries, can be attacked by this fungus, but lesions on shoots and berries are most common and distinctive.
Diseased plants may exhibit stunting and death of young shoots, deterioration of older shoots and stocks and loss of fruit yield.
Starting from flowering the plants are susceptible as long as succulent green tissues are formed.

On **leaves** lesions are usually circular with dark brown margins, pale centers and surrounded by a light green halo. When veins are affected, especially on young leaves, the lesions prevent normal development, resulting in malformation or complete drying or burning of the leaf.

On young succulent **shoots** first appear as numerous small, circular, and reddish spots. Spots then enlarge, become sunken, and produce lesions with gray centers and round or angular edges . Dark reddish-brown to violet-black margins eventually surround the lesions. Lesions may coalesce, causing a blighting or killing of the shoot.

On **petioles** appears similar to that on the shoots.

On **berries** lesions start out black, but become light in the center with age and crack into the flesh.

Disease Cycle

The fungus overwinters, surviving in adverse conditions as sclerotia on the shoots, providing inoculum in spring (primary infections). Sporulation in spring is favoured by wet, humid weather, however, it may occur at temperatures as low as 2·C.

Once the disease is established, asexual fruiting bodies form on diseased areas. These asexual fruiting bodies produce conidia formed on young shoots in the primary infections during periods of wet weather. These conidia are the secondary source of inoculum and are responsible for continued spread of the fungus and the disease throughout the growing season. Splashing rain to new growing tissues spreads conidia.

Control:

Sanitation is very important. Prune out and destroy diseased plant parts during the dormant season. This includes infected shoots, cluster stems, and berries. This should reduce the amount of primary inoculum for the disease in the vineyard.

Canopy management can aid in disease control. Any practice that opens the canopy to improve air circulation and reduce drying time of susceptible tissue is beneficial for disease control. These practices include selection of the proper training system, shoot positioning, and leaf removal.

The disease proves to be difficult to control once it established itself during the growing season. The most effective way to control anthracnose is by the application of a lime sulfur spray applied shortly before budbreak during dormancy followed by applications of foliar fungicides during the growing season.

Active ingredient	**Activity**	**Rates**
Mancozeb 15% + copper oxychloride 22%	Contact	0.40%
Mancozeb 40% + Copper sulphate 11%	Contact	0.30%

Mancozeb 8% + calcium Copper sulphate 20%	Contact	0.40-0.60%
Maneb 17.5% + copper oxychloride 30%	Contact	0.30-0.50%
Maneb 8% + calcium Copper sulphate 20%	Contact	0.40-0.60%
Tiram 50%	Contact	0.35-0.50%

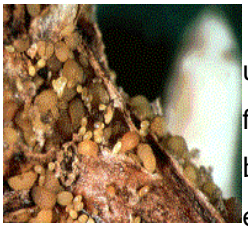
4. PEST

1. **Name of pest:** **PHYLLOXERA VASTATRIX** ***(Daktulosphaira vitifoliae)***
FILOXERA
(Hemiptera, Homoptera, Aphidae)

Host range: grapevine
Grape phylloxera is a tiny aphidlike insect that feeds on *Vitis vinifera* grape roots, stunting growth of vines or killing them.

Occurrence and importance:
The phylloxera has made its appearance in almost every vinegrowing country in the world.
Originating from North America, this louse is known as Phylloxera Vastatrix (PV). Phylloxera is the species name and 'Vastatrix', meaning destroyer, was appended during the devastation of the French vineyards. PV has not been eradicated. The louse still exists today and is a dangerous pest to the vineyard but, with careful controls and with the knowledge acquired over the centuries, its damage can be limited.

Symptoms:
Grape phylloxera damage the root systems of grapevines by feeding on the root, either on growing rootlets, which then swell and turn yellowish, or on mature hardened roots where the swellings are often hard to see.
Necrotic spots develop at the feeding sites on the roots. The necrotic spots are a result of secondary fungal infections that can girdle roots, killing large sections of the root system. Such root injury causes vines to become stunted and produce less fruit.



If the roots are examined numerous fusiform swellings are found upon the smaller rootlets. These are at first yellowish in color and fleshy, but as they grow older they become rotten and assume a brown or black color. If the roots, on which these swellings occur be examined with a lens, a number of minute insects of a yellowish-brown color are observed. These are the root-forms (radi cola) of Phylloxera.

The vines are stunted and bear few leaves, and those small ones. When the disease reaches an advanced stage the leaves are discoloured, yellow or reddish, with their edges turned back, and withered.

The grapes are arrested in their growth and their skin is wrinkled.

Severity of infestation will differ with the vigor of the grapevine as well as with soil texture and drainage. This pest prefers heavy clay soils.

Description of pest:

The **adult** of Phylloxera is a small insect, about 8 mm long and vary in color from yellow, yellowish green, olive green, to light brown, brown, or orange. They are generally oval shaped. The head bears small red eyes and pair of three-jointed antenna, the first two joints being short and thick, the third more elongated, with the end cut off obliquely. (FIG 48)

The **eggs** are yellow, oval, and about twice as long as wide.

Nymphs resemble adults except they are smaller.

Life cycle:

The majority of grape phylloxera adults are wingless females, which lay parthenogenetic eggs.

The insect is fixed by its proboscis, but moves its abdomen about and lays thirty to forty yellow eggs in small clusters.

After the lapse of six, eight or twelve days, according to the temperature, the larvae hatch out of the eggs.

They move actively about for a few days and then, having selected a convenient place on the young roots, insert their proboscis and become stationary.

As the summer wears on a second form of insect appears amongst the root-dwellers, though hatched from the eggs. These are the nymphs, destined to acquirt wings. Their body is more slender in outline, and at first they bear well-marked tubercles.

