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Present status and research on rice virus diseases in India*

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In the book on 'Rice Diseases', Ou (1985) listed a total of 21 virus diseases on rice distributed all over the world of which 13 virus diseases are transmitted by insect vector (Hibino 1989) of which leafhopper and plant hopper play a vital role on virus transmission. Out of 13 insect transmitted rice virus only three viruses namely rice tungro virus, rice grassy stunt and rice ragged stunt virus have been recorded from India of which rice tungro virus (RTV) is of prime importance. Extensive research on different aspects of RTV have been made from State Agricultural Universities and Research institutes of the country. Incidence of other virus diseases from India are very low in comparison to RTV.

With the intensification of rice production system with high yielding varieties, adequate nutrient supply particularly of inorganic nitrogen and continuous rice-rice overlapping situation aggravated the incidence of RTV. Incidence of RTV is of periodic in nature and mostly found in kharif(aman) rice grown during rainy season (May-June to Nov.-Dec.) under Indian conditions.

In this article a comprehensive review on current status of RTV and its research informations on various aspects conducted in India has been discussed.

Key words : Rice tungro discease, Tungro epidemiology, research in India.

INTRODUCTION

Rice tungro virus disease, subsequently referred as Rice tungro disease (RTD) is one of the most important virus diseases in India. The disease is mostly prevalent in India and appears as periodic in nature. The other three virus diseases namely as grassy stunt, rice ragged stunt and rice necrosis mosaic have also been reported from southern states but with low intensity. Extensive researches have been made on various aspects only on RTD considering crop losses, its spread to many high yielding as well as traditional rice varieties. Tungro disease has been first identified in India from the state of West Bengal (Raychaudhuri and Ghosh, 1967, Raychaudhuri *et al.*, 1967) subsequently a comprehensive studies on the incidence and epidemiology of RTD has been initiated by Mukhopadhyay and Chowdhury (1970, 1973).

Two Indian bred rice varieties namely 'Padma' and 'Joya' and number of IR varieties have been released in India in 1969 due to their good performance in regards to yield as well as non-photosensitive character which has accelerated the rice-rice rotation for consecutive years in irrigated condition. After a few years of intensive cultivation all such varieties are succumbed for RTD epidemic in many states of north-eastern and south-eastern India (John, 1968, 1970). During 1973-74 cropping season, RTD epidemics occurr sporadically in many states of north-eastern India particularly in West Bengal, Assam, Tripura, Manipur, Kerala (Anjaneyulu and Chakraborti, 1977). After 1975 incidence of the disease has been found to increase in southern states and within couple of years RTD becomes widespread and attacks about 80,000 has planted crops mostly with high yielding semi-dwarf varieties (Chowdhury, 1997). A sudden severe out break of the disease during 1990 in considerable areas of West Bengal stimulated the scientist, rice growers and government administration to pay more

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attention to complex etiology of RTD in respect to its vector, host, environment so as to formulate a strategy to minimize the losses due to the disease. The status of RTD has been reviewed time to time by Mishra (1977), Mukhopadhyay (1986) and Chowdhury (1997). Considering the importance of RTD many state agricultural universities, research institutes of ICAR (Indian Council of Agricultural Research), IARI (Indian Agriculture Research Institute) and state research institutes initiate extensive studies on RTD. This report summarises the status and present research of RTD in India.

EPIDEMIOLOGY

Tungro virus

'Tungro' is a philippino word means degenerated growth of rice plant and it was known by different names in Philippines and other rice growing countries of the world. In Malayasia it was known as 'Penyakit merah, 'Mentek' in Indonesia Yellow orange leaf in Thailand and leaf yellowing in India (Ou, 1985). After establishment of International Rice Research Institute (IRRI) all those diseases were studied in detailed and named as Rice tungro virus. Tungro is a composite disease caused by two virus particles namely Rice tungro spherical virus (RTSV) and Rice tungro bacilliform virus (RTBV). They differ distinguishly from each other on the nature of virus as well as expression of symptoms. RTSV is spherical particle with RNA as genetic material where as RTBV contained ds DNA. Both the viruses are transmitted by Rice Green leafhopper (GLH) primarily by *Nephotetix virescens* and *N. nigropictus* in non-circulative manner. Tungro infected plants exhibit prominent yellowing, stunting, low tillering, incomplete emergence of inflorescence with less number of filled grain. However, infection severity depends on type(s) of virus present, time of infection, susceptibility of varieties etc. As mentioned earlier that incidence of tungro is periodic although in the past years it appears and causes epidemic in some rice growing of north-eastern and south-eastern states of India.

Tungro virus Research

Research on RTD in India has been initiated when the disease first appear during 1967 from West Bengal (Ray Chaudhuri and Ghosh, 1967) and subsequently by John (1968). Major institutions involved in tungro research include IARI, CRRI (Centred Rice Research Institute), BCKV (Bidhanchandra Krishi Viswavidyalaya), TNAU (Tamil Nadu Agricultural University), Assam Agricultural University, Delhi University and some state research institutes of the country.

