Organisation Européenne et Méditerranéenne pour la Protection des Plantes
European and Mediterranean Plant Protection Organization

Normes OEPP
EPPO Standards

Good plant protection practice
Bonne pratique phytosanitaire

PP 2/33

Organisation Européenne et Méditerranéenne pour la Protection des Plantes
1, rue Le Nôtre, 75016 Paris, France

Approval

EPPO Standards are approved by EPPO Council. The date of approval appears in each individual standard. In the terms of Article II of the IPPC, EPPO Standards are Regional Standards for the members of EPPO.

Review

EPPO Standards are subject to periodic review and amendment. The next review date for this set of EPPO Standards is decided by the EPPO Working Party on Plant Protection Products.

Amendment record

Amendments will be issued as necessary, numbered and dated. The dates of amendment appear in each individual standard (as appropriate).

Distribution

EPPO Standards are distributed by the EPPO Secretariat to all EPPO Member Governments. Copies are available to any interested person under particular conditions upon request to the EPPO Secretariat.

Scope

EPPO Standards on Good Plant Protection Practice (GPP) are intended to be used by National Plant Protection Organizations, in their capacity as authorities responsible for regulation of, and advisory services related to, the use of plant protection products.

Outline of requirements

For each major crop of the EPPO region, EPPO Standards on Good Plant Protection Practice (GPP) cover methods for controlling pests (including pathogens and weeds). The main pests of the crop in all parts of the EPPO region are considered. For each, details are given on biology and development, appropriate control strategies are described, and, if relevant, examples of active substances which can be used for chemical control are mentioned.

Existing EPPO standards in this series

Thirty-two EPPO standards on good plant protection practice have already been approved and published. Each standard is numbered in the style PP 2/4 (1), meaning an EPPO Standard on Plant Protection Products (PP), in series no. 2 (guidelines on GPP), in this case standard no. 4, first version. The existing standards are:

PP 2/1 (2) Principles of good plant protection practice. *Bulletin OEPP/EPPO Bulletin* **33**, 87–98
PP 2/2 (2) Potato. *Bulletin OEPP/EPPO Bulletin* **31**, 183–200
PP 2/3 (2) Lettuce under protected cultivation. *Bulletin OEPP/EPPO Bulletin* **31**, 201–210
PP 2/4 (2) Allium crops. *Bulletin OEPP/EPPO Bulletin* **31**, 211–230
PP 2/5 (1) Rodent control for crop protection and on farms. *Bulletin OEPP/EPPO Bulletin* **25**, 709–736
PP 2/6 (1)* Hop. *Bulletin OEPP/EPPO Bulletin* **26**, 295–309
PP 2/7 (1)* Vegetable brassicas. *Bulletin OEPP/EPPO Bulletin* **26**, 311–347
PP 2/8 (1) Rape. *Bulletin OEPP/EPPO Bulletin* **26**, 349–367
PP 2/9 (1) Strawberry. *Bulletin OEPP/EPPO Bulletin* **26**, 369–390
PP 2/10 (1) Wheat. *Bulletin OEPP/EPPO Bulletin* **27**, 311–338
PP 2/11 (1) Barley. *Bulletin OEPP/EPPO Bulletin* **27**, 339–362
PP 2/12 (1) Beet. *Bulletin OEPP/EPPO Bulletin* **27**, 363–384
PP 2/13 (1) Ornamental plants under protected cultivation. *Bulletin OEPP/EPPO Bulletin* **28**, 363–386
PP 2/14 (1) Pea. *Bulletin OEPP/EPPO Bulletin* **28**, 387–410
PP 2/15 (1) Tobacco. *Bulletin OEPP/EPPO Bulletin* **28**, 411–424
PP 2/16 (1) Farm grassland. *Bulletin OEPP/EPPO Bulletin* **29**, 353–366
PP 2/17 (1) Maize. *Bulletin OEPP/EPPO Bulletin* **29**, 367–378
PP 2/18 (1) Pome fruits. *Bulletin OEPP/EPPO Bulletin* **29**, 379–406
PP 2/19 (1) Rye. *Bulletin OEPP/EPPO Bulletin* **29**, 407–422
PP 2/20 (1) Mushrooms. *Bulletin OEPP/EPPO Bulletin* **31**, 231–242
PP 2/21 (1) Sunflower. *Bulletin OEPP/EPPO Bulletin* **31**, 243–256
PP 2/22 (1) Umbelliferous crops. *Bulletin OEPP/EPPO Bulletin* **31**, 257–288
PP 2/23 (1) Grapevine. *Bulletin OEPP/EPPO Bulletin* **32**, 371–392
PP 2/24 (1) Oat. *Bulletin OEPP/EPPO Bulletin* **32**, 393–406
PP 2/25 (1) Leguminous forage crops. *Bulletin OEPP/EPPO Bulletin* **32**, 407–422
PP 2/26 (1) Ribes and Rubus crops. *Bulletin OEPP/EPPO Bulletin* **32**, 423–442
PP 2/27 (1) Citrus. *Bulletin OEPP/EPPO Bulletin* **34**, 43–56
PP 2/28 (1) Cotton. *Bulletin OEPP/EPPO Bulletin* **34**, 57–64
PP 2/29 (1) Solanaceous crops under protected cultivation. *Bulletin OEPP/EPPO Bulletin* **34**, 65–78
PP 2/30 (1) Outdoor solanaceous crops. *Bulletin OEPP/EPPO Bulletin* **34**, 79–90
PP 2/31 (1) Cucurbits under protected cultivation. *Bulletin OEPP/EPPO Bulletin* **34**, 91–100
PP 2/32 (1) Outdoor cucurbits. *Bulletin OEPP/EPPO Bulletin* **34**, 101–108

With the publication of the present Standard, series PP 2 is considered to be complete. EPPO Standards PP 2/1–26 have been published together in a separate publication Good Plant Protection Practice, available from the EPPO Secretariat, 1 rue Le Nôtre, 75016 Paris (FR). This will soon be updated to include the full series.

*Note that these two guidelines for hop and vegetable brassicas appeared in *Bulletin OEPP/EPPO Bulletin* as, respectively, numbers 5 and 6, whereas they are in fact, respectively, numbers 6 and 7. This numbering error is now corrected.

Good plant protection practice
Bonne pratique phytosanitaire

Stone fruits

Specific scope

This standard describes good plant protection practice for stone fruits.

Specific approval and amendment

First approved in 2004–09.

This Standard on good plant protection practice (GPP) for stone fruits forms part of an EPPO programme to prepare such guidelines for all major crops of the EPPO region. It should be read in conjunction with EPPO Standard PP 2/1(2) Principles of Good Plant Protection Practice. It covers methods for controlling pests (including pathogens and weeds) of crops of the genus *Prunus*, particularly peach (*Prunus persica*), nectarine (*Prunus persica* var. *nucipersica*), apricot (*Prunus armeniaca*), European plum (*Prunus domestica*), Japanese plum (*Prunus salicina*), sweet cherry (*Prunus avium*), sour cherry (*Prunus cerasus*) and almond (*Prunus amygdalus*), and their rootstocks.

