

◆ **EPPO Standards** ◆

GUIDELINES ON GOOD PLANT PROTECTION PRACTICE

TOBACCO

PP 2/15(1) English



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APPROVAL

EPPO Standards are approved by EPPO Council. The date of approval appears in each individual standard.

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 guidelines 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.

REFERENCES

All EPPO guidelines on good plant protection practice refer to the following general guideline:

OEPP/EPPO (1994) EPPO Standard PP 2/1(1) Guideline on good plant protection practice: principles of good plant protection practice. *Bulletin OEPP/EPPO Bulletin* **24**, 233-240.

OUTLINE OF REQUIREMENTS

For each major crop of the EPPO region, EPPO guidelines 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.

Guidelines on good plant protection practice

TOBACCO

Specific scope

This standard describes good plant protection practice for tobacco.

Specific approval and amendment

First approved in September 1998.

This guideline on GPP for tobacco (*Nicotiana tabacum*) 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(1) Principles of Good Plant Protection Practice. The guideline covers methods for controlling pests (including pathogens and weeds) of crops of *Nicotiana tabacum*.

Tobacco is grown from seed under protected conditions, and the seedlings are then transplanted into the field. This guideline accordingly considers plant protection problems both in the seedbed and in the field. In general, it is a major element of GPP to produce healthy seedlings in a high-quality compost, preferably sterilized by steam or chemical treatment (e.g. dazomet, metam-sodium), which will control animal pests, seedling diseases and many weeds. In the field, since the harvested product is the leaf itself, a high degree of control of leaf-attacking pests has to be achieved.

It is GPP to use appropriate application techniques, and to reduce drift and unwanted dispersal. Repeated spraying of plant protection products with the same mode of action and known to cause resistance problems should only be done in accordance with a resistance management strategy, e.g. by combining systemic with contact fungicides.

The principal tobacco pests considered are the following:

- *Peronospora tabacina* (blue mould, downy mildew)
- damping-off;
- *Chalara elegans* (black root rot);
- *Sclerotinia sclerotiorum* (stem rot);
- *Phytophthora parasitica* var. *nicotianae* (black shank);
- *Alternaria* spp. (brown spot);
- *Erysiphe cichoracearum* (powdery mildew);
- *Pseudomonas syringae* pv. *tabaci* (wildfire);
- viruses;
- soil insects;
- noctuids;

- aphids;
- *Thrips tabaci*;
- nematodes;
- weeds;
- sucker control.

Explanatory note on active substances

The EPPO Panel on Good Plant Protection Practice, in preparing this guideline, 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.

Peronospora tabacina (blue mould, downy mildew)

General

This fungus causes the most dangerous epidemic disease of tobacco. It can damage tobacco at every stage of development (seedbed, field) and is able to attack every green part of the plant. It can be severe on seedlings, killing patches of seedlings in the seedbed, particularly when they are exposed to conditions of high humidity, leaf wetness and cool temperatures. On seedlings, the appearance of sporangiophores bearing sporangia is often an obvious symptom (blue mould). The sporangia spread the disease to older plants, on which the "oil spot symptom" typical of downy mildews may be seen before the lesion tissue becomes chlorotic and dies. In the EPPO region, the fungus mainly overwinters in Mediterranean countries, and is

spread from south to north each season by rain and wind. Monitoring of this spread in different countries is the basis of an international warning service run by CORESTA.

Basic strategy

Cultural and related practices in seedbeds are very important: sowing should not be too dense, watering should preferably be applied in the morning, excess of nitrogen should be avoided, seedbeds should be destroyed by digging immediately after the end of transplanting. At the seedling stage, it is essential to control infection by frequent spraying with protectant fungicides (e.g. at 4-7-day intervals), in order to avoid early losses and prevent introduction of the disease into the field. Under protected conditions, it will then be necessary to take measures to reduce humidity and leaf wetness. In the field, it is advised to spray contact or systemic fungicides at longer intervals (e.g. 8-14 days), taking into consideration the persistence of the products used, the weather conditions and the infection situation. The basic strategy relies on prevention. Curative treatments will not succeed in controlling the disease. It is GPP to monitor regularly for first detection of symptoms.

