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PM 9/2 (3) *Clavibacter sepedonicus*

Specific scope: This Standard describes a national regulatory control system for *Clavibacter sepedonicus* that provides guidance on surveillance for the pest and its containment and eradication if found.
Specific approval and amendment: First approved in 2003–09. Revisions approved in 2011–09 and in 2023–09. Authors and contributors are given in the Acknowledgements section.

1 | INTRODUCTION

Clavibacter sepedonicus, which causes bacterial ring rot of potato, is an A2 pest for EPPO. It has a restricted distribution, being found mainly in the north and east of the EPPO region. This reflects its biology, since persistence of the disease is favoured by cool moist conditions. Prevention of further spread of the pest within the region is achieved primarily by international phytosanitary measures and the operation of certification schemes for seed potato. If a country can demonstrate that it is a pest-free area, or can establish pest-free areas within its territory, potato plants from these areas will not be subject to the ring-rot restrictions, which otherwise apply. Requirements for establishing pest-free areas are described in EPPO Standard PM 3/61 (EPPO, 2019). EPPO Standard PM 8/1 on commodity-specific phytosanitary measures specifies requirements for commodities of potatoes with respect to *C. sepedonicus* (EPPO, 2017). The present Standard presents the basis of a national regulatory control system for the surveillance, containment and eradication of *C. sepedonicus*.

2 | OUTLINE OF THE SYSTEM

A national regulatory control system is recommended to all EPPO countries for the surveillance, containment, and eradication of the pest if present, and it provides sufficient guarantees to allow export of potatoes within the region, in conformity with EPPO Standard PM 8/1. This system is described in the present Standard and takes into account EU Commission Implementing Regulation 2022/1194 on establishing measures to eradicate and prevent the spread of *Clavibacter sepedonicus* (EU, 2022). It is also recommended that EPPO member countries at risk prepare a pest-specific contingency plan (based on EPPO Standard PM 9/10 *Generic elements for contingency plans*; EPPO, 2009) to ensure that the necessary management and operational arrangements are in place to deal with an outbreak.

Visual inspection of potato tubers alone is not adequate to prevent the spread of ring rot because the disease is often latent. Ring rot control therefore depends primarily on the use of certified seed potatoes and on the testing of seed potato samples by internationally agreed methods for detection and identification of *C. sepedonicus*. Whenever the disease is found, measures need to be taken to contain and suppress it, with the aim of eradication, especially by delimitating a regulated area, by investigating possible sources of contamination and spread, and by restricting the cultivation of potato and controlling volunteer potatoes for several years. *C. sepedonicus* can also survive in a dry state for several years so the contamination of surfaces, for example in storage areas, grading equipment and boxes, can result in disease spread. Strict hygiene measures are therefore a key element in disease control.

The national regulatory control system is devised to ensure that countries, which demonstrate that they apply this control system, can export potatoes and other host plants on the same basis as countries which have demonstrated that *C. sepedonicus* does not occur in their territory.

3 | CONTROL SYSTEM

This control system for *C. sepedonicus* has five objectives:

- to determine if the pest is present in the country, and, if present, to locate it and determine its distribution.
- to prevent its spread.
- to prevent introduction in the potato production system.
- to eradicate incursions.
- to eradicate the pest from potato production systems in areas where it is present.

3.1 | Surveillance

The holding and handling of *C. sepedonicus* should be prohibited, except under authorization (licence) from the NPPO; see EPPO Standard PM 3/64(1) *Intentional import of organisms that are plant pests or potential plant pests* (EPPO, 2006b). *C. sepedonicus* should be considered as a notifiable pest. All persons suspecting or confirming the presence of the disease should therefore notify this to the NPPO.

Surveillance for the presence of *C. sepedonicus* in a country or area not known to have potato ring rot, is usually based on a systematic detection survey. The intensity of the surveillance should be based on risk assessment and should provide assurance for pest freedom covering the whole production system.

Surveys should be undertaken on potato tubers, sampling from the growing crop or from tuber lots in storage. Surveys on farm saved seed potatoes should be based on the pest risk identified. When sampling of tubers is undertaken in the field (e.g. for early potatoes) it should be done as late as possible between desiccation of haulms and harvest. Samples should be taken at random to help ensure that they are representative and that reliable results can be obtained (see ISPM No. 31 *Methodologies for sampling of consignments*; IPPC, 2016). An individual sample for analysis should be comprised of not more than 200 tubers. Additional tubers may be inspected by cutting them and examining the exposed cut surfaces for any sign of the disease in the vascular tissue. Growing potato crops may be visually inspected at appropriate times for typical signs and symptoms of the disease. It should be considered that under European climatic conditions symptoms are rarely found and then often only at the end of the season.

ISPM No. 31 (IPPC, 2016) may be used as a basis for establishing sampling rates and for providing probability levels for detection at a given tuber sampling rate.

