

Hops Latent Viroid – A Primer

Hops Latent Viroid (HLVd) is a pathogen of concern primarily in the hops industry but has gained attention in the cannabis industry due to its impact on *Cannabis sativa*. Viroids are small, circular, non-coding RNA molecules capable of infection and pathogenesis in plants. Unlike viruses, viroids do not encode proteins and rely entirely on the host's cellular machinery for replication and movement. HLVd is particularly insidious because it can remain asymptomatic (latent) in some host plants, making it difficult to detect and control. The following provides an overview of some of our current understanding of HLVd while acknowledging that HLVd research, particularly in the field of cannabis, is still emerging in many areas.

Mechanism of Infection

HLVd infects plants through a process that involves several key steps:

1. *Entry*: The viroid enters the plant host through mechanical damage or wounds. This can occur through tools used in plant cultivation, grafting, or any process that causes breaks in the plant tissue.
2. *Replication*: Once inside the host, HLVd utilizes the plant's RNA polymerase II to replicate. The viroid's RNA is transcribed into a complementary strand, which then serves as a template to produce new viroid RNA copies.
3. *Cell-to-Cell Movement*: The viroid moves from cell to cell through plasmodesmata, the microscopic channels that connect plant cells. This movement relies on the host's cellular machinery.
4. *Systemic Movement*: For systemic infection, HLVd hijacks the phloem vascular system of the plant, allowing it to spread throughout the host.

Mode of Infection

HLVd does not encode any proteins, including movement or replication proteins. Its infection and replication are solely dependent on the host's cellular machinery. The viroid's RNA interacts with host factors to replicate and interfere with the normal function of plant cells. The exact molecular mechanisms of these interactions are still under investigation, but they likely involve the viroid RNA adopting specific secondary structures that mimic those of host RNAs, thus interfering with normal cellular processes.

Disease Progression

In hops and cannabis, HLVd can cause a range of symptoms, often dependent on the host's genotype, environmental conditions, and the viroid's strain. Symptoms may include:

- Stunted growth
- Reduced yield
- Lower quality of flowers
- Brittle stems

- Chlorosis and leaf deformation in severe cases

However, in many cases, plants can be asymptomatic carriers of HLVD, making it a silent threat to crops. The latent nature of the viroid complicates detection and management strategies, often requiring molecular diagnostic tools like RT-PCR for identification.

Routes of Infection

The primary routes of HLVD infection include:

- *Mechanical Transmission*: The most common route, through the use of contaminated cutting tools, handling of plants, and grafting practices.
- *Seed Transmission*: There's evidence to suggest that HLVD can be seed-transmitted, though the efficiency and impact of this route are less understood.
- *Vegetative Propagation*: Cuttings from infected plants are a major way the viroid spreads, as they carry the viroid and increase the chances of spreading to new plants within the shared grow space.

Control and Management

Managing HLVD infection focuses on prevention, as there is no guaranteed cure for viroid diseases. Strategies include:

- Using certified disease-free plants for cultivation.
- Implementing strict hygiene protocols for tools and equipment.
- Regular monitoring and testing of plants for early detection.

There are some reports suggesting that meristem tissue culture methods have been used to successfully rid a segment of plant tissue of HLVD in subsequent generations in that genetic line. Success rates of this method are limited and depend on the quality of the clonal tissue and disease progression.

Understanding the mechanism and pathology of HLVD is crucial for developing effective strategies to mitigate its impact, especially in crops where it can remain latent and undetected until it causes significant economic loss.

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February 2024.

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