Stone fruits are produced for the fresh-fruit market or for processed-fruit products. In the latter case, external quality is less important and the level of damage which is tolerable is much greater than for fresh fruits. Therefore, managing pests and diseases causing external damage is less needed, and biological control can be applied much more easily. Almond is the only crop in this genus where the nut is marketed rather than the fruit.

Stone fruits are grown successfully under a wide range of climatic and soil conditions, with or without irrigation and with several degrees of mechanization. Soil conditions, particularly fertility factors and drainage, have a major influence on *Prunus* tree health, production and fruit quality. The soil should supply adequate nutrients. Drainage is important. Cherry is often grown under netting or polythene covers for protection against birds; this may also give protection against fungal diseases.

Although chemical treatment is still the most common pest control method, an IPM strategy to rationalize chemical applications is recommended. Where possible, the products used should be compatible with 1PM, i.e. safe or less harmful to parasites or predators which may be present. Careful selection of healthy, high-quality certified nursery plants is essential. Preventive measures, phytosanitary and certification programmes should guarantee the absence of graft-transmissible diseases caused by viruses, viroids and some bacteria. Sampling methods such as visual and sexual attractants are used to monitor the main pests. Control tactics include the lure-and-kill methods, mass trapping and mating disruption. Thresholds have been developed for the main insect pests. Forecasting models particularly developed for some key pests of plum and peach can effectively be used to determine the right time to spray and therefore rationalize chemical input in the orchard environment. Care should be taken if insecticides are to be applied during flowering, when bees' pollination activity is higher. It is GPP to use appropriate application techniques to reduce drift and unwanted dispersal of sprays. Repeated spraying of plant protection products with the same mode of action, known to cause resistance problems, should only be done in accordance with a resistance management strategy, such as provided by the guidelines of the RAC (Resistance Action Committees).[1]

Post-harvest diseases can cause heavy losses and their incidence may be influenced by various cultural practices such as proper irrigation, soil drainage, pruning, removing plant debris from the soil and minimizing mechanical injury to fruits during harvesting processes.

The principal pests considered in this guideline are the following:

Venturia carpophila
Powdery mildews
Taphrina deformans
Taphrina pruni
Wilsonomyces carpophilus
Apiognomonia erythrostoma
Rusts
Chondrostereum purpureum
Phomopsis amygdali
Blumeriella jaapii
Monilinia spp.
Post-harvest fruit rots

[1]RACs (Fungicide RAC, Insecticide RAC, Herbicide RAC) are Specialist Technical Groups of the Global Crop Protection Federation (GCPF). Their purpose is to provide resistance management guidelines to prolong the effectiveness of 'at risk' plant protection products and to limit crop losses should resistance occur.

Xanthomonas arboricola pv. *pruni*
Pseudomonas syringae
Agrobacterium tumefaciens

Viruses

Aphids
Thrips
Scale insects
Orgyia antiqua
Grapholita molesta and *Anarsia lineatella*
Hoplocampa spp.
Tortrix moths
Cydia funebrana
Rhagoletis cerasi
Ceratitis capitata
Eurytoma amygdali

Mites

Weeds

Explanatory note on active substances

The EPPO Panel on Good Plant Protection Practice, in preparing this standard, considered information on specific active substances used in plant protection products and how these relate to the basic GPP strategy. These details on active substances are included if backed by information on registered products in several EPPO countries. They thus represent current GPP at least in those countries. It is possible that, for any of numerous reasons, these active substances are not registered for that use, or are restricted, in other EPPO countries. This does not invalidate the basic strategy. EPPO recommends that, to follow the principles of GPP, only products registered in a country for a given purpose should be used. It may be noted that many active substances currently used in registered products in EPPO countries will no longer be authorized in the EU after 2003–07.

Venturia carpophila

General

Venturia carpophila (anamorph *Fusicladium carpophilum*, syn. *Cladosporium carpophilum*) causes scab of stone fruit. It is an important disease of peaches and nectarines in warm and humid climates. Even though the disease principally affects twigs rather than leaves, both are the source of conidia for the infection of the fruits. On fruits, lesions first appear as circular spots. These enlarge to up to 3 mm and become blackish, sometimes with a green halo. Finally, they coalesce and, as the fruit enlarges, cracks appear. The fungus overwinters on twigs or on the bark surface as mycelium and chlamydospores respectively. Conidia are produced after the calyx splits and increase with favourable climatic conditions (70–100% relative humidity). Optimum temperature for germination is 25–30°C. Fruit infections generally occur about 30 days after petal fall, at the base of the hairs of the skin. After a latent period of 40–70 days, visible symptoms occur on fruits from which other conidia form and disperse to produce new infections. There have been no reports on the role of the teleomorph. Usually, later-fruiting cultivars are the most susceptible to the disease. The disease is occasionally seen on plum.

Basic strategy

Sanitation is not usually feasible because of the numerous over–wintering lesions present on fruiting wood. Indirect control can be achieved by pruning and destruction of infected branches. The disease is mainly controlled by fungicide sprays. Treatments are recommended against the over-wintering fungus in autumn and before the growing season. Usually, treatments applied for the control of *Taphrina deformans* and *Wilsonomyces carpophilus* are effective against this disease. In spring, sprays should be applied when first symptoms occur and repeated at 8–10 days interval.

Main fungicides

Sprays: captan, sulphur, tebuconazole, thiophanate–methyl, thiram, triforine, ziram.

Powdery mildews

General

Peach, nectarine, plum, apricot and cherry orchards are susceptible to powdery mildew. Epidemics occur in a wide range of geographical areas, particularly those with semi-arid climatic conditions. The disease mainly affect fruits and leaves, the latter being most important in nursery plantings. Three species of powdery mildew fungi attack stone fruits: *Sphaerotheca pannosa*, *Podosphaera tridactyla*, *Podosphaera clandestina*.

S. pannosa affects peach, nectarine, plum and apricot. On leaves, first symptoms appear as a fine net-like growth. As the disease progresses, vast numbers of conidia form, producing a white powdery mass. Infected leaves show chlorosis and necrosis, roll upward and then fall to the ground. Infected shoots are usually stunted. *S. pannosa* affects mainly young fruits, older fruits becoming resistant with maturity. Young fruits appear deformed while, on older ones, necrotic areas form. On peach, *S. pannosa* overwinters as mycelium on bud scales or in infected dormant buds. As leaves emerge from the bud, they become infected. Secondary infections are caused throughout the growing season by air-borne conidia (optimum temperature for germination 21°C). The foliage is more susceptible to infection during the night, with high relative humidity. On the other hand, disease pressure decreases when temperatures are above 28–30°C and relative humidity is well below 70%.

P. tridactyla mainly affects older leaves of apricot, which appear distorted and covered with white mycelium. Eventually, premature defoliation occurs. Ascospores give rise to primary

infections, while conidia (*Oidium passerinii)* cause secondary infections throughout the growing season.

P. clandestina affects the leaves, shoots and fruits of cherries. It overwinters as cleistothecia on plant debris on the ground or in the plant bark. Primary infections occur on young leaves closest to the trunk. Secondary infections take place during the entire growing season.

