



Rice Black-Streaked Dwarf Virus (RBSDV): A Serious Threat to Rice Production

Deepak Kumari

Assistant Professor (Agriculture), GDC Memorial College, Bahal (Bhiwani), Haryana, India

*Corresponding author - deepusangwan28@gmail.com

Introduction

Rice (*Oryza sativa* L.) is one of the most important staple food crops in the world, feeding more than half of the global population. It plays a crucial role in ensuring food security, particularly in Asian countries where it is cultivated extensively. However, rice production is continuously challenged by several biotic stresses, among which viral diseases have emerged as a significant concern. One of the most destructive viral diseases affecting rice is Rice black-streaked dwarf virus (RBSDV).

Rice black-streaked dwarf virus belongs to the genus *Fijivirus* in the family *Spinareoviridae* (formerly *Reoviridae*). It was first reported in Japan in 1952, and since then it has become a major constraint to cereal production in East Asia, particularly in China, Japan, and the Korean Peninsula.

The first major out-breaks of RBSDV in Japan were recorded in maize during 1957–1961 and in rice and maize during 1965–1967. RBSDV infects several cereal crops, including rice and maize, resulting in substantial economic losses during epidemic years.

Host range

RBSDV has a relatively broad host range, infecting only members of the grass family (*Poaceae*). Major cultivated hosts include rice, maize, wheat, barley, and oat, while several gramineous weeds such as *Alopecurus aequalis*, *Beckmannia syzigachne*, and *Poa annua* also serve as natural reservoirs of the virus. These alternate hosts play an important role in the survival of both the virus and its insect vector during the off-season, thereby contributing to disease outbreaks in subsequent cropping seasons.

Distribution

RBSDV is mainly distributed in East Asia and is considered one of the most economically important viral diseases affecting rice and maize in this region. The disease has been reported from China, Japan, South Korea, North Korea, and Taiwan. Among these countries, China experiences the most severe and frequent epidemics, particularly in provinces such as Jiangsu, Zhejiang, Anhui, Shandong, Hebei, Henan, and Hubei. Disease outbreaks are closely associated with large populations of the small brown plant-hopper.

Although RBSDV has not yet become a major disease in India, changing climatic conditions, increasing international trade, and the movement of insect vectors highlight the importance of continuous surveillance and strict quarantine measures to prevent its introduction.

Yield Losses

Yield losses caused by RBSDV depend on the crop, growth stage at infection, cultivar susceptibility, and vector population. Plants infected at the seedling stage suffer the greatest damage, often exhibiting severe dwarfing, poor panicle emergence, and incomplete grain filling. Under epidemic conditions, yield losses may range from 30–80%, while early infections can occasionally result in near-complete crop failure. Besides reducing grain yield, RBSDV also lowers grain quality and significantly affects farmers' income.

Disease Symptoms

The symptoms of Rice black-streaked dwarf virus (RBSDV) vary depending on the growth stage of the plant at the time of infection. Plants infected during the seedling stage exhibit the most severe symptoms and suffer the greatest yield losses. One of the earliest visible symptoms is severe stunting, accompanied by dark green leaves and twisting of the tips of young leaves. As the disease progresses, infected plants produce excessive tillers and remain noticeably shorter than healthy plants.

A characteristic feature of RBSDV infection is the development of white, waxy enations (small swellings) along the veins on the underside of leaf blades, leaf sheaths, and stems. These enations become more prominent during the later stages of infection. Internally, the virus disrupts

normal vascular tissue development, causing abnormal cell enlargement, tumour-like swellings, and impaired movement of water and nutrients within the plant.

Another diagnostic symptom is the appearance of black or dark-colored waxy streaks on the leaf sheaths, stems, and veins, from which the disease derives its name. Infected plants often produce partially or completely deformed panicles with poor grain filling, and although they usually survive until harvest, their growth and productivity are severely reduced.

Virus transmission

Rice black-streaked dwarf virus is not transmitted through seed, soil, water, or mechanical contact. Instead, it is spread exclusively by the small brown planthopper (*Laodelphax striatellus*), which serves as its natural insect vector. The virus is transmitted in a persistent, propagative, and non-transovarial manner, meaning it multiplies inside the insect after acquisition, remains infectious throughout the insect's life, but is not passed to its offspring through eggs.

Planthoppers acquire the virus by feeding on infected plants for at least 30 minutes, with first-instar nymphs being more efficient at virus acquisition than older stages. After a latent period of 7–35 days (commonly 7–21 days), the insects become capable of transmitting the virus to healthy plants. An inoculation feeding period as short as 5 minutes is sufficient for transmission, although longer feeding periods increase transmission efficiency. Once infected, the planthopper remains viruliferous for life and continuously spreads the virus while feeding on healthy rice and other susceptible cereal crops.

Because no curative treatment is available once plants become infected, effective management of RBSDV relies on preventing virus transmission through vector control, cultivation of resistant varieties, healthy nursery practices, and proper field sanitation. These integrated measures are essential for minimizing disease spread and reducing yield losses.

Disease Cycle and epidemiology

The occurrence and severity of Rice black-streaked dwarf virus (RBSDV) epidemics largely depend on the movement of its insect vector, the small brown planthopper (SBPH, *Laodelphax striatellus*), because the virus cannot spread naturally without this insect. The planthopper acts as the sole carrier of the virus, transmitting it between cereal crops and various grass hosts.

