

# Control Techniques of Chinese Chestnut Yellow Crinkle

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**Abstract** This paper initially delineates the symptoms, characteristics, and hazards associated with Chinese chestnut yellow crinkle, as well as the transmission and infection pathways of the disease. Additionally, it proposes the prevention and control strategies of the disease, including rigorous investigation and monitoring of the disease, enhanced monitoring of seedlings and scions, and integrated disease management techniques to promote the tree's health and vitality. These strategies serve to inform the prevention and control of Chinese chestnut yellow crinkle in production.

**Key words** Chestnut; Chinese chestnut yellow crinkle; Symptom; Prevention and control

## 1 Introduction

The chestnut (*Castanea mollissima*), a member of the Castanea family<sup>[1]</sup>, is distinguished by its distinctive flavor, aroma, sweetness, and glutinousness. It is primarily found in the Yanshan Mountain Range, which falls under the jurisdiction of Hebei and Beijing. The chestnut is renowned as the "oriental pearl", and the stable and healthy development of the chestnut industry plays a pivotal role in the economic advancement of Hebei Province<sup>[2]</sup>. In recent years, a disease that is highly destructive to the chestnut tree, Chinese chestnut yellow crinkle, has emerged in China's northern chestnut production areas. The disease is characterized by the development of significantly smaller leaves on infected trees, which has led to the common designation of the disease as "small leaf of chestnut" among chestnut growers. The typical symptoms of this disease include leaf shrinkage and chlorosis at maturity, small chestnut nuts that are difficult to mature, and a shriveled and rough surface texture of the chestnuts after ripening. Furthermore, the chestnut will lose its commercial value and the entire plant will decline significantly when the disease is severe<sup>[3–4]</sup>. Previously, it was widely believed that Chinese chestnut yellow crinkle was caused by a nutritional deficiency. This deficiency was thought to be due to soil zinc deficiency, magnesium deficiency, as well as the imbalanced nutrient ratio of zinc and phosphorus in trees. However, over the years, despite the implementation of prevention and treatment strategies for deficiencies, these efforts have not achieved significant results. Our research team has conducted investigations into diseased chestnut plants in numerous counties and cities within Hebei Province. The findings indicate that Chinese chestnut yellow crinkle is not a symptom of a deficiency of nutrients, but rather a destructive disease with high infectivity.

## 2 Symptoms

The Chinese chestnut yellow crinkle, colloquially referred to as

"small leaf of chestnut", is a phytoplasma disease<sup>[5–7]</sup>. Infection of chestnut trees results in damage to various plant parts, including roots, stems, branches, leaves, flowers, buds, and fruits. The extent of this damage varies depending on the specific plant part and the severity of the infection. The leaf blade exhibits a yellow tip in the early stage of development, a green coloration in the middle and lower parts of the leaf, and a yellowing along the leaf veins in the mature leaf blade. The leaf blade is folded and not spreading, and it is abnormally narrow, exhibiting a clear reduction in size compared to the typical leaf blade. The branches of diseased trees exhibit the following characteristics: thickening at the base, death at the tip, significant shortening of the internodes, raised and enlarged lenticels, hardening and brittleness of the texture, and yellowish xylem. In the intermediate phase of the disease, the expansion and growth of the prickly bracts are impeded, resulting in a notable reduction in volume compared to uninfected plants. The prickly bundles remain soft during the nut ripening stage, and the prickly bracts gradually lose their green color and dry up and fall off. In the event of a severe outbreak of the disease, the tree is significantly weakened, with a high prevalence of empty buds. Even in the presence of chestnut fruit, the peel of the fruit is also wrinkled, deflated, small, and lacking in luster. Furthermore, the fruit has no commercial value, and in some cases, the plant blooms but does not bear fruit. This phenomenon is observed to occur approximately 7–8 years prior to the death of the tree.

## 3 Characteristics and hazards

The Chinese chestnut yellow crinkle is distinguished by a high infectiousness, a lengthy incubation period, and the difficulty of eradication. Infection of chestnut trees may occur from the periphery of the crown of one or several large branches, or alternatively, the whole plant may be affected simultaneously. This phenomenon is known as Chinese chestnut yellow crinkle and represents a systematic infestation. In the initial stages of infection, trees exhibit a decline in vigor and yield. As the disease progresses, it leads to the gradual extinction of the plant, manifested in the form of crop failure and branch death. The pathogen has a specific period of latency within the plant, which typically lasts 1–2 years for small trees and 3–5 years for large trees. During this period, the plant may exhibit symptoms of damage. In the event that a chestnut tree is infected and not prevented in a timely manner, the disease will

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likely spread to other chestnut trees in the vicinity, acting as a center of infection with high infectivity. Over time, the infection may extend to encompass the entirety of the chestnut garden, or even thousands of acres of chestnut gardens.

