

Resistance of potato varieties to *Synchytrium endobioticum*

Advisory paper from DCA - Danish Centre for Food and Agriculture

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Data sheet

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| Title: | Resistance of potato varieties to <i>Synchytrium endobioticum</i> |
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Background

In a request sent by the Danish Agricultural Agency (LBST) on October 24, 2023, to DCA – Danish Centre for Food and Agriculture – at Aarhus University (AU), the Danish Agricultural Agency has requested a report on the resistance of potato varieties to *Synchytrium endobioticum*. The purpose is to guide potato growers regarding resistant varieties and to stay informed in this field. This report provides a categorization and determination at the European level of potato varieties' resistance to *Synchytrium endobioticum*, with the aim of recommending a Danish list of resistant varieties. Attached to the order was a list of registered varieties in Denmark and the publication "Redegørelse for kategorisering og bestemmelse på europæisk plan af kartoffelsorters resistens overfor *Synchytrium endobioticum* (kartoffelbrok)" from 2017.

Introduction

Potato wart, caused by *Synchytrium endobioticum* (Schilbersky) Percival, is considered one of the most important quarantine pests of potatoes [1-4]. *S. endobioticum* is classified as a quarantine pest known to occur in the EU territory (Annex II, part B of the EU directive 2019/2072) [5].

Disease symptoms on potato tubers are characterized by warty cauliflower-like malformations that result from hypertrophy and cell hyperplasia induced by the pathogen [1, 3]. These warts act like sinks for nutrients and increase in size at the expense of the plant, leading to significant yield loss ranging from 50-100%.

Resting spores of the pathogen can survive for >15 years in the soil. Therefore, fields infested with *S. endobioticum* become unsuitable for potato production (i.e. de-scheduled) for approximately 20 years [6]. Moreover, there are no effective chemical treatments of the pathogen either in plant material or in the soil, making the management of the disease difficult.

The most practical means of managing the disease is via phytosanitary measures and host resistance. Given the difficulty of managing the disease, countries worldwide have implemented strict phytosanitary measures or legislations to prevent the entry or restrict the spread of pathogen in the country. The EU directive 2022/1195 provides the regulatory framework for establishing measures to eradicate and prevent the spread of *S. endobioticum* [7]. The use of resistant varieties is a significant tool for preventing the spread of *S. endobioticum*. According to the EU directive 2022/1195 a potato variety should be regarded as resistant to a particular race of *S. endobioticum* when it reacts to it in such a way that there is no danger of secondary infection [7]. In this report, a list of potato varieties and their resistance to five pathotypes of *S. endobioticum* is provided in Annex 1 (sheet: "Final List").

Methodology

Source of data

In this report, a comprehensive search of results of resistance tests for potato varieties was conducted using official potato variety lists or databases from potato breeders or companies in Europe. The references for the databases or variety lists that were searched are presented in Table 1. Moreover, links to the resistance ratings of specific varieties are provided under the columns "Sources" in Annex 1 (Sheet: "Final_List"). The resistance ratings for all the varieties listed in Annex 1 (Sheet: "Final_List") for each source/reference are also provided in the sheets named with the institution or company from which the data was sourced. A comprehensive list of varieties, including those in Annex 1 and those not in Annex 1, and their resistances to different *S. endobioticum* pathotypes are provided in Annexes 2-6. Note that Annex 2 contains three sheets named DANESPO, KMC, and NVWA, corresponding to the companies or institutions from which the data was sourced.

Definition of resistance

The report adopts the method of Nielsen [8] for describing the resistance of potato varieties to potato wart. According to this method, potato varieties resistant to a *S. endobioticum* pathotype are assigned the letter "R," corresponding to EPPO ratings R1-R2 [9]. The databases used for this report either classified resistance level of the varieties to *S. endobioticum* based on a numerical scale or qualitatively (i.e., 'resistant', or 'susceptible'). Varieties were categorized as susceptible to a given pathotype by assigning them the letter "S" if their resistance score is lower than that required for classification as resistant or if they were described as susceptible qualitatively by the source (See Annex 1, sheet: "Final_List"). Accordingly, resistance was rated/classified as follows for each source.

1. Scores of 9 (KMC, Semagri), 7-9 (Merethe Bagge [Danespo]), 10 (Stet-Potato [Stet], Agrico Potatoes [Agrico], AKV Langholt [AKV], HZPC Potatoes [HZPC], and The Netherlands Food and Consumer Product Safety [NVWA]), and 5 (MeijerPotato) were interpreted as resistant (R), while values lower than this score for resistance were interpreted as susceptible (S).
2. Julius Kuhn Institute, European Cultivated Potato Databases [EuroPotato], EuroPlant, and Federal Plant Variety Office, Germany [BSL], Solana, and AgroPlant describe varieties qualitatively as either resistant or susceptible.
3. The Polish Research Center for Cultivar Testing (COBORU) rates a variety as resistant to a *S. endobioticum* pathotype by assigning the plus symbol (i.e., "+").
4. In some cases, a variety was described as susceptible or resistant without the mention of the specific pathotype. This is the case with varieties "Botond" and "Magda" from UniPatatas, and "Up to Date",

“Swift”, and “King Edward” from EuroPotato (See Annex 1, Sheet: “Final_List”). These varieties are marked with asterisk (*).