During winter, both the virus and its vector survive on wheat, barley, and several grassy weeds. These overwintering planthoppers serve as an important source of infection by carrying the virus from one growing season to the next. In early spring, the overwintered nymphs mature into adults and reproduce on winter cereal crops, particularly wheat. While feeding on infected plants, they acquire RBSDV and retain the virus throughout their lifetime.

As temperatures increase, the newly emerged viruliferous adults migrate to young rice, maize, and other susceptible grass species during late May and early June. While feeding, they transmit the virus to healthy seedlings, initiating new infections. Each fertilized female planthopper can lay approximately 150–200 eggs, resulting in a rapid increase in the vector population.

The newly hatched nymphs feed on infected plants, acquire the virus, and become capable of transmitting it after a latent period. These viruliferous nymphs and adults then disperse to nearby fields, spreading the disease over a wide area and causing secondary infections. By autumn, the later generations of planthoppers migrate back to wheat, barley, and wild grasses, where they survive the winter while carrying the virus. This seasonal movement completes the annual disease cycle and provides the initial source of infection for the following cropping season.

Large-scale cultivation of susceptible cereal varieties greatly increases the risk of disease outbreaks. However, the efficiency of virus transmission by the small brown planthopper is the primary factor responsible for epidemic development. In addition, environmental and agronomic factors such as cropping patterns, indiscriminate use of insecticides, and favourable climatic conditions can influence planthopper survival and multiplication, thereby affecting the incidence and severity of RBSDV.

Disease Management

Since there is no curative treatment available for plants infected with Rice black-streaked dwarf virus (RBSDV), disease management should focus on preventing virus infection and minimizing the population of its insect vector, the small brown planthopper (*Laodelphax striatellus*). An integrated disease management (IDM) approach that combines cultural, genetic, and chemical methods offers the most effective and sustainable strategy for reducing disease incidence and limiting economic losses.

1. Use Healthy Seedlings

Although RBSDV is not transmitted through seed, the use of healthy and disease-free nursery seedlings is essential for preventing early infection. Rice nurseries should be established away from infected wheat fields and other cereal crops that may harbor viruliferous planthoppers. Protecting nurseries with insect-proof nets can further reduce vector infestation and minimize the risk of virus transmission.

2. Cultivation of Resistant Varieties

Growing resistant or tolerant rice varieties is one of the most economical, environmentally friendly, and sustainable methods of managing RBSDV. Resistant cultivars reduce disease severity and yield losses while decreasing dependence on insecticides. Continuous breeding efforts are focused on identifying and developing rice varieties with improved resistance to both the virus and its vector.

3. Vector Management

Effective management of the small brown planthopper is crucial because it is the sole natural vector of RBSDV. Regular monitoring of vector populations using yellow sticky traps and light traps helps in detecting early infestations and determining the need for control measures. Chemical control should be aimed at reducing overwintering and first-generation planthopper populations in wheat fields before they migrate to rice. In areas with high populations of viruliferous planthoppers, insecticides such as pymetrozine, imidacloprid, nitenpyram, thiamethoxam, and buprofezin may be applied according to local recommendations. Seed treatment before sowing and insecticide application 3–5 days before transplanting can

effectively protect rice seedlings from early infection. However, indiscriminate insecticide use should be avoided, as it can eliminate beneficial insects and encourage insecticide resistance. Therefore, Integrated Pest Management (IPM) should always be preferred for sustainable vector control.

4. Field Sanitation

Maintaining clean fields helps reduce sources of virus inoculum. Farmers should promptly remove and destroy infected plants, eliminate volunteer rice plants, control alternate weed hosts, and maintain clean field boundaries. These practices reduce the survival of both the virus and its insect vector between cropping seasons.

5. Crop Rotation

Crop rotation with non-host crops can interrupt the life cycle of both the virus and the vector. Avoiding continuous cultivation of rice and maize helps reduce virus reservoirs and lowers planthopper populations, thereby decreasing the likelihood of disease outbreaks.

6. Optimum Planting Time

Adjusting sowing and transplanting dates to avoid periods of peak planthopper migration can significantly reduce disease incidence. Early or synchronized planting within a region minimizes the exposure of young rice seedlings to viruliferous vectors.

7. Balanced Nutrient Management

Excessive application of nitrogen fertilizers promotes lush vegetative growth, making rice plants more attractive to planthoppers. Therefore, balanced fertilization with appropriate amounts of nitrogen, phosphorus,

and potassium improves plant vigor, enhances tolerance to infection, and reduces vector preference.

8. Quarantine and Surveillance

Strict quarantine measures are essential to prevent the introduction of infected planting materials and viruliferous planthoppers into disease-free areas. Regular surveillance, early detection, and continuous monitoring of vector populations are equally important for preventing new outbreaks and limiting the spread of RBSDV.

Conclusion

Rice black-streaked dwarf virus is one of the most destructive viral diseases of rice in East Asia. The disease is characterized by severe

dwarfing, black streaks on stems, excessive tillering, poor panicle emergence, and drastic reductions in grain yield. Because the virus is transmitted persistently by the small brown planthopper and cannot be controlled once plants become infected, preventive measures remain the cornerstone of disease management.

An integrated strategy combining resistant varieties, healthy seedlings, vector monitoring, balanced fertilization, field sanitation, synchronized planting, crop rotation, and integrated pest management offers the most effective and sustainable solution. Continued research on host resistance, vector ecology, and virus epidemiology will further strengthen disease management programs and contribute to stable rice production and global food security.

