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Effect of Tree Age and Various Rootstocks of Apple on *Phytophthora cactorum*, The Cause of Crown and Root Rot in Malakand Division

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Abstract

An extensive survey of apple orchards of different ages was conducted to explore the incidence of *Phytophthora cactorum*. Crown and root rot was observed on trees of all ages, but trees grown on Malling-Merton and standard (local) rootstocks during the first 3-5 years, when they first come into bearing, were most affected. As the age of the trees increased, severity and incidence of the disease decreased. Different rootstock types of apple were evaluated for their resistance to *P. cactorum*. Depending on various factors, all the tested rootstocks were found to be susceptible except for M-9. This rootstock, if horticulturally suitable, may provide field resistance to *P. cactorum* in Malakand Division.

Introduction

Crown and root rot has been reported from all apple growing regions of the world. It is caused by various species of *Phytophthora*, however, *P. cactorum* is predominately associated with this disease world wide (Roiger and Jeffers, 1991). Crown and root rot is a disease of the rootstock portion of the tree, affecting bark tissues of the crown portion and root system. It has become increasingly important because of the increased use of susceptible clonal rootstocks particularly Malling (M) and Malling-Merton (MM) size controlling rootstocks, (Jullis *et al*., 1978; Jeffer and Aldwinkle, 1988). Similarly tree age is also an important factor in the incidence of *Phytophthora* crown and root rot of apple. Malling-Merton rootstocks may either succumb throughout the life of the orchard or during the first 4-5 years (Harris, 1990).

In Malakand Division, *P. cactorum* was the most commonly encountered fungus on apple rootstocks. Susceptibility of host to this fungus is further aggravated with the cultivation of Malling and Malling-Merton rootstocks (Jahangir *et al*., 1995). Although the pathogen activities are greatly influenced by soil moisture, soil type, management techniques and environment, the age of the tree and rootstock type also plays a vital role in the disease incidence and development. Therefore, it was imperative to determine the effect of tree age on *P.cactorum*, and to evaluate various rootstocks of apple, both indigenous and exotic, currently used by nursery-men and orchardists in Malakand Division for comparative resistance to *P. cactorum*.

Materials and Methods

An extensive survey of the major apple growing areas in Malakand Division was carried out during 1993-94. A total of 23 apple orchards of different ages, each containing more than 200 trees and at different topographic localities, were examined thoroughly. Trees were examined each autumn from 1993 to 1994 for foliar symptoms of *Phytophthora* crown and root rot i.e., premature leaf reddening, sparse terminal growth, and wilt. Disease incidence was assessed by excavating soil from around the trunks of symptomatic trees, then removing the outer bark from portions of the crown and roots to reveal the reddish brown cortical necrosis, characteristic of *Phytophthora* crown and root rot. Trees showing typical symptoms of *Phytophthora* crown and root rot were counted in each orchard. Also, soil samples and plant saplings from each orchard were collected randomly for confirmation of the field diagnoses.

Isolation of *P. cactorum*: Isolations were made using small pieces of bark cut from the margins of the advancing lesions on the root crowns of apple plants. These pieces were surface sterilized for one minute in 0.5 percent sodium hypochlorite and plated on VYS-PCNB agar medium (Schmitthenner, 1973). The plates were incubated for seven days at 20 ± 1°C for fungal growth. Similarly, isolation of the pathogen from the soil samples was made using apples cotyledon baits. The isolated fungus was identified as *P. cactorum* using the key of Waterhouse (1963). The fungus was maintained on V-8 juice agar for further studies.

Evaluation of various apple rootstocks: This experiment was conducted at Agricultural Research Station, Mingora, Swat during 1994-95. For the preparation of zoospore suspension of *P. cactorum*, a modified version of McIntosh's method (1968) was used. Agar plugs bearing mycelia of *P. cactorum* were plated on lima bean agar plates. After five days at 24 ± 1°C the plates were flooded with sterile distilled water to enhance production of sporangia. Two weeks later, these plates were put into a deep freezer at -3°C for 20 minutes, to encourage release of zoospores. The water was poured off and the resultant suspension was standardized to 20,000 zoospores per ml using a haemocytometer. The method used by Welsh (1942) for the Inoculation of rootstocks was followed. Eighteen plants each of six different types of rootstocks (Table 1) were planted in a loam: peat: sand mix (1:1:1 v/v) in earthen pots during December, 1994. Before planting, the plants the mixture was sterilized in a soil sterilizer. In early spring, the bark of each rootstock was deep wounded below the soil level. These wounded plants were inoculated with 100 ml aliquot of the zoospores suspension of *P.cactorum* . Five plants of each rootstock were maintained and the experiment was replicated three times, using randomized

complete block design. One plant in each rootstock type was wounded with a sterilized scalpel. This plant was not inoculated and served as a comparison with the inoculated one. All plants were sprinkle irrigated regularly to keep the soil wet. Above ground symptoms of the disease appeared after one month and the plants were kept under observation until late autumn. The data on infected/dead plants was recorded and a comparison was made between inoculated and uninoculated plants.

