◆ EPPO Standards ◆

GUIDELINES ON GOOD PLANT PROTECTION PRACTICE

LETTUCE UNDER PROTECTED CULTIVATION

PP 2/3(2) English

European and Mediterranean Plant Protection Organization
1, rue Le Nôtre, 75016 Paris, France

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.

EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPÉENNE ET MÉDITERRANÉENNE POUR LA PROTECTION DES PLANTES

PP 2/3(2) English

Guidelines on good plant protection practice

LETTUCE UNDER PROTECTED CULTIVATION

Specific scope

This standard describes good plant protection practice for lettuce under protected cultivation.

Specific approval and amendment

First approved in September 1994.
Revision approved in September 2000.

This guideline on GPP for glasshouse lettuce 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 lettuce under protected cultivation.

GPP for the protected lettuce crop presents particular difficulties:

1 as a monoculture under protected conditions, lettuce is liable to rapidly spreading pest attacks;

2 the product is the leafy vegetable as such, and market standards tolerate no spotting, discoloration, visible insect damage, etc. (in contrast to other important vegetables in protected cultivation like tomatoes or cucurbits, where fruits are the marketed product and a certain amount of damage to the foliage can be tolerated);

3 partly as a consequence of (2), there is no practicable biological control of pests in lettuce at present;

4 residue tolerances are very low, as the part of the plant treated is the part consumed, and it is consumed fresh (without a significant storage period).

GPP in lettuce also implies good management of the protected environment, for the incidence of pests can be much affected by general cultural conditions. In particular, crops should be well spaced, conditions favouring very high RH should be avoided, plants should be well watered during hot dry periods to prevent marginal leaf necrosis (which favours botrytis rot) but should not be watered late in the day when the crop might stay wet for a long time (possibly overnight), infected plants should be carefully removed (avoiding spore dispersal as far as possible), general hygiene should be high. Special attention should be given to the control of weeds (using herbicides or other means of control) around the glasshouses, as they can be reservoirs for many pests and also sources of weed seeds.

Soil sterilization is a common practice for pest control (including weed control) in protected crops. It is GPP to use steam sterilization for this purpose.

Viruses are also important pests of lettuce, and control of their vectors (soil fungi, aphids) has to reflect this. Some viruses can be partially controlled by using tolerant cultivars. Use of virus-free planting material is essential. Plants should be regularly inspected for virus symptoms and infected plants immediately removed.

Lettuces for protected cultivation are mostly grown from seedlings raised in small peat pots (or similar containers) or peat blocks, transplanted as a whole into the final growing medium. The grower frequently buys in the seedlings from another source, but may also produce them himself. Thus, the guidelines for the different pests given below refer separately to the recommended practice for seedlings. Seedlings should be produced in a high-quality compost. They should be raised in an isolated location, away from lettuce crops or other crops (to prevent infection especially by downy mildew and viruses). The seeds should meet normal certification standards for *Lettuce mosaic potyvirus* or tolerant cultivars should be used. Normal precautions should be taken against damping-off diseases, including the use of seed treatments.

Cultural conditions can markedly affect disease risk in lettuce. Planting large or damaged plants, or planting into dry soil should be avoided to reduce *Botryotinia fuckeliana*. Watering is carried out mostly early in crop growth, creating a reserve in the soil, so that there is less need to water later on, when watering is likely to encourage downy mildew. Balanced nutrition with adequate potassium is also believed to reduce botrytis risk.

Finally, it may be noted that most glasshouse lettuces are grown in soil, so that appropriate precautions have to be taken to avoid carry-over of pests in the soil, including pathogens and weed seeds. However, some lettuces are grown in soil-less media or by liquid-film methods. In these circumstances, the guidelines given below for soil-borne animal pests will not, or rarely, apply. In many countries in the EPPO region, lettuce is grown under the protection of plastic tunnels. Under these conditions, general hygiene standards need to be

maintained at a very high level, but the basic strategies to control pests remain broadly the same.

The principal lettuce pests considered are the following.

- *Bremia lactucae* (downy mildew);
- fungal rots;
- *Lettuce big-vein varicosavirus;*
- *Cucumber mosaic cucumovirus;*
- *Lettuce mosaic potyvirus;*
- aphids;
- noctuids;
- *Liriomyza huidobrensis* and other leaf miners;
- *Meloidogyne* spp (root-knot nematodes);
- slugs;
- weeds.

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.

Bremia lactucae (downy mildew)

General

Bremia lactucae causes the most serious disease of lettuce under protected cultivation. It persists as oospores in soil, and is air-dispersed as sporangia. Lettuce plants can be infected at the seedling stage and all the way through the growing period. Lesions on leaves are first discoloured, and finally rot after sporulation of the pathogen.