After several moults the rudiments of two pairs of wings appear, and then the insect creeps up to the surface of the earth, and on to the vine. Here it undergoes its fifth and last moult, and appears as a winged female, capable of reproducing parthenogenetically.

Control:

The best preventative measure against Phylloxera vastatrix is to use resistant or tolerant root stocks in infected areas. The vast majority of vines in Europe and the rest of the world are grafted on to American rootstocks, because they are resistant.

Another measure that should be taken are:

- Clean planting material.
- Restrict the movement of machinery from infected areas.

Some success as been claimed with management of infected vines through careful watering and nutrient supply.

2. **Name of pest: POLYCHROSIS BOTRANA OR MEDITERRANEAN VINE MOTH (*Lobesia botrana*)**

(Insecta, Lepidoptera, Tortricidae).

Host range:

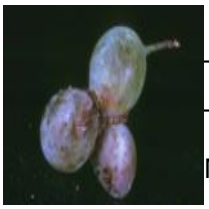
Stone fruits (Prunus), and grapevine (Vitis) are the chief hosts. Other hosts are *Daphne gnidium*, a wild plant as well as ivy (*Hedera*), privet (*Ligustrum vulgaris*), black currant, currant.

Occurrence and importance:

This pest is distribuited in South-central and southern Europe, particularly Spain, southern Russia, Portugal, southern France, Italy, Greece, and Bulgaria. Also it is present in North and East Africa, Middle East Assia and Japan.

Symptoms:

The damage caused by the parasites is "indirect". In fact, they empty the berries and create a favorable environment for the development of various moulds, in particular Botrytis.



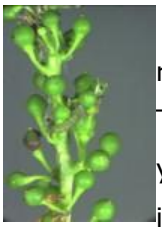
The attacked fruits turn brown at the place of attack and rot.

The presence of larvae and rotten fruits lowers the quality of the crop. Moulds render vine making difficult and may require the crop to be

harvested prematurely.

Description of pest:

The **adult** is 18 to 20 mm wingspan. It present long and thin antennae. The wings are pearly grey fore sprinkled with small reddish brown areas with 3 slightly slanted bands: one at the base, one at the centre of the wing, broadened in its middle, and one apical, quite dark bordered by a clearer zone. The head and thorax are white, suffused with brown and the abdomen is grey.



The **egg** is circular, of a diameter of 0.6 to 0.7 mm with fine polygonal reticulation. Initially it is yellow, becoming translucent grey.

The **larva** is narrow, yellowish green to greyish green, with a brownish yellow head and thoracic plate. It is very agile and moves rapidly. When it is disturbed, it drops to the ground, suspending itself by a silk thread.

The **pupa** is dark brown, slender. It present dorsal abdominal bands of spines well developed.

Life cycle:

The small parasite passes the winter as chrysalis inside a whitish cocoon in the wrinkles of the vine trunk.

The adults appear towards the month of April and the beginning of May and by the middle of the month you can start finding the eggs on grape blossoms, on young grapes, or on the vine.

In spring the eggs hatch in 7-11 days, and in summer in 3-5 days. Larvae of the first generation feed on buds and on flowers.

In June the larva become chrysalis and the adults deposit the eggs of the second generation directly on the berries, and this is the phase when the damage is initiated by *Lobesia botrana*.

Development ceases at temperatures below 10’5º·C.

All moths of the same generation do not emerge at the same time. Several weeks may pass between the emergence of the first and last moth of the same generation.

Control:

It is utilized the method of "mating disruption", based on the inhibition of males ability to recognize the odorous trails left behind by the females.

Several kinds of pheromone dispensers are available: rubber tubes, simple or multiple plastic capillaries, ampoules, plates made of different materials. Some of these systems brought about positive results on a large scale application.

Chemical control:

Active ingredient	Activity	Rates
Sulfur 70% + Cipermetryn 0.2%	Contact/ingest	15-25 kg/ha
Sulfur 80%+ Fenitrotion 4%	Contact/ingest	20-30 kg/ha
Bacillus thuringiensis kurstaki 17'6%	Ingest	0.50-1.5 kg/ha
Carbaryl 50%	Contact/ingest	0.20-0.30%
Carbaryl 37.5% + chlorpyrifos 24%	Contact/ingest/inhale	0.20-0.30%
chlorpyrifos 3%	Contact/ingest/inhale	20-30 kg/ha
chlorpyrifos 24% + Endosulphan 20%	Contact/ingest/inhale	0.13-0.18%
Deltametrin 2'5%	Contact/ingest	0.03-0.05%
Esfenvalerate 5%	Contact/ingest	0.2-0.3 l/ha
Fenitrotion 40%	Contact/ingest	0.15-0.20%
Flufenoxuron 10%	Ingest	0.05-0.10 %
Fosmet 45%	Contact/ingest/inhale	0.15-0.25%
Lamda Cihalotryn 10%	Contact/ingest	0.40-0.50%
Malathion 50%	Contact/ingest	0.30 l/ha
Methyl azinfos 3%	Contact/ingest	20-30 kg/ha
Tebufenozide 24%	Contact/ingest	0.05-0.06%
Methyl pirimiphos 2%	Contact/inhale	20-30 kg/ha
Tiodicarb 37'5%	Contact/ingest	1.5-2.5 l/ha
Trichlorfon 50%	Contact/ingest	0.25-0.40%

3. **Name of pest: LEAF ROLLING TORTRIX** (*Sparganothis pilleriana)*
(Insecta, Lepidoptera, Tortricidae).

Host range

Main hosts are vines, Artemisia (*Artemisia vulgaris*), yellow bedstraw (*Galium sp.*), bramble (*Rubus sp*.), elm (*Ulmus sp*.), hop, pear, plantain (*Plantago sp*.), strawberry.

Occurrence and importance:

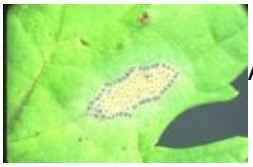
This tortricid moth is world wide distributed. It may cause occasional serious damage to grapevines.