Basic strategy

Control of these powdery mildews can be achieved by fungicides and by the use of resistant cultivars. Knowledge of the disease pressure, and of the susceptibility of cultivars grown in the area, is essential for an effective strategy of fungicide use. Where the disease occurs every year on susceptible cultivars, some preventive fungicide sprays at the end of flowering and fruit set are recommended. In all other cases, fungicides can be applied curatively soon after the occurrence of first symptoms. Timing of fungicide application is critical to slow disease progress. Some agronomic practices may help to reduce the inoculum potential, such as pruning affected shoots, removing of infected young fruits, limiting irrigation and avoiding overfertilization with nitrogen. Biological control may be possible by the application of *Ampelomyces quisqualis*: foliar sprays on peach seem to be effective in controlling the disease.

Main fungicides

Sprays: bitertanol, bupirimate, carbendazim, dinocap, fenarimol, hexaconazole, kresoxim-methyl, myclobutanil, nuarimol, penconazole, propiconazole, sulfur, tetraconazole, thiophanate-methyl, tolylfluanid, triadimenol, trifloxystrobin, triforine.

Taphrina deformans

General

T. deformans, the cause of peach leaf curl, is a major pathogen, particularly in the Mediterranean peach-growing areas. The disease affects peach flowers, buds, shoots, fruits and leaves. Most damage occurs on the leaves. First symptoms may appear as soon as the young leaf emerges from the bud. Firstly, yellow to reddish areas appear on young leaves; they progressively thicken, making the leaf curl. A white coating of spores then develops. Infected leaves prematurely fall to the ground, or remain attached to the plant but become dark brown. Fruits may be also affected in severely infected trees. On these, symptoms appear as irregular, wrinkled red lesions; early infections may cause them to fall to the ground. Young shoots may develop thickenings and distortions. Morphological deformations of the leaves reduce the photosynthetic activity of the plant, with effects in the following year. Infected shoots produce irregular growth with shortened internodes.

The pathogen overwinters as ascospores or blastospores on the bark surface or in bud scales. It can also survive as mycelium on branches or buds contaminated the year before. With temperatures over 7–8°C and periods of prolonged wetness, the spores start to germinate and infect the young leaves. Mycelium actively penetrates the leaf cuticle. New infections then result from ascospore release. Disease progress is favoured by prolonged cold and rainy days in the spring. Several infection cycles may occur during spring until temperature becomes stable above 25°C. Some peach cultivars are less susceptible.

Basic strategy

Disease control depends on fungicide sprays. Control strategy is based mainly on two sprays carried out at leaf fall (in order to reduce the inoculum potential on the trees), and early in the spring as soon as temperatures start to rise. Other sprays can be applied as first symptoms occur, to contain spread. Recent experiments have shown that preventive sprays are more effective than curative ones. Where possible, elimination of infected leaves and shoots in the spring may help to reduce the disease pressure.

Main fungicides

Sprays: copper compounds, dithianon, dodine, thiram, ziram.

Taphrina pruni

General

This pathogen of plum can affect leaves and shoots, but the most obvious symptom is on the fruits, usually 6–8 weeks after bud break. Firstly, small whitish spots appear which rapidly enlarge; these areas later become reddish with a velvety grey appearance. Upon dehydration, only the exterior fruit shell remains, the stone being absent (‘pocket plums’). Deformed fruits become brown with age and fall from the trees. The pathogen overwinters on twigs and bud scales and the life cycle is similar to that of *T. deformans*.

Basic strategy

Removal of affected branches, or in severe cases, of affected trees is recommended. Fungicide sprays at leaf fall and at before bud break in the spring can reduce disease incidence.

Main fungicides

Sprays: as for *T. deformans*.

Wilsonomyces carpophilus

General

W. carpophilus (syn. *Stigmina carpophila*, *Coryneum beijerinckii*) causes shot-hole disease, which mainly affects peach, nectarine, apricot and almond. Symptoms may appear on buds, stems, leaves and fruits. On leaves, lesions appear as small purple areas that progressively expand to spots, brown in colour

and 3–10 mm in diameter. On fruits, lesions mostly develop on the upper part, which becomes rough and corky. During warm dry weather, the fungus causes lesions on leaves, and abscission follows. Usually, the disease does not defoliate the trees. On shoots, lesions may develop to form open cankers producing gums. The pathogen overwinters as mycelium or conidia (in temperate climates) on the bark surface or bud scales. On peach, heavy infections occur in autumn, while on apricots and sometimes on cherry, they may develop in spring.

Basic strategy

Sprays carried out against *T. deformans* are also effective in controlling shot-hole disease. Sprays in autumn to reduce the inoculum potential are recommended. Fungicide applications in spring are justified only with heavy attacks. Use of resistant cultivars and destruction of infected plant debris are recommended.

Main fungicides

Sprays: bitertanol, copper compounds, dithianon, dodine, flusilazole, sulphur, thiophanate-methyl, ziram.

Apiognomonia erythrostoma

General

*A. erythrostoma (*syn. *Gnomonia erythrostoma*) causes a leaf disease affecting mainly apricot and cherry. On apricot, it causes leaf scorch, whereas on cherry it is known as red spot. Leaf symptoms usually occur in summer as reddish areas surrounded by a wide chlorotic halo. The infected areas progressively darken, necrose and curl lengthwise, remaining attached to the plant until the following spring. Heavy attacks may defoliate trees and affect fruits, which the show sunken and deformed areas. Fruits stop maturing and necrose, while remaining attached to the plant. *A. erythrostoma* overwinters as perithecia, formed on infected leaves which fell to the ground the year before. Ascospores are released in the spring and they infect the new leaves. Heavy attacks are influenced by the inoculum potential in the orchard and a rainy and humid spring and summer. Some apricot and cherry cultivars have a degree of resistance.

Basic strategy

Fungicide treatments applied against *Wilsonomyces carpophilus* usually control the disease. Specific sprays may be needed on young orchards when first symptoms are observed. Destruction of fallen leaves in autumn helps to reduce the inoculum potential in the orchard.

Main fungicides

Sprays: bitertanol, carbendazim, copper, dithianon, dodine, fenbuconazole, ziram.

Rusts

General

Tranzschelia pruni-spinosae commonly affects all *Prunus* spp. It does not cause heavy damage because it occurs sporadically at the end of summer. Severe infections in a rainy spring may occur in plum trees in southern Europe, where leaves, shoots and fruits may be affected. In northern Europe, only leaf infection is normally seen and this usually occurs after mid summer. *Puccinia cerasi* mainly affects cherry, but may also infect other *Prunus* species and wild plants. Symptoms caused by the pathogens are similar. They appear as small chlorotic spots on the leaves followed by the appearance of pustules on the underside of the leaf. In *T. pruni-spinosae*, these are initially pale yellow then, as the season progresses, orange (urediniospores or uredinia) and, finally, brown and dusty (telia). The teliospores infect the alternate host (*Anemone* spp.). The number and distribution of rust pustules depends on the *Prunus* species. On plum, they are located interveinally, on peach they are numerous and located along the leaf veins, on apricot and almond they are few and sparse. Usually, heavily affected trees produce abundant gummosis. *P. cerasi* produces pustules which are initially white, then pale yellow (urediniospores and teliospores), located in clusters on the lower side of the leaf. The teliospores infect the alternate host (*Eranthis hyemalis*). Both pathogens overwinter as urediniospores and teliospores on infected leaves fallen to the ground and in some cases on twigs. In spring, new infections are mainly caused by urediniospores, while teliospores are responsible for long-distance spread (carried by wind).

