Incidence and etiology of mouldy core and core rot of apple in Shimla district, Himachal Pradesh

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ABSTRACT

The investigations on the incidence and etiology of mouldy core and core rot of apple causing pre-harvest fruit drop in major apple growing belts in Shimla district of Himachal Pradesh were conducted during 2009 cropping season. Highest incidence (17.7%) of mouldy core and core rot of apple in dropped as well as intact fruits was found in the Kotkhai region of the Shimla district followed by Rohroo (16.6%) and Thanedhar (15.5%) while least was observed in Jubbal area. The percentage incidence of mouldy core and core rot of apple was more in the dropped (30.1 and 17.1%) fruits as compared to the intact ones (12.4 and 5.1%). *Alternaria alternata* was the predominant fungal pathogen isolated from the infected fruits. In a few cases *Trichothecium roseum* was observed as a secondary pathogen causing dry rot symptoms. Artificial inoculation of the mature fruits through calyx tube showed 100 per cent rotting after 25 days of inoculation.

Keyword: Apple; etiology; incidence; disease; mouldy core; core rot

INTRODUCTION

Apple (*Malus* x *domestica* Borkh) a member of family Rosaceae is the most important fruit crop grown extensively in temperate regions all over the world. India ranks seventh with average yield of about 7.24 tonnes per hectare (Thamaraikannan et al 2010). All three northwest Himalayan states of India viz Himachal Pradesh, Jammu and Kashmir and Uttarakhand are the major apple producing states of India. Its cultivation has revolutionized the socio-economic conditions of hilly farmers and it has become the number one commercial fruit crop.

With the intensive cultivation this crop in the state of Himachal Pradesh some new disease problems have cropped up over a fairly large area. Few years back a new problem of pre-harvest fruit drop associated with core rot was encountered in major fruit growing areas of Shimla and Kullu districts of the state. This paper emphasises on the incidence and etiology of the diseases in the Shimla district of Himachal Pradesh.

MATERIAL and METHODS

Disease survey and surveillance

Periodic surveys of different apple growing areas in Shimla district of Himachal Pradesh were conducted during July-August months in 2008 season for the collection of dropped as well as intact fruits.

The areas surveyed included Kotkhai, Jubbal, Rohroo and Thanedhar. Ten dropped and intact fruits from each of the 5 randomly selected trees were collected, cut into two halves and observed for mouldy core and core rot symptom at each location. The incidence of mouldy and core rot of apple under natural epiphytotic conditions was recorded as per the equation given as under:

$$\text{Disease incidence (\%)} = \frac{\text{Number of fruits with mouldy core and core rot}}{\text{Total number of fruits observed}} \times 100$$

Isolation and identification

Repeated isolations of the major pathogens involved in the mouldy core and core rot were made from the diseased core of the fuit samples of apple collected from different apple growing areas. The diseased fruits were surface-sterilized with absolute alcohol under aseptic conditions; cut into two halves with the help of sterilized knife aseptically and from the core region of fruits showing fresh infection of mouldy core and core rot a fresh mycelial mat was taken and further transferred to potato dextrose agar (PDA) slants and incubated in BOD incubator at 25 + l°C for growth of the pathogen. The isolated fungi were purified by hyphal tip method and identified on the basis of morphological and taxonomic characters mentioned in the key given by Barnett and Hunter (1998).

Pathogenicity

The pathogenicity of the isolated fungi was proved by inoculating the healthy fruits of Starking Delicious apple cultivar by injecting the spore suspension into the fruit core and covering the injured area by cellophane tape and incubated at room temperature or 25 ± 1°C. After inoculation the fruits were immediately covered with the sterilized filter paper; the filter paper was kept wet with the help of sterilized distilled water to maintain the relative humidity. Similar set of apple fruits inoculated with distilled water only served as control. Observations were recorded on disease appearance, incubation period (days) and per cent rotting.

Well method (Granger and Horne 1924)

In this method wells were made on the healthy fruit surface of Starking Delicious with the help of cork borer (internal diameter 4 mm) aseptically. A bit from fresh culture of *Alternaria alternata* was placed at the bttom of the well. The injured area or the wells were then sealed with the help of cellophane tape and incubated at 25 ± 1°C at room temperature. Wells inoculated with PDA only served as control.

Spore suspension method (Reuveni and Sheglov 2002)

In this method healthy fruits of Starking Delicious were brought from the orchard, surface-sterilized with 90 per cent ethanol and allowed to dry at room temperature. On the other side a spore suspension was prepared in sterilized distilled water containing 5×10^4 spores/ml and with the help of dispovan syringe the spore suspension (100 µl) was injected into the core cavity of the fruits through the calyx tube and body of the fruits. The inoculated area was then sealed with the help of cellophane tape and incubated at 25 ± 1°C at room temperature. Fruits inoculated with sterilized water only served as control.

RESULTS and DISCUSSION

To record the prevalence of mouldy core and core rot of apple periodic surveys of different major apple growing areas located in Kotkhai, Jubbal, Rohroo and Thanedhar (Shimla district) were conducted during July-August 2009. The data recorded on disease incidence are presented in Table 1 which reveal the natural occurrence of mouldy core and core rot in dropped as well as intact fruits examined.