Symptoms:

The larva causes by feeding on buds, shoot, leaves, inflorescences and grape bunches.
The leaves appear pierced and gnawed keeping them together with silk threads. In spring, damage can be extremely serious and the leaves of the extremity of vines can be totally destroyed.
It also nibbles the peduncle of leaves, which dry up and turn reddish.
The attacked grapevine presents a silvery aspect.

Description of pest:

The **adult** is 20 to 25 mm wingspan, brown head with 2 long labial palps directed anteriorly, forming a type of rostrum. The wings are trapezoidal fore, straw yellow with 3 reddish brown transversal bands; uniformly slate grey and finely fringed hind wings.



At the first the **egg** is emerald green, and later becomes brownish

The **larva** at the first-instar larva is 1’2 to 2’0 mm and the fully-grown larva is 30 mm. The head and the prothorax are shiny brown-black. The greyish, greenish or reddish body has fine bristles inserted on the clear pinacula. It is very alert and the caterpillar allows itself to drop suspended by a silk thread if disturbed.

Life cycle:

The moth is active at dusk. The flights occur from mid-July to the end of July according to the regions and egg laying takes place a few days later.

The female deposits about 200 to 250 eggs on the upper surface of the leaves, one beside the other, in egg-rafts formed of about 100 eggs at the beginning of the period and about 10 at the end. Embryonic development lasts about 15 days.

Once hatched the larva moves towards the trunk and takes shelter under the bark, in the support-stakes or under the grass inside a small silken cocoon, and enters into diapause until the next spring.

In spring, the larva eats the buds.

They pupate towards mid-June in the fold of a leaf.

Control:

Chemical control use chlorpyrifos, thiodicarb, trichlorfon. Chemical control is often inefficient due to the particular life habits of the larva, that make difficult to accurately time applications of insecticide and for insecticides to contact the larva.

Lately, mating disruption using sex pheromones has been proved to control this moth.

Active ingredient	**Activity**	**Rates**
Sulfur 70% + Cipermetryn 0.2%	Contact/ingest	15-25 kg/ha
Sulfur 80%+ Fenitrotion 4%	Contact/ingest	20-30 kg/ha
Carbaryl 50%	Contact/ingest	0.20-0.30%
Carbaryl 37.5% + Chlorpiriphos 24%	Contact/ingest/inhale	0.20-0.30%
chlorpyrifos 3%	Contact/ingest/inhale	20-30 kg/ha
Fenitrotion 40%	Contact/ingest	0.15-0.20%
Tebufenozide 24%	Contact/ingest	0.05-0.06%

Thiodicarb 37'5%	Contact/ingest	1.5-2.5 l/ha
Trichlorfon 50%	Contact/ingest	0.25-0.40%

4. .- Name of the Pest: VINE LEAFHOPPER (*Empoasca vitis*)

Host range: various trees and shrubs, vine, hop, potato

Occurrence and importance:

This pest is especially important in coast regions of Spain.

Symptoms:

The vine leafhopper feeds by inserting its stylets into the main vessels, especially the veins. Feeding punctures of this pest lead to the appearance of necroses.

Veins become dry and the leaf lamina turns brown. Scorch spreads from the edge of the lamina to the centre.

Heavy infestations sometimes cause leaves to fall as early as August. Dry areas on host plants are demarkated by a colored border, the color of which varies according to the variety of vine.

Description of the pest:

(Homoptera, Cicadellidae)

The **adults** are 2-3 mm long, with narrow body greenish or pink colour.

The **eggs** are oblong about 0'7 mm long

The **nymph** is elongate, being en first instar white color. Later instars have colors resembling of the adult.

Life cycle:

The adult overwinters in woods and hedges, migrating to grapevine in the spring. The female deposits about 50 eggs in epidermal tissue on the underside of the leaves. Hatching occurs 5-7 days later.

The nymphs have 5 instars.

The leafhooper have 3, sometimes 4 generations per year. The most important economically are the first two.

Control:

There is not usual an isolated control of this pest. The chemical control of second and third generation of *Lobesia* can control the vine leafhopper, using a polyvalent product and applying under the grape leaves.

Active ingredient	**Activity**	**Rates**
chlorpyrifos 48%	Contact/ingest/inhale	0.15-0.20%
Fenitrotion 50%	Contact/ingest	0.10-0.15%

5. **Name of pest: TWO SPOTTED MITE** (***Tetranychus urticae)***

(Arachnida; Acari; Tetranychidae)

Host range:

This mite is extremely polypahgous attacking almost 200 different hosts. It is particularly damaging to vine, bean, cucumber, bean, hop, cotton, clover, sunflower and fruit trees.

Occurrence and importance:

Webspinning spider mites are a major pest of wine grapes. The varieties Zinfandel and Chardonnay are especially prone to spider mite injury.

Symptoms:

High populations may cause leaf burning, which can decrease photosynthesis and accumulation of vine energy reserves.

Leaf tissue is destroyed by the feeding of the mites on the lower surface of the leaf. The damage reduces photosynthesis and other physiological functions.

Spider mite populations usually reach a seasonal peak during the hottest part of the summer, often as the fruit enters the ripening phase after veraison. Sugar accumulation in the fruit is slowed down or stopped entirely as normal harvest time approaches.

Vines that are under severe water stress are most prone to attack, because vine biochemical defense systems do not function properly without adequate moisture.

Description of pest:

The adults have 2 typical dark spots on the back and 4 pairs of legs. The female is 0.5 mm long; the male is smaller and slender (0.3 mm long). The eggs are spherical, less than 0.1 mm in diameter, smooth, whitish and translucent after the laying, becoming opaque before hatching.

The larva is reduced size, and it has 3 pairs of legs.