Basic strategy

Usually, specific fungicide applications are needed in plum orchards, which are more susceptible to the disease. Sprays should be applied after the occurrence of the first symptoms. Preventive sprays, normally carried out at the end of June and July, are recommended only when susceptible plum cultivars are grown and the disease occurs every year. Destruction of fallen leaves in autumn helps to reduce the inoculum potential in the orchard.

Main fungicides

Sprays: copper, cyproconazole, metiram, myclobutanil, propineb, sulfur, tebuconazole, thiram, triadimefon.

Chondrostereum purpureum

General

C. purpureum (syn. *Stereum purpureum*) is a very common fungus infecting numerous woody plants. On plum, nectarine, peach and cherry, it causes silver blight or silver-leaf disease. Apricots and almond are also susceptible. The disease may occur both in commercial orchards and in fruit-tree nurseries. After the fungus enters the tree through wounds in the wood, the typical symptoms of leaf silvering begin to appear. Severely

affected leaves then curl upward and finally necrose. Fungal toxins move in the xylem and lead to symptoms and, eventually, tree death. Once the plant is dead, basidiocarps form on the bark surface. The pathogen is spread by basidiospores during wet periods. As they reach fresh pruning cuts of susceptible hosts, they germinate and spread into the wood. Vigorous cultivars are most susceptible.

Basic strategy

Curative fungicide treatment of the infected plants fails to give satisfactory results, so prevention is essential. Trees should be pruned after harvest in summer during warm dry weather to minimize infection, and the pruning wounds should be treated with a fungicidal wound protectant. If there are poplars in the vicinity of the orchard, any fruiting bodies of the pathogen on these trees could usefully be eliminated. Affected branches below a sign of internal wood staining should be removed and badly affected trees should be destroyed. Infected material should not be left near the orchard as basidiocarps will form on it. Tree stumps should be removed or covered for the same reason. Application of the fungal antagonist *Trichoderma viride* may in some cases give some control of the disease but this depends on its ability to colonize the plant and on the time and method of application.

Main fungicides

Wound protectant: octhilinone, thiophanate-methyl.
Biological treatment: *Trichoderma viride*.

Phomopsis amygdali

General

P. amygdali (syn. *Fusicoccum amygdali*) causes constriction canker, which mainly affects peach and nectarine, although plum and almond are also susceptible. The disease affects twigs on which it causes reddish-brown elongate lesions centred on a bud or node of one-year-old shoots. Cankers firstly appear in the spring, then they enlarge and become sunken, being clearly visible on the surface of wood. Gums often exude from the infected area. Leaves may also be infected, but twig lesions are far more dangerous. Fungal invasion may occur through buds and scars or shoots in the autumn close to leaf fall, or in the spring or summer in particularly wet weather. Heavy infection may cause shoots to die. On the infected areas, pycnidia form and air-borne conidia spread the disease during rainfall.

Basic strategy

Prevention is essential and recommended agricultural practices include: use of non-susceptible cultivars in disease-prone areas, elimination of all shoots infected with cankers, disinfection of pruning cuts, avoidance of heavy nitrogen fertilization, use of drip irrigation, pruning only during cold or dry weather. Fungicide sprays can be applied just before leaf fall and repeated in case of prolonged rainy weather.

Main fungicides

Sprays: carbendazim, thiophanate-methyl.

Blumeriella jaapii

General

B. jaapii causes leaf spots and early defoliation of cherry. The spots are at first 3 mm, reddish to purple, later turning brown. Lesions become visible in 5–15 days depending on temperature and moisture. Optimum conditions are temperature 15–20°C accompanied by rainfall or high humidity. As lesions appear, the spots develop conidia on the underside of the leaf. Splashing rain and air currents carry conidia from leaf to leaf. Repeated secondary spread by conidia continues until the autumn. The fungus survives through the winter in leaves on the ground from the previous year. In spring, the disease is spread to new leaves. Sweet cherry is less susceptible to leaf spot than sour cherry.

Basic strategy

All commercially acceptable cultivars of cherry are susceptible to leaf spot, but some are more resistant than others. Generally, fungicides are applied in cherries at regular intervals. First application may start after the first leaves unfold and may continue at regular intervals until harvest. In Northern Europe, 2–3 applications are needed in most seasons. Often a post-harvest spray is also applied, 3 weeks after harvest. Post leaf-fall application of urea to leaves of sour cherry, or leaf shredding to stimulate leaf decomposition, or application of selected antagonistic fungi, helps to destroy the overwintering stage and can be used as an alternative method to fungicides.

Main fungicides

Sprays: bitertanol, chlorothalonil, dithianon, dodine, fenbuconazole, mancozeb, propineb, tebuconazole.

Monilinia spp.

General

Brown rot is one of the most dangerous diseases of stone fruits and is caused by three related pathogens, *Monilinia fructigena*, *Monilinia laxa* and *Monilinia fructicola*. The last, which is an A1 quarantine pest for the EPPO region (and thus absent from the region), is more aggressive and more specific to peach[2]. The pathogens affect flowers, twigs, leaves and fruits with different aggressiveness.

On peach, first symptoms appear as necrosis of anthers and spread up to the pedicel. Affected flowers necrose and remain

[2]*M. fructicola* has recently been detected at a few localities in some European countries, and it does not appear feasible to eradicate it. It has not immediately spread and had a serious impact, but it still presents a definite risk. It can probably be controlled by the same GPP as its sister species.

attached to the plant. Under humid climatic conditions, they are covered by grey fungal fructifications. On apricot and plum, all parts of the flower are susceptible to the disease. Apricot is the most susceptible to flower infections, followed by plum, cherry and peach. On twigs, symptoms appear as sunken and elongated areas, that progressively crack, forming open cankers. On affected shoots, leaves wilt and remain attached. Fruits are susceptible from fruit set to harvest. Symptoms appear as brown rotted areas and infected fruits may remain attached to the tree and mummify. *M. fructigena* forms small pale brown fructifications in concentric circles on affected fruits while those of *M. laxa* are grey in colour.

The pathogens overwinter as mycelium on twig cankers or as conidia. Mummified fruits attached to the trees, as well as those fallen on the ground, play an important role in pathogen survival. Formation of conidia on fruits or twigs in the spring seems to be influenced by long rainy periods. Conidia are carried by the wind, rain and sometimes insects. Conidia germinate in a wide range of temperature (0–25°C) but *M. fructigena* is more sensitive to cold weather. Ascocarps may form on the overwintered fruits but do not apparently have a significant role in the disease cycle.

