**VIROIDS**

Viroids are plant pathogens made up of short, circular, single-stranded RNA molecules (usually around 246-375 bases in length) that are not surrounded by a protein coat.

They have internal base-pairs that cause the formation of folded, three-dimensional, rod-like shapes. Viroid’s apparently do not code for any polypeptides (proteins). Which have the Following basic properties:

1. Genome: The viroid genome consists of a single RNA strand that forms intricate secondary structures. These structures are essential for viroid function and replication.
2. Replication: Viroids replicate in the host plant cell nucleus using host enzymes. The mechanism of replication involves an RNA-dependent RNA polymerase, which is usually provided by the host plant.
3. Transmission: Viroids are typically transmitted horizontally between plants, often through mechanical means such as contaminated tools or by vectors like insects. They can also be transmitted vertically from one generation to the next through seeds.
4. Symptoms: Viroid infections can lead to various symptoms in plants, such as **stunting, deformities, and necrosis**. Symptoms vary depending on the specific viroid and the host plant.
5. Host Range: Viroids infect a wide range of plant species, and some viroids may have a narrow host range, while others can infect multiple plant families.
6. Stability: Viroids are relatively stable in the environment and can withstand harsh conditions. They are resistant to nucleases that would degrade other RNA molecules.

Discovery: Viroids were first discovered in the early 1970s. The first viroid identified was the potato spindle tuber viroid (PSTVd)

Viroids are of practical importance as they cause several economically significant diseases and are of general biological interest as being among the smallest known agents of infectious disease.

Viroid names are abbreviated to initials with a “**vd**” added to distinguish them from abbreviations for virus names.

 **Classification of Viroids**

 Viroids are classified based on their genomic properties, sequence similarities, and the diseases they cause.

 viroids are classified into two families: **Pospiviroidae and Avsunviroidae**.; each family has several genera.

1. **Pospiviroidae:**

This family includes viroids with a positive polarity, meaning their genomic RNA can serve as a messenger RNA.

Examples of viroids in the Pospiviroidae family include:

**Potato spindle tuber viroid (PSTVd)**

**Tomato chlorotic dwarf viroid (TCDVd)**

**Citrus exocortis viroid (CEVd)**

1. **Avsunviroidae:**

This family includes viroids with an avocado sunblotch disease.

Avsunviroidae viroids have a circular, single-stranded RNA genome and replicate in the chloroplast.

Examples of viroids in the Avsunviroidae family include:

**Avocado sunblotch viroid (ASBVd)**

**Peach latent mosaic viroid (PLMVd)**

Each family is further divided into different genera based on specific characteristics and sequence variations.

**Pathology of Viroids**

**1-Macroscopic Disease Symptoms**

Viroids infect both dicotyledonous and monocotyledonous plants. From an agricultural crop point of view, symptoms cover a wide range from the slowly developing lethal disease in coconut palms caused by coconut cadang-cadang viroid (CCCVd) to the worldwide symptomless infection of Hop latent viroid (HLVd).

**2. Cytopathic Effects**

Various effects of viroid infection on cellular structures have been reported. For example, in some infections changes have been observed in membranous structures called plasmalemmasomes.

**3-Location of Viroids in Plants**

Using confocal laser scanning microscopy and transmission electron microscopy in conjunction with in situ hybridisation, both Citrus exocortis viroid (CEVd) and CCCVd were found in vascular tissues as well as mesophyll cells. From experiments involving fractionating components of viroid-infected cells, it has become generally accepted that most viroids are located in the **nucleus**. The main exception is Avocado sun blotch viroid (ASBVd),which is found in **chloroplasts**. Within nuclei, PSTVd and CCCVd are located in nucleoli, whereas CEVd accumulates to higher concentrations in the **nucleoplasm**.

**4. Movement in the Plant**

Viruses with defective coat proteins and naked RNAs move slowly through the plant by cell-to-cell movement. By contrast, viroids move rapidly from cell to cell of a host plant in the manner of competent viruses.

1. The cell-to-cell movement is via **plasmodesmata** and is mediated by specific sequences or structural motifs.
2. Long-distance movement of viroids is almost certainly through the **phloem**. The relative resistance of viroid RNA to nuclease attack probably facilitates their long-distance movement.

 It is also possible that viroid particles undergoes RNA translocation while bound to some host protein.

**6. Epidemiology**

The main methods by which viroid's are spread through crops are by

1. vegetative propagation
2. mechanical contamination
3. and pollen and seed.

The relative importance of these methods varies with different viroid and hosts. For example, vegetative propagation is dominant for PSTVd in potatoes and Chrysanthemum stunt viroid in chrysanthemums.

 Mechanical transmission is a significant factor for others, such as CEVd in citrus and HSVd in hops.

 Seed and pollen transmission are factors in the spread of ASBVd in avocados.