Methods for processing, testing and identification of *C. sepedonicus* from samples are described in EPPO Standard PM 7/59 (EPPO, 2022a).

3.2 | Determination of presence

If an outbreak is detected by routine testing, or if an outbreak is suspected, the NPPO should prohibit all movement of the material directly concerned and may take various other safeguarding measures, such as prohibiting the movement of other potatoes or other host plants from the place of production[1] under investigation. Samples of suspect material should be submitted to the laboratory for confirmatory testing as soon as possible, following EPPO Standard PM 7/59 (EPPO, 2022a). The NPPO should ensure the preservation of appropriate specimens (e.g. the original sample, the original extract, IF-microscope slides or DNA prepared from extracts, relevant documentation pertaining to the sample or lot) until the completion of all tests. Cultures of the pest should be kept and stored appropriately for at least one month after finalization of the tests.

If the material presents a risk to another country, the NPPO of that country should be informed immediately of suspect findings. Information for the potato or other host plant lots exported should consist of at least:

- the variety name of the potato or other host plant lot.
- for potatoes, the type (ware, seed, etc.) and where applicable the seed category.
- the name and address of the consignor and the consignee.
- the date of delivery of the lot.
- the quantity delivered.

Additionally, the crop or lot identification number, the registration number of the grower or merchant, a copy of the phytosanitary certificate and a copy of the delivery note should be provided if available.

If the outbreak is associated with material from another country, evidence such as appropriate specimens or material and documentation should be kept for at least one year according to the requirements in ISPM No. 13 *Guidelines for the notification of non-compliance and emergency action* (IPPC, 2021) as appropriate.

The NPPO should investigate the extent and primary source of the outbreak. This investigation should include sampling and testing of at least all other lots of potatoes grown at the place of production and the clonally-related seed potato and ware potato stocks. Where relevant, the investigation should also include, for example, adjacent places of production or places of production that have been in contact with infected material through the shared use of machinery, crates, storage facilities or potato-cleaning and grading premises.

The NPPO should designate as 'infested', where appropriate:

- the lot from which the sample was taken.
- the waste from an infested lot (e.g. soil, processing waste).
- vehicles, equipment and other articles (e.g. machinery, packing material, store) which have been in contact with the lot.
- the place of production or production site, where the lot was grown.

The extent of 'probable infestation'[2] should also be determined, considering, at least all potato stocks clonally

[1]A place of production is defined as "*Any premises or collection of fields operated as a single production or farming unit. This may include production sites which are separately managed for phytosanitary purposes*" (ISPM No. 5, 2010).

[2]No positive test result, but a strong presumption that infection is possible.

related to the infected lots of potato tubers, and where relevant, seed potato and ware potato stocks which may have been in contact with infested lots and possible inoculum, host plants, places of production, stores and machinery linked with the designated infestation.

A regulated area should be demarcated, composed of places/sites of production designated as 'infested', and places/sites of production designated as 'probably infested.'

In some cases, the regulated areas may extend into other countries, in which case the NPPOs of these countries will also have to establish an equivalent regulated area considering the geography, production links and clonal links.

3.3 | Containment

As part of the eradication measures (see Section 3.4) or in the case of an established population of the pest, when eradication is no longer considered feasible, the following measures for the containment of *C. sepedonicus* should be applied:

3.3.1 | General containment measures

The following containment measures apply for all outbreaks of *C. sepedonicus*:

- The planting of tubers or plants designated as 'infested' or 'probably infested' should be prohibited.
- All seed potatoes intended for marketing should meet the requirements laid down in EPPO Standard PM 4/28 *Certification scheme for seed potatoes* (EPPO, 1999, under revision); and additional tests for *C. sepedonicus* should be carried out on each plant of the initial clonal selection or on representative samples of basic seed potatoes (or higher grades of propagation stock) prior to certification in the regulated area.
- If *C. sepedonicus* is detected (and confirmed by testing) in the seed potato production system:
  - Other seed potato clones related or non-related should be tested systematically to investigate whether the infestation has spread clonally or by contact.
  - If the source of infestation cannot be identified, sampling and testing for *C. sepedonicus* in the seed potato production system should be intensified in accordance with sound scientific and statistical principles or at least each seed potato crop should be sampled and tested.
- If *C. sepedonicus* is detected (and confirmed by testing) in ware production similar action should be taken as for seed potatoes, particularly if farm-saved seed potatoes have been used.
- Cleaning and disinfection measures should be applied according to Sections 3.4.1 and 3.4.3, in particular for all vehicles which have been used for transportation of infested and probably infested material in the containment area before they leave this area.
- Infested waste from industrial potato processing or packaging premises should be treated according to EPPO Standard PM 3/66 *Guidelines for the management of plant health risks of biowaste of plant origin* (EPPO, 2022b).

