

## EPPO Datasheet: *Synchytrium endobioticum*

Last updated: 2020-09-02

### IDENTITY

**Preferred name:** *Synchytrium endobioticum*

**Authority:** (Schilbersky) Percival

**Taxonomic position:** Fungi: Chytridiomycota: Chytridiomycetes:  
Chytridiales: Synchytriaceae

**Other scientific names:** *Chrysophlyctis endobiotica* Schilberszky,  
*Synchytrium solani* Masee

**Common names:** black scab of potato, black wart of potato, wart  
disease of potato, wart of potato

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**EPPO Categorization:** A2 list

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**EU Categorization:** Quarantine pest ((EU) 2019/2072 Annex II B)

**EPPO Code:** SYNCEN



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### Notes on taxonomy and nomenclature

Several pathotypes exist in *Synchytrium endobioticum*. In the past some countries have not followed the usual system of numerical coding of pathotypes. Therefore, a standardized coding system was developed by Baayen *et al.* (2006).

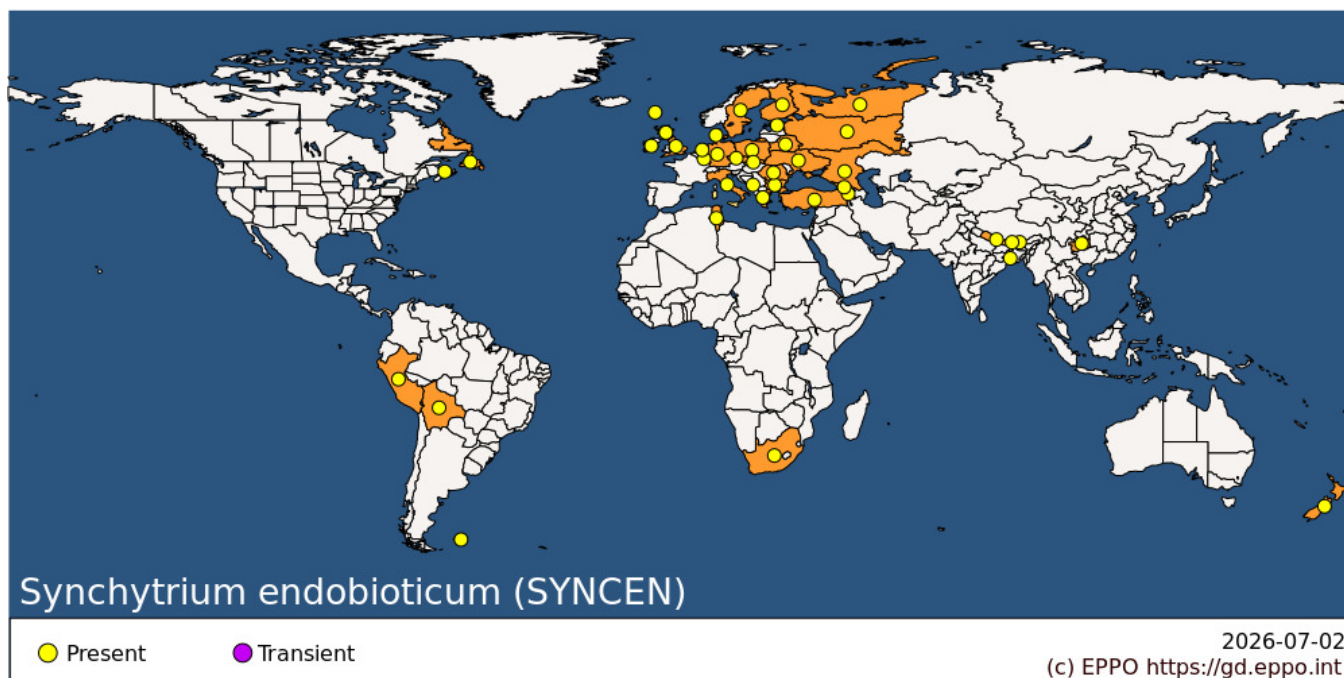
### HOSTS

Potato is the only cultivated host, but wild *Solanum* spp. are also infected in Mexico. A number of solanaceous plants, including tomatoes, can be artificially inoculated. Potatoes are the host of concern throughout the EPPO region.

**Host list:** *Datura metel*, *Solanum sp.*, *Solanum tuberosum*, *Solanum*

### GEOGRAPHICAL DISTRIBUTION

*S. endobioticum* originates in the Andean zone of South America, from where it was introduced into Europe in the 1880s. It spread widely in Europe, but statutory measures have restricted its distribution to other parts of the world.