Basic strategy

Elimination of the overwintering pathogens in infected twigs, leaves and fruits (mummified and fallen) is essential to control the disease. Other preventive measures involve avoiding nitrogen over-fertilization and prolonged irrigation, and appropriate pruning to improve canopy ventilation. Fungicide treatments can also give some control of brown rot and blossom wilt. Sprays are recommended after insect infestation, hail or frost that causes wounds which are easily colonized by the fungi. Cracking of fruits after rainfall can lead to devastating losses. In areas particularly favourable to the disease or on susceptible hosts (apricot, plum, almond, peach and nectarine), fungicides should be applied during flowering after prolonged wet periods (rain, fog, heavy dew) and/or close to harvest on susceptible late cultivars. Timing of application is critical for the control of flower blight; fungicides should be applied very early during flower-bud development. Treatments in the field protect fruits against post-harvest infection provided the storage period is not too long.

Main fungicides

Sprays: bitertanol, carbendazim, chlorothalonil, copper compounds, cyproconazole, cyprodinil, fenbuconazole, fenhexamid, fludioxonyl, iprodione, myclobutanil, procymidone, pyrimethanil, tebuconazole, thiophanate-methyl, thiram, triadimenol, trifloxystrobin, ziram.

Xanthomonas arboricola pv. *pruni*

General

Xanthomonas arboricola pv. *pruni* mainly affects plum but all *Prunus* spp. are susceptible. On all stone fruits, symptoms are similar. On leaves, dark angular spots form and dry up. The necrotic areas detach, leaving small holes in the leaves. On shoots and twigs, oval dark and sunken areas (cankers) may form. On fruits, circular sunken areas surrounded by a water-soaked halo form. Heavy infections may cause plant death. On peach, cankers on twigs may cause buds to die. The pathogen overwinters in the cankers and these can remain active for some years. Survival also takes place on buds and leaf scars. Bacteria may penetrate the bark causing spring cankers. During wet weather, bacteria are carried by wind, rain and insects and may infect other young shoots, flowers and fruits. In summer, cankers may form on twigs. Temperature of 19–28°C and prolonged rain along with persistent wind are favourable conditions for the disease.

Basic strategy

Preventive measures are essential. Certified healthy plants should be used. *P. domestica* is less susceptible than *P. salicina*. Infected plants, or parts of plants, should be eliminated. In peach orchards, use of non-susceptible cultivars such as Cresthaven, Suncrest, Early Sungrand is recommended. Copper compounds may be used during most critical periods to give some control.

Main bactericides

Sprays: copper compounds.

Pseudomonas syringae

General

P. syringae pv. *syringae* infects mainly apricot, but also peach, plum, cherry and almond. Symptoms on leaves have a shot-hole appearance. On green apricot fruits, lesions appear as irregular, superficial spots, sometimes surrounded by a greenish to reddish halo. The bacterium can survive in winter in buds. In cherry, infection results in the die-back of branches and may lead to death of the tree.

P. syringae pv. *persicae* is a more serious pathogen, affecting only peach. It is absent from most EPPO countries, which consider it as a quarantine pest. Symptoms appear on young twigs around buds as olive-green areas which darken progressively. Infection may spread to older twigs and affect the whole branch. In spring, infections can be seen as die-back of the twigs. Young plants (5–6 years old) are more susceptible. On leaves, the pathogen causes circular necrotic spots that falls out giving a 'shot-hole' effect. The leaves then fall prematurely. On nectarine, fruits show superficial sunken spots sometimes oozing gum. Pathogen multiplication, in winter, is favoured by cold weather. Pruning cuts allow infections to occur.

Basic strategy

Preventive measures are essential. Use of certified healthy plants of non-susceptible cultivars is recommended. *Prunus* spp. should be planted on well-drained soils without problems

of water-logging. Copper compounds applied on 2 or 3 occasions, at 7-10-day intervals, at leaf fall are recommended. Copper sprays should be applied after pruning. Infected plants or parts of plants should be eliminated and burned. A wound protectant paste may be applied to cut surfaces immediately after pruning.

Main bactericides

Sprays: copper compounds.

Agrobacterium tumefaciens

General

Crown gall is a widespread disease affecting a wide range of host species, including *Prunus*. Galls primarily form on the roots and crowns, often at wound sites. The bacterium may give rise to latent infections in roots or be present in soil adhering to roots. It may be spread with plants for planting or by movements of soil or water. Infection is favoured by poorly drained and alkaline soils.

Basic strategy

Preventive measures include long rotations (4–5 years), use of non-susceptible plants, destruction of all infected plants, avoidance of tree propagation on contaminated soils, and dipping of the young trees in copper solutions before transplanting. Biological control is recommended by using the antagonist *Agrobacterium radiobacter* (K84), applied by dipping before planting, or as a soil drench for planted trees. Preferably, only certified plants for planting, free from *A. tumefaciens*, should be used.

Viruses

General

Stone fruits are affected by many viruses. The expression of symptoms may vary depending on the host, the cultivar, the strain of virus, the age of the infected tree and the environment. Symptoms are often not so characteristic that a reliable diagnosis can be based on symptomatology alone. For reliable identification, it is advisable to use additional diagnostic methods such as mechanical inoculation to test plants, ELISA, PCR, etc. To minimize the effects of viruses, it is important to know which is causing the disease and how it is transmitted. Each virus has its own modes of transmission (Table 1). In addition, all viruses are spread by grafting and by transport of infected plants.

Table 1 Most important viruses and virus–like diseases affecting fruit–producing species of *Prunus* in the EPPO region and their modes of transmission

Virus	Natural transmission
Apple chlorotic leaf spot trichovirus	unknown
Apple mosaic ilarvirus	pollen (possibly)
Cherry green ring mottle foveavirus	unknown
Myrobalan latent ringspot nepovirus	unknown
Plum pox potyvirus	aphids in a non-persistent manner
Prune dwarf ilarvirus	pollen, seeds
Prunus necrotic ringspot ilarvirus	pollen, seeds
Strawberry latent ringspot nepovirus	*Xiphinema diversicaudatum*
Tomato black ring nepovirus	*Longidorus attenuatus*, *L. elongatus*
Viroid	
Peach latent mosaic pelamoviroid	unknown
Phytoplasma	
European stone fruit yellows phytoplasma	*Cacopsylla pruni*

Basic strategy

Viruses are difficult to control and can result in substantial crop losses. As there are no cures for virus-infected plants, all measures should be directed to prevention. This includes removal or avoidance of sources of infection, prevention or limitation of virus spread by vectors, and improvement of cultivar resistance to viruses. However, since all the viruses are transmitted by grafting, use of healthy plants for planting is the fundamental control method. Systems for the production of healthy plants for planting are described in EPPO Standards PM 4/29 Certification scheme for cherry and PM 4/30 Certification Scheme for almond, apricot, peach and plum.

The main problem remains the aphid-transmitted *Plum pox potyvirus* (PPV, sharka). Insecticides used to control aphids do little to control spread of the disease. PPV affects plum, peach and apricot, together with numerous ornamental *Prunus* spp. Though there are isolated reports in cherry, the disease is practically unknown in this host in Europe. PPV is regulated in many countries as an EPPO A2 quarantine pest, since there are still areas where it has not appeared or remains relatively rare, and may be subject to eradication. Most stone-fruit producing regions focus on preventing the introduction of PPV into newly planted orchards, by requiring that plants for planting should be virus-certified (cf. above) or at least derive from PPV–tested mother plants in registered nurseries. Alternative disease management strategies are needed only when prevention and eradication programmes fail, or when the disease becomes established in wild *Prunus* populations.