Main fungicides

Sprays: benalaxyl, fosetyl-aluminium, mancozeb, metalaxyl, oxadixyl, propineb, zineb.

Damping-off

General

A complex of soil fungi can cause serious damping-off disease in seedbeds. Most often involved are: *Thanatephorus cucumeris* (anamorph *Rhizoctonia solani*), *Pythium* spp. (e.g. *P. aphanidermatum*, *P. ultimum*), *Phytophthora parasitica* var. *nicotianae*, *Thielaviopsis basicola* and *Fusarium* spp. Some of these fungi cause other diseases on older plants.

Basic strategy

Cultural practices should create conditions unfavourable for damping-off fungi. Thus, it is GPP to carry out proper soil sterilization and to construct well flattened and cultivated seedbeds, high (20-30 cm) above the ground, with proper (not dense) sowing, and to avoid excess of fertilization and irrigation. Cultivars with resistance to *Fusarium* spp. may be used. Fungicides are applied by drenching, starting at the 4-leaf stage of the seedlings.

Main fungicides

Soil sterilization in seedbed: dazomet, metam-sodium.
Sprays: metalaxyl, propamocarb.

***Chalara elegans* (black root rot)**

General

Chalara elegans (synonym *Thielaviopsis basicola*) is a soil-borne fungus which can destroy the roots of tobacco seedlings very quickly. The roots become dark-coloured and are covered by mycelium and conidia (black root rot). The infected plants become stunted, turn yellow and die. This fungus is included in the complex of soil fungi which causes damping-off in seedbeds (see above). It also infects tobacco in the field, where the affected plants are stunted and flower earlier. Rainy weather and relatively high temperatures are suitable for the fungus. Types of Burley are the most susceptible cultivars.

Basic strategy

In the seedbed, *T. basicola* is controlled as part of the damping-off complex (see above). In the field, it is GPP to transplant healthy plant material, to use a 2-3-year crop rotation with cereals or maize, and to avoid alkaline fertilizers or lime.

Main fungicides

In the seedbed, as for damping-off.

***Sclerotinia sclerotiorum* (stem rot)**

General

This fungus attacks tobacco both in the seedbed and in the field. The inoculum comes from sclerotia in the soil. The fungus infects shoots around the petioles. Severely affected plants lodge, may wilt and die.

Basic strategy

Chemical or steam sterilization of the soil in the seedbed is the basic strategy for controlling *Sclerotinia sclerotiorum*. If infected plants are found in the field, it is GPP to destroy them. Alternatively, fresh soil can be used for the seedbed.

Main fungicides

Soil sterilization in seedbed: dazomet, metam-ammonium, metam-sodium.

***Phytophthora parasitica* var. *nicotianae* (black shank)**

General

Besides its role as part of the damping-off complex (see above), *Phytophthora parasitica* var. *nicotianae* soil fungi can cause serious damage in the field. Rotting and blackening of the root system causes wilting and yellowing of the above-ground parts. The

black root rot can spread to the base of the stem (black shank), causing the leaves to shrivel and die. The temperatures and moistures which favour tobacco growth also favour the incidence of the disease.

Basic strategy

To avoid the disease in the field, it is GPP to transplant only healthy planting material, to maintain a 2-4-year crop rotation (for example, with cereals), to apply strict hygiene methods when the disease is found (e.g. avoiding transportation of infested soil by machinery, disposing of debris), to use resistant cultivars and to control nematodes (*Meloidogyne* spp.). If, despite these measures, the disease appears, fungicide treatment can reduce losses.

Main fungicides

Sprays: metalaxyl.

***Alternaria* spp. (brown spot)**

General

Several species of *Alternaria* infect tobacco. In the EPPO region, *A. longipes* is mainly involved. The disease is not generally of major importance. The fungus can destroy seedlings in the seedbed, when conditions are unfavourable to the plants (wet soil, high humidity, etc.). In the field, tobacco leaves are attacked. Symptoms range from small discrete black spots to large zonate lesions up to 12 mm diameter with brown centres.

