Four Major Diseases Affecting Pear Trees and Their Prevention and Control Methods

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Abstract This paper presents an overview of the pathogens, symptoms of damage, patterns of occurrence, and chemical control methods associated with four major pear tree diseases: pear scab, pear ring rot, pear anthracnose, and pear speckle. The objective is to provide valuable references for the scientific and precise prevention and management of diseases in pear orchards, thereby contributing to the production of high-quality and high-yield pear fruits.

Key words Pear, Disease, Pathogen, Symptoms of damage, Patterns of occurrence, Prevention and control methods

1 Introduction

Pears, as one of the major fruit crops globally, have established significant economic value and industrial importance owing to their wide adaptability, rich nutritional content, strong storage capacity, and considerable potential for deep processing. China is the world's leading producer and exporter of pears. According to data from the Food and Agriculture Organization of the United Nations (FAO), in 2021, the area cultivated with pear trees in China was approximately 981 500 hm^2, yielding a total production of about 18.88 million t. These figures represent 73.57% of the global cultivated area and 70.13% of the total global output, respectively. Pear cultivation has thus become a cornerstone of the rural economy in numerous regions. Consequently, achieving high-quality, high-yield, and stable pear production is critically important for securing the income of fruit farmers and fostering regional economic development.

In recent years, diseases affecting pear trees in China have exhibited patterns of regional outbreaks and increased severity in certain production areas, posing significant challenges to the healthy and sustainable development of the pear industry. Pear scab is prevalent in both northern and southern pear-growing regions of China, causing substantial damage in provinces such as Liaoning, Hebei, and Shandong. During years of high disease incidence, the proportion of affected leaves can reach up to 90%, while the proportion of infected fruits ranges from 50% to 70%. In recent years, pear ring rot has become widespread in certain pear orchards in Tianjin, with an average incidence rate ranging from 30% to 50%. Similarly, the prevalence of pear speckle in Liaocheng, Shandong Province, has intensified, leading to significant early defoliation in pear orchards during August and September. Typically, the proportion of diseased leaves ranges from 20% to 40%, while in severe cases, it exceeds 60%. In some instances, entire pear trees have experienced complete leaf loss. The widespread prevalence of these diseases not only directly impacts the quality and yield of pears in the current year but also weakens the tree, subsequently affecting flower bud differentiation and fruit production in the following year. This creates a detrimental cycle that ultimately results in economic losses amounting to hundreds of millions for the entire pear industry. Therefore, in the cultivation and management of pear trees, alongside efforts to enhance the genetic quality of the species, the scientific prevention and control of diseases must be prioritized.

This paper provides a systematic overview of four major diseases affecting pear trees, detailing their pathogens, symptoms of damage, patterns of occurrence, and chemical control methods. The objective is to offer scientific guidance for the effective prevention and management of diseases in pear orchards, thereby supporting the production of high-quality pears.

2 Pear scab

2.1 Pathogen Pear scab, also referred to as scab disease, fog disease, or black mold disease, is caused by two pathogenic species: *Venturia pirina* Aderhold and *V. nashicola* Tanaka et Yamamoto. *V. pirina*, classified within the phylum Deuteromycota, exclusively infects Western pear varieties. In contrast, *V. nashicola*, belonging to the phylum Ascomycota, primarily affects Eastern pear cultivars.

2.2 Symptoms of damage Pear scab primarily affects the leaves and fruits of the pear tree. The characteristic symptom is the development of a black, mold-like layer on the affected tissues.

2.2.1 Leaves. In the early stages of the disease, pale yellow lesions of circular, elliptical, or irregular shapes develop along the main and secondary veins on the abaxial (underside) surface of the leaves. Subsequently, black, mold-like growths emerge along the edges of the main veins, accompanied by the appearance of

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yellowish-brown lesions on the adaxial (upper) surface of the leaves corresponding to these mold-like formations. In severe cases, the abaxial leaf surface becomes entirely covered with a black mold layer, leading to leaf abscission[1].

2.2.2 Fruits. In the initial stage of the disease, nearly circular, water-soaked, pale yellow small spots develop around the lenticels. Subsequently, these spots turn brown and progressively enlarge, accompanied by the growth of a black mold layer. As the fruit enlarges, the lesions become sunken, corky, and cracked[2].

2.3 Patterns of occurrence *V. pirina* primarily overwinters as mycelium or conidia on bud scales or lesions located at the base of buds. In the subsequent spring, infected buds sprout, giving rise to diseased shoots. The conidia produced on these shoots serve as the principal source of primary infection. These conidia are disseminated by wind, rain, or air currents[3], subsequently landing on nearby young leaves, fruits, and shoots. Infection occurs when environmental conditions are favorable, with an optimal temperature for pathogen invasion of approximately 20 ℃. Under suitable temperature and humidity conditions, the invasion process can be completed within 48 h. The incubation period typically ranges from 12 to 29 d, after which new conidia are produced on the infected leaves and fruits, leading to secondary infections.