Aphids

General

There are many aphids associated with stone-fruit trees. *Myzus persicae*, a polyphagous aphid, commonly curls the new growth of stone-fruit trees (especially plum, peach and apricot). Infested leaves turn yellow, necrose and often fall to the ground. As a result, shoot growth is reduced. *M. persicae* and *Aphis spiraecola* are the two main vectors of *Plum pox potyvirus.* Other aphids have been shown to transmit the virus at lower frequency: *Aphis craccivora*, *Aphis fabae*, *Aphis gossypii*, *Brachycaudus cardui*, *Brachycaudus helichrysi*, *Brachycaudus persicae*, *Hyalopterus pruni*, *Myzus varians* and *Phorodon humuli*. *P. humuli* lives on

the underside of the leaves and, although it causes little growth distortion, weakens the plant and contaminates foliage and fruit with honeydew causing crop rejection. Most populations of *A. spiraecola, M. persicae* and *P. humuli* are highly resistant to many insecticides in many regions, particularly where hops are grown commercially.

Myzus cerasi often builds up high populations on cherry leaves in late spring and produce abundant amounts of sticky honeydew. *Myzus varians* occurs on the underside of cherry leaves which undergo severe curling, thus taking on the shape of a cigar. The lamina reddens progressively. Shoots of cherry become distorted and growth is severely slowed down by *B. persicae*. Young plants remain weak and may die. *B. helichrysi* is particularly harmful on plums. It causes severe leaf-roll and restricts the growth of new shoots. *H. pruni* colonizes the lower leaf surface causing premature leaf drop and significant loss of vigour of trees. It attacks primarily plum, peach and apricot, whereas *H. amygdali* can be found on almond.

Basic strategy

Some agronomic practices are recommended, such as limiting nitrogen fertilization and pruning green twigs in spring in order to reduce vegetation. Most aphids damaging to stone-fruit trees overwinter in the egg stage, near tree buds, so that they can easily be controlled by using sprays when trees are dormant or at bud break. In late spring, most of the above–mentioned aphids leave the plant for their alternative summer hosts. Insecticide sprays should be applied as soon as first infestations occur because the severe leaf-curl limits the effectiveness of many insecticides. Following the IPM strategy, insecticide sprays should be applied when 10% of leaves, shoots or fruits are infested. Certain non-commercial cultivars of peach are resistant to infestation by *M. varians* and *M. persicae*. For most active substances, use is limited to one or two applications per year, with the aim of preventing resistance.

Main insecticides

Sprays: acetamiprid, alpha-cypermethrin, amitraz, azinphos methyl, bifenthrin, cyfluthrin, deltamethrin, dimethoate, fluvalinate, imidacloprid, lambda-cyhalothrin, methamidophos, methomyl, petroleum oils (dormant season only), pirimicarb, pymetrozine, rotenone, thiacloprid.

Thrips

General

Thrips meridionalis attacks all stone-fruit trees, but it causes most damage to peach and especially nectarine. Often it appears in mixed populations with *Thrips major* and *Taeniothrips inconsequens*. The three species have similar biology. In the Mediterranean region, *T. meridionalis* has three generations per year. Living mainly on flowers, it first appears on almond flowers before migrating to other *Rosaceae* as these begin flowering. Damage occurs at flowering and close to ripening. At the end of fruit set, *T. meridionalis* migrates to wild grasses while *T. major* remains on peach, feeding on shoots and fruit. It can cause fruit discoloration close to harvest.

The introduction of *Frankliniella occidentali*s has led to increased thrips damage on nectarine. Plum is also affected by this pest. Feeding and egg-laying activities scar the fruit surface and can lead to deformed fruits.

Basic strategy

Timing for control is difficult. Thresholds are difficult to establish. Coloured sticky traps can be used to monitor populations. Chemical control is often constrained by the secretive habits of *F. occidentalis,* and because populations have been found to develop resistance quickly. Usually, insecticide sprays are applied during flowering, and may need to be repeated at petal fall if the flowering period is extended. Following an IPM strategy, insecticide treatments are justified only on nectarines when the presence of thrips is detected during flowering. Any sprays applied during flowering should be safe to pollinating insects and be approved for use in this period.

Main insecticides

Sprays: acrinathrine, alpha-cypermethrin, bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, lufenuron, malathion, methiocarb, methomyl, tau-fluvalinate, zeta-cypermethrin.

Scale insects

General

Quadraspidiotus perniciosus is highly polyphagous and widespread. The female is apterous, pear-shaped, covered by a detachable circular, dark grey scale. It is viviparous. Tiny yellow 1st instar nymphs (crawlers) are at first mobile, then settle down permanently and secrete a waxy covering over their body that will protect them from insecticides. *Q. perniciosus* overwinters as the 1st instar nymph. There are 2–4 generations per year, depending on the climate. As it feeds, *Q. perniciosus* injects a toxin into the plant causing localized discolorations. If left uncontrolled, it will cause premature leaf fall, decline of affected branches and possibly death of the entire tree within two years.

Pseudaulacaspis pentagona forms circular dull white scales on numerous hosts. It infests the bark, fruit and leaves of plants. Depending on the climate, it may have 2 or 3 generations per year. It overwinters as the immature female. The adult females begin laying eggs approximately two weeks after mating. The eggs hatch 3–4 days after being deposited and 1st instar mobile nymphs emerge.

Among soft scales (*Coccida*), *Lecanium persicae* attacks peach, whereas *Lecanium corni* also attacks plum, cherry and apricot. Both species have one generation per year and over-

winter as nymphs. They mainly feed on leaves. Flowers are sparse on affected plants and fruits remain small. These scales produce large quantities of honeydew and trees are often covered with sooty mould.

Basic strategy

Often scales go unnoticed until large populations have developed, so trees should be inspected for scales, especially on 1-year-old wood. Purplish-red halos on young bark are an indication of infestation by *Q. perniciosus*. Pheromone traps may be used to indicate when the activity of the male scales begins and to predict emergence of 1st instar nymphs. Sticky tapes may be used to monitor for emerging nymphs. Effective control may be achieved by application of mineral oil in the dormant period. Insecticide sprays should be aimed at the immature 1st instar nymphs. In case of heavy infestation, a second application two weeks after the first may be necessary. *Q. perniciosus* is particularly difficult to control and only a few active substance are effective.

Prospaltella perniciosi, a specific parasite of *Q. perniciosus*, may be introduced for its control. *P. berlesei* attacks *P. pentagona*. In general, scale insects have many natural enemies, such as parasitic wasps and predators of the families *Coccinellidae* and *Chrysopidae*. They should be conserved and encouraged.

Main insecticides

Sprays: azinphos-methyl, buprofezin, chlorpyrifos, chlorpyrifos-methyl, cypermethrin, methamidophos, methidathion, mineral oils (dormant season only), quinalphos.
For *Q. perniciosus*: chlorpyrifos-methyl, methidathion.