**EPPO Region:** Armenia, Belarus, Bulgaria, Czechia, Denmark, Estonia, Finland, Georgia, Germany, Greece (mainland), Ireland, Italy (mainland), Luxembourg, Montenegro, Netherlands, Poland, Romania, Russian Federation (Central Russia, Northern Russia, Southern Russia), Slovakia, Sweden, Tunisia, Türkiye, Ukraine, United Kingdom (England, Scotland)

**Africa:** South Africa, Tunisia

**Asia:** Bhutan, China (Guizhou), India (Sikkim, West Bengal), Nepal

**North America:** Canada (Newfoundland, Prince Edward Island)

**South America:** Bolivia, Falkland Islands, Peru

**Oceania:** New Zealand

## BIOLOGY

*S. endobioticum* is an obligate parasite which does not produce hyphae, but produces sporangia containing 200-300 motile zoospores. In the spring, at temperatures above 8°C and given sufficient moisture, the winter sporangia (also called resting spores), in decaying warts in the soil germinate and release uninucleate zoospores. The zoospores possess a single flagellum enabling them to move in soil water and reach the living host. The flagellum is then lost, and the zoospore penetrates the host cell. This becomes greatly enlarged and the enclosed fungus forms a short-lived, quickly reproducing stage, the summer sporangium, from which numerous zoospores are rapidly discharged to reinfest surrounding cells, which again produce summer sporangia (Langerfeld, 1984a).

This cycle may be repeated as long as infection conditions are suitable, so that the host tissue is extensively invaded. The cells around the penetrated cells also swell, and the tissue proliferates, producing a characteristic cauliflower-like appearance.

Under certain conditions of stress, such as water shortage, the zoospores may fuse together in pairs to form a zygote; the host cell in which it forms does not swell but divides. The host cell wall remains closely attached, forming an outer layer to the resistant, thick-walled resting spore. This matures and is released into the soil from rotting warts. Resting spores can remain viable for at least 30 years and can be found in the soil at depths of up to 50 cm (Laidlaw, 1985). The disease can be spread in infected seed tubers which may have incipient warts that pass undetected, or in infested soil attached to tubers. The resting spores resist digestion by animals and can thus be spread in faeces.

Many pathotypes of the fungus exist, defined by their virulence on differential potato cultivars (Stachewicz, 1989). An overview of the worldwide distribution of pathotypes was given by Baayen *et al.* (2006). Pathotype 1(D1) is the most common in the EPPO region and, in addition, the only pathotype occurring in most countries. Other pathotypes, now numbered up to 39(P1) (Przetakiewicz, 2015) occur mainly in the rainy mountainous areas of Central and Eastern Europe (Alps, Carpathians), for example in the Czech Republic and Germany (Langerfeld, 1984b), but a new

pathotype, coded 38(Nevsehir), has also been found in Turkey (Çakir *et al.*, 2009).

## DETECTION AND IDENTIFICATION

### Symptoms

#### *Aerial symptoms*

These are not usually apparent, although there may be a reduction in plant vigour. Small greenish warts may form in the position of the aerial buds at the stem bases (van de Vossenbergh *et al.*, 2019). Leaves may also be infected.

#### *Subterranean symptoms*

The fungus affects the tuber initials and tubers, but not the roots. Early infection of young developing tubers results in them becoming so distorted and spongy as to be scarcely recognizable (Langerfeld, 1984a). In older tubers, only the eyes are infected; they develop into characteristic, warty, cauliflower-like protuberances; these are initially whitish or green if exposed to light, but gradually darken and eventually rot and disintegrate. The whole tuber may be entirely replaced by the warty proliferation. Similar warts occur on stolons. Warts which develop in a potato store, i.e. in the dark, may be the same colour as the tuber's skin.

### Morphology

The most conspicuous morphological character of *S. endobioticum* is the resting spore (winter sporangium). Resting spores are mostly spherical, thick-walled, about 50 µm in diameter (25-75 µm); resting spores are present in warts and after the warts disintegrate the resting spores end up in the soil.

### Detection and inspection methods

In the field, symptoms of the disease are easily observed during harvest of the potato crop, when infected eyes of the tubers show the characteristic, warty, cauliflower-like protuberances (EPPO, 2007). This is the case with susceptible cultivars; however, inconspicuous warts may be present in cultivars with a certain degree of resistance, and thus potentially be overlooked during visual inspection (EFSA, 2019).