Basic strategy

The treatments applied to seedling compost or soil against fungi are not very effective against *B. lactucae* oospores. If possible, soils in which significant downy mildew was seen on a previous lettuce crop should be avoided. Treatment of seedlings is essential, usually with sprays of dithiocarbamates (zineb or mancozeb) and continues after planting out. Because the dithiocarbamates are the fungicides most likely to present residue problems, it is most usual to use them alone on seedlings, or in the first 2 weeks after planting, then use a systemic fungicide on the crop. Lettuce cultivars with resistance to *B. lactucae* are available. This is often through the combination of several vertical resistance genes, but numerous corresponding pathotypes of *B. lactucae* exist. It is not advised to use a resistant cultivar, without chemical treatment, relying on the absence of the matching pathotype, as the pathotypes which occur on the crop may not correspond to the resistance of the plant. However, under such circumstances, the number of treatments could be reduced, if no downy mildew is seen.

Problems with fungicide resistance

Resistance to phenylamides has been found in *B. lactucae*. It is recommended in general not to use phenylamides more than twice on a crop, preferably only once. They should not be used curatively, i.e. when disease is visibly present. The number of treatments is more important than the timing in reducing resistance risk.

Main fungicides

Sprays: cymoxanil, folpet, fosetyl-aluminium, mancozeb, maneb, metalaxyl, oxadixyl, propamocarb, thiram, zineb.

Fungal rots

General

Several fungi cause a collar rot of lettuce, the inoculum coming from sclerotia in the soil: *Thanatephorus cucumeris (*anamorph *Rhizoctonia solani); Sclerotinia sclerotiorum* and *Sclerotinia minor*. These rots then spread to the basal leaves, and may eventually destroy the heart of the lettuce. *Botryotinia fuckeliana* (anamorph *Botrytis cinerea*) can also persist as soil-borne sclerotia, but, unlike the others, produces abundant air-borne conidia which can infect leaves directly, especially if these are damaged. Because of the close relationship between *Botryotinia* and *Sclerotinia*, the same fungicides are generally effective against them (in particular, those of the dicarboximide group). *T. cucumeris*, a Basidiomycete, requires quite distinct fungicides. The fungicides used against *B. lactucae* (see previous section) have little useful action against any of the fungi considered here.

Basic strategy

With soil-borne fungi it is essential to ensure that both the compost used for seedling production and the soil are free from inoculum. Seedling compost should be based on new peat. If there is any indication that the soil may be infested, it should be treated by steam sterilization (to 10-cm depth for 15 min) if possible. Such treatment will also destroy *Olpidium brassicae*, the fungal vector of several lettuce viruses (*Lettuce big*

vein varicosavirus, *Lettuce ring necrosis virus*) and *Pythium* spp. which may cause damping-off.

If steam sterilization is not an option, mepronil, pencycuron or tolclofos-methyl can be used as a specific pre-planting treatment against *T. cucumeris*. Alternatively, a single treatment may be used, immediately after planting, with mepronil or pencycuron or tolclofos-methyl.

For partial control of the sclerotia of *Sclerotinia* spp., the antagonist *Coniothyrium minitans* may be applied pre-planting. Any plants affected by *Sclerotinia* spp., and the surrounding soil, should be carefully removed to reduce any soil inoculum for future crops.

Foliar sprays can be applied to minimize air-borne infection by *B. fuckeliana* and the spread of *Sclerotinia* spp. between young plants.

Problems with resistance

Resistance to benzimidazoles (as benomyl) and dicarboximides (e.g. iprodione, procymidone, vinclozolin) is fairly common in *B. fuckeliana*, in view of their use on the many different hosts it attacks. It is possible then to substitute a fungicide from a different group, e.g. tolylfluanid. If as many as three or four treatments are made, it is advisable to alternate fungicides from different groups.

Main fungicides

Seed treatments: mancozeb, maneb, mepronil, thiram.

Soil treatments: *Coniothyrium minitans*, dazomet, mepronil.

Sprays: benomyl, dichlofluanid, dicloran (or fog), iprodione, mepronil, procymidone, thiram, tolclofos-methyl, tolylfluanid, vinclozolin.

