Incidence of pathogenic *Mucor* spp. in Anjou pear orchard soils in the Okanagan Valley of British Columbia

P.L. Sholberg and G.R. Owen[1]

Fifty-one Anjou pear orchards were surveyed for Mucor spp. in the Naramata area of the Okanagan Valley of British Columbia by sampling the top 5 cm of soil beneath pear tree canopies within the orchards. Mucor spp. were found in 49 of the 51 orchards sampled. A study of Mucor spp. levels of propagule per gram of dry soil (p/gds) within 50 of the 51 orchards showed that *22* had less than 100 (p/gds) whereas *28* had higher counts. Single spore isolates which grew at 10°C were made from the cultures isolated from the soil of 49 orchards. These isolates were tested for pathogenicity on Anjou pear fruit. Thirty-six of the 49 isolates were pathogenic Mucorspp. The pathogenic species formed distinct groups, having either tall, short or intermediate sporangial height. The short isolates have been positively identified as *Mucor piriformis* Fisher.

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Une enqulte a été effectuée dans 51 vergers de poiriers d'Anjou situés dans la region de Naramata dans la vallée de l'Okanagan (Colombie-Britannique),afin de determiner la presence de Mucor spp. Pour ce faire, on a échantillonné les cinq premiers cm de sol sous la frondaison des poiriers. On a retrouvé Mucor spp. dans 49 des 51 vergers. Une Btude des densités de propagules par gramme de sol sec (p/gss) dans 50 des 51 vergers, a montré que *22* avaient moins de 100 (p/gss) tandis que *28* en avaient davantage. Des isolats de spore unique germant à 10°C ont été prélevés à partir des cultures isolées du sol de 49 vergers et leur pathogénicité déterminée sur des poires d'Anjou. Trente-six des 49 isolats de Mucorspp. étaient pathogènes. Les espèces pathogènes se répartissaient en groupes distincts selon la hauteur des sporanges. Les isolats à sporanges courts ont pu Itre identifies comme appartenant a Mucor piriformis Fisher.

Introduction

Mucor ***piriformis*** Fischer causes a stem-end rot of Anjou pear fruit. Losses due to this fungus have been recorded in the Okanagan Valley since 1971 when it was first reported (2). Mucor ***piriformis*** has also been a problem on Anjou pears in the mid-Columbia area of Oregon and Washington since 1975 (1). Recent studies in Oregon have shown that the organism is confined to the soil and is spread by contaminated soil which adheres to fruit bins and harvested fruit (3).

The objectives of this study were to determine: a) how widespread this organism was in Anjou pear orchards of one area in the Okanagan Valley; b) propagule numbers in the orchard soils surveyed and c) pathogenicity of the isolates from the various orchards. An abstract of this work has been published (4).

Materials and methods

Field survey. Fifty-one Anjou pear orchards consisting of approximately 35 ha were surveyed in the Naramata area of the Okanagan Valley of British Columbia. Soil was sampled approximately 2 weeks after Anjou pear harvest from the top 5 cm of soil under the tree canopy at several locations within the orchard to produce one composite sample for each orchard. The soil samples were processed by a method based on that of Bertrand and Saulie-Carter (1). Fifty grams of soil from each sample were placed in 100 mL of water and thoroughly mixed with a blender for 1 minute. The mixture was allowed to settle for approximately 5 min., and then 0.1 mL of the soil solution was placed on acidified potato dextrose agar (pH 4.8) in 50 mm diameter plates and spread over the surface of the plate with a glass rod. Two plates were made for each sample. This procedure was followed each time plates were incubated at 2, 10 and 20°C. Plates incubated at 20°C were examined for Mucor spp. colonies after **3** days, at 10°C after **6** days and at 2°C after 14 days. Precise counts were made only on plates incubated at 2" because these Mucor spp. would likely be those which cause rot in cold storage. Counting Mucor colonies with the aid of a stereo-microscopeshortly after they had germinated gave the most accurate counts. For each orchard in which Mucor spp. were found representative colonies were isolated from one or two plates.