For detection of resting spores in soil a number of methods are described (EPPO, 2017a). The method of Pratt (1976a) is based on wet-sieving of soil using a stack of sieves. A disadvantage of the method is the use of the noxious chemical chloroform to extract the spores from soil. In a similar wet-sieving method described by van Leeuwen *et al.* (2005), calcium chloride is used instead. A fully automated machine for extraction of resting spores from soil, called Hendricks centrifuge, is described by Wander *et al.* (2007). Molecular methods to detect the organism in plant tissue and soil have been developed and validated (van Gent-Pelzer *et al.*, 2010; Smith *et al.*, 2014; EPPO, 2017a).

## PATHWAYS FOR MOVEMENT

*S. endobioticum* has a very limited capacity for natural spread (i.e. passive dispersal by water/wind; Hampson, 1996), which is principally why it has been possible to control it so effectively by statutory means. It may be carried in international trade in infected potato tubers. Indeed, infected tubers were intercepted 16 times over the period 1998-2017 in the EU. The organism can also be carried in soil, alone or accompanying plants (including non-host plants) or used equipment, vehicles, and machinery, from land on which potato wart has occurred in the past (EFSA, 2018). In particular, *S. endobioticum* can spread via discarded potatoes, soil and water from the potato processing industries (EFSA, 2018; 2019).

## PEST SIGNIFICANCE

## **Economic impact**

Wart disease is so important that, for almost 100 years, quarantine and domestic legislation has been in force world-wide to prevent its spread. Numerous EPPO publications were devoted to it in the 1950s and 1960s, and in recent decades discussions and publications showed a distinct upsurge (van Leeuwen *et al.*, 2016; van de Vossenberg, 2019). At the start of the present century some innovating publications appeared (e.g. Baayen *et al.*, 2005 proposing the use of field-resistant cultivars in areas affected by the disease), and several international meetings were organized/convened (e.g. EPPO, 2005). In the same period a sudden rise in the number of European countries affected by the disease was observed (Çakir *et al.*, 2009; Dimitrova *et al.*, 2011; Vloutoglou *et al.*, 2012). In 2005, in Turkey, a total of 1000 ha in central Anatolia was already affected by the disease, while the disease was only first detected end 2003 in this region (Çakir, 2005).

Once a crop has been found with potato wart, the whole crop may be rendered unmarketable. Moreover, the fungus is so persistent (resting spores in soil) that potatoes cannot be grown again safely in the field for many years, nor can the land be used for any plants intended for export. Actual direct losses are minimal, except where a new pathotype is involved (Çakir *et al.*, 2009). Since the distribution of *S. endobioticum* is more limited outside Europe, European countries may face indirect losses arising from restrictions on the export of plants from infested areas.

## **Control**

There are no effective plant protection products available for the treatment of tubers. As recommended by EPPO in a national regulatory control system (EPPO, 2017b), all tubers and haulms of potatoes that were growing on an infected plot should be ‘treated’ so as to destroy *S. endobioticum* (e.g. by steaming the tubers and incinerating plant debris, burying and treating with slaked lime) or processed under safe conditions. In scheduled plots it should be prohibited to grow potatoes or to grow (or place in the soil) any plant for planting. Only officially specified resistant potato cultivars are allowed to be planted in a buffer zone around infested land (e.g. as also required in the EU with Council Directive 69/464/EEC (EU, 1969)). Because of these stringent quarantine and sanitation measures mainly applied domestically, potato wart is now very well contained in the EPPO region.

Wart resistance remains an important element to be considered in potato breeding programmes. Three methods are recommended for testing of wart resistance, these are all laboratory assays: Glynne-Lemmerzahl method, SASA testing method (modified Glynne-Lemmerzahl) and Speieckermann method (EPPO, 2017a; EPPO, 2020).

## **Phytosanitary risk**

*S. endobioticum* is of quarantine significance for all the regional plant protection organizations which have established quarantine lists. The pest is currently present in several EPPO countries. EFSA suggests that climate would be suitable for its establishment wherever potato is grown in the EU (EFSA, 2018). Though present in many countries, it has a very restricted distribution within them, which justifies its quarantine status. *S. endobioticum* resting spores persist so long in soil that it has not been possible to evaluate any differences in survival potential under differing soil and climatic conditions and in the presence of other plants.

## **PHYTOSANITARY MEASURES**

Potatoes should derive from a stock found free from *S. endobioticum*. EPPO recommends that seed potatoes (except micropropagative material and minitubers) and ware potatoes for import should not be grown in fields where *S. endobioticum* has occurred and is still present (EPPO, 2017b,d). Possible similar measures could apply for any kind of host plants with roots (including bulbs and tubers) for import.