Life cycle:

The spider mite overwinters as a mature female under the bark of the grapevine.

In the spring, it migrates to the new shoots and begins to feed. Numerous generations are produced throughout the growing season, and all stages of the mite feed actively on the leaf.

At the hottest part of the summer, the spider mite can complete a generation in about ten days, and thus has an explosive population potential. Decreasing day length triggers hibernation.

Control:

Use preventive measures first, and chemical controls only as a last resort.

An integrated program for spider mites should include the following:

- Maintain available soil moisture throughout the season, especially in sandy soils.
- Avoid compacted soils, those with poor water penetration.
- Protect leaves from excessive dust.
- Monitor populations of the pest and the predaceous mites.
- Protect vines against other pests such as nematodes or phylloxera, which can stress the vine.
- Chemical treatments must not be disruptive to predators of spider mites (*Orius*, *Euseius tularensis, etc)* .

Active ingredient	**Activity**	**Rates**
Summer oil 66%+ Fenitrotion 4%	Contact/ingest	1-2%
Summer oil 70% + methyl pirymiphos	Contact/ingest/inhale	0.75-1%
Sulfur 80%	Contact	0.2-0.5%
Bifentrin 10%	Contact/ingest	0.06-0.08%

6.- Name of pest: RUST MITE OF GRAPE VINE (*Calepitrimerus vitis)*

(Arachnida, Acari, Eriophyidae)

Host range:

This mite strongly attached to the vine.

Occurrence and importance:

Damages can be more evident with low temperatures in spring.

Symptoms:

The damage depends on the density of the pest population:

On the underside of the scales appear canker lesions.

When the vine has 5-6 leaves, the feeding of the mite frequently interrupts the development of the shoots, that may die because of the lesion on the basal part. Also, affects to the formation of the flowers.

The foliage has a browning and russeting aspect. The leaves present malformation followed by a premature dropping.

As a result of the shortened internodes and the development of additional shoots after the death of the main bud, the vine presents witches broom appearance.

Description of pest:

The protogynous summer females has a body (0.15 to 0.16 x 0.05 mm) with 2 similar pairs of legs.

The **eggs** are white, elongated, about 0.4 mm long.

The protonymph is white color with 2 pairs of legs. The opisthosoma is marked about 50 punctuated rings.

The deutonymph has also 2 pairs of legs but only about 15 puntuated rings on opisthosoma.

Life cycle:

Deutogynous winter females remain protected under the scales of the buds, in the downy zone between the meristem, as well as under the bark of the vinestock and the small branches, generally near the buds.

At the opening of the buds in spring, the females feed the tissues of the buds and where they lay eggs.

They remain there with their offspring, until the shoot has between 8 and 12 leaves, then they migrate to the underside of the leaves where they live and lay eggs until October-November. Some of the mites migrate towards the new young buds.

The winter females, produced from August, replace the summer females and constitute in autumn the whole of the *C. vitis* population.

Control:

(🔔) It is important to prevent the entrance of this pest on the grape vine, so use mite- free plants is fundamental.

Chemical control

Once the pest is introduced, chemical treatments with contact acaricides (dicophol or endosulphan) can be effective if they coincide with the period when the mite is more exposed

Active ingredient	Activity	Rates
Winter oil 83%	Contact	2-3%

Summer oil 66% + Fenitrotion 4%	Contact	1-2%
Sulfur 80%	Contact	0.25-0.75%
Sulfur 60%+ Endosulphan 3%	Contact/ingest	20-30 kg/ha
Dicophol 35%	Ingest	0.10-0.15%

7. **Name of the Pest: MEDITERRANEAN FRUIT FLY** (***Ceratitis capitata***)

Host range:

The fruit fly is found in all regions with a warm climate (Mediterranean type). This pest attacks more than 260 different fruits(vines, cherry, citrus, peach, apple, apricot, pear, plum, etc), flowers, vegetables and nuts. Thin-skinned, ripe, succulent fruits are preferred. Plant hosts include avocado, banana, bittermelon, carambola (star fruit), coffee, guava, mango, papaya, peppers and persimmon.

Occurrence and Importance:

The Mediterranean fruit fly, Ceratitis capitata is one of the world's most destructive fruit pests. Because of its wide distribution over the world, its ability to tolerate cooler climates better than most other species of fruit flies, and its wide range of hosts, it is ranked first among economically important fruit fly species. On vine grape important attacks are not usual.

Symptoms

The damage to crops caused by Mediterranean fruit flies result from the oviposition in berries, the feeding by the larvae, and decomposition of plant tissue by invading secondary microorganisms.

Larval feeding damage in berries is the most damaging. Attacked berries may develop a water soaked appearance.

The larval tunnels provide entry points for bacteria and fungi.

Description of the pest:

(Diptera; Tephritidae)

The **adult** is 4-5 cm long, which is about 2/3 the size of a house fly.

The general color of the body is yellowish with a tinge of brown, especially the abdomen, legs, and some of the markings on the wings. The oval shaped abdomen is clothed on the upper surface with fine, scattered black bristles, and has two narrow, transverse, light colored bands on the basal half.

Its long ovipositor at the apex of the abdomen can distinguish the female. When fully extended, the ovipositor (the egg laying tube) is about 6 times as long as its greatest width.

The wings are broad, transparent and glassy with black, brown and brownish yellow markings, with tints appearing faded. There is a fairly wide, brownish yellow band across the middle of each wing. The extreme base is blotched with brownish yellow, with the rest of the basal area curiously marked with black, forming dark lines of the radiating wing veins, with dark spots between them.

The head of the male bears two long, black bristles with broadly flattened, somewhat diamond shaped tips, arising between the eyes near the antennae. The eyes are reddish purple.

Larvae is 9x2 mm, elongate, cream colored, cylindrical maggot-shaped, anterior end narrowed and somewhat recurved ventrally, with anterior mouth hooks, and flattened caudal end.