#### 4 Transmission of infection

The transmission of Chinese chestnut yellow crinkle is facilitated by insects with piercing and sucking mouthparts, scion grafting, pruning tools, and diseased seedlings. Insects with piercing and sucking mouthparts, such as leafhoppers, aphids, plant hoppers, *Halyomorpha halys*, *Lycorma delicatula*, *etc.*, feed on the phloem. Following the sap-sucking activity of the insects on the diseased tree, they subsequently move to the healthy tree to feed, thereby introducing the pathogen into the healthy chestnut tree. This results in the healthy tree becoming infected by the disease. It is possible for disease to be transmitted from diseased seedlings during grafting, grafting (budding and branching), and other related processes. One side of the scion or rootstock infected with the pathogen can result in the grafted plant developing disease. Furthermore, the question of whether interconnected root systems (mycorrhizae) in the soil can transmit and whether pollen can transmit is currently being investigated.

#### 5 Prevention and control methods

The prevention of infection is based on the control of the source of infection, the elimination of pathogenic bacteria, and the cutting off of transmission routes. The center is to enhance the cultivation management, balanced fertilization, and reasonable pruning of trees, thereby strengthening their resilience and reducing the risk of disease. The efficacy of this treatment is guaranteed by the administration of trunk drilling and drug infusion. Concurrently, the cultivation of improved varieties, the disinfection of tools, the elimination of the spread of piercing and sucking insects, and other measures should be employed for comprehensive prevention and control.

**5.1 Rigorous investigation and monitoring of the disease** It is recommended that the forestry administration departments at all levels and the forestry prevention and quarantine institutions in chestnut-producing areas enhance their surveillance and investigation of Chinese chestnut yellow crinkle. Concurrently, the incidence and behavior of insects with piercing and sucking mouthparts should be monitored, with the aim of mastering the occurrence of its distribution changes and other information. Timely release of forecast information and prevention and control programs should be facilitated, with the objective of guiding chestnut growers to actively prevent and control insects, thereby avoiding the transmission of diseases.

**5.2 Enhanced monitoring of seedlings and scions** In order to prevent the spread of disease, it is imperative that customers and chestnut growers exercise caution when inspecting the trunk, branches, leaves, roots, scion buds, and skin holes of seedlings. This is to prohibit the transport, spread, and production of diseased seedlings and to cut off the transmission of diseased seedlings and scions from communication.

**5.3 Clearly marking disease trees to avoid overlapping infections** In order to effectively treat and prevent the disease, the diseased trees in the chestnut garden should be marked in the summer and autumn, when the disease is fully manifested and eas-

ily identified by the unaided eye. It is recommended that plants exhibiting severe disease symptoms should be eradicated and destroyed in their entirety to reduce the potential for further infection. It is recommended that scion grafts from diseased trees and surrounding chestnut trees should not be collected during the spring season in order to prevent the artificial spread of the disease. In the event of pruning diseased trees, it is imperative to utilize a separate set of pruning tools, to disinfect said tools after completion, and to remove the diseased branches after pruning.

**5.4 Integrated disease management techniques to promote the tree's health and vitality** It is recommended that the integrated management of chestnut trees should be strengthened, with particular attention paid to reasonable pruning, appropriate amount of load, application of organic fertilizer, and enhancement of the tree to improve disease resistance. It is recommended that a foliar fertilizer should be applied by spraying to enhance the tree's resistance. For the newly infected trees and their surrounding chestnut trees, a low concentration of potassium dihydrogen phosphate, magnesium sulfate, and iron sulfate is mixed with the foliar fertilizer and sprayed during the spring leaf spreading period. This treatment is designed to promote tree health and enhance resistance.

**5.5 Timely control of pests with piercing and sucking mouthparts** During the annual growth cycle of chestnut trees, it is imperative to provide timely warnings regarding the potential occurrence of insect pests in chestnut gardens. Furthermore, it is crucial to implement comprehensive control measures against piercing and sucking insects, such as mites, aphids, and *Tettigella viridis*, in order to effectively mitigate the risk of infection.

**5.6 Chemical control** The optimal control period is the germination and leaf spreading period of the chestnut tree in the spring. At this time, the sap begins to flow from the root system to the upper crown of the tree, and the pathogens are transported upward along with the nutrients in the sieve tube of the phloem. It is therefore important to drill and transfuse the holes in time. It has been demonstrated that antibiotics such as tetracycline have superior efficacy.

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