2.4 Chemical control methods The timing of pesticide application is critical for the effective chemical control of pear scab. During the inflorescence separation stage, a 5°Be lime sulfur solution may be applied. Subsequent application timing and frequency should be determined based on rainfall patterns and disease severity. Protective fungicides, including 80% mancozeb WP at an 800-fold dilution and 50% captan WP at dilutions ranging from 400- to 600-fold, can be employed. Systemic fungicides comprise 50% carbendazim WP at dilutions of 800- to 1 000-fold and 25% myclobutanil EC at dilutions between 4 000- and 5 000-fold. Alternating between these two types of fungicides is recommended to prevent the development of resistance.

3 Pear ring rot

3.1 Pathogen Pear ring rot, also referred to as pear ring brown rot, coarse skin disease, or tumor skin disease, is commonly known as water rot. The causative agent of pear ring rot is the asexual form of *Macrophoma kawatsukai* Hara, a fungus classified within the phylum Deuteromycota. Its sexual stage is identified as *Botryosphaeria dothidea*, a fungus belonging to the phylum Ascomycota.

3.2 Symptoms of damage Pear ring rot primarily affects the branches, trunks and fruits of pear trees, and occasionally the leaves as well.

3.2.1 Branches and trunks. Following the onset of the disease on the branches and trunks, raised, dark brown, tumor-like lesions develop near the lenticels. These lesions exhibit nearly round or irregular shapes and possess a firm texture. In the advanced stages, the periphery of the lesions gradually becomes depressed, resulting in the formation of a ring groove between the cracked edges and the adjacent healthy tissue. During the subsequent spring, numerous small black dots emerge on the lesions. Extensive coalescence of lesions leads to the formation of dense cracks, producing a very rough surface characterized by cracking and lifting of the diseased tissue.

3.2.2 Fruits. The fruit is susceptible to infection from May to August. Typically, no symptoms manifest from the time of infection until the fruit approaches ripening. Symptoms become evident only near ripening or during storage. Upon disease onset, the fruit surface develops nearly circular, brown, water-soaked small spots centered around the lenticels. These spots rapidly expand in all directions, forming concentric ring-shaped lesions characterized by alternating dark and light brown hues. Under favorable conditions, the infected fruits undergo rapid rot, often accompanied by a sour and unpleasant odor and the exudation of brown juice, while retaining their overall shape. Subsequently, as the fruit loses water and shrinks, it becomes blackened and rigid[4].

3.2.3 Leaves. Following the onset of infection, circular or irregularly shaped lesions emerge on the leaves, characterized by distinct concentric rings of varying sizes. Initially brown, these lesions gradually become grayish-white, accompanied by the development of small black dots. In cases of severe damage, the affected leaves frequently wither and abscise prematurely[5].

3.3 Patterns of occurrence *B. dothidea* primarily overwinters within the affected tissues of diseased trees in the form of mycelium, pycnidia, and perithecia, and it can also persist on dead and pruned branches. Following the onset of sprouting in pear trees during the subsequent spring, conidia begin to disseminate. These conidia are dispersed in the field primarily by wind and rain, typically traveling distances of 5 to 10 m. Dispersal beyond 10 m is markedly reduced. However, under conditions of strong wind and rain, conidia can be transported over distances exceeding 20 m. Conidia, dispersed by wind and rain, settle on young branches and fruits that are covered with water films. Under suitable temperature and after a certain incubation period, the conidia germinate and penetrate the host tissue through the stomata of branches or fruits, as well as through unhealed bark pores, thereby initiating primary infection. The subsequent infection rate is influenced by the frequency of rainfall. Disease proliferation is most rapid when the temperature exceeds 20 ℃ and relative humidity surpasses 75%, or rainfall amounts to over 10 mm and continuous rainfall persists for 3 – 4 d.

3.4 Chemical control methods Given the extended infection period of the pathogen on the fruit, it is essential to apply pesticides promptly throughout the growth phase for effective protection. A 3 – 5 °Be lime sulfur solution should be sprayed once prior to the sprouting of the pear tree. From approximately 10 d after flower abscission until the conclusion of the fruit expansion period, pesticide applications should be conducted in accordance with prevailing weather conditions. Suitable pesticides include 40% flusi-

lazole EC diluted 6 000 times, 10% difenoconazole WG diluted 5 000 times, 70% thiophanate-methyl WP diluted 800 to 1 000 times, and 75% chlorothalonil WP diluted 800 times. Prior to fruit harvest, a potent systemic fungicide, such as 50% carbendazim WP diluted 800 times, may be applied[6].