3.3.2 | Additional containment measures for areas with a high incidence of *C. sepedonicus*

In areas where *C. sepedonicus* has been found to be present in multiple locations over a number of consecutive years and could be present more widely additional requirements on movement of ware potatoes out of those areas should be implemented to limit the risk of further spread. Ware potatoes should:

- Originate from a place of production registered and supervised by the NPPO and officially recognized to be free from *C. sepedonicus*, or
- Have no *C. sepedonicus* detected in representative samples of for example 200 tubers taken from the lot. The sample size should take into consideration the lot size and the probability of detection to be achieved (ISPM No. 31; IPPC, 2016).

3.4 | Eradication from the production system

To ensure that *C. sepedonicus* is eradicated from the potato production system a programme of phytosanitary measures should be undertaken.

3.4.1 | Measures for 'infested' and 'probably infested' material

Successful application of the disposal methods recommended below for all material designated as 'infested' or 'probably infested' will require careful implementation to ensure containment of the pest during treatment and its elimination prior to release of the treated material from containment. To ensure the effectiveness of the disposal procedures, regular monitoring and auditing should be carried out. In addition, if material is transported for processing, a system of cleaning and disinfection (see below) should be in place, especially for vehicles used for transportation of this material.

3.4.1.1 | *All tubers or plants of potato designated as 'infested'*

This material should be disposed of. Possible means of disposal include:

- incineration.
- heat sterilization.
- industrial processing at a processing plant with appropriate waste facilities with a system of cleaning and disinfection of at least the departing vehicles, except when used for transportation of the same lot.
- controlled composting according to EPPO Standard PM 3/66 (EPPO, 2022b) at an officially approved composting site. Considering the conflicting information available on heat tolerance of *C. sepedonicus* in plant material (Steinmöller et al., 2013; Stevens et al., 2021) the resulting compost should not be returned to arable agricultural land. It can be returned to non-agricultural land as well as to e.g. orchards, Christmas tree production sites or short rotational plantations (e.g. fast-growing trees for biomass production) which are not and will not be used for arable crop production; or in permanent wooded area, grassland or pastures.
- heat treatment at an officially approved facility according to EPPO Standard PM 3/66. Considering the conflicting information on heat tolerance of *C. sepedonicus*, the resulting material should not be returned to arable agricultural land (see controlled composting).
- feeding to animals after steaming.
- disposal (e.g. deep burial) at an officially approved dedicated waste disposal site where there is no risk of the pest spreading (e.g. seepage to agricultural land or surface water).

Additionally, in cases where a crop is found to be infected during the growing season, or has been planted prior to being designated as infested, destruction of the growing plants (including the tubers) is recommended. If progeny tubers have formed these should be harvested and disposed of appropriately. Alternatively, the planted potatoes could be harvested before emergence and disposed of according to Section 3.4.1.1.

3.4.1.2 | *All tubers or plants of potato designated as 'probably infested'*

This material should also be disposed of, by one of the means noted in Section 3.4.1.1.

Alternatively:

- Tubers may be used as ware potatoes under the control of the NPPO for direct consumption, provided that they are packed, ready for direct delivery and use without repacking. Packing should be done on a site with appropriate waste disposal facilities.
- On-farm composting at the place of production is also suitable provided it is conducted under official supervision to ensure that the entire quantity of material is adequately composted by exposure to a temperature of at least 55°C during an uninterrupted period of at least 2 weeks, and returned to the site of production.
- Tubers may also be returned to the production site of origin during winter and left on the surface to be killed by exposure to frost. This should be under official control, and there should be no significant risk of any movement of the material away from the production site.
- Anaerobic digestion for production of bio-gas at an officially approved site may also be a suitable method for disposal. A suggested treatment is to subject the entire volume of material in a thermophilic digester, to a minimum temperature of 55°C, maintained over a period of 24 h without interruption with a hydraulic dwell time in the reactor of at least 20 days. However, the process needs to be validated before it is used as a phytosanitary control treatment.

All equipment and other objects classed as 'infested' or 'probably infested' should be thoroughly cleaned and disinfected (see below) before further use (unless authorized otherwise by the NPPO), or destroyed.

3.4.2 | Solid and liquid waste

Any remaining waste associated with and arising from the 'infested' material should be disposed of under conditions which ensure that no further risk for spreading the bacteria remains:

- Solid waste should be either
  - disposed of at an officially approved dedicated waste disposal site, or
  - incinerated, or treated by another measure (authorized by the NPPO) ensuring that further spread of the bacterium is excluded.
- Prior to disposal, liquid waste containing suspended solids should be subjected to filtration or settlement processes to remove such solids, which should be disposed of according to the requirement for solid waste. Liquid waste should be heated to a minimum of 60°C throughout the entire volume consistently, for at least 1 h (Stevens et al., 2021) prior to disposal, or treated by another measure (authorized by the NPPO) ensuring that further spread of the bacterium is excluded. Other time–temperature schedules may be approved based on scientific evidence.