In practice, this means an extensive system of ‘scheduling’ of wart-infested fields (EPPO, 2017b) which goes back to the wart epidemic in the first decades of the 20th century. An EPPO-recommended method for ‘descheduling’ fields, i.e. determining that the pathogen has disappeared, has been published (EPPO, 2017c). However, *S. endobioticum* resting spores are extremely long-lived (Pratt, 1976b; Laidlaw, 1985) and there is still debate as to how soon fields can safely be descheduled. Countries in which only pathotype 1(D1) occurs are advised to require that imported potatoes come from areas where the other pathotypes do not occur.

## REFERENCES

Baayen RP, Bonthuis H, Withagen JCM, Wander JGN, Lamers JL, Meffert JP, Cochius G, van Leeuwen GCM, Hendriks H, Heerink BGJ, van den Boogert PHJF, van de Griend P & Bosch RA (2005) Resistance of potato cultivars to *Synchytrium endobioticum* in field and laboratory tests, risk of secondary infection, and implications for phytosanitary regulations. *EPPO Bulletin* **35**, 9-23. <https://doi.org/10.1111/j.1365-2338.2005.00775.x>

Baayen RP, Cochius G, Hendriks H, Meffert JP, Bakker J, Bekker M, van den Boogert PHJF, Stachewicz H & van Leeuwen GCM (2006) History of potato wart disease in Europe- a proposal for harmonisation in defining pathotypes. *European Journal of Plant Pathology* **116**, 21-31. <https://doi.org/10.1007/s10658-006-9039-y>

Çakir E (2005) First report of potato wart disease in Turkey. *Plant Pathology* **54**, 584.

Çakir E, van Leeuwen GCM, Flath K, Meffert JP, Janssen WAP & Maden S (2009) Identification of pathotypes of *Synchytrium endobioticum* found in infested fields in Turkey. *EPPO Bulletin* **39**, 175-178. <https://doi.org/10.1111/j.1365-2338.2009.02285.x>

Dimitrova L, Laginova M, Becheva A & van Leeuwen GCM (2011) Occurrence of potato wart disease (*Synchytrium endobioticum*) in Bulgaria. *EPPO Bulletin* **41**, 195-202. <https://doi.org/10.1111/j.1365-2338.2011.02453.x>

EFSA (2018) Scientific opinion on the pest categorisation of *Synchytrium endobioticum*. *EFSA Journal* **16**(7): 5352. <https://doi.org/10.2903/j.efsa.2018.5352>

EFSA (2019) Schenk M, Camilleri M, Diakaki M, Schrader G & Vos S. Pest survey card on *Synchytrium endobioticum*. EFSA supporting publication 2019 EN-1591. <https://doi.org/10.2903/sp.efsa.2019.EN-1591>

EPPO (2005) EPPO Workshop on *Synchytrium endobioticum*, Paris, December 2005. [www.eppo.int/MEETINGS/2005\\_meetings/wk\\_synchytrium](http://www.eppo.int/MEETINGS/2005_meetings/wk_synchytrium)

EPPO (2007) EPPO Standard PM 3/71 General crop inspection procedure for potatoes. *EPPO Bulletin* **37**, 592-597. Available from <https://gd.eppo.int/standards/PM3/>

EPPO (2017a) EPPO Standard PM 7/28 (2) *Synchytrium endobioticum*. *EPPO Bulletin* **47**, 420- 440. Available from <https://gd.eppo.int/standards/PM7/>

EPPO (2017b) EPPO Standard PM 9/5 (2) National regulatory control systems for *Synchytrium endobioticum*. *EPPO Bulletin* **47**, 511-512. Available from <https://gd.eppo.int/standards/PM9/>

EPPO (2017c) EPPO Standard PM 3/59 (3) *Synchytrium endobioticum*: descheduling of previously infested plots. *EPPO Bulletin* **47**, 366-368. Available from <https://gd.eppo.int/standards/PM3/>

EPPO (2017d) EPPO Standard PM 8/1(2) Commodity-specific phytosanitary measures: Potato. *EPPO Bulletin* **47**, 487-503. Available from <https://gd.eppo.int/standards/PM8/>