The larvae can be distinguished from other fruit fly larvae by the anterior, or thoracic, spiracles that bear small, finger-like tubules ranging from 7 to 11 in number, typically 9 to 10 in number.

Eggs are very slender, curved, smooth and shiny white

Pupae are cylindrical and dark reddish brown.

Life cycle:

The length of time required for the Medfly to complete its life cycle, under tropical conditions, is 21-30 days.

Female Medflies deposit the eggs under the skin of fruit that is just beginning to ripen, often in an area where some break in the skin has already occurred. Several females may use the same deposition hole with 75 or more eggs clustered in one spot. Each female will deposit 2 to 10 eggs.

Eggs hatch in 1.5 to 3 days in warm weather. Females usually die soon after they stop ovipositing.

When the eggs hatch, the larvae begin feeding almost immediately. Tunnels are formed, but the larvae often feed together in the same vicinity until they are nearly fully grown.

Larvae pass through three stages, or instars. The body in the first larval stage is transparent; in the second larval stage is partially transparent with the fruit in the gut visible; the fully grown third larval stage is with a body fully opaque white or the color of ingested food. Exact size of larva depends on diet.

The larval stage may last as short as 6 to 10 days or as long as 14 to 26 days depending on temperature and host.

By the time the larvae have fully developed and are ready to pupate, the fruit has usually dropped to the ground where pupation occurs.

Larvae leave the fruit in largest numbers at or just after daybreak and pupate in the soil 2-4 cm below the surface or whatever is available. Minimum duration of the pupal stage is 6-13 days

Adults emerge from the pupal cases in largest numbers early in the morning during warm weather and emerge more sporadically in cooler weather.

They can fly short distances, but winds may carry them a 1 km or more away.

Copulation may occur at any time throughout the day. Newly emerged adults are not sexually mature. Males often show sexual activity 4 days after emergence, and copulation has been observed 5 days after emergence. Most females are ready to mate from 6 to 8 days after emerging from the pupa. Both sexes are sexually active throughout the day.

Adults die in greatest numbers within 2-4 days after emergence if they cannot obtain food. Usually about 50% of the flies die during the first 2 months after emergence. Some adults may survive up to a year or more under favorable conditions of food, water, and cool temperatures. When host fruit is continuously available and weather conditions favorable, successive generations will be large and continuous. Lack of fruit for 3 to 4 months reduces the population to a minimum.

CONTROL:

Chemical sprays of Malathion, and Triclorfon, at the beginning of maturity of berries is a recommended method of controlling adult Mediterranean fruit fly populations.

Active ingredient	Activity	Rates
Malathion 118%%	Contact/ingest	1-1.5 l/ha
Triclorfon	Contact/ingest	0.40-0.50%

8. **Name of the Pest*:* THRIPS *(*Triphidae*)***

TRIPS

Grape thrips (*Depanothrips reuteri*) and western flower thrips (*Frankliniella occidentalis*) are the most important species causing damage on grapes.

Host range: any cultivated and weedy plant.

Occurrence and importance:

Thrips are world wide distributed. They can be found in most grape growing areas. In general, thrips, are a minor problem on wine and raisin grapes, however, table grapes are susceptible to thrips damage. Thrips primarily are a problem on Red Globe, Calmeria, Italia, and occasionally on Thompson Seedless.

Symptoms:

Frankliniella occidentalis can damage table grapes directly by causing halo-spotting when they oviposit in fruit soon after bloom, when berries are small.

Both *Frankliniella occidentalis* and *Depanothrips reuteri* can scar berries with their feeding, which renders certain white varieties used for table grapes unmarketable.

Fruit feeding discontinues in summer when both species feed on new vegetative growth.

Grape thrips is mainly responsible for summer foliage damage; however they may occasionally feed on shoots shortly after budbreak.

While summer damage of leaves by thrips is common, it is not considered a problem.

Description of the pest:

Thrips are small, elongate insects in the Order Thysanoptera. Because of their minute size they are easily overlooked.

Adults are pale yellow to dark brown and have fully developed wings. The wings are very different from other insects. They have a single longitudinal vein in which there are several hairs connected perpendicular to the vein. The wing appears as fringe with hairs. When at rest, the wings are folded along the back of the insect.

Adults are more mobile than immatures and pupae because they can fly. They are attracted to yellow and white colors.

Thrips **pupae** is very small pale yellow to brown. it appears as an intermediate form between the immature and the adult. They have short antennae and the wing buds are visible but short and not functional. It is located in the base of the plant neck or in the soil.

Thrips **eggs** are microscopic and almost impossible to see. They are white or yellow cooler.

Life cycle:

Thrips can complete the life cycle in 14 to 30 days. When temperatures are over 30°C the life cycle can be shortened to 10 or 11 days. The adults may live up to 20 days.

The life cycle of a thrips species consists of an egg, two larval feeding stages, a non-feeding pre-pupal stage, a non-feeding pupal stage and feeding adults.

Thrips do not need to mate for reproduction. Females that do not mate will produce only female progeny. Each female can produce up to 80 eggs. In some places of the world the entire population of thrips is composed of females. This reproductive aspect is very important because from a single thrips a population can be generated in very short time.

Eggs are inserted one by one by the females in the plant tissue. Only one end of the egg will be near the surface of the tissue to allow the immature to emerge. Adults prefer to lay their eggs in leaf, cotyledon, or flower tissues.

Control:

Avoid mowing cover crops infested with thrips at budbreak or before bloom because thrips may move to vines; high populations of thrips feeding on the vines before bloom can cause shoot stunting.

Chemical bloom sprays may be necessary if the infestation is apparent in flowers especially in vineyards of Almeria, Calmeria, and Italia varieties.

