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Identification of Rice Tungro Disease (RTD) tolerant traditional varieties of rice (*Oryza sativa* L.) of West Bengal using forced inoculation methods with insect vector, green leafhopper (GLH), *Nephotettix virescens* (Distant).

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ABSTRACT

A majority of cereal viruses are disseminated among plants by insect vectors. Rice tungro disease (RTD) is associated with two viruses—rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) which are transmitted by the green leafhopper (GLH) Nephotettix virescens (Distant). Rice varieties differ greatly in resistance/tolerance towards RTD. Adaptation by populations of GLH has led to a breakdown of resistance in many of these varieties. Identification of new varieties tolerant to tungro, which may be used for future crop improvement, is imperative in the disease management programme.

KEYWORDS : RTD, traditional rice, forced inoculation, GLH

INTRODUCTION

Insects cause millions of dollars' worth of losses annually to food crops all over the world. A majority of cereal viruses are disseminated among plants by insect vectors. The green leafhopper (GLH) transmitted tungro virus results in one of the most economically important and wide spread viral disease of rice. Rice tungro disease (RTD) is one of the significant fears to sustainable annual rice productions in the world (Bunawan *et al,* 2014). RTD is fairly wide spread in rice growing areas of India. An epidemic outbreak of tungro during 2001 in three districts of West Bengal caused an unmilled rice production loss of 0.5 mt valued at Rs 2911 million (Muralidharan *et al*, 2003). At early stage RTD may result 100% yield loss (Rao and Anjaneyulu, 1980).

RTD is caused by the co-infection of rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). The virus is transmitted mainly by green leafhopper (GLH) *Nephotettix virescens* (Distant) and *Nephotettix nigropictus* (Stal). *Nephotettix virescens* Distant is the most efficient vector of tungro virus with transmission ability of 80% (Hibino and Cabunagan 1986). RTSV is independently transmitted by GLH, whereas RTBV can be transmitted by GLH only in the presence of RTSV (Hibino *et al.* 1990)

Identifying Varietal Resistance to tungro virus

Host-plant resistance is the most effective and environment friendly approach to control the damage caused by insect pests and increase yield potential of cereal crops (Jena *et al.* 2006). Management of RTD by the use of conventional tungro resistant rice cultivars has been the most important aspect of tungro research (Khush and Vinnani, 1985). It is a practical, cost-effective and environmentally sound way to stabilize rice yield and protect farmers' income. Varieties behave differently in tungro epidemic according to their susceptible and resistance nature (Dahal *et al,* 1992). Some traditional rice varieties viz. Indrasail, Rajmalati, Kalamkathi, Madhumalati and Dhushri are reported to be RTD tolerant (Mukhopadhyay and Chowdhury, 1973).

However, the sources of natural resistance genes are very limited or lacking for many viruses and the durability of some natural resistance genes is often questionable (Suzuki, 2015). Adaptation by populations of *N. virescens* (Distant) has led to a breakdown of the 'field' resistance in many of these varieties to tungro over a period of time (Dahal *et al.,* 1990). Diverse genes for resistance are needed to cope with the development of new biotype populations. Entomologists and breeders have investigated the inheritance of resistance to identify diverse genes for resistance (Shahjahan *et al.,* 1990). Identification of genotypes resistant to tungro is part of the disease management programme (Latif *et al* 2011). Many major resistance genes have been identified that condition race-specific resistance rice tungro (Azzam and Chancellor, 2002). So RTD management requires constant effort to identify new resistant genotypes, improvement and maintenance of the resistance.

Detailed record of the reaction against Rice Tungro Disease among the traditional rice varieties of West Bengal is scanty. In the present investigation an attempt is made to screen and identify traditional rice varieties of West Bengal tolerant to RTD using forced inoculation methods with insect vector, green leafhopper (GLH), *Nephotettix virescens* (Distant).

