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A Streptomyces species identified as the cause of carrot scab

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In 1986 during a dry growing season a severe outbreak of scab was recorded on carrot (*Daucus carota* L.) in the Netherlands. Production fields in the NE of the country were most severely attacked and several hundreds of hectares were rejected for industrial processing. Symptoms were equal to the deep, superficial and raised scab of potato as described by Labruyère (1971). Carrot fields where sprinkler irrigation had been used during dry periods showed less disease incidence.

Isolations from scabbed carrots always yielded a high number of actinomycetes producing a brown diffusable pigment on the isolation media. In the literature, (the actinomycete) *Streptomyces scabies* (Jones, 1953; Vakhrusheva, 1976) or a *Streptomyces* species, not identified to species level (Massfeller, 1971) have been mentioned as causing carrot scab. Only Massfeller (1971) reported isolation (without description) and inoculation experiments. In his pathogenicity tests, inoculation of carrot with *Streptomyces* isolates from carrot induced only mild symptoms.

This article presents the results of a morphological and biochemical characterization and a pathogenicity test on carrot of seven *Streptomyces* isolates from carrot and one from potato. All isolates tested including the one obtained from potato were pathogenic to carrot causing moderate to severe symptoms of scab and were morphologically and biochemically very similar. The taxonomic position of the isolates is discussed.

Isolates PD 1027-1032 and 1034 (PD = Culture Collection of the Plant Protection Service, Wageningen, the Netherlands) from carrot from three different locations and PD 1033 from potato 'Agria' were obtained by plating a suspension of macerated scab tissue in sterile distilled water on a tyrosin-containing medium (pH 7.2) with the following composition: aqua dest, 1000 ml, L-asparagine 1 g, glycerol 10 g, L-tyrosine 0.5 g, K_2HPO_4 1 g, agar 20 g, trace salt solution 1 ml (trace salt solution contains in g . 100 ml^{-1} aqua dest: $FeSO_4.7H_2O$ 0.1 g, $MgCl_2.6H_2O$ 0.1 g, $ZnSO_4.7H_2O$ 0.1 g).

For morphological characterization the isolates were grown on yeastextract – maltextract agar (YMA, Shirling and Gottlieb, 1966). Spore shape was examined in a transmission electron microscope. Utilization of carbon sources was studied on the basal salts medium described by Shirling and Gottlieb (1966).

The pathogenicity test was performed with *Daucus carota* 'Amsterdamse Bak', using 60 plants per isolate. Sixty plants were kept for control. Sixty ml of 10^7 spores ml^{-1} suspension of a 4 week YMA culture was added to 20 l steam-sterilized loamy soil with pH 5.9 prior to sowing carrots. Plants were grown at 18 °C at 80% RH, 10 000 Lux light and c. 50% of water saturation of the soil. Plant roots were harvested 4 months

after sowing and examined for presence of symptoms. Reisolations were made from typical lesions for each isolate.

All isolates produced a brown diffusable (melanoid) pigment on YMA, reacted positive in the Gram stain and showed smooth cylindrical spores. En masse substrate mycelium on YMA was brown, immature aerial hyphae white and spores gray. Spore chains formed spirals of up to three turns, many incomplete. All isolates utilized L (+) arabinose, D-fructose (PD 1029 and 1031-33 doubtful), I-inositol (PD 1029 and 1030 doubtful), D-mannitol, D-raffinose, soluble potato starch, sucrose and D-xylose as sole carbon source. Not any isolate was able to use cellulose. Use of rhamnose was variable (PD 1029-1031 and 1034 negative, the others positive).

In the pathogenicity test, all isolates were pathogenic to carrot 'Amsterdamse Bak', causing moderate to severe symptoms of deep, superficial and raised scab (Figs 1 and 2). Percentage of infected plants ranged from 35-90% (potato isolate 68%). Infected roots often showed constrictions and reduced growth. The results also show that a *Streptomyces* species isolated from potato scab is pathogenic for carrot, causing exactly the same symptoms as isolates from carrot. Reisolations from infected plants were positive and control plants remained healthy. More detailed studies should determine losses caused by *Streptomyces*, influence of rotation of carrot with potatoes and/or other crops and ways to control (possibly by irrigation?) carrot scab in order to prevent calamities in the future.

On the basis of the above mentioned results the isolates obtained from carrot show close relationship to the isolates from potato, studied by Elesawy and Szabó (1979) and named *Streptomyces scabies*. However the type strain of this species is absent (Bradbury, 1986) and the name *S. scabies* has no standing in nomenclature. The neotype

Fig. 1. Severely scabbed carrot 'Amsterdamse Bak' (right) grown in soil inoculated with *Streptomyces* isolate PD 1032 isolated from carrot. Left: carrot grown in non-inoculated soil.

Fig. 2. Carrot 'Amsterdamse Bak' showing symptoms of deep, superficial and raised scab grown in soil inoculated with *Streptomyces* isolate PD 1033 obtained from potato.

designation by Elesawy and Szabó (1979) is invalid because it was not published in the International Journal of Systematic Bacteriology. Therefore it is still impossible to assign a valid species name to their 'scabies' strains or the carrot strains described in this study. This is unsatisfactory and a thorough taxonomical and nomenclatorial study of this group of organisms is desirable.

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Samenvatting

Een Streptomyces species geïdentificeerd als de veroorzaker van schurft bij peen

In 1986 werd een ernstige schurft-aantasting bij peen (*Daucus carota*) gevonden met name in NO-Nederland. Vanuit schurftlesies werd steeds weer eenzelfde type streptomyceet geïsoleerd. In proeven met zeven isolaten van peen en één van aardappel bleek dat deze morfologisch en biochemisch sterk overeen kwamen, terwijl alle isolaten, ook dat van aardappel, pathogeen waren voor peen 'Amsterdamse bak'.

De hier onderzochte isolaten komen sterk overeen met een soort die in de literatuur

bekend is als *Streptomyces scabies*, de veroorzaker van aardappelschurft. *S. scabies* is echter een ongeldige naam door het ontbreken van een typestam. Zolang er niet een geldig neotype is gepubliceerd kan geen speciesnaam aan deze isolaten worden gegeven. Taxonomisch en nomenclatorisch onderzoek is dus gewenst, evenals onderzoek naar schade, invloed van vruchtwisseling met aardappel en/of andere gewassen en effectieve bestrijding (wellicht door beregening?) van schurft bij peen.

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Book review

F. Roll-Hansen & H. Roll-Hansen, 1987. Skogskader i farger. Forest injuries in colour. Landbruksforlaget, Oslo. 122 pp. ISBN 82-529-1241-9. Price: £ 13.00.

Fifteen common forest diseases, four types of insect damage and some symptoms caused by abiotic agents such as frost, drought, air pollution and nutrient deficiencies are depicted in this booklet. Each chapter is preceded by a short general introduction, after which the various symptoms are shown in colour plates, each with a short description. The chapter on frost and drought damage is especially instructive, since such symptoms are often attributed to damage caused by air pollution. Only a few types of injury are presented and the choice in not well balanced. As the authors themselves state, it is merely examples. No references or suggestions for further reading are given. The text is in Norwegian and English. With its excellent plates, this book may be helpful in identifying some forest injuries. The basic information it contains makes it more than merely a field guide. People in forestry practice and all those interested in the actual decline syndrome of forest may use this book as an introduction.

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