Active ingredient	**Activity**	**Rates**
Malathion	Contact/ingest	20-25 kg/ha
Cypermetrin 2% + Methyl chlorpyrifos 20%	Contact/ingest/inhale	0.15-0.25%
Methyl chlorpyrifos 50%	Contact/ingest/inhale	0.15-0.2 %
Methiocarb 50%	Contact/ingest	0.1-0.2 %

9. **Name of pest:** ***Haltica ampelophaga***

ALTICA

(Insecta, Coleoptera, Chrysomelidae).

Host range:

Host plant: preferably grapevine.

Occurrence and importance:

Although considered a minor pest, the grape flea beetle can pose a serious threat to developing buds on grapevines.

The adults attack the lamina of the young leaves, producing holes of varying dimensions. This brings about locally important damage due to the then limited foliar surface and to attacks on the future bunches of grapes.

Haltica is often the first the first insects to appear in vineyards in spring.

The beetles cause two types of damage adults feed on buds before and during budburst, then and eat young leaves. Larvae and adults that emerge in summer gnaw holes in the foliage feeding on the upper and lower leaf surfaces, but cause much less damage than adults from the first generation when emerge from overwintering sites and feed on newly swollen grape buds. They chew holes in the sides and ends of the newly developing grape buds, damaging primary and occasionally secondary and tertiary buds.

Description of pest:

Adults measure 4-5 mm x 2 mm. The body is dark green with a bluish sheen, metallic iridescent. The legs are black with a coxae of the hind legs strongly developed for jumping. The elytra are marked by fine points.

Neonate **larvae** are yellowish-grey and becoming darker until they turn black in the final instar, measuring then 7-8 mm.

The last instar larvae has a round head and the abdomen is transversally crumpled with fleshy tubercles each crowned by a single hair.
The **pupa** is 4 mm long, yellowish.

The **eggs** are Orangy yellow,1.0 x 0.4 mm sizes.

Life cycle:

The adults overwinter in litter, under stones or in trunk crevices. At the vine sprouting period (April) they attack the leaves. Egg laying occurs shortly after mating. The female lays 500 eggs on average. They are laid on bark, buds and the underside of the leaves

Later (May-August) the 2nd-generation larvae gnaw the lower epidermis of the leaves, leaving intact the upper surface giving the leave a lacy look.

Control:

Infestations are generally very localized and usually restricted to border rows.

Brush and woodlots located near a vineyard can be a continual source of beetles and these areas should be cleaned up if possible. Cultivation of open areas between rows and around the vineyard can reduce the number of newly-emerging adults. However, one can not depend on this practice to control flea beetles.

Chemical control:

If beetles are present at bud swell, a broad-spectrum insecticide should be applied to prevent bud damage. This should be effective against adults migrating to vines from their hibernation sites; timing is critical.

Active ingredient	Activity	Rates
Carbaryl 48%	Contact/ingest	0.25-0.30%
Fosmet 50%	Contact/ingest/inhale	0.15-0.25 %
Malathion 50%	Contact/ingest	0.2-0.3%
Trichlorfon 50%	Contact/ingest	0.25-0.4%

10.- Name of the pest: GRAPE MEALYBUGS (*Planococcus spp)*

Different species of mealybugs in the genus *Pseudococcus* may infest vineyards: *Planococcus citri*, *Planococcus maritimus*, *P. viburni*, *P. longispinus*

Host range: Grapevine, citrus genus, cotton. Other crops attacked are banana, carambola (starfruit), cocoa, flowering ginger, macadamia, mango.

Occurrence and Importance:

Planococcus is an endemic pest in southeast of Spain, and produces important economic loses in table grape production areas.

Symptoms:

Susceptibility to mealybug damage varies by variety.

Mealybugs extract plant sap, reducing vigor, and damage grapes by contaminating clusters with cottony egg sacs, larvae, adults, and honeydew Often the honeydew is covered with a black fungus, *Cladosporium* spp., Serious honeydew and sooty mold contamination will make the fruit unsuitable for processing into wine or juice.

Indeed, mealybugs can transmit grape viruses, producing a sooty mold.

Description of the pest:

Mealybugs are soft, oval, flat, distinctly segmented, and covered with a white, mealy wax that extends into spines (filaments) along the body margin and the posterior end. The female mealybug is unable to fly

Female mealybugs lay several hundred yellow to orange **eggs** within an egg sac.

Newly hatched **nymphs** are light yellow and free of wax, but soon start to excrete a waxy cover.

Life cycle:

Life cycle duration (egg to egg-laying adult) ranges from 20 to 44 days .

Mealybugs overwinter as eggs and crawlers, usually under bark on the trunk and cordons. After budbreak, the crawlers feed on the new shoots. They mature in early summer, and the adults move back to the trunks and laterals to lay eggs.

Females lay from 200 to 400 eggs, averaging 300 eggs in a lifetime.

Eggs are laid in groups covered by ovisac wax threads. Eggs hatch in 2-10 days.

The second-generation crawlers move back to the green tissue, including the fruit, where they mature by late summer. The honeydew produced by the second generation can cause processors to reject the fruit.

Mealybugs have 2-4 generations a year, depending on climate and species. During summer all life stages, from eggs to adults, are found on the leaves and fruit.

Control:

Mealybugs are primarily managed by conserving their natural enemies and reducing ant populations. Once established, parasites and predators can help keep populations down, but an infestation may slowly spread unless controlled with insecticides. Leaving untreated areas in the vineyard is effective in increasing predator and parasite populations.