MATERIALS AND METHODS

A total of 13 (Thirteen) rice varieties were screened along with 1 (one) susceptible check, 1 (one) tolerant check and a basmati variety. The screening and analysis was done according to Standard Evaluation System (SES) for rice (IRRI 1996) to assess their reaction against RTD in Bose Institute Experimental Farm at Madhyamgram, West Bengal. The screening was done as follows:

Forced Inoculation method

The seedlings of different rice varieties were planted in 10 inch pots. The pots were placed inside insect-proof enclosures in the greenhouse of 6 x 7 ft area. Infected TN 1 rice plants were placed inside the mosquito net. 500 GLH were released inside the mosquito net periodically. The pots were taken out after 7 days and observed for further development of the symptoms. A suspected susceptible variety was treated with enough fertilizers. After a few days if the plant recovered from the symptom, it was confirmed that symptoms were not due to RTD. The old leaves from a suspected susceptible variety were removed, if the new leaves develop RTD symptoms it was considered to be virus infected.

RESULTS

The traditional rice varieties showed great variation in the phenotypic expression of the RTD. The rice varieties and their symptoms are shown in Table 1.

Table 1. Effect of Rice Tungro Disease (RTD) on rice varieties

Sl. No.	Name of the rice variety	Variety Type	Reduction in height (in %)	Increase or decrease in Tiller number (in %)	Increase or decrease of Flag Leaf length (in %)	Delay in Flowering (in days)	Reduction in yield (in %)
1	Balam	TV	3.45	- 4.91	- 3.29	13	14
2	Chandrakanta	TV	12.38	- 22.36	- 3.87	11	13
3	Dumursail	TV	13.24	+ 12.25	0	0	0
4	Gobindobhog	TV	5.6	- 4.3	- 7	4	13

5	Jugal	TV	7.6	- 11.34	- 3.21	2	17
6	Latasail	TV	3.42	+ 19.36	- 2.85	3	6
7	Radhuni-pagol	TV	18.83	+ 4.19	+19.8	0	0
8	Raghusail	TV	10.17	+ 21.24	0	3	0
9	Rupsail	TV	7.89	- 2.3	- 3.27	3	13
10	Sonajhuli	TV	4.53	- 16.31	- 2.47	11	7
11	Tulaipanja	TV	2.6	+ 9.2	- 1.12	2	0
12	Tulsibhog	TV	11.11	- 22.39	- 1.89	7	9
13	Pusa Bsa-mati 1	BV	41.9	- 50	- 21.62	18	63
14	Taichung Native 1 (TN 1)	SC	All plants de-stroyed	All plants de-stroyed	All plants destroyed	All plants de-stroyed	100
15	IR 36	TC	15.89	+ 4.66	----	+ 1	0

TV= Traditional variety, BV=Basmati variety, SC= Susceptible Check, TC= Tolerant Check

DISCUSSION

Identification of tolerant/resistant rice varieties among the traditional is necessary to complement conventional breeding method by using transgenic method for genetic improvement of disease resistance and reduction of pesticide usage. Several studies and reviews suggest that more research is needed to elucidate the interaction components between the host and pathogens that can be used to engineer tungro disease resistance. (Hibino *et al* 1990, Ordon *et al.,* 2009; De *et al,* 2012).

Breeding for resistance is the environmentally most sound and also most cost-effective approach to prevent losses caused by plant viral diseases. Enhanced understanding of the identification, genome type, transmission and biological control of these viruses makes tungro disease very significant in terms of plant virology, molecular biology and entomology, with the focus on achieving the ultimate goal of improved management strategies for control of RTD in order to reduce the economic damage to global rice production (Bunawan *et al*, 2014).

From this screening Latasail, Sonajhuli and Tulsibhog were found to be moderately tolerant with only 6%, 7% and 9% yield reduction respectively. Dumursail, Radhunipagol, Raghusail and Tulaipanja were tolerant varieties with zero yield loss. Rupsail and Gobindobhog varieties which are commonly consumed in West Bengal showed a yield reduction of 13%.

The tolerant varieties that were identified following forced inoculation may be used as future tolerance donors in rice breeding programs. From this study identification of tolerant genotypes from this data is possible. The results must be confirmed by other tests like serological and/or PCR based detection before using the genotypes as tungro disease resistance donors. This baseline data may be exploited in many ways to strengthen the long-term conservation, to rationalize the maintenance of the collections and to improve accessibility to the conserved germplasm for creating RTD tolerant varieties suitable for West Bengal.