Results and Discussion

To assess the incidence of Phytophthora crown and root rot disease on trees of different ages and rootstock types, 23 well established apple orchards grown on standard (local) and MM-106 and MM-111 rootstocks were examined thoroughly during 1993-94. Most of the orchards being surveyed were either in full production or in the initial stages of bearing, except for a few which were near to, but not yet started, the production period. Incidence of *Phytophthora* crown and root rot in 23 apple orchards, 16 grown on standard rootstocks and 7 on MM-106 and MM-111, is shown in Tables 1 and 2 respectively. From the data shown in both the tables it was observed that percent infection was high in two orchards which were 5 years old. The 5-year-old trees grown on the standard rootstocks were near to, but had not yet started, production. However, the 5-year-old trees grown on MM-106 and MM-111 were in the early stages of full bearing. There were clear differences in the severity and incidence of the disease between orchards grown on standard and those grown on Malling-Merton rootstocks. Percent infection of the disease was higher on Malling-Merton rootstocks as compared to the standard one. In order to simplify and clarify the data and results, the data was arranged according to the age of the orchards, ranging from 3-5, 6-10, 11-15, and 16-21 years old, as shown in Table 3. It was significant from the data that tree age and rootstock type has a profound influence on the incidence of the disease. The disease was more serious during the first 3-5 years, and as the trees aged so the disease incidence declined. It was concluded that 3-5 years was the most critical period for the incidence and severity of the disease, and therefore attention to the management is necessary during this time. Likewise, MM-106 and MM-111 rootstocks were found to be more susceptible to the disease than the standard one. The present increase in the disease incidence and severity could probably be attributed to the size controlling rootstocks i.e. MM-106 and MM-111. Welsh (1942), and McIntosh and MacSwan (1966) reported that *Phytophthora* crown and root rot occurred on trees of all ages, but trees were most susceptible when they first came into bearing. Similarly, Harris (1990) worked on the natural outbreak of the disease and reported that only two rootstocks, MM-104 and M 106, were affected by *Phytophthora* crown and r rot. He further stated that MM-104 succumbed to disease throughout the life of the orchard, wher MM-106 was affected only during the first 4-5 ye

Table 1: Incidence of apple root rot on standard rootstock

Locality	% infection	Age of trees(Year)
Nulkot 1 (n = 500)	0.4	20
Nulkot 2 (n = 300)	6.0	3
Durushkela 1 (n = 100)	0.5	21
Durushkela 2 (n = 240)	2.5	16
Durushkela 3 (n = 500)	3.6	7
Baidara (n = 100)	3.0	10
Arkot (n = 700)	2.85	20
Chuprial (n = 300)	2.33	20
Bandai (n = 500)	2.0	15
Khwazakela 1(n = 400)	1.25	18
Khwazakela 2(n = 460)	12.39	5
Madyan (n = 320)	0.93	17
Kabal 2 (n = 300)	3.33	15
Fatehpur (n = 208)	2.4	16
Shahpur 2 (n = 200)	2.5	3
Sherpalam (n = 600)	0.83	20

Table 2: Incidence of root rot in apple orchards of Sw Malling-Merton rootstocks

Locality	Total trees	% infection	Tree Age (Year)
Ronial	250	20.4	5
Chuprial	400	3.25	3
Charbagh	400	8.25	7
Shahpur	500	3.2	6
Fatahpur	209	5.74	7
ARSNM	300	2.33	10
Sherpalam	2000	4.8	6

Table 3:Effect of tree age and rootstock on root disease in apple orchards of Swat

Name of rootstocks	Tree age (year) and percentage of the disease			
	3-5	6-10	11-15	16-21
MM-106 and MM-111	11.82	4.86	-	-
Standard	5.86	3.3	2.66	1.55

Means followed by same letter do not differ statistica
During the survey other factors like precipitation and bl time were also taken into consideration to assess influence on the incidence of the disease in relation to age and rootstock types. Bloom time in the month of is the period when apple trees are most susceptibl infection by *P. cactorum*. It is also a period when s

commonly saturated in apple orchards, due to high precipitation and low evapotranspiration in Malakand Division. Although soil moisture was not measured during April, most of the rainfall occurred during this month, and visual observations of standing water and substantial surface runoff in the orchards suggested that the soil was saturated for several days. As the pathogen is semi-aquatic, the availability of saturated soil and pressure on the roots to provide nutrients during bloom time predisposed the young trees from 3-5 years old to *P. cactorum* infection. Merwin *et al.* (1992) also stated similar observations.

Table 4:Infected/dead plants inoculated with P. cactorum

Rootstock type	Infected plants*
MM-106	5 a
M-27	5 a
M-26	4 a
MM-111	4 a
Standard (Local)	4 a
M-9	0 b

LSD Value at (P=0.050) = 1.334
* Means of three replications.

Among the six different rootstock types inoculated with *P. cactorum*, M-9 was found to be the only resistant one (Table 4). Variations in susceptibility to *Phytophthora* crown and root rot among the rootstocks are however, very inconsistent. In the case of M-26, MM-111 and local (standard) rootstocks, four out of five plants were infected, while M-27 and MM-106 were found to be totally susceptible. None of the uninoculated plants of all the rootstocks were found to be infected. Bark tissues from the margin of the advancing lesion on the root crown of the inoculated apple rootstocks yielded a fungus with the morphological characteristics of *P. cactorum* when plated on schmitthenner's medium. These findings agree with those of Utkhede and Quamme (1988) and Barritt *et al.* (1990). They observed that susceptibility of the rootstocks varied from one area to another principally due to soil type, and soil conditions. However, Harris (1990) reported that M-26 and MM-111 are resistant to *P. cactorum* under British conditions whereas M-27 and MM-106 are highly susceptible. On the other hand McIntosh (1975) found all the rootstocks to be susceptible to *P. cactorum* with the exception of M-9.The present results therefore coincide with those reported earlier albeit with slight variations. These are probably due to different inoculation and evaluation procedures used by the researchers and different environmental conditions of the various locations.

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