There are numerous parasitic wasps that attack the grape mealybug and several predatory beetles. The most important are:

- The mealybug destroyer beetle, (*Cryptolaemus montrouzieri),* is a voracious feeder of the pest in both the larval and adults stages. (fig 77)
- (🔔) The wasp *Leptomastix dactylopii* is a parasitoid that lays eggs within the host body and is capable to find an host at very long distances. The parasitoid lays an average of 80-100 eggs and at 26ºC a new parasitoid will emerge after 15 days. The host feeding is very low or absent. A possible interference due to ant activity could give some trouble since their attendance on mealybugs colonies is very active, making ant control very important in integrated production programs. (fig 78)

Chemical control with insecticides is most effective when the pest is in the crawler stage when the mealybugs are small and vulnerable, so time treatments must coincide with this stage. once they are more than half-grown, foliar treatments may not be effective. A application with chlorpyrifos is most effective.

Active ingredient	**Activity**	**Rates**
Winter oil 83%	Contact	2-3%
Summer oil 66% +Fenitrotion 4%	Contact/ingest	1-2%
Fosmet 45%	Contact/ingest/inhale	0.15-0.25%
Methiocarb 30% + pirydafention 20%	Contact/ingest	0.15-0.25%

11.- Name of pest: NEMATODES

Many genera of nematodes are detected in soils from vineyards (citrus nematode *(Tylenchulus semipenetrans)*, lesion nematode *(Pratylenchus vulnus)*, ring nematode (*Criconemella xenoplax)),* being the most important the root knot nematode *(Meloidogyne sp.)*, and the dagger nematodes *(Xiphinema index, X. Diversicaudatum, X. Vuittenezi* and *X. italiae)*. These last, transmit Grapevine Fanleaf Virus (GFLV), Arabis Mosaic Virus, Grapevine chrome mosaic virus and GFLV neporiviruses of grapevine, respectively.

Host range:

Root knot nematode *has a* wide range of host, including more than 2.000 plant species.

The most important host of the dagger nematodes is grapevine. Host range also includes woody plants, tree fruit, soybean, corn and some cereals.

Occurrence and importance:

Nematodes are present worldwide. Native habitat, soil texture, grape cultivar, cropping history, weed spectrum, and growing region are the determining factors as to which nematode is present in which vineyard. The root knot nematodes cause more damage worldwide than any other genus.

Symptoms:

Plant parasitic nematodes feed on roots, reducing vigor and yield of the vine usually in irregular patterns across the vineyard. Damage patterns are frequently associated with soil textural differences.

Root knot nematodes penetrate into roots and form complex feeding sites inducing giant cell formation, usually resulting in root galls. Giant cells and galls disrupt uptake of nutrients and water, and interfere with plant growth.

The dagger nematodes, may cause slight galling, cellular hypertrophy, necrosis, lack of lateral roots, and multinucleate condition of cortical cells near the feeding sites, but is more important for its transmission of grapevine fanleaf virus.

They feed from outside the roots, but can reach the vascular tissues with their long stylet.

Virus transmission by dagger nematode produces symptoms on leaves such as yellowing of veins, mosaic, and malformation with symptom expression less apparent among white varieties and in warmer regions.

Description of pest:

Plant parasitic nematodes are microscopic, unsegmented roundworms that feed on plant roots by puncturing and sucking the cell contents with a needlelike mouthpart called a stylet. Nematode males are very rare.

The dagger females are about 3 mm long. they have a long odontostylet and an odontiphore. Tail shape varies from short, rounded, to elongate conoid, occasionally filiform they are sedentary ectoparasites.

Life cycle:

The reproduction is by meiotic parthenogenesis. Males are very rare. The female lay 500 to 1000 eggs outside her body in a gelatinous sac, in late summer.

Eggs are produced in late summer. The larvae develop into first stage juveniles in the egg sac, and root feeding occurs after emergence of the second stage juvenile. Maturation and sexual reproduction occurs at the adult stage. Feeding larvae and adults are active throughout the winter and the growing season.

Control:

Generally, nematode infestations result in areas of the vineyard with vines that lack vigor and have restricted growth and reduced yields.

Manures and other soil amendments can improve vine vigor and frequently reduce the effect of nematode infestation. To reduce stress on vines, take measures to prevent soil compaction and stratification, to improve soil tilth and drainage, and to control other pests. Proper irrigation and fertilizer application also reduce stress on vines and help lessen the effect of nematodes such as root knot.

Vineyards planted in fumigated ground are known to have generally improved growth and yields compared to those planted on non-fumigated ground.

Active ingredient	Activity	Rates
1,3 Dichloropropene 107%	Fumigant	100-150 l/ha
Etoprofos 20%	Contact/inhale	15 l/ha
Fenamyfos 40%	Systemic	25-50 l/ha

12.- Name of pest: EUROPEAN FRUIT SCALE, BROWN SCALE *Eulecanium corni* (Bouché), *Eulecanium persicae*(F). *Parthenolecanium corni*
(Insecta, Homoptera Lecaniidae).

Host range:

E. persicae infests vine, peach, currant, rose and *Wistaria*.

E. corni is more polyphagus and also attacks plum, cherry, apricot, walnut, hazel, dogwood (*Cornus*).

Occurrence and importance:

This pest has a wide distribution.

Symptoms:

A more common problem is the discoloration of fruit and leaves from a black sooty mold which grows on the honeydew produced by feeding scale.

Insects sucking the sap of leaves, canes and stems of the vine, often immobile during their adult stage.

They debilitate the plants, blossom on affected plants is sparce, fruits remain small and favour the development of a fungus disease sooty mould

Description of pest:

Adult is 4.7 mm wide, circular, reddish to dark brown, and often covered with white powder.

Adult female is dark reddish-brown, often with black mottling and banding radiating down the sides. It has a very convex hemispherical shape, with a crimped margin and it is slightly larger.

Eggs are oval and pearly white and the number produced is about 1500-2000

Young nymphs move rapidly on the surface of plants and may be transported by the wind over long distances.

Crawlers are light colored.

Life cycle:

Nymphs overwinter on roots, branches and trunks. The adults emerge in April and migrate to young branches, shoots and young leaves.

The female lays her eggs during several days from late May to early July. Then, she dies and her scale protect the eggs the embryonic development period.

