Chapter 8
Biological Control of Rice Tungro Disease (RTD)

Rice tungro disease (RTD) consists of a spherical virus (RTSV) and a bacilliform virus (RTBV) and the disease is a significant yield constraint in rice-growing areas of South and Southeast Asia. Disease symptoms are caused largely by infection by the rice tungro bacilliform virus (RTBV).

Conventional Biocontrol Agents

Traditional management practices and conventional biological control agents are considered unsuitable or not effective for reduction of RTD. It is understood that RTD is very difficult to control with these practices. Therefore, these methods have not been used in experiments conducted with biocontrol agents. However, in one single study, Ganesan (1999) obtained noticeable differences in RTD development between untreated IR50 rice seedlings that received viruliform green leafhoppers (GLH) and rice seedlings that received a spray inoculation with a strain of *Pseudomonas fluorescens* that showed insect-toxicity, before they received the same number of GLH/seedling. However, this method of biological suppression of RTD by reduction of the GLH vectors has to be verified through further studies.

Transgenic Rice for RTD Management

Apart from conventional breeding for virus resistance, the development of transgenic lines has been considered the most reliable means of curtailing yield losses caused by rice viruses. Vasudevan, Kavitha, Priyadarisini, Babujee, and Gnanamanickam (2002) and Datta (2002) reviewed the efforts to engineer rice for viral resistance. These efforts largely deployed pathogen-derived resistance (PDR) involving the expression of pathogen-derived transgenes such as the coat or capsid protein (CP) genes, in rice plants to interrupt the virus infection cycle (Potrykus et al., 1995; Fauquet et al., 1997; Sivamani et al., 1999).

S.S. Gnanamanickam, *Biological Control of Rice Diseases*,
Progress in Biological Control 8, DOI 10.1007/978-90-481-2465-7_8,

Rice Trungro Spherical Virus (RTSV)

For the first time Sivamani et al. (1999) developed transgenic rice plants resistant to the rice tungro spherical virus (RTSV), also perhaps a first example of CP-mediated protection against a virus that contains more than one CP gene. They introduced the coat protein (CP) genes CP1, CP2 and CP3 of rice tungro spherical virus (RTSV) individually or together into indica and/or japonica rice cells by particle bombardment and generated transgenic plants. Plants derived from selfed progeny of the primary transformants were subjected to virus inoculation via leafhoppers, the natural vector of the virus. Sixteen out of the nineteen selected transgenic plant lines, as well as their R1, R2 and/or R3 progeny that contained the target gene, accumulated transcripts of the chimeric CP gene(s) in RNA blot analysis. These researchers obtained evidence of moderate levels of protection to RTSV infection, ranging from 17 to 73% of seedlings that escaped infection and a significant delay in virus replication under greenhouse conditions in plant lines that expressed the RTSV-CP1, CP2 and CP3 genes singly or together.

Rice Tungro Bacilliform Virus (RTBV)

Tyagi, Rajasubramaniam, Venkatrajam, and Dasgupta (2008) applied the concept of RNA-interference (RNAi) for the control of RTBV infection in transgenic rice plants they developed by expressing DNA encoding ORF IV of RTBV, both in sense as well as in anti-sense orientation. This resulted in the formation of double-stranded (ds) RNA. RNA blot analysis of two representative lines indicated specific degradation of the transgene transcripts and the accumulation of small molecular weight RNA, a hallmark for RNA-interference. In the two transgenic lines expressing ds-RNA, different resistance responses were observed against RTBV. In one of the above lines, there was an initial rapid buildup of RTBV levels following inoculation, comparable to that of untransformed controls, followed by a sharp reduction, resulting in approximately 50-fold lower viral titers, whereas the untransformed controls maintained high levels of the virus till 40 days post-inoculation (dpi).

In a more recent breakthrough, Beachy and his team of researchers at the Danforth Plant Science Center in St. Louis, MO have discovered a technology that reduces the spread of the rice virus (Dai et al., 2008). Two host transcription factors, RF2a and RF2b regulate expression of the RTBV promoter and are important for plant development. Expression of a dominant negative mutant of these factors in transgenic rice resulted in phenotypes that mimic the symptoms of RTD, whereas overexpression of RF2a and RF2b had essentially no impact on plant development. Conversely, lines with elevated expression of RF2a or RF2b showed weak or no symptoms of infection after *Agrobacterium* inoculation of RTBV, whereas control plants showed severe stunting and leaf discoloration. These researchers believe that gaining disease resistance by elevating the expression of host regulators provides another strategy against RTD and may have implications for other pararetrovirus infections.

Cultural Practices for RTD Management

Cultural practices that target to reduce the GLH vector populations have been useful for RTD management. Some of these practices include, large scale synchronous planting of rice with a definite fallow period in between cropping seasons, avoidance of late planting, roguing and removal of infected plants and manipulating the rice planting space (Azzam & Chancellor, 2002). A closer planting space, particularly in direct-seeded rice is known to reduce RTD incidence.

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