

## **Viroids - general characteristics and examples of diseases caused by viroids**

Viroids are covalently closed circular RNA molecules. Viroids were the first circular RNAs to be discovered in nature. These are the smallest known infectious agents. Potato spindle tuber viroid was the first viroid reported, and it is widely prevalent in different potato growing areas. Citrus exocortis viroid is wide spread in citrus production areas where trifoliolate ornage(*Poncirus trifoliata*) is used as root stock. Hop stunt viroid has a wide range of hosts. Mechanism of viroid pathogenesis in plants has been elucidated recently.

### **Structure of Viroids**

Viroids are nucleic acids that exist naturally with no protein coat. They consist of ribonucleic acid (RNA). These mini viruses are the smallest known causal organisms of infectious diseases. They are subviral and their size ranges from 246 to 388 nucleotides in length. The RNA structure of viroids is different from transfer RNA (t RNA), ribosomal RNA (r RNA) and messenger RNA (m RNA). Viroids are the first circular RNA's to be discovered in nature.

### **Important viroids causing diseases**

The following are viroids that cause diseases in important crops:

- Apple scar skin viroid
- Australian grapevine viroid
- Avocado sunblotch viroid
- Chrysanthemum chlorotic mottle viroid
- Chrysanthemum stunt viroid
- Citrus exocortis viroid
- Coconut cadang cadang viroid
- Coconut tinangaja viroid
- Cucumber pale fruit viroid
- Grapevine viroid
- Grapevine yellow speckle viroid
- Hop latent viroid
- Hop stunt viroid
- Potato spindle tuber viroid
- Tomato apical stunt viroid

Tomato planta macho viroid



**Potato spindle tuber viroid**



**Potato spindle tuber viroid - stiff and upright growth habit on infected potatoes**



**Hop Stunt viroid**



**Cadang Cadang disease**



**Citrus exocortis viroid**



**Grapevine yellow speckle viroid**

## **Viroid Infection Process and Management**

### **Infection process**

The viroid RNA does not code for any genes. Viroid replication and pathogenesis may depend completely on the enzyme systems of the host. The viroid RNA is dependent upon the host for its replication as well as intraplant movement. The functions necessary for propagation of the viroids are derived completely from the host. The viroids are associated with and replicate in either the nucleus or the chloroplasts of the plants. They are replicated by the host encoded RNA polymerases. They do not encode proteins. Viroids replicate within the nucleus of infected cells without a helper virus. Viroids are transported into the plant nucleus and typically potato spindle tuber viroid (PSTV) possesses a sequence or structural motif for nuclear transport. Phloem proteins may be involved in systemic transport of viroids in the plants. Phloem protein 2 a dimeric lectin, is the abundant component of phloem exudates of cucumber. This protein interacts with the viroid RNA and facilitates the systemic movement of hop stunt viroid.

### **Symptoms**

Infection with viroids does not result in obvious macroscopic symptoms. Common symptoms of viroid diseases include retardation of plant growth and stunting. Potato plants infected with the potato spindle tuber viroid are smaller than healthy plants. However, tuber symptoms are prominent. The diseased tubers are spindle shaped. Citrus trees infected with the citrus exocortis viroid are stunted. Symptoms of the disease include scaling of the bark below the graft union. Stunted trees crop well for their size, and the fruit is normal. Stunting is the important symptom of tomato plants affected by the tomato bunchy top viroid, hop plants infected by the hop stunt viroid and chrysanthemum plants infected by the chrysanthemum stunt viroid and the chrysanthemum chlorotic mottle viroid.

### **Mode of spread**

Viroids are highly contagious and mechanically transmitted. They are spread by leaf contact. Viroids are spread also by contaminated planting and cultivating equipments. They may be disseminated mostly as a result of cultural operations through contaminated knives, tools and hands. Some reports indicate that viroids are transmitted by insects. Potato spindle tuber viroid has been reported to be transmitted by aphids, grass hoppers, flea beetles, tarnished plant bugs,

larvae of Colorado potato and leaf beetle. However, the transmission of viroids by insects is negligible and mechanical transmission is more important.

### **Viroid disease management**

Because viroids are spread mechanically, disease free planting materials should be used for planting. Cutting knives and all planting and field equipment should be cleaned scrupulously. Commercial cultivars with high resistance to the diseases are lacking.

### **Virusoids (Encapsidated, viroidlike, satellite RNA's)**

Some viruses contain a viroid like satellite RNA in addition to a linear, single stranded molecule of genomic RNA. Such viroid – like satellite RNA's are called virusoids. They show little sequence homology with viroids, but they do show significant homology with the linear satellite RNA associated with Tobacco ringspot virus. The virusoids in infected plants exist almost solely as circular molecules, either free or encapsidated within virion of the helper virus. Virusoids do not code for any polypeptides.