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European Apple Canker caused by *Neonectria ditissima*

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Introduction

European canker, caused by the fungal pathogen *Neonectria ditissima* (Tul. & C. Tul.), is one of the most destructive diseases of apple (*Malus domestica*) that has been a significant issue in Canada, Europe, and New Zealand. The disease leads to branch dieback, reduced yields, and significant orchard losses in regions with cool, wet climates. In Virginia and across the Mid-Atlantic, conditions can favor the establishment of this pathogen, especially in high-density orchards and at higher altitudes. Despite decades of study, *N. ditissima* remains challenging to manage due to its long latent infection period, ability to infect a wide range of wounds and hosts, and production of multiple spore types throughout the year.

Symptoms

European canker symptoms vary depending on the host organ and stage of infection. On branches and trunks, the disease causes sunken, oval lesions often surrounded by concentric rings of callus tissue (Fig. 1a. As the canker enlarges over time, bark lesions become evident, and stem girdling can occur, killing entire limbs or trees. On young shoots, infections lead to dieback above the infection site, resulting in characteristic wilting. Fruit may also be affected, developing blossom-end rot or postharvest storage rot (Fig. 1b & c), especially when harvested from heavily infected orchards. In many cases, the pathogen establishes a latent infection that remains symptomless for months or even years. Trees may appear healthy for up to three years following nursery infection, before lesions suddenly become visible.

Disease Cycle

The disease cycle begins when N. ditissima survives winter in the form of perithecia and mycelium within existing cankers on branches, trunks and pruned debris (Fig. 2). During periods of high humidity in spring and fall, cankers produce both conidia in sporodochia and ascospores in perithecia. Conidia (microconidia and macroconidia) are primarily spread short distances within the tree canopy by rain splash, while ascospores enable long-distance dispersal of disease through wind currents. Spores enter susceptible tissues through natural openings or wounds, including leaf scars, pruning cuts, fruit picking injuries, and frost cracks. After infection, the fungus may remain latent for several months or years, making detection and management challenging. As lesions develop around the infection point, new cankers become active sources of inoculum, allowing the disease to spread rapidly within and between trees.

Integrated Management Strategies

An integrated pest management approach is essential for successful control of European canker. Because the pathogen can infect throughout the year and persist latently within trees, no single strategy is sufficient. Successful management requires combining cultural, organic, chemical, and genetic resistance tactics to reduce inoculum levels, prevent infection, and limit disease spread.

Cultural Control

Using clean nursery stock is essential, as latent infections are one of the most important sources of inoculum for newly established orchards. Sanitation

practices such as pruning out and destroying cankered wood reduce the amount of inoculum available to initiate new infections. Pruning should be carried out during dry weather, and tools must be disinfected between cuts to prevent the spread of spores. Managing nitrogen fertilization to avoid excessive vegetative growth can also lower susceptibility and limit the formation of highly vulnerable tissues.