It is apparent that the highest incidence (17.7%) of mouldy core and core rot of apple in dropped as well as intact fruits was found in the Kotkhai region of the Shimla district followed by Rohroo (16.6%) and Thanedhar (15.5%) while least was observed in Jubbal area. The data also reveal that the percentage incidence of mouldy core and core rot of apple was more in the dropped (30.1 and 17.1%) fruits as compared to the intact ones (12.4 and 5.1%) which indicated that the pathogen might be involved in the pre-harvest fruit drop of apple up to some extent. On an average there was 16.2 per cent incidence of both these diseases in the surveyed areas with 21.3 and 11.1 per cent fruits showing mouldy core and core rot infections respectively.

Symptomatology

Dropped as well as intact Starking Delicious apple fruits brought from the surveyed areas of Shimla district of Himachal Pradesh showed mouldy core, core rot and dry rot symptoms. Mouldy core was characterized by presence of fungal mycelium within the core without causing penetration into the flesh of the fruits. However when invasive penetration of mycelium into the flesh of the fruit was present causing wet rot type of symptoms the disease was said to be a core rot. Fruits brought from lower altitude of the district showed the dry rot symptoms characterized by drying of infected tissue (Plate 1).

Isolation and identification

Repeated isolations of the major pathogen(s) involved in the mouldy core and core rot were attempted from the diseased core of dropped and intact fruit samples. In most of the cases predominant fungal pathogen isolated was *A alternata* (Plate 2) and it was

Plate 1. Characteristic symptoms of core rot, mouldy core and dry rot in apple

identified as per the key given by Barnett and Hunter (1998). In a few cases *Trichothecium roseum* was observed as a secondary pathogen causing dry rot symptoms especially in those fruits where calyx tube was injured by insects and other factors especially at lower altitudes. Gupta and Sharma (2008) also reported the natural occurrence of water core and core rot of apple in some localities of Shimla district on Starking Delicious and Golden Delicious cultivars of apple to be caused by *A alternata*. However Raina et al (1971) reported the natural occurrence of core rot in the Kullu valley of Himachal Pradesh and identified the causal organism of this disease as *T roseum.* Earlier Harrison (1935) reported *A tenuis* and *Fusarium* sp as causal invaders in the mouldy core of Gravenstein apples in Nova Scotia. Imre (1983) from Hungary reported that

Plate 2. Typical mycelia and conidia of *Alternaria alternate* causing mouldy core and core rot of apple

Plate 3. Methods of inoculation and pathogenecity of *Alternaria alternate* causing mouldy core and core rot in apple

in 95 per cent of the cases of mouldy core and core rot of Starking Delicious apples the pathogen found was *A tenuis* (*alternata*).

Pathogenicity test

To prove the pathogenic nature of the isolated fungus, healthy fruits of Starking Delicious apple were inoculated by different methods described above and incubated at 25 ± 1°C. The symptoms of the disease appeared in all the treatment methods but per cent rotting was higher in case of calyx tube method described by Reuveni and Sheglov (2002) for mouldy core and core rot of apple.

In the inoculations through calyx tube, first symptom of the disease was observed on the tenth day of inoculation with 35.50 per cent rotting while no rotting was observed in inoculation through cork borer (Table 2). Complete rotting of the inoculated fruits was observed after 25 days of inoculation with 100 per cent rotting in inoculation through calyx tube whereas only 5.00 per cent rotting with dry rot symptom restricted

Table 1. Incidence of mouldy core and core rot of apple in dropped and intact fruits in different areas of Shimla district during 2009

Location	Disease incidence (%)						
	Dropped		Intact		Average		Mean
	MC	CR	MC	CR	MC	CR	
Kotkhai	33.6	17.7	13.1	6.6	23.3	12.1	17.7
Rohroo	32.0	16.3	12.8	5.5	22.4	10.9	16.6
Jubbal	26.0	15.6	12.5	5.2	19.5	10.4	14.9
Thanedhar	29.0	18.7	11.2	3.3	20.1	11.0	15.5
Mean	30.1	17.1	12.4	5.1	21.3	11.1	16.2

MC= Mouldy core, CR= Core rot

Table 2. Pathogenicity of *Alternaria alternata* causing mouldy core and core rot in Starking Delicious apples

Incubation period (days)	% rotting	
	Calyx tube method	Well method
10	35.50	0.00
20	64.80	5.00
22	75.00	5.00
25	100.00	5.00 (dry rot)
Mean	68.80	3.75

to the inoculated area by the cork borer was observed in the cork borer method (Plate 3). No rotting was however observed in the control fruits. Kaiqi et al (1995) also tested the pathogenicity of the mouldy core causing fungi such as *Alternaria*, *Fusarium*, *Trichothecium* and *Penicillium* species by inoculating the mature fruits of Starking Delicious apples by injecting a spore suspension into the fruit core. Reuveni and Sheglov (2002) proved the pathogenicity of mouldy core of Starking Delicious cultivar by injecting 15 µl spore suspension containing 5 x 10^5 spores/ml into the fruit core.

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