Orgyia antiqua

General

This lepidopteran is a fairly common species that feeds on a range of deciduous trees including *Prunus*. It is usually considered to be a secondary pest because it does not cause severe damage. The females are wingless and sedentary. The population overwinters as white egg masses, which are laid on what remains of the pupal cocoon. Hatched caterpillars are gregarious and very hairy. They feed on leaves and can cause substantial defoliation. *O. antiqua* can complete 4 generations per year in warm climates, but in more temperate areas there is only one generation.

Basic strategy

The large, brightly coloured larvae are readily seen and, in small infestations, can be hand-picked and killed. The hairs on the caterpillar's body can cause an itchy rash (tussockosis) in some people. *O. antiqua* is mostly controlled adequately by treating against other pests. Large infestations can be controlled by insecticide sprays soon after the occurrence of the first larvae. The IPM control strategy makes use of *Bacillus thuringiensis* var. *kurstaki* when young larvae are present in the orchard.

Main insecticides

Sprays: azinphos-methyl, *Bacillus thuringiensis* var. *kurstaki*, lambda-cyhalothrine, phosalone.

Grapholita molesta & Anarsia lineatella

General

On peach, nectarine and apricot, these lepidopterans are considered major pests, but they infest all stone fruit plus apple, pear and quince. Although they belong to different families (*Tortricidae* and *Gelechiidae*, respectively), they have similar biology. *Anarsia lineatella* overwinters as a young larva in sheltered places. When the first leaves appear, the larvae emerge and start to feed on flowers, penetrating deep inside the calyx. They then feed on young leaves and fruits. At the end of April, they pupate between the damaged leaves and shoots. From the first half of May to June, the first adults emerge and, after mating, the females lay their eggs singly or in small clusters on the leaves, shoots and fruits. Larvae penetrate the fruits and feed on them causing heavy damage. Adults of the second generation emerge from the beginning of July until August, while those of third generation emerge from the end of August to September.

Grapholita molesta overwinters as mature larvae in cocoons in crevices under bark or in the soil, or in old fruit containers or packing sheds. First adults appear when peach is in flower. Females lay 20–50 eggs on the underside of the leaves or on new shoots. The newly hatched first-generation larvae bore into the tips of terminal shoots and tunnel downward, causing them to wilt. Before maturing, a single larva may destroy 2–5 shoots. The larvae pupate on the trunk of the tree (mostly in summer) or on the ground. *G. molesta* may complete 3–4 generations each year and, because of overlapping generations, adults are constantly present in the orchards in July and August. Larvae of summer generations feed on fruits, as the new shoots begin to harden.

Basic strategy

Where infestation is low, and especially in young orchards, infested wilted shoots can be cut and burned. Pheromone traps are recommended to monitor for the presence of the pests, as control tools to capture them, as confusants to disrupt their mating and as lures to attract them to insecticide baits. Forecasting models exist and are a useful tool to determine the right time for insecticide sprays.

The traditional strategy for the control of *A. lineatella* is based on insecticide application against overwintering larvae at bud break, followed by further applications on eggs and larvae of the following generations. An adult threshold is fixed for treatment against the first generation of *A. lineatella*, and larvicidal applications should be carried out after 15 days.

Against *G. molesta*, insecticides are applied at the hatching of the larvae or when first attacks are observed. Sprays may be needed through the harvesting period, and choice of active substances will then be limited by post-harvest interval. In case

of heavy infestations, insecticides may be used after the harvest against larvae feeding on shoots. The use of selective insecticides such as insect growth regulators or *Bacillus thuringiensis* var. *kurstaki* is preferred.

Main insecticides

Sprays: acrinathrin, alpha-cypermethrin, azinphos-methyl, *Bacillus thuringiensis* var. *kurstaki*, bifenthrin, cypermethrin, diflubenzuron, esfenvalerate, etofenprox, fenitrothion, fenoxycarb, flufenoxuron, lambda-cyhalothrin, methidathion, methomyl, methoxifenzide, tau-fluvalinate, tebufenozide, teflubenzuron, thiacloprid, triflumuron.

Hoplocampa spp.

General

Adults of plum sawflies (*Hoplocampa minuta*, *Hoplocampa flava*) can be observed in plum orchards just before blossom and each female lays 50–70 eggs singly on the flower calyx. Newly hatched larvae bore into the fruit. After their first moult they emerge and infest an adjacent fruitlet. In warm conditions, they can complete their development in 20–25 days. All fruits where the larva penetrated to the seed will fall to the ground. When the larva is mature, it falls to the ground and forms a compact cocoon. In February–May of the following year, the larvae complete their metamorphosis and emerge to start a new infestation.

Basic strategy

Traditional control of this pest is based on a single insecticide spray carried out at petal fall. The IPM strategy does not allow specific treatments but recommends taking advantage of the incidental control obtained from insecticide treatments applied for the control of *Cydia funebrana*.

Main insecticides

Sprays: acetamiprid, deltamethrin, dimethoate, imidacloprid, lambda-cyhalothrin, phosalone, thiacloprid.

Tortrix moths

General

Argyrotaenia ljungiana is a polyphagous tortricid which overwinters as the pupa and completes three generations per year. Adults can usually be observed in *Prunus* orchards in April, June and end of July. Most damage is caused by the larvae of second and third generations which feed on the pedicel of fruits just before harvest. *Pandemis heparana* overwinters as young larvae sheltering under dried-up leaves on the upper branches of the tree. It completes its development in spring feeding on leaves, flower buds and young fruits. Adults can usually be observed in June. *Archips podana*, like *P. heparana*, overwinters as young larvae and, in spring, damages leaves, flowers and fruits. Larvae are present in the orchards in May and August. *A. podana* may have two or three generations per year. Damage caused by these three lepidoptera is mainly caused by feeding on fruits and pedicels (*A. ljungiana*). Besides these, a fourth species *Adoxophyes orana* has increasingly been observed on cherries.

Basic strategy

The traditional control strategy is based on insecticide sprays against newly hatched larvae, with a repeated treatment after two weeks if needed. The IPM strategy recommends regular monitoring to detect first infestations, and application of *Bacillus thuringiensis* var *kurstaki* when more than 5% of infested shoots are found.

Main insecticides as for *Grapholita molesta*.

Cydia funebrana

General

C. funebrana is a tortricid which mainly attacks fruits of cultivated and wild *Prunus domestica*. Late cultivars are very susceptible to this pest. It overwinters as the mature larva in a cocoon located between the bark scales of trunks and branches, and completes its metamorphosis in March and April in the warmest areas. Adults can be observed as early as one or two weeks after petal fall, but in cooler areas they may not occur for 6 or 8 weeks after petal fall. Females lay eggs on the lower part of the fruit. Larvae of the first generation penetrate the young fruitlet leaving a small hole which oozes gum. Fruits infested very early turn purple and fall to the ground. Later infested fruit will remain on the tree, but tend to ripen earlier than healthy fruits. Larvae mature in about 4–6 weeks, emerge from the fruit and spin a cocoon on the bark. In cooler areas there is only one generation per year, but in other areas a full second generation is common. Adult moths can be found over long periods during the summer.