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REFERENCES

1. Azzam, O. and Chancellor, T.C.B. 2002. The biology, epidemiology, and management of rice tungro disease in Asia. *Plant Dis.,* 86: 88-100.
2. Bunawan, Hamidun; Dusik, Lukas; Bunawan, Siti Noraini and Amin, Noriha Mat. 2014. Rice Tungro Disease: From Identification to Disease Control. World Applied Sciences Journal. ISSN 1818-4952, 31 (6): pp 1221-1226.
3. Dahal, G., Hibino, H., Cabunagan, R.C., Tiongco, E.R., Flores, Z.M., & Aguiero, V.M. 1990. Changes in cultivar reactions to tungro due to changes in "virulence" of the leafhopper vector. Phytopathology 80: pp 659-665.
4. Dahal G., Dasgupta I., Lee G., Hull R. 1992. Comparative transmission and varietal reaction to, three isolates of rice tungro virus disease. *Ann. Appl. Biol.,* 120: pp 287-300.
5. De, M., Dey, S. R. and Ghose T. K. 2012. Advances in Rice Tungro Disease (RTD) resistance and management: From Conventional to Molecular Breeding. Plant Science Research in Human Welfare. (ISBN 978-93-80673-71-4). Edition 1. Nov 2012. Proceedings of UGC Sponsored National Seminar on 'Plant science research in Human Welfare' organized by Department of Botany, Bidhannagar College, Kolkata in collaboration with Botanical Survey of India on 11th and 12th January, 2012 pp 59-68.
6. Hibino H., Daquioag R.D., Mesina E.M. and Aguiero V.M. 1990. Resistances in rice to tungro-associated viruses. Plant Dis. 74: 923–926.
7. Hibino, H. and R.C. Cabunagan. 1986. Rice tungro associated viruses and their relation to host plants and vector leafhopper. Trop. Agric. Res. Ser. 19: 173-182.
8. IRRI. 1996. Standard Evaluation System for Rice. 4th Edition. INGER Genetic Resources Center, Manila, Philippines. 52 pp.
9. Khush, G. and Virmani, S.S. 1985. Breeding for disease resistance in rice. In: *Progress in Plant Breeding.* Vol. I. (Ed .. Russell, O.E.). Oxford. Blackwell, pp 239-279.
10. Jena, K.K., Jeung, J.U., Lee, J.H., Choi, H.C., Brar, D.S. 2006. High-resolution mapping of a new brown planthopper (BPH) resistance gene, *Bph18*(t), and marker-assisted selection for BPH resistance in rice (*Oryza sativa* L.). *Theor Appl Genet.* 112: pp 288–97.
11. Latif, M. A., Badsha, M. A., Tajul M. I., Kabir, M. S., Rafii, M. Y. and Mia, M. A. T. 2011. Identification of genotypes resistant to blast, bacterial leaf blight, sheath blight and tungro and efficacy of seed treating fungicides against blast disease of rice. *Scientific Research and Essays* Vol. 6 (13), pp. 2804-2811.
12. Mukhopadhyay, S. and Chowdhury, A. K. 1973. Some epidemiological aspects of tungro virus disease of rice in West Bengal. *Int. Rice Comm. Newsl.* 22: pp 44 – 57.
13. Ordon, F., Habekuss, A., Kastirr, U., Rabenstein, F., and Kuhne, T. 2009. Virus resistance in cereals: Sources of resistance, genetics and breeding. J. Phytopathol. 157: pp 535–545.
14. Rao and Anjaneyulu, 1980. Estimation of yield losses due to tungro virus infection in rice cultivars. *Oryza.* 17: pp 210-214.
15. Shahjahan, M., B.S. Jalani, A.H. Zakri, T. Imbe and O. Othman.1990. Inheritance of tolerance to rice tungro bacilliform virus (RTBV) in rice (*Oryza sativa* L.). *Theor. Appl. Genet.* 80: pp 513-517.
16. Suzuki, Nobuhiro; Sasaya, Takahide; Choi, Il-Ryong. 2015. Editorial: Viruses threatening stable production of cereal crops. *Front Microbiol.* 6: pp 470.