5. In cases where two or more sources provided information about the resistance rating of a given variety, and the ratings conflicted, the resistance level of the variety is described as undefined (UND*).
6. Blank cells in the final list in Annex 1 means no recognizable results or the variety has not been tested against the corresponding pathotype.

Pathotypes

There are over forty pathotypes of *S. endobioticum* [3]. However, the most widespread pathotypes, namely 1 (D1), 2 (G1), 6 (O1), 8 (F1), and 18 (T1), are considered in testing for varietal resistance in Europe, and thus, were included in this report. Some sources used in this report provided resistance ratings to additional pathotypes as follows:

1. NVWA: P10 (E1) and P38 (Nevşehir)
2. EUROPLANT: P38 (Nevşehir)
3. COBORU: P2(CH1) and P3 (M1)
4. Merethe Bagge (DANESPO): P39 (P1)

However, these are not included in the Final list in Annex 1 because none or very few varieties have been tested against these pathotypes. Nevertheless, the resistances of varieties to these pathotypes are provided in the following sheets in Annex 1: 'COBORU', 'DANESPO', 'EUROPLANT', and 'NVWA'."

Table 1. Sources and Links for Potato Varieties

| Name | Resistance scale | Full Reference or Link |
|---|--|---|
| KMC starch (KMC) | 1-9 scale, where 1 is the most susceptible and 9 is resistant. | https://www.avlerinfo.dk/sortsinfo/ Kristian Elkjær (2024), Personal Communication. |
| Bundessortenamt (BSL) | Resistance is qualitatively described by indicating the pathotype number. | BSL Kartoffel 2023_internet_Korrektur.indd (bundessortenamt.de) |
| Julius Kuhn Institute | Resistance is qualitatively described by indicating the pathotype number. The backlash symbol (\) is used to denote the absence of recognizable result. | https://pflanzengesundheits.julius-kuehn.de/dokumente/upload/bm-2023_resistente-kartoffelsorten.pdf/ |
| AKV Langholt (AKV) | 1-10 scale, where 1 is the most susceptible and 10 is resistant. | Henrik Pedersen (2024), Personal Communication, AKV Variety List, AKV Langholt. |
| HZPC Potato* | 1-10 scale, where 1 is the most susceptible and 10 is resistant. | https://www.hzpc.com/our-potato-varieties |
| Tystofte | Qualitative rating of resistance as susceptible (m) or resistant (r). “- “is used to denote the absence of results. | https://www.tystofte.dk/wp-content/uploads/2023/06/BSL-2023-1.pdf |
| The Netherlands Food and Consumer Product Safety (NVWA) | 1-10 scale, where 1 is the most susceptible and 10 is resistant. | https://www.nvwa.nl/documenten/plant/plantziekten-plaag/plantziekte/wratziekte/overzicht-aardappelpelassen-met-resistentieniveaus-voor-wratziekte/ |
| Agrico Potatoes (Agrico)* | 1-10 scale, where 1 is the most susceptible and 10 is resistant. | https://www.agricopotatoes.com/ https://www.agrico.co.uk/ |
| Merethe Bagge | 1-9 scale, where 1 is the most susceptible and 9 is fully resistant. However, to classify a variety as resistant or susceptible, scores from 7 to 9 are considered resistant, while scores below 7 are considered susceptible | Merethe Bagge (2024), Personal Communication, Danespo, Denmark. |

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| Stet-Potato (Stet)* | 1-10 scale, where 1 is the most susceptible and 10 is resistant. | https://stet-potato.com/ |
| European Potato Cultivated Potato Database (EuroPotato)* | Qualitative rating of resistance as susceptible or resistant. | https://www.europotato.org/ |
| Semagri* | 1-9 scale, where 1 is the most susceptible and 9 is resistant. | https://www.semagri.eu/starch-varieties/ |
| Solana* | Qualitative rating of resistance as susceptible or resistant. | https://www.solana.de/ |
| Unipatatas* | Qualitative rating of resistance as susceptible or resistant. | https://unipatatas.dk/ |
| AgroPlant* | Qualitative rating of resistance as susceptible or resistant. | https://www.agroplant.nl/ |
| MeijerPotato* | Resistance is rated on 0-5 scale, where 1 is very susceptible and 5 is very high resistance. Score zero (0) is used to represent no resistance or unknown. | https://www.meijerpotato.com/en/ |
| Research Center for Cultivar Testing, Poland (COBORU)* | Resistance is indicated by the plus (+) symbol. | https://coboru.gov.pl/index_en/ |

* Refers to the Excel document for the specific links to the listed varieties

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