Basic strategy

The adult population should be monitored using pheromone traps during the late spring and through the summer. Forecasting models are available and should be used, in conjunction with pheromone traps, to determine the right time for insecticide sprays. Where more than one generation occurs, treatment strategies may need to be adjusted. The use of selective insecticides such as insect growth regulators or *Bacillus thuringiensis* var. *kurstaki* is preferred.

Main insecticides as for *Grapholita molesta*.

Rhagoletis cerasi

General

Rhagoletis cerasi is the most important pest of cherry orchards in warmer areas. It has only one generation per

year and overwinters as a pupa in the soil under the tree. Adults start to fly in May or June, depending on the geographical environment and climate. Females first feed for about 10–15 days, then start egg-laying. Eggs are laid singly in the young cherry fruits. Hatching takes 5–10 days. The young larvae bore into the fruit flesh close to the cherry stone. They reach maturity after 10–30 days, emerge and fall to the ground where they pupate.

Basic strategy

Monitoring the presence of the adults in cherry orchards by using yellow sticky traps is highly recommended. Insecticide sprays are applied according to the location of the orchard in relation to known risky areas (usually orchards located 200 m above sea level are more susceptible). Traditional control of *R. cerasi* is achieved by spraying insecticide as soon as the fruits turn yellow. An approved feeding attractant may be used to enhance the efficacy of the insecticide.

Main insecticides

Protein baits.

Sprays: deltamethrin, diazinon, dimethoate, fenthion, lambda-cyhalothrin, malathion.

Ceratitis capitata

General

Ceratitis capitata is present in the Mediterranean region and damages stone fruits ripening from July onwards (particularly peach). The adult oviposits in developing fruits, and hatching larvae burrow within the fruits to feed. The larvae in fruits cause direct damage resulting in local decay and premature fruit drop. Fungi and bacteria may enter the fruits through injuries. Even greater concern is the presence of larvae in harvested fruits, because of the threat of introduction into countries where *C. capitata* is regulated as a quarantine pest. The number of generations varies (normally 3–4 generations, but up to 7–8 in regions where winter temperatures remain above 0°C). *C. capitata* usually overwinters as a pupa, buried a few cm deep in the soil.

Basic strategy

Efforts have been made to develop biological control methods, but no consistent biological control exists. The pest population should be monitored by yellow sticky traps and/or pheromone traps. Use of attractive protein bait permits localized treatments on parts of orchards. The sterile-male technique used in other continents (release of males sterilized by irradiation) is eradicative in purpose. It has been tried in Mediterranean countries, but has failed because populations of *C. capitata* survive on wild hosts. The method is not cost-effective for simple suppressive control.

Main insecticides

Sprays: alpha-cypermethrin, deltamethrin, dimethoate, fenthion, malathion.

Eurytoma amygdali

General

Eurytoma amygdali is considered as one of the most important pests of almond, especially in the southeastern Mediterranean region. The larvae bore in the kernel of the fruits. This hymenopteran can cause up to 70% harvest loss.

Basic strategy

Fruits on the ground before winter should be collected and burned. Insecticide sprays can be applied, but their timing is critical. To monitor adult emergence, cages containing infested almonds from the previous year are placed in the field and emerged adults are counted. In case of heavy infestation, 2–3 sprays at 10-day interval may be needed.

Main insecticides

Sprays: phosalone.

Mites

General

Spider mites damage foliage of stone-fruit trees by sucking the cell contents from leaves. Prolonged feeding causes leaves to turn yellow and drop off. *Tetranychus urticae* overwinters as the adult female and lays eggs on the leaves. *Panonychus ulmi* overwinters as eggs located at the base of buds and in bark cracks. During favourable conditions, mites develop within 7 days and may have up to 10 generations per season. Rust mites also occur on *Prunus* (*Eriophyes similis*, *Eriophyes padi*).

Basic strategy

The best course of action is to conserve and promote existing predators. *T. urticae* and *P. ulmi* used to be important pests of stone fruit, but application of IPM has made it possible to forego almost entirely any control of spider mites. Predatory mites of the family *Phytoseiidae*, particularly *Amblyseius andersoni* and *Amblyseius californicus*, and the coccinellid *Stethorus puntillum* are currently able to prevent onset of infestation by spider mites. The control programme should be based on early detection of mites through regular orchard inspection. Orchards should be monitored for both predators and mites at least once every two weeks in spring and during the growing season once a week. The need to control mites with acaricide sprays is based on temperature and humidity conditions, population levels, tree vigour and time of the year. Orchards stressed

by lack of water or some other factor, and those in which presence of predatory mites have not been detected, may require treatment at lower spider mite densities. To minimize the risk of resistance, specific acaricides should not be applied more than once per season.

Main acaricides

Sprays: etoxazole, fenazaquin, fenbutatin oxide, fenpyroximate, hexythiazox, propargite, pyridabene, tebufenpyrad.

Weeds

General

Heavy weed infestation of stone-fruit orchards may cause serious damage, particularly in new plantings, due to high competition for nutrients. There may be an effect on vegetative growth the following year. Also, commercial orchards may be affected by heavy weed infestations which lead to nutrient deficiency and favour attacks of pathogenic fungi such as *Monilinia* spp. and *Botryotinia fuckeliana*. However, a well balanced presence of herbaceous plants, particularly between the tree rows, provides the soil with nutrients and organic matter and allows machinery to move more easily in the orchard. Therefore, sowing a mix of herbs to facilitate grass coverage is sometimes recommended. On the other hand, this agronomic practice should be avoided in orchards located in semi-arid climates and no irrigation.

Basic strategy

Different control strategies exist. Orchards may be totally grass-covered and periodically mowed, or grass–covered between the rows, or without grass coverage at all. Weed control may be mechanical (with different level of grass growth), by fire, plastic film mulching, or herbicides. The use of herbicides in *Prunus* orchards is not a common practice. They are commonly used in orchards where plants have a weak or superficial root system, or the plants are being grown in dense stands. Herbicides may be applied at any time of year, depending on the specific weed to be controlled and the herbicide used.

Stone–fruit trees are susceptible to herbicide uptake by the roots, leading to symptom expression on the leaves. So preference should be given to contact herbicides.

Main herbicides

Apricot
Cycloxydim, diquat, glyphosate, glyphosate trimesium, glufosinate-ammonium, oryzalin, oxadiazon, oxyfluorfen, paraquat, simazine, trifluralin.

Peach
Cycloxydim, diquat, fluazifop-P-butyl, glyphosate, glyphosate–trimesium, glufosinate-ammonium, oryzalin, oxadiazon, oxyfluorfen, paraquat, simazine, trifluralin.

Cherry
Diquat, fluazifop-P-butyl, glyphosate, glyphosate trimesium, glufosinate-ammonium, oryzalin, oxyfluorfen, paraquat, simazine, trifluralin.

Plum
diquat, fluazifop-P-butyl, glyphosate, glyphosate-trimesium, glufosinate-ammonium, oryzalin, oxadiazon, oxyfluorfen, paraquat, simazine, trifluralin.