Solid and liquid waste, e.g. wash water, arising from sources other than 'infested' material and considered to pose a risk for the potato production may be sampled from the processing and packing facilities and sent to the laboratory for testing.

3.4.3 | Measures applied in the regulated area

3.4.3.1 | *Measures applied at infested places of production*

All machinery, vehicles and storage facilities, in particular wooden storage boxes, which have or might have been in contact with 'infested' or 'probably infested' potatoes or production sites should be immediately and thoroughly cleaned and disinfected, according to EPPO Phytosanitary Treatment PM 10/1 *Disinfection procedures in potato production* before being used or moved (EPPO, 2006a). In addition, any machinery, vehicles and storage facilities involved in potato production should be cleaned and disinfected in the year of the infection and after the first subsequent growing year.

Volunteer potato plants and other natural hosts of *C. sepedonicus* should be eliminated from all sites of the place of production, according to EPPO Standard PM 3/89 *Control of volunteer potato plants* (EPPO, 2020).

3.4.3.1.1 | *Measures for infested production sites.*

- No potatoes or crops on which there is an identified risk of the pest spreading, should be grown for at least 3 years and until no volunteer potato plants are found for two consecutive years.
- When potatoes are grown for the first time after the infestation was found, only ware potatoes should be produced and a laboratory test should be carried out on the harvested tubers.
- When potatoes are next grown after an appropriate rotation cycle, either seed or ware potatoes may be produced and a survey should be conducted. In the case of seed potatoes, there should be at least a 2-year period before potatoes are grown.

Alternatively:

- Infested production sites may be left in bare fallow, used for cereals or under permanent pasture with frequent close cutting or intensive grazing, or as grass for seed production, for 4 years.
- When potatoes are next grown, either seed or ware potatoes may be produced, provided no volunteer potato plants were found for 2 consecutive years, with a laboratory test carried out on the harvested tubers.

3.4.3.1.2 | *Measures for other production sites.*

- For three consecutive years, laboratory tests should be performed on potato tubers harvested from these production sites.
- In the first year, only ware potatoes may be produced from certified seed potatoes.
- In the second and third years, either seed or ware production from certified seed potatoes is permitted. Alternatively, in the second and third year, potatoes grown under official control and tested for *C. sepedonicus* may be planted instead of certified seed potatoes. In the third year, potatoes grown under official control from certified seed potatoes may also be planted instead of certified seed potatoes.

3.4.3.1.3 | *Measures for protected crop production where changing of the growing medium is possible*. Host plants should not be planted until the production site (e.g. unit in the facility) has been subjected, under official control, to measures to eliminate *C. sepedonicus*, including the removal of all host-plant material, change of the growing medium, cleaning and where appropriate disinfection of the unit and all equipment.

3.4.3.2 | *Further measures applied in the whole regulated area*[3]

3.4.3.2.1 | *In the year of the infection*. Machinery and storage facilities used in potato production should be cleaned and disinfected (but within infested places of production stricter measures are required; see Section 3.4.3.1: Measures applied at infested places of production).

3.4.3.2.2 | *For 3 years (or as long as the infested production sites are subject to the above requirements).*

- Potato production, handling and storage should be kept under official supervision.
- Harvested seed potato and ware potato stocks should be kept separate or cleaning and disinfection should be carried out between the handling of seed potato and ware stocks.
- Only certified seed potatoes, or potatoes grown under official control, should be planted (but with additional restrictions within infested places of production, see above).
- Harvested seed potato crops on probably infested places of production should be tested for *C. sepedonicus*.
- An official survey should be conducted annually (see Section 3.1. Surveillance).

All seed potato stocks within the regulated area should, if appropriate, be replaced over a suitable period of time.

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[3]i.e. within both 'infested' and 'probably infested' places of production.

(JKI, DE). In 2022, a new revision was prepared by an Expert Working Group (EWG) composed of Ms E. Fornefeld (JKI, DE), Ms K. Fraser (SASA, GB), Mr. W. Jennes (FAVV, BE), Mr. S. König (JKI, DE), Mr. N. Ponserre (SEMAE, FR), Mr R. Sanz-Diez (MAPA, ES), Ms L. Stevens (DEFRA, GB), Mr. M. van Sabben (NVWA, NL), Ms S. Sudarikova (VNIIKR, RU), Ms. L. Tomassoli (CREA-DC, IT), and comments received from Mr. C. Jeffries (SASA, GB). The EWG considered all the changes recently made to the EU Control Directive. The Standard was reviewed by the Panel on Phytosanitary Measures for Potato.

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