Pathogenicity test. Mucor spp. that had been isolated from the 49 orchard soil samples were single-spored to obtain pure cultures. The single spore isolates were grown at 10°C for several days in 150 mL flasks containing 50 mL of potato dextrose agar (PDA). One culture from each orchard was transferred to a 50 mm petri plate containing PDA and tested on Anjou pear fruit for pathogenicity.

A cork borer was used to remove 5-mm diameter mycelial plugs from the petri plates on which the fungus had been growing. The plug was placed on the fruit over an injury in the epidermis made by a glass rod. Two pears were inoculated with each isolate and incubated at 23°C for 7 days. Pathogenicity was considered positive if visible rot was present at this time.

The pathogenic isolates were grouped according to sporangial height above the media. Ten representative isolates were sent to an expert in Mucorspp. identification.

[1] Research Station, Agriculture Canada, Summerland, British Columbia, VOH *1Z0.* Contribution *No. 662*

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Results and discussion

Field survey. Mucor spp. were isolated from the soil of 49 of the 51 orchards surveyed when isolations incubated at 2, 10, and 20°C were considered together. Propagule levels counted in 50 orchards varied widely between the different orchards (Table 1). Twenty-two orchards had a hundred or less propagules per gram of dry soil (p/gds) whereas 28 had more than one hundred when Mucor spp. were accurately counted at the **2°C** incubation temperature. Spotts (5) has shown that the percent infection of M *piriformis* increases the fastest at concentrations under about 1000 spores per milliliter. Thus, it is important that packinghouse managers reduce spore concentrations in dump tanks and flumes to the lowest possible level, because any viable inoculum will lead to decay when wounds are present.

Table 1. Propagule levels of Mucor spp. in soil from 50 orchards plated on potato dextrose agar and incubated at 2°C for 14 days.

Propagules per gram of dry soil	No. of orchards in this range
0	12
1-100	10
101-200	17
201-1000	3
1001-10,000	5
10,001-100,000	2
100,001-346,000	1

One orchard stood apart from all the other orchards because of its extremely high count of 345,821 (p/gds). This orchard had a history of neglect and perhaps the higher than usual number of propagules were due to the buildup of inoculum by fruit allowed to rot on the orchard floor. Very little soil from this orchard would be necessary to contaminate the dump water.

Pathogenicity test. Thirty-six of the 49 single-spore isolates from 49 different orchards were pathogenic. Six of the 13 orchards which did not have a pathogenic isolate had very low counts of Mucorspp. in the soil. Pathogenic Mucorspp. would likely have been detected in the remaining seven orchards if more isolates would have been tested for pathogenicity.

The pathogenic isolates could be divided into distinct groups based on the sporangial height above the medium (Fig.1). Thirteen were 0-10mm, 11 were 11-20 mm, six were 21-30 mm and seven were 31-40 mm. The pathogenic Mucor spp. whether short, intermediate or tall are most likely strains of Mucor *piriformis* Fischer, however only the group with short sporangial height has been identified conclusively by mating tests to be M *piriformis*.

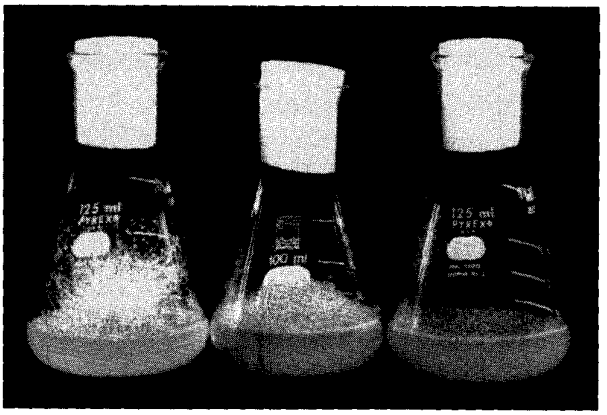

Figure 1. Pathogenic Mucorspp. isolated from the soil of Anjou pear orchards growing on potato dextrose agar after 1 month at **2°C** in 125 ml flasks. The isolate with short sporangial height on the right has been positively identified as *M. piriformis* whereas the other two cultures are thought to be M *piriformis* but await further confirmation to their identity.

Acknowledgements

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