Eggs hatch into crawlers mid-June. The first nymphal moult ocurrs in mid-August.

Crawlers migrate to the underside of foliage to feed for about one month.

Female scales return to the bark of twigs and limbs to continue feeding, whereas males usually mature on foliage and emerge to mate with females.

There are one or two generations per year.

Control:

Since much of the vine is removed at pruning, it may not be necessary to apply control measures unless the scale is infesting the main framework of the vine (main canes, laterals, and trunk).

Scale insects generally are parasitized heavily by parasitic wasps.

Chemical control:

Contact insecticides are effective when timed with the appearance of crawlers. Dormant oil sprays will kill overwintering scales.

Active ingredient	Activity	Rates
Winter oil 83%	Contact	2-3%
Summer oil 66% +Fenitrotion 4%	Contact/ingest	1-2%
Fosmet 45%	Contact/ingest/inhale	0.15-0.25%

5. WEEDS

Many different species of monocotyledon and dycotyledon, summer and winter annual and perennial weeds are found infesting vineyards. Weeds vary from area to area and year to year, even within a vineyard.

Perennial weeds, like field bindweed *(Convolvulus arvensis)*, johnsongrass *(Sorghum halepense)*, dallisgrass *(Paspalum dilatatum)*, bermudagrass *(Cynodon dactylon)*, and nutsedge *(Cyperus spp.)* are especially troublesome due to their difficult control.

WEED CONTROL

Grapevines are most sensitive to weed competition during the first few years of growth and where soil depth is limited.

Grapevine takes at least 3 years for an orchard to become established under normal growing conditions. Established vines are more tolerant of many herbicides than newly planted vines, thus increasing the options available for weed control.

The weed control depends on the grapevine age and the present weed types. Generally weeds are controlled between vine rows by discing or mowing, and with a basal treatment of herbicide around each vine or with a strip application of herbicide down the vineyard row.

Cultural controls:

Before planting vines an effective method of weed control is to cultivate, then irrigate to germinate new weeds, and cultivate again to destroy seedling weeds.

Frequent cultivation lowers weed seed populations in the soil, thus reducing weed growth. At least two cycles of cultivation, irrigation, followed by a shallow cultivation are needed for a marked reduction in weed seedlings. Unfortunately, this method is not effective on established perennial weeds.

A method of control for perennial grasses is to cultivate the soil when it is very dry. Cultivation cuts the rhizomes into small pieces so they can dry. The soil is reworked frequently using spring tooth harrows to pull new rhizomes to the surface and dry them out as well.

Seedlings of perennials can be controlled with repeated cultivation.

For the first year or two after planting is recommended to manage weeds without herbicides. This usually requires hoeing, cultivating, or using weed knives (less than 2 inches deep) around vines several times during spring and summer as well as cultivating or mowing between vine rows. This is best accomplished when weeds are still in the seedling stage. It becomes more difficult when weeds are allowed to get large.

Hand tools are generally used close to the vine to minimize injury, particularly when the vines are young.

Mechanical cultivators available for use in the vine row include: weed knives, spider cultivators, and rotary tillers. Disks, tillers, or mowers can be used between the rows.

Mechanical control of weeds must be done repeatedly when weeds are immature. The equipment should be set to cut shallowly, to minimize damage to vine roots. As weeds mature, they are difficult to control, may clog equipment, and produce seed.

In established vineyards, cultivation can be used to control annual and biennial weeds and seedlings of perennial weeds, but cultivating established perennials in an irrigated vineyard often increases the weed problem, because the roots of the vines can be damaged.

Chemical controls:

Before planting weed seedlings and established annual weeds can be controlled either with pre emergent or post emergent herbicides. Post emergent herbicides generally have a short soil residual and are safer to use before planting vines.

After grapevines are planted and before bearing weeds can be controlled with applying pre emergent herbicides, to either a square or circle around each vine or as a band down the vine row.

Herbicides can also be applied to control weeds after they emerge. Selective herbicides are available for annual grass control and suppression of perennial grasses. Non selective herbicide as glyphosate, can control broadleaf weeds after emergence, but it should be used only around mature vines with brown bark and should not be allowed to contact leaves or green shoots. In conjunction with the use of herbicides in the vine row, mow or cultivate the weeds between the rows.

In established vineyards weed control can be done using a pre emergent herbicide or combinations of herbicides in fall after harvest, or split into two applications (fall and spring), or in winter with a post emergent (foliar) herbicide if weeds are present.

It is possible to use post emergent herbicides as new weeds germinate. For greatest safety, direct herbicide sprays only at the soil or at weed foliage, not at the vine leaves, shoots, or 1- to 2-year-old wood.

Frequently, two or more herbicides need to be applied to obtain adequate weed control. It is critical to identify the weed species present in the vineyard. It is important to determine which herbicide or combinations will provide the most effective control. Combinations may include one or more pre emergent herbicide or a mixture of pre emergent and post emergent herbicides.

	Active ingredient	**Rates**	**Control**
Pre emergence	Simazine 50%	3 l/ha	Dycotyledoneous+ Annual grasses
	Diuron 30% + Simazine 20%	3-5 l/ha	Wide spectrum
	Oxyfluorfen 25%	2-4 l/ha	Annual weeds

Post emergence	Glyphosate 36%	3-6 l/ha 5-12 l/ha	Annual weeds Perennial weeds
	Diquat 20%	1.5-4.5 l/ha	Annual and perennial Dycotyledoneous
	Diquat 10%+Paraquat 15%	1.5-4.5 l/ha	Dycotyledoneous and grasses
	Oxadiazone 25%	8 l/ha	Wide spectrum
Pre/post emergence	Glyphosate 10%+Simazine 28%	5 l/ha	Annual weeds
	Paraquat 10%+Simazine 40%	3.5 l/ha	Annual weeds