Basic strategy

Plants should be well spaced, very high humidity should be avoided, and plants should be well watered. A balanced fertilization with potassium phosphate and magnesium can reduce the disease; excess of nitrogen should be avoided. Fungicide sprays recommended against other fungal diseases of tobacco are effective against this fungus. Plants weakened by attacks of *Meloidogyne* spp. are more susceptible to attacks by *Alternaria* spp., and these nematodes should be controlled in fields where the disease occurs.

Main fungicides

Sprays: chlorothalonil, mancozeb, propineb, zineb.

***Erysiphe cichoracearum* (powdery mildew)**

General

Erysiphe cichoracearum mainly attacks the lower leaves of tobacco plants, causing typical powdery mildew symptoms. It is only occasionally damaging. Some cultivars are more susceptible.

Basic strategy

Dark areas with high relative humidity should be avoided. In areas where a risk exists, use resistant cultivars, decrease the density, and avoid excessive nitrogen fertilization. If necessary, fungicides may be sprayed.

Main fungicides

Sprays: dinocap, fenarimol, penconazole, propiconazole, sulphur.

***Pseudomonas syringae* pv. *tabaci* (wildfire)**

General

Wildfire is the most important bacterial disease of tobacco. It is most serious on young plants in the seedbed, but also occurs in the field. The source of inoculum is mainly infected tobacco debris in the soil, but cases of seed transmission have been reported. The bacterium can be spread by surface water in the soil. Leaves become infected by rainsplash, through stomata or wounds caused by insects or mechanical damage. The lesions appear as water-soaked, then necrotic, 1-8 mm spots, with angular margins. Some strains of the bacterium, producing a toxin, cause the appearance of a large chlorotic halo (up to 2.5 cm) around the lesion.

Basic strategy

The main strategy is to prevent outbreaks of the disease in the seedbed, by using healthy seed, maintaining strict hygienic precautions, and rotating sites used as seedbeds. It is advisable to sterilize the soil and tools used in growing planting material. If infected plants are found in the seedbed, they should be destroyed. If, despite these precautions, outbreaks occur in the field, very little can be done to prevent losses. There are no suitable bactericidal treatments.

Viruses

General

Virus diseases are among the most dangerous diseases of tobacco. Mixed infections are commonly seen in the field. For the EPPO region, the principal viruses are described below in order of importance.

Tomato spotted wilt tospovirus (TSWV), transmitted by *Thrips tabaci*, is favoured by hot dry weather, which favours the insect vector. Numerous plants (cultivated, ornamentals and weeds) other than tobacco are affected by both the thrips and TSWV, and can serve as a source of infection. Tobacco is affected both in the seedbed and in the field.

Tobacco mosaic tobamovirus (TMV) causes symptoms varying from mosaic, vein clearing or mild mottling to gross distortion or puckering of the leaves. Burning or scalding of the leaves may also occur (mosaic burn). TMV is a very stable virus, which persists for long

periods in infected debris. It is also very easily mechanically transmitted, for example on hands or implements. Hygiene is thus the key to its control. Early infection of tobacco can seriously reduce yield (33%) and lower quality (50%).

Potato Y potyvirus (PVY) causes mosaic symptoms including vein clearing, banding or mottling, yellowing and chlorotic rings of leaves. Necrotic symptoms are also seen: small, yellow necrotic spots, whitish necrotic rings, partially slight or large necrosis of midrib and veins. The virus is transmitted from vegetables and weeds to tobacco by aphids (more than 25 species, especially *Myzus persicae*) in the non-persistent manner.

Cucumber mosaic cucumovirus (CMV) gives symptoms which vary widely, depending on the strain and tobacco cultivar. The most common symptom is a mosaic pattern (confused with TMV). Yellow to white mosaic, necrotic alterations on the bottom leaves may also appear, or more or less filiform patterns on young leaves, or "oak leaf" patterns of necrosis. CMV is transmitted in the same manner as PVY by aphids (more than 60 species).

Alfalfa mosaic alfamovirus (AMV), transmitted by aphids and by seeds, and *Tobacco rattle tobnavirus* (TRV), transmitted by nematodes and by seeds, are relatively minor viruses of tobacco in the EPPO region.