Lettuce big-vein varicosavirus

General

The most common symptom in big-vein affected lettuce is a clearing along the veins. Infected head lettuce plants grow like leaf lettuce. Many lettuce types can be severely stunted. The virus is associated with the soil-borne fungus *Olpidium brassicae*. The fungus persists in soils for very long periods of time. It is spread by soil and irrigation water. It also transmits the uncharacterized *Lettuce ring necrosis virus.*

Basic strategy

Lettuce big-vein varicosavirus can be especially severe when lettuce is grown under cool conditions (<16°C) and the soil moisture is favourable for spread of *O. brassicae*. There is presently no control. There are attempts to control the fungal vector by steaming of the soil. Use of uncontaminated water is recommended. It is possible to use carbendazim against *O. brassicae*.

Cucumber mosaic cucumovirus

General

Cucumber mosaic cucumovirus (CMV) is usually a minor pathogen of lettuce, but it can be a significant problem in glasshouses. Symptoms can be very difficult to differentiate from those induced by *Lettuce mosaic potyvirus*. They include stunted plant growth and yellow mottling, distortion, and necrotic spots on leaves. CMV is transmitted by aphids in the non-persistent manner.

Basic strategy

Because CMV is acquired and transmitted by aphids in a matter of seconds and because of its wide host range, it is a difficult virus to control. Thus, spread may occur rapidly and regular control of aphids is necessary. Lettuce should not be grown near autumn crops of cucumber or near infected plants. CMV cannot be spread by mechanical means. The most effective method of control is the use of resistant cultivars.

Lettuce mosaic potyvirus

General

Lettuce mosaic potyvirus (LMV) is one of the commonest and potentially most damaging pathogens of lettuce. Symptoms vary depending on the type of lettuce and cultivar, the growth stage when infected, and environmental conditions. Seedling leaves originating from infected seeds appear irregular in shape and develop a light green mottle or mosaic.

Basic strategy

All types of lettuce are susceptible. The virus is seed-transmitted and sap-transmissible. Effective control is provided by the use of virus-free seed and/or resistant cultivars. An annual lettuce-free period of 2 weeks is recommended. The virus is also transmitted in a non-persistent manner by many species of aphids, therefore their control is needed. Alternate hosts should be removed, in particular the weed host *Senecio vulgaris*.

Aphids

General

Lettuce in protected cultivation is attacked by aphids, mainly *Myzus persicae*, *Macrosiphum euphorbiae*, *Aulacorthum solani*, *Nasonovia ribisnigri* and *Hyperomyzus lactucae* (the root-feeding aphid *Pemphigus bursarius* does not usually occur on glasshouse crops). These aphids feed on the lower side of the leaves and even in the heart of the plant. They cause poor growth, malformation and discoloration. Their physical presence is not acceptable on the marketed product, even after treatment when dead insects and shed skins remain. *Myzus persicae* is also

the vector of LMV and CMV, and one of the objectives of aphid control is to treat early so as to prevent any virus transmission within the crop.

Basic strategy

The need to treat against aphids is determined by their appearance in the crop. Yellow sticky traps can be used to monitor aphid flight but this is not as reliable as monitoring the plants. Treatments should not be carried out routinely. Nevertheless, because of the virus-vector risk, it is important to be vigilant in aphid detection during the period immediately after planting. This is particularly important at times when aphids are most likely to be viruliferous. A single early treatment may be sufficient but, if more aphids appear, up to three treatments may be needed. Exclusion of aphids by insect-proofing is technically feasible but costly.

The range of insecticides which can be used is very wide. Pirimicarb is favoured as a specific product against aphids, but some strains of some species are known to be resistant. *Myzus persicae* and *N. ribisnigri* strains found on protected crops in Europe are likely to be resistant to commercially available insecticides. Therefore, insecticides with different modes of action should be used in alternation. Biological control agents should be used where possible.

Main insecticides

Sprays: cypermethrin, deltamethrin, dimethoate, dichlorvos, heptenophos, malathion, mevinphos, pirimiphos-methyl, pymetrozine.

Fogs: diazinon, dichlorvos, pirimicarb (aerosol dispenser), pirimiphos-methyl.

Smoke: diazinon, pirimicarb (smoke generator), sulfotep (fumigant / vapour-releasing product).

Noctuids

General

The most important insect pests of lettuce in protected cultivation, apart from aphids, are the larvae of noctuid moths, especially *Agrotis ipsilon*, *A. segetum* (cutworms, i.e. soil-inhabiting noctuid larvae feeding on the roots) and *Autographa gamma*, *Mamestra brassicae* and *Mythimna unipuncta* (leaf-feeding noctuid larvae, whose eggs are laid directly on the foliage). However, these pests are only sometimes important, occurring especially in crops grown in soil rather than in soil-less culture.