4 Pear anthracnose

4.1 Pathogen Pear anthracnose, also referred to as pear bitter rot or pear late rot, is caused by the asexual fungus *Colletotrichum gloeosporioides* Penz., which belongs to the phylum Deuteromycota. Its sexual stage is known as *Glomerella cingulata*, classified within the subphylum Ascomycota.

4.2 Symptoms of damage

4.2.1 Fruits. The disease commonly manifests during the middle to late stages of fruit development. Initially, small, light brown, water-soaked circular spots appear. Subsequently, the affected areas become soft, rotten, and sunken, with the coloration intensifying to a blackish-brown hue. These regions develop small black dots arranged in concentric rings. Under favorable temperature and humidity conditions, these dots penetrate the epidermis and secrete pink, sticky substances. As the lesions progressively enlarge, the diseased tissue may rot from the flesh to the core, resulting in browning of the flesh and the development of a bitter taste. The shape of the decayed flesh is often conical. In severe cases, most or the entire fruit undergoes rot, leading to fruit drop or shriveling on the branches, resulting in hardened fruits[7].

4.2.2 Leaves. Following infection, brown circular spots develop on the upper surface of the leaves, which subsequently enlarge and coalesce into irregularly shaped large lesions. The center of these lesions appears grayish-white, bordered by a black margin. The entire leaf becomes scorched and withered, occasionally exhibiting distinct ring patterns. Ultimately, premature leaf abscission occurs, impairing the photosynthetic capacity of the pear tree and consequently reducing its yield[8].

4.3 Patterns of occurrence The pathogen primarily overwinters as mycelium on diseased and stunted fruits, infected branches and leaves, and fruit spurs. With the increase in temperature and humidity during the subsequent spring, the mycelium germinates and generates a substantial number of conidia, which constitute the primary source of infection. Conidia are disseminated by wind, rain, or insects, with rain serving as the principal transmission pathway. Insects facilitate medium- and long-distance dispersal between plants and orchards.

4.4 Chemical control methods Beginning in late May or early June, medication is administered in conjunction with treatments for ring rot and scab. For pear orchards that have experienced severe disease impact in previous years, specific pesticides should be selected, such as 25% bromothalonil WP diluted 300 – 500 times, or 50% Tuzet WP diluted 600 – 800 times. In pear orchards employing bagged fruit cultivation, systemic fungicides should be applied one to two times to the fruit surface prior to bagging[9].

5 Pear speckle

5.1 Pathogen Pear speckle, also referred to as pear leaf spot or pear leaf blight, is caused by the asexual pathogen *Septoria piricola* Desm., which belongs to the phylum Deuteromycetes. Its sexual stage is identified as *Mycosphaerella sentina* (Fr.) Schrot., classified within the phylum Ascomycota.

5.2 Symptoms of damage Pear speckle primarily affects the leaves of pear trees. In the initial stage of the disease, small circular or nearly circular brown spots emerge on the upper surface of the leaves, gradually expanding with well-defined edges. The center of the lesions becomes grayish-white, surrounded by a brown periphery and a black outer margin. Numerous small black dots are densely distributed within the affected areas. In severe cases, multiple lesions coalesce to form irregular, large, brown, and desiccated patches that are prone to perforation, ultimately leading to premature leaf abscission[10].

5.3 Patterns of occurrence The pathogen overwinters on diseased lesions of fallen leaves in the form of pycnidia and perithecia. In the subsequent spring, conidia and ascospores are dispersed to new leaves by wind and rain. Under favorable environmental conditions, these spores germinate and invade the host tissue, initiating primary infection. During the growth period of pear trees, pycnidia develop on the lesions, producing conidia that are subsequently disseminated by wind and rain to re-infect the leaves. Throughout the growing season, the pathogen undergoes multiple cycles of re-infection, resulting in continuous disease development on the leaves[11].

5.4 Chemical control methods In early spring, during the leaf expansion period of pear trees, Bordeaux mixture can be applied in conjunction with measures for the prevention and control of pear rust. After the flowers have fallen, and either before or at the initial stage of disease development, treatments such as 70% thiophanate-methyl WP diluted 600 to 800 times or 10% difenoconazole WG diluted 1 500 to 2 000 times may be employed. Additionally, 50% carbendazim WP diluted 800 times and 12.5% diniconazole diluted 2 500 times have demonstrated efficacy in the prevention and control of pear speckle[12].

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