Basic strategy

It is important to provide well balanced nutrients and to avoid over-fertilization with nitrogen. In heavily infested areas, early ripening cultivars should be grown. Cultivars resistant to TMV or tolerant to PVY also exist and should be used.

The strategy of control relates mainly to the type of transmission. Plant hygiene is very important for the control of the stable, mechanically transmitted TMV. Heat sterilization of the seedbed and disinfection of the pots and borders of the seedbed with sodium hydroxide solutions can be done. The soil should as far as possible be free from tobacco debris, and the tools used in planting operations should be sterilized. As far as possible, contact between the plants and machinery used in cultural operations should be avoided.

For the insect-transmitted viruses, the appropriate isolation distance should be kept (500-1000 m) mainly to reduce risk from TSWV and CMV. No potatoes should be grown in the vicinity of tobacco plantations as they can be a source of PVY. In relation to the nematode-transmitted viruses, soils infested with vector nematodes should be avoided. The control of the vectors with insecticides is used to restrict the spread of viruses and reduce direct damage.

Soil insects

General

Coleopteran larvae of the families *Elateridae* (e.g. *Agriotes* spp.), *Tenebrionidae* (*Gonocephalum* spp.)

and *Scarabaeidae* (e.g. *Melolontha melolontha*) may damage tobacco in the field during the first 2-4 weeks after transplanting. *Elateridae* (wireworms) are particularly important. The main factors which favour damage are: level of infestation in the soil, moisture content near the root system and the previous crop.

Basic strategy

The soil of the seedbed should in any case be adequately sterilized. The need for control measures in the field depends on the level of infestation of the soil, which is mainly related to the preceding crop. Beans, peas, flax or mustard are recommended as preceding crops which are not favourable to these pests, while pasture or uncultivated land is not recommended. Counts of larvae in the soil can be used to determine infestation levels. A granular insecticide can, if necessary, be applied by incorporation at the last soil cultivation.

Main insecticides

Carbofuran, chlorpyrifos, dazomet, fonofos, metam-sodium, tefluthrin, terbufos.

Noctuids

General

There are many species of noctuids that attack tobacco. In the soil, the larvae of *Agrotis* spp. (cutworms) feed on the roots and attack the collars (stems) of transplanted tobacco plants, especially during the first 2-3 weeks after setting. Another group, the leaf feeding noctuids, lay eggs on weeds and tobacco plants (e.g. *Heliothis* spp., *Mamestra* spp. and *Autographa gamma*). Larvae of these noctuids feed on leaves and may destroy them completely, leaving only the main veins.

Basic strategy

Plants should be checked regularly for eggs or young caterpillars and sprayed when these are easily found. Weed control may reduce problems with noctuids. Pheromone traps are available for some moth species and indicate when plant inspections should begin. The best moment for treatment with an insecticide is while the caterpillars are very small and are feeding above the ground. Usually, only one foliar spray, applied with high water volume, is necessary. Application of dusts and baits is also possible.

Main insecticides

Sprays: acephate, *Bacillus thuringiensis*, chlorpyrifos, cypermethrin, deltamethrin, lambda-cyhalothrin, phosalone, pymetrozine. These insecticides are best alternated to avoid resistance.

Aphids

General

Tobacco is attacked by aphids, mainly *Myzus persicae* or *M. nicotianae*, but sometimes also *Aulacorthum solani* and *Macrosiphum euphorbiae*. They cause damage to the crop directly as sucking insects, especially in the field, and indirectly as virus vectors (see viruses) in both seedbeds and fields. Heavy infestations, especially during prolonged warm summer weather, cause leaf distortion, lower yield and bad-quality product. Aphids usually appear 20-30 days after transplanting into the field, depending on weather conditions and neighbouring crops (e.g. *Prunus* spp.). The growth of young plants may be retarded.

