

Data Sheets on Quarantine Pests

*Synchytrium endobioticum***IDENTITY**

Name: *Synchytrium endobioticum* (Schilbersky) Percival

Taxonomic position: Fungi: Chytridiomycetes: Chytridiales

Common names: Potato wart disease (English)

Gale (noire) verruqueuse de la pomme de terre (French)

Kartoffelkrebs (German)

Sarna verrugosa de la patata (Spanish)

Bayer computer code: SYNCEN

EPPO A2 list: No. 82

EU Annex designation: I/A2

HOSTS

The only cultivated host is potatoes, 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.

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 finally restricted its distribution and it has spread only to a limited extent to other parts of the world.

EPPO region: *S. endobioticum* occurs locally in almost all EPPO countries (Austria, Belarus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, Germany, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia (European), Slovenia, Sweden, Switzerland, Tunisia, UK, Ukraine and Yugoslavia (Montenegro)), with a fragmentary distribution resulting from many years of statutory control (OEPP/EPPO, 1954-1968). According to national reports, it has been found but is not established in Algeria, Belgium, France and Luxembourg; it is not clear whether such records really correspond to a different situation from that in the other listed countries. Also Egypt (unconfirmed), Lebanon (unconfirmed). Found in the past but eradicated in Portugal (unconfirmed).

Asia: Armenia, Bhutan, China (unconfirmed), India (Assam, Sikkim, West Bengal), Iran (unconfirmed), Japan (absent; earlier reports by EPPO are erroneous), Korea Democratic People's Republic (unconfirmed), Korea Republic (unconfirmed), Lebanon (unconfirmed), Nepal.

Africa: Algeria, Egypt (unconfirmed), South Africa, Tunisia, Zimbabwe (unconfirmed).

North America: Canada (Newfoundland only), Mexico (on wild potato only, and even this record not confirmed by the Mexican authorities), USA (Pennsylvania, West Virginia -

eradicated in 1950s and 60s, respectively; Maryland, thought to have been eradicated in 1974 but found again in 1974; finally declared eradicated in 1994).

South America: Bolivia, Chile (found in the past but eradicated), Ecuador (unconfirmed), Falkland Islands, Peru, Uruguay (early record now strongly denied by Uruguayan authorities).

Oceania: New Zealand (South Island).

EU: Present.

Distribution map: See CMI (1983, No. 1).

BIOLOGY

S. endobioticum is an obligate parasite which does not produce hyphae, but sporangia containing 200-300 motile zoospores. In the spring, at temperatures above 8°C and given sufficient moisture, the winter (i.e. long-lived) sporangium in decaying warts in the soil germinates and releases uninucleate zoospores. The latter 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 and reinfect surrounding cells, which again produce summer sporangia.

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

Under certain conditions of stress, such as water shortage, the zoospores may fuse 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 winter sporangium. This matures and is released into the soil from rotting warts. Winter sporangia can remain viable for at least 30 years and are found at depths of up to 50 cm. 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 sporangia 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. Pathotype 1 (European race 1) is the most common in the EPPO region and, in addition, the only pathotype occurring in most countries. Other pathotypes, numbered up to 18 (OEPP/EPPO, 1982), occur mainly in the rainy mountainous areas of central and eastern Europe (Alps, Carpathians), for example in the Czech Republic, Germany (Langerfeld, 1984b), Poland and the former USSR. They persist mainly in small garden potato plots, and not in commercial potato crops (Bojnansky, 1984).

For more information, see also Percival (1910), Keller (1968), Noble & Glynne (1970), Langerfeld (1984a), Stachewicz (1989).

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. Leaves may also be attacked.

Subterranean symptoms

The fungus affects the tuber initials and tubers, but not the roots. Early infection of young developing tubers results in their becoming so distorted and spongy as to be scarcely

recognizable. 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 show the same colour as the tuber's skin.

For further information, see also Keller (1968), Noble & Glynne (1970), Langerfeld (1984a).

Morphology

Winter sporangia mostly spherical, thick-walled, about 50 µm in diameter (25-75 µm); tend to be integral components of small aggregates or crumbs of soil, 0.1-2.0 mm in diameter.

Detection and inspection methods

There are a number of methods of routine soil testing for viable winter sporangia. For information, see Mygind (1954), Nelson & Olsen (1964), Pratt (1976a) (a wet-sieving and flotation technique), OEPP/EPPO (1977), Efremenko & Yakovleva (1983), Laidlaw (1985). An EPPO quarantine procedure is in preparation.

MEANS OF MOVEMENT AND DISPERSAL

S. endobioticum has a very limited capacity for natural spread, which is principally why it has been possible to control it so effectively by statutory means. It is liable to be carried in international trade in infected potato tubers, or in soil, alone or accompanying plants, from land on which potato wart has occurred in the past.

PEST SIGNIFICANCE

Economic impact

Wart disease is so important that, for some 65 years, quarantine and domestic legislations have been in force throughout the world to prevent its spread. Numerous EPPO publications were devoted to it in the 1950s and 1960s.