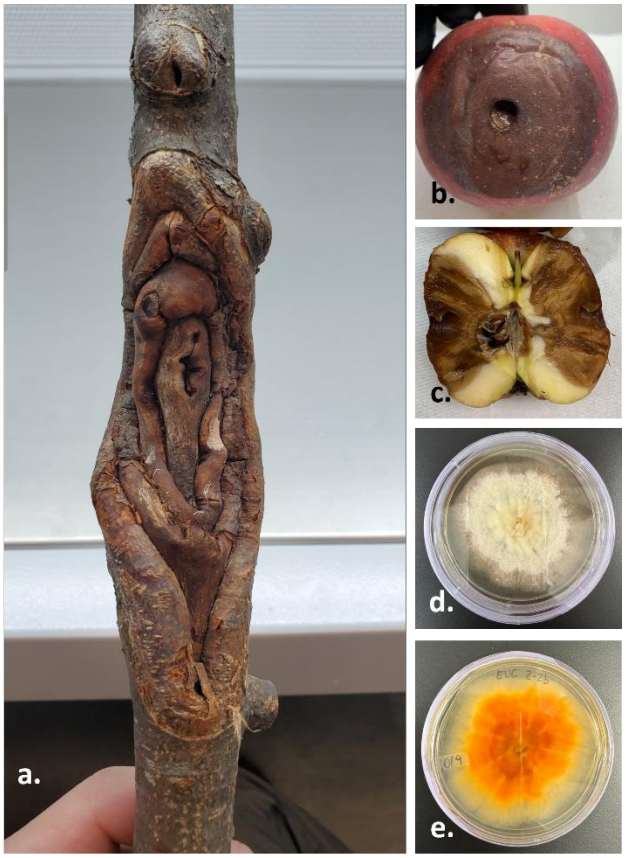

Figure 1. (**a**) European canker symptom; (b & c) Symptoms of N. ditissima rot 'Gala' fruits; (d & e) and N. ditissima mycelium morphology; (Photos by Aćimović, S. G. and Borba, M. C.).

Organic Control

For organic production systems, copper formulations such as copper hydroxide and copper sulfate remain the primary means of controlling European canker. However, copper use must be carefully managed to prevent environmental accumulation. Biological control agents, including beneficial bacteria such as *Bacillus* species, are being investigated and have shown promise in reducing the severity of infections in experimental trials. Enhanced pruning hygiene, immediate removal of infected material, and destruction of debris are critical components of organic management strategies, where fungicide options are limited.

Chemical Control

Protective fungicides play an important role in integrated management, especially during high-risk infection periods. Captan and Ziram are among the most used materials. These products are most effective when applied at leaf fall to protect leaf scars and after pruning to reduce wound infections. Fungicide applications should be timed to coincide with periods of elevated disease pressure, particularly during autumn leaf drop, late winter pruning, and prolonged wet conditions.

Germplasm Resistance

Selection of resistant scions and rootstocks offers a sustainable and long-term approach to European canker management. Research has identified rootstocks such as M116 and EMR-006 as being less susceptible to infection compared to widely used rootstocks like M9 and MM106. Cultivars such as 'Santana', developed in the Netherlands, and advanced breeding lines show promise for reduced canker severity. Integrating resistant germplasm into orchard design, alongside sanitation and fungicide programs, strengthens disease management and reduces long-term reliance on chemical inputs.

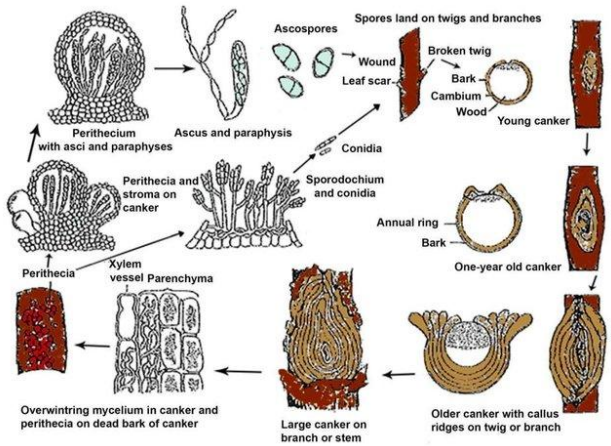

Figure 2. Disease cycle of European canker caused by Neonectria ditissima (Figure by Agrios, 1997).

Cultivar Susceptibility

Apple cultivars vary widely in their susceptibility to European canker. Highly susceptible cultivars include 'Braeburn', 'Gala', 'Gravenstein', 'King', 'Macoun', 'McIntosh', 'Red Delicious', 'Spartan',

'Kanzi', and 'Scifresh'. Cultivars such as 'Golden Delicious', 'Honeycrisp', 'Jonagold', 'Jonathan', 'Northern Spy', and 'Rome Beauty' tend to be moderately susceptible, while others like 'Santana' and 'Grenadier' exhibit comparatively lower susceptibility. Pears are susceptible but only when conditions are very favorable for disease development. No cultivar offers complete resistance, but ongoing breeding programs are focusing on quantitative resistance to reduce orchard losses and improve long-term management options.

Summary

European canker remains one of the most significant challenges in apple production. Its complex disease cycle, long infection latency, and adaptability make it difficult to control, particularly in humid climates where environmental conditions favor infection (e.g., Canada, United Kingdom, New Zealand). Successful management depends on combining clean nursery material, rigorous sanitation, targeted fungicide or organic spray applications, use of resistant cultivars and rootstocks, and newly emerging molecular tools for early detection. Continued research into pathogen biology, resistance breeding, and innovative detection methods offers promising avenues for improving control in the future.

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