Basic strategy

Plants should be monitored regularly to ensure that aphids have not established. A single early spray treatment may be sufficient, but if more aphids appear, up to 4 spray treatments may be needed. Organophosphorus resistance is known in *M. persicae*. General methods favouring aphid control are: early and effective weed control, destruction of remaining crops in seedbeds and fields, proper nitrogen fertilization, early topping and sucker control in Burley cultivars and flue-cured tobacco, careful selection of insecticides to help biological control by beneficials.

Main insecticides

Sprays: acephate, cypermethrin, deltamethrin, formothion, imidacloprid, lambda-cyhalothrin, oxydemeton-S-methyl, phosalone, pirimicarb, pymetrozine.

Thrips tabaci

General

Thrips tabaci is a polyphagous species, attacking many other host species. Adults and nymphs can damage tobacco directly in the seedbed and in the field. In hot dry weather conditions, heavily attacked leaves lose their moisture, showing silvery spots and especially along the veins. They are easily rubbed during manipulation, leading to poor quality and rejection. *T. tabaci* is also the vector of *Tomato spotted wilt tospovirus*.

Basic strategy

T. tabaci is favoured by hot dry conditions, and its multiplication is inhibited by rain or irrigation. It is important to ensure that transplants are not infested, so the pest should be controlled by insecticide sprays in the seedbed if necessary. External sources of infestation should be avoided or removed as far as possible (weeds, crop debris), and adjoining crops should be monitored for development of thrips. Their

population should be monitored using coloured traps (blue, yellow and white). Insecticides used against aphids are often also effective against thrips, keeping the population low. If a special treatment against thrips is nevertheless necessary, an insecticide can be sprayed.

Main insecticides

Sprays: cypermethrin, formothion, permethrin.

Nematodes

General

The most damaging nematodes on tobacco are *Meloidogyne* spp., *Pratylenchus* spp. and *Ditylenchus dipsaci*. The stem and bulb nematode *D. dipsaci* causes "stem break". The root nematodes *Meloidogyne* spp. and *Pratylenchus* spp. may cause direct damage, by feeding on the root system of tobacco and also indirect damage, by facilitating infection by fungi such as *Thielaviopsis basicola* (mostly in the seedbed) or *Phytophthora parasitica* var. *nicotianae* (mostly in the field). In fields, plants are stunted, turn yellow and wilt. Such plants give low yields and produce leaves of poor quality. Nematodes can cause very serious damage in rainy weather or heavy irrigation, especially in hot sandy or sandy clay soils, if the attack occurs early in the season at soil temperatures of 22-23°C.

Basic strategy

Infestation of preceding crops should be taken into account. Sterilization of seedbeds is a very good practice to ensure production of healthy transplants. Crop rotation (2-4 years) and destruction of crop debris in seedbeds and fields are also good practices for root nematodes.

Main nematicides

Sterilization in the seedbed: aldicarb, dazomet, 1,3-dichloropropene, metam-sodium.

Weeds

General

Tobacco has poor ability to cover the ground to suppress weeds. Weed control in tobacco is essential, particularly in the early stages of crop growth. Although there are possibilities for mechanical weed control between rows in tobacco, chemical treatments are the normal practice. Problems of perennial weeds should be solved in the previous crop.

Basic strategy

It is good practice to use pre-planting treatments. They have good effect against broad-leaved and grass weeds, but the addition of other herbicides may be needed in order to broaden the spectrum of action.

Main herbicides

In fields

Pre-planting: benfluralin (with soil incorporation), butralin, metobromuron, metolachlor, napropamide, oxyfluorfen, pendimethalin.

Post-emergence (control of *Sorghum halepense* and annual grasses): cycloxydim, fluazifop-P-butyl, quizalofop.

In seedbeds

Fumigation (e.g. dazomet, see sterilization of seedbeds, in Introduction).

Pre-emergence by spraying on top of seed cover material: diphenamid, napropamide.

Sucker control

General

Topping (cutting the axial flower) is needed with all cultivars used for industrial tobacco production in order to obtain high quality. Due to the lack of apical dominance, suckers regrow and cause deterioration of the quality. The growth of suckers should be prevented, initially by hand, then if necessary by spraying a growth regulator.

Main plant growth regulators

Decan-1-ol, flumetralin, maleic hydrazide, pendimethalin.