Once *S. endobioticum* has been introduced into a field, the whole crop may be rendered unmarketable and moreover the fungus is so persistent that potatoes cannot be grown again safely for many years, nor can the land be used for any plants intended for export. Regulations (e.g. EEC Council Directive 69/464/CEE of 1969-12-08) also require the use of officially specified resistant potato cultivars in a protection zone around infested land. Because of these stringent quarantine and sanitation measures mainly applied domestically, potato wart is now very well contained in the EPPO region and actual direct losses are minimal. *S. endobioticum* has a much more limited distribution outside Europe, and European countries have also to face the problem of indirect losses arising from restrictions on the export of plants from infested areas.

Control

Wart control relies on the statutory measures mentioned under Economic impact. Wart resistance remains an important element to be considered in potato breeding programmes, especially in central and eastern Europe, and new screening methods have recently been described (Stachewicz, 1984; Potocek & Broz, 1988).

Phytosanitary risk

S. endobioticum is on the A2 quarantine list of EPPO (OEPP/EPPO, 1982), and is also of quarantine significance for all the regional plant protection organizations which have established quarantine lists. Though present in many countries, it has a very restricted distribution within them, which justifies its quarantine status. *S. endobioticum* sporangia

persist so long in soil that it has hardly been possible to evaluate any differences in survival potential under differing soil and climatic conditions and in the presence of other plants. On the whole, in Mediterranean countries with warm, light, well drained soils, the disease is unlikely to cause serious direct losses, but its introduction and persistence could still be a problem.

PHYTOSANITARY MEASURES

According to the EPPO specific quarantine requirement (OEPP/EPPO, 1990), potatoes should derive from a stock found free from *S. endobioticum*. Potatoes, and indeed any kind of plants with roots (including bulbs and tubers) for export, should not be grown in fields where *S. endobioticum* has occurred and is still present.

In practice, this means an extensive system of "scheduling" of wart-infested fields 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, is under study (see, for example, OEPP/EPPO, 1983). However, *S. endobioticum* resting sporangia are extremely long-lived (Pratt, 1976b; Laidlaw, 1985) and there is still debate how soon fields can safely be descheduled. Countries in which only pathotype 1 occurs are advised to require that imported potatoes come from areas where the other pathotypes do not occur.

BIBLIOGRAPHY

- Bojnansky, V. (1984) Potato wart pathotypes in Europe from an ecological point of view. *Bulletin OEPP/EPPO Bulletin* **14**, 141-146.
- CMI (1983) *Distribution Maps of Plant Diseases* No. 1 (edition 6). CAB International, Wallingford, UK.
- Efremenko, T.S.; Yakovleva, V.A. (1983) [Comparative assessment of the methods used in USSR and abroad for determining soil infestation by *Synchytrium endobioticum*, the pathogen of potato wart]. *Mikologiya i Fitopatologiya* **17**, 427-433.
- Keller, E.R. (1968) Der Kartoffelkrebs. *Mitteilungen der Schweizerischen Landwirtschaft* **2** (K/20), 4 pp.
- Laidlaw, W.M.R. (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.
- 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. *Bulletin OEPP/EPPO Bulletin* **14**, 135-139.
- Mygind, H. (1954) Methods for the detection of resting sporangia of potato wart (*Synchytrium endobioticum*) in infested soil. *Acta Agriculturae Scandinavica* **4**, 317-343.
- Nelson, G.A.; Olsen, O.A. (1964) Methods for estimating numbers of resting sporangia of *Synchytrium endobioticum* in soil. *Phytopathology* **54**, 185-186.
- Noble, M.; Glynne, M.D. (1970) Wart disease of potatoes. *FAO Plant Protection Bulletin* **18**, 125-135.
- OEPP/EPPO (1954-1968) Potato wart disease in Europe. *EPPO Publications Series B* Nos 8, 48, 52, 63, 65.
- OEPP/EPPO (1977) First report of the working party on potato wart disease. *EPPO Publications Series C* No. 50.
- OEPP/EPPO (1982) Data sheets on quarantine organisms No. 82, *Synchytrium endobioticum*. *Bulletin OEPP/EPPO Bulletin* **12** (1).
- OEPP/EPPO (1983) Second meeting of the EPPO panel on potato wart disease. *EPPO Document* No. 5205.
- OEPP/EPPO (1990) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

- Percival, J. (1910) Potato wart disease: the life history and cytology of *Synchytrium endobioticum*. *Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene* **2** (25), 440-447.
- Potocek, J.; Broz, J. (1988) [A new system of testing potatoes for resistance to potato wart and potato cyst nematode]. *Sbornik UVTIZ, Ochrana Rostlin* **24**, 47-56.
- Pratt, M.A. (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, (1976b) The longevity of resting sporangia of *Synchytrium endobioticum* in soil. *Bulletin OEPP/EPPO Bulletin* **6**, 107-109.
- Stachewicz, H. (1984) [Application of in vitro culture to identify pathotypes of the potato wart pathogen]. *Archiv für Phytopathologie und Pflanzenschutz* **20**, 195-205.
- Stachewicz, H. (1989) [100 years of potato wart disease its distribution and current importance]. *Nachrichtenblatt für den Pflanzenschutz in der DDR* **43**, 109-111.