Rice Grassy Stunt

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Known Distribution

Rice grassy stunt virus (RGSV) disease (grassy stunt) occurs in South and Southeast Asia, China, Japan, and Taiwan (Hibino 1996). RGSV incidence was high from 1970 to 1977 in Indonesia; from 1973 to 1977 and from 1982 to 1983 in the Philippines (Hibino 1989, Hibino et al 1985); from 1973 to 1974 and 1981 in Kerala, India (Kulshreshtha et al 1974); in 1972 and 1984 in Tamil Nadu, India (Mariappan et al 1984); and in 1978 in Kyushu, Japan (Iwasaki and Shinkai 1979). High incidences of grassy stunt together with ragged stunt disease (ragged stunt) were also reported in the Mekong Delta of Vietnam during 2000 to 2007 (Du et al 2005, Huan and Heong 2000).

Causal Virus

Fig. 1. Rice grassy stunt virus.

Rice grassy stunt virus (Fig. 1) is a member of the Tenuivirus group, which consists of 6 members along with rice stripe virus as the type species (Hibino 1986, Toriyama 1995, Mayo et al 2000, Toriyama 2004). The RGSV particle is a circular filament of 6 to 8 nm in width. The filamentous particles of RGSV are ribonucleoproteins, which are composed of a single nucleocapsid protein and genomic single-stranded RNA segments (Ramirez and Haenni 1994). RGSV differs from other tenuiviruses in that it possesses 6 ambisense RNA segments (Miranda et al 2000, Toriyama et al 1997, 1998). RNAs 1, 2, 5, and 6 are equivalent to rice stripe virus (RSV) RNAs 1, 2, 3, and 4, respectively, and RGSV RNAs 3 and 4 are unique in RGSV. RNA 1 of RSV and all other tenuiviruses except RGSV are negative sense and encode only a large RNA-dependent RNA polymerase (RdRp) on the complementary strand (cRNA 1), while RNA 1 of RGSV is ambisense and contains a small open reading frame on the viral strand (vRNA 1) (Miranda et al 2000, Toriyama et al 1998). Thus, the tenuivirus genome encodes at least 7 proteins; one on cRNA 1 and two each on 3 other ambisense RNA segments. Among those proteins, only the functions of the 339-kDa RdRp encoded on cRNA 1 and the 35–36-kDa nucleocapsid protein (N) encoded on cRNA 3 (cRNA 5 in the case of RGSV) are known. The RGSV virion consists of vRNA, cRNA, N proteins, and a few molecules per particle of RdRp (Mayo et al 2000). A 94-kDa protein encoded on cRNA 2 is hypothesized to be a membrane protein (Estabrook et al 1996) but enveloped virions have not been observed in tenuivirus-infected plants or insects by electron microscopy (Falk and Tsai 1998). A 21-kDa p6 protein encoded on RGSV vRNA 6 and a 20-kDa protein encoded on vRNA 4 of maize stripe virus have been shown to be expressed in infected plants and form cytoplasmic inclusion bodies, but they have not been detected in the vector insects (Falk et al 1987). Otherwise, expression and functions of other proteins are not yet known. RGSV is serologically distantly related to RSV.

Symptoms

Grassy stunt-infected rice plants show pronounced stunting and proliferation of short, erect, and narrow leaves that are pale green or pale yellow. Infected leaves may show mottling symptoms. RGSV strains that cause yellow-orange leaf discoloration and premature death of plants were found in 1977 in Taiwan (Chen and Chiu 1982), in 1982-83 in the Philippines and Thailand (Hibino et al 1985), and in 1984 in India (Mariappan et al 1984). The aggressive strain that occurred in Taiwan was called rice wilted stunt virus. RGSV-infected rice cells contain masses of fibrils in the nuclei and cytoplasm, and membrane-bound bodies with fibrils in the cytoplasm. Tubules associated with isometric particles of 18 to 25 nm in diameter can be seen in the sieve tubes.

Fig. 2. Typical symptoms of rice grassy stunt.

Transmission

RGSV is transmitted in a persistent manner by the brown planthopper (BPH) *Nilaparvata lugens* and by two other *Nilaparvata* species, *N. bakeri* and *N. muiri* (Hibino 1986, 1989). RGSV propagates in the vectors but is not transmitted via eggs. BPH is one of the most important pests of rice in Asia, causing feeding damage commonly known as “hopperburn.” The average lifespan and fecundity are lower in RGSV-infective BPH than in virus-free BPH (Hirao et al 1987, Ling 1977). Populations of BPH in which RGSV-transmission ability is low can be selected by mating noninfective BPH (Iwasaki et al 1982). Isometric particles similar to those found in infected rice tissues are found in crystalline arrays in the fat body and tracheas of infected BPH.

Epidemiology of the Disease

Grassy stunt naturally infects only rice. BPH is monophagous to rice. It flies from grassy stunt-affected fields to newly planted rice fields in distant areas and disperses RGSV, as well as another BPH-borne virus, rice ragged stunt virus (RRSV). In the tropics, grassy stunt and BPH are generally endemic in areas where rice is planted year-round. In cooler areas where rice is not planted during the winter season, BPH migrates annually during the monsoon season from the endemic areas (Cheng et al 1982, Kishimoto 1976, Lee and Park 1977). Some of the migrant BPH traveling long distances overseas carry RGSV (Hirao et al 1984, Iwasaki et al 1985).

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Infected rice stubble and volunteer rice plants also serve as a source of the virus. Since 1984, the incidence of grassy stunt has been generally low in Asia. The low incidence of grassy stunt during recent years is thought to be due to a change in virus transmission ability of BPH populations. In the Philippines, the proportion of RGSV transmitters in populations in an experimental condition ranged from 3% to 50% before 1977, but the proportion dropped to 0 to 15% in 1984 (Hirao et al 1987).

Management Options

Planting rice cultivars with resistance to BPH has been used in many countries in Asia to control BPH and the viruses they carry. However, BPH biotypes that can overcome the resistance have often developed a few or several years after release of the cultivars (Hibino 1996, Claridge and Den Hollander 1980). Once populations of BPH that can colonize resistant cultivars have built up, these cultivars were easily infected with RGSV. In the Asian tropics, use had been widespread of rice cultivars with a resistance gene to RGSV introduced from a wild rice species, *Oryza nivara* (Khush and Ling 1974). The severe strain of RGSV (RGSV-2) that occurred in the Philippines was highly pathogenic to resistant cultivars derived from *O. nivara* (Cabauatan et al 1985, Hibino et al 1985).

Insecticides may be used to control grassy stunt by drastically reducing BPH population sizes, which otherwise may migrate to uninfected fields. However, the logic of this strategy implies continuous pesticide application, and local protection of a given field is in general ineffective because of the very strong mobility of the vector. Other management options include cultural practices, such as a timing adjustment, synchrony of crop establishment, and the plowing under of infected stubbles. These methods are in general quite effective.

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