- EPPO (2020) EPPO Standard PM 3/ Testing of potato varieties to assess resistance to *Synchytrium endobioticum*. *EPPO Bulletin*, in press. Available from <https://gd.eppo.int/standards/PM3/>
- EU (1969) Council Directive of 8 December 1969 on control of Potato Wart Disease (69/464/EEC). Official Journal of the European Communities **No L. 323/1**, 561-562
- van Gent-Pelzer MPE, Krijger M & Bonants PJM (2010) Improved real-time PCR assay for detection of the quarantine potato pathogen, *Synchytrium endobioticum*, in zonal centrifuge extracts from soil and in plants. *European Journal of Plant Pathology* **126**, 129-133. <https://doi.org/10.1007/s10658-009-9522-3>
- Hampson MC (1996) A qualitative assessment of wind dispersal of resting spores of *Synchytrium endobioticum*, the causal agent of wart disease of potato. *Plant Disease* **80**, 779-782.
- Laidlaw WMR (1985) A method for the detection of the resting sporangia of potato wart disease (*Synchytrium endobioticum*) in the soil of old outbreak sites. *Potato Research* **28**, 223-232. <https://doi.org/10.1007/BF02357446>
- Langerfeld E (1984a) [Comprehensive literature survey of the causal agent of potato wart]. *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft Berlin-Dahlem* No. 219.
- Langerfeld E (1984b) Potato wart in the Federal Republic of Germany. *EPPO Bulletin* **14**, 135-139.
- van Leeuwen GCM, Wander JGN, Lamers J, Meffert JP, van den Boogert PHJF & Baayen RP (2005) Direct examination of soil for sporangia of *Synchytrium endobioticum* using chloroform, calcium chloride and zinc sulphate as extraction reagents. *EPPO Bulletin* **35**, 25-31. <https://doi.org/10.1111/j.1365-2338.2005.00777.x>
- van Leeuwen GCM, van de Vossen BTLH & Westenberg M (2016) Final report Eupresco SENDO project Diagnostic methods for *Synchytrium endobioticum*, especially for pathotype identification. <https://zenodo.org/record/3228343#.XR9CBI86-71>
- Percival J (1910) Potato wart disease: the life history and cytology of *Synchytrium endobioticum*. *Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene* **2**, 440-447.
- Pratt MA (1976a) A wet-sieving and flotation technique for the detection of resting sporangia of *Synchytrium endobioticum* in soil. *Annals of Applied Biology* **82**, 21-29.
- Pratt MA (1976b) The longevity of resting sporangia of *Synchytrium endobioticum* in soil. *EPPO Bulletin* **6**, 107-109.
- Przetakiewicz J (2015) First report of new pathotype 39(P1) of *Synchytrium endobioticum* causing potato wart disease in Poland. *Plant Disease* **99**, 285-286. <https://doi.org/10.1094/PDIS-06-14-0636-PDN>
- Smith DS, Rocheleau H, Chapados JT, Abbott C, Ribero S, Redhead SA, Levesque CA & de Boer SH (2014) Phylogeny of the genus *Synchytrium* and the development of TaqMan PCR assay for sensitive detection of *Synchytrium endobioticum* in soil. *Phytopathology* **104**, 422-432. <https://doi.org/10.1094/PHYTO-05-13-0144-R>
- Stachewicz H (1989) [100 years of potato wart disease -its distribution and current importance]. *Nachrichtenblatt für den Pflanzenschutz in der DDR* **43**, 109-111.
- Vloutoglou I, van Leeuwen GCM, Eleftheriadis H, Sarigkoli I, Simoglou KB, Tsirogiannis D & Gilpathi D (2012) First report of potato wart disease caused by *Synchytrium endobioticum* (Schilb.) Perc. in Greece: detection, impacts and pathotype identification. *Abstracts of 16<sup>th</sup> Hellenic Phytopathological Congress*, Thessaloniki, Greece, 16-18 October 2012.
- van de Vossen BTLH (2019) From metagenome to gene: Identification of the first *Synchytrium endobioticum* effector through comparative genomics. PhD Thesis, Wageningen University & Research Centre, Wageningen, the Netherlands
- van de Vossen BTLH., van Gent-Pelzer MPE, Boerma M, van der Gouw LP, van der Lee TAJ & Vossen JH

(2019) An alternative bioassay for *Synchytrium endobioticum* demonstrates the expression of potato wart resistance in aboveground plant parts. *Phytopathology* **109**, 1043 – 1052. <https://doi.org/10.1094/PHYTO-01-19-0024-R>

Wander JGN, van den Berg W, van den Boogert PHJF, Lamers JG, van Leeuwen GCM, Hendrickx G & Bonants P (2007) A novel technique using the Hendrickx centrifuge for extracting winter sporangia of *Synchytrium endobioticum* from soil. *European Journal of Plant Pathology* **119**, 165-174. <https://doi.org/10.1007/s10658-007-9156-2>

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## How to cite this datasheet?

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## Datasheet history

This datasheet was first published in the EPPO Bulletin in 1982 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2020. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1<sup>st</sup> and 2<sup>nd</sup> edition)*. CABI, Wallingford (GB).

EPPO (1982) Data sheets on quarantine organisms, *Synchytrium endobioticum*. *Bulletin OEPP/EPPO Bulletin* **12**(1), 129-134.



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