Basic strategy

Trapping adult moths can be used to determine the time of application of irrigation and/or sprays. Where there is regular irrigation, there are few problems with cutworm damage. For the soil noctuids, a single treatment (bait, granule or spray) should be done if a pest problem is detected, or if pheromone-trap catches indicate a risk, just before or after planting. When pyrethroids are used, it is recommended to avoid the products to be used later against aphids or leaf-feeding noctuids.

For leaf-feeding noctuids, a single treatment is recommended, when damage is seen. This should not normally be applied later than the 15–17-leaf stage, but emergency treatments are available for later use (see Aphids).

Main insecticides

Against soil noctuids: acephate, *Bacillus thuringiensis* ssp. *aizawai*, bifenthrin, chlorpyrifos, deltamethrin, diazinon, fenitrothion, malathion, tralomethrin.

Sprays (against leaf-feeding noctuids): acephate, alpha-cypermethrin, *Bacillus thuringiensis* ssp. *aizawai*, cypermethrin, deltamethrin, lambda-cyhalothrin.

Liriomyza huidobrensis and other leaf miners

General

Several *Liriomyza* spp. infest lettuce*: Liriomyza bryoniae*, *Liriomyza trifolii* and *L. huidobrensis*. The last was introduced into the EPPO region in 1987 and is still absent, or under eradication, in some countries. These GPP guidelines have no relevance in such cases. Where the pest is considered established, however, chemical control is needed. *Liriomyza trifolii* has limited potential to survive outdoors in northern Europe.

Phytomyza horticola may also attack lettuce. This leaf-mining species is polyphagous and very common in Europe.

Basic strategy

Since leaf miners in general are mainly pests of protected crops, at least in northern Europe, the first point in the strategy is to exclude them by general hygienic precautions and to use seedlings free from infestation. Weekly observations with, for example, sticky traps should be used to detect imminent outbreaks. Seedlings can be covered with insect nets (0.8-mm mesh) during the hardening period before planting. A single spray when the pest is detected may be sufficient, but treatment may be repeated at 3- to 5-day intervals if necessary. Leaf miner resistance can sometimes make control difficult. Biological control with *Diglyphus isaea*, *Dacnusa sibirica* and *Opius pallipes* is also possible, and recommended as GPP. The mines in the leaves disfigure the crop for marketing but are usually confined to the lower leaves, so that they can be trimmed off at harvest.

Main insecticides

Sprays: abamectin, cypermethrin, cyromazine, dichlorvos, mevinphos, oxamyl, propoxur, pirimiphos-methyl.

Meloidogyne spp. (root-knot nematodes)

General

Root-knot nematodes (*M. incognita, M. hapla, M. arenaria, M. javanica*) are polyphagous nematodes causing characteristic knots (galls), swellings and other malformations on the roots of lettuce. This results in poor growth, occasionally wilting and thus poor yields. The smaller discrete galls with adventitious root proliferation formed by *M. hapla* are distinctive. Although *M. hapla* prefers coarse-textured soils, it also occurs in organic soils, and it is a major pest of lettuce which is commonly grown in this kind of soil.

Basic strategy

Nematode-free planting material and non-infested soil are normally sufficient to keep lettuce free from these nematodes. Weeds should be thoroughly controlled, throughout the areas where lettuces may be grown. The broad host range of *Meloidogyne* spp. adds to the problem of selecting suitable rotation crops. Steam sterilization of the soil is an effective curative measure. It is not GPP to treat soil systematically with nematicides. Such treatments should be limited to what is strictly necessary, and may be subjected to official limitations.

Main nematicides

Pre-planting soil treatment, allowing for the above considerations (that nematicide use should be restricted rather than recommended): dazomet, oxamyl.

Slugs

General

Slugs (*Agriolimax* spp., *Arion* spp., *Deroceras* spp.) may inflict considerable damage to lettuce seedlings and established plants by feeding and by forming slimy tracks. They can be particularly troublesome in autumn.

Basic strategy

General hygiene is important. All plant debris, left-over plastic and growing medium etc. that may serve as hiding places or oviposition sites should be removed. The soil surface should be clod-free and free from weeds, also along the walls. Moist conditions favour the development of slugs. Biological control is possible with *Phasmarhabditis hermaphrodita*. If problems with slugs persist, molluscicides formulated as baits can be used until 1 week before sowing or planting, but not during the growing period.

Main molluscicides

metaldehyde, methiocarb.

Weeds

Absence of weeds is generally assured by use of clean growing medium, by steam sterilization if necessary. In general, herbicide use is not recommended for lettuce under protected cultivation.