The thrust area of research are primarily on virus epidemiology, host resistance, vector biology, virus ecology and disease management. A collaborative research has been initiated with IRRI and BCKV and TNAU to find out the host resistance against the advance breeding lines developed by IRRI. (Chowdhury, 1999).

Virus epidemiology

Tungro virus is mostly adapted to rice plant although few weed host play a role on the survival of virus. The major weed hosts have the potentiality to help the survival of virus includes *Echinochloa colonum, Eleusine indica, Hemarthria compressa, Polypogon monspeliensis. Eschaemum rugosum* and few more (Tarafdar and Mukhopadhyay, 1980; Raychaudhuri and Ghosh, 1967, Mallick *et al.* 1999). Several weed hosts from different agroclimatic zones of India have been tested by transmission studies by GLH but the results are somewhat contradictory (Mishra *et al.* 1973; Rao and Anjaneyulu 1978). In most of the studies ELISA, PCR and presently available tools used for virus detection from the weed host have not been used.

Like the wered host few wild rice can also harbour tungro virus when artificially inoculated by GLH. Few of them are *Oryza nivera, O. pernesis, O. bartii, O. australiensis, O. brachyanha, O. cichingeri, O. punctata,* etc. (Rao and Anjaneyulu, 1978; Anjanenyulu *et al.* 1982).

Most potential source of RTD is infected rice stubbles that survive between cropping seasons. Under Indian situation stubbles remain in the field for a considerable time and such stubbles regenerate on the on set of early rain and stubbles those are infected with tungro virus, act as a potential source of virus for successive crops (Chakraborty *et al.*, 1985, Mallick *et al.*, 1999, Tarafder *et al*, 1997).

Virus transmission

In India *N. virescens* and *N. nigropictus* are the principal vector of RTD. Transmission efficiency of

N. virescens is more than *N. nigropictus*, both nymph and adult transmit the virus efficiently. RTSV is of non-persistent nature while RTBV behaves as semi-persistent type and maximum retention of virus in vector is upto 3-4 days after acquisition and it varies with resistance and susceptibility of rice cultivars (Chowdhury *et al.* 1990). RTSV is independently transmitted by its vector but the leafhopper are capable to uptake RTBV only when they are exposed or fed on RTSV infected plant. Hibino and Cabauatan (1987) have suggested that a helper compound is produced in RTSV infected plant and during acquisition feeding such helper compound or accessory factors is also acquired by the leafhopper which is retained by the vector for 7-days and help for the transmission of RTBV (Chowdhury *et al.* 1990).

Besides rice green leafhopper another vector zigzag leafhopper (*Recilia dorsalis*) in West Bengal has also been found to transmit rice tungro viruses under glass house condition (Mondal *et al.*, 2004) and this suggests that this insect to some extent might play a role on the carry over of virus in between *kharif* to *rabi* rice.

Population dynamics of GLH

Considering the importance of GLH as principle vector of RTD, elaborate ecological studies has been made in BCKV for a considerable periods (Mukhopadhyay *et al.*, 1995), both under field and laboratory conditions.

Population of GLH are seasonal and depends mainly on weather conditions particularly temperature, rainfall and relative humidity. In general, population of GLH is highest in kharif seasons, and it starts appearing on the on-set of monsoon (May-June) with minimum number and reaches it peak in Oct-Nov. Peak population of GLH in West Bengal usually occurs during September-October when the temperature ranges between 30°C and 35°C and RH is 60-70%. Mukhopadhyay and Mukhopadhyay (1987) have established a correlation between peak light-trap catches and rainfall. Peak catches of GLH usually observe 60 ± 10 days after peak monsoon rains, however peak population may varies between the years and location. Population of *N. virescens* in rice are more than *N. nigropictus* in field conditions, besides it also varies in respect to variety, plant growth, type of cultivation and weather condition (Mallik and Chowdhury, 1999; Tarafder and Chowdhury, 2001, 2002).

In laboratory studies (Chakravarti *et al.*, 1979) established that meteorological conditions influence the biology of *N. virescens*. Decreasing temperature increases the duration of the life cycle both in the pre-ovipositional and nymphal periods and life cycle is also increased al low relative humidity. Life span of GLH also governes by environmental conditions and the threshold values of maximum and minimum temperate ranges in between 30°C and 15°C respectively. The GLH does not multiply below 15°C.

Host-virus-vector interaction

Interaction between virus-host and its vector is very complex. Large number of traditional tall indica and high yielding rice varieties have been tested in different research institute all over the country and their results is not uniform. Time to time a large number promising IR and traditional rice varieties are tested both in glass house and field conditions and none of the varieties are found resistance but they may differ with the expression of symptoms and disease severity (Tarafdar *et al.*, 2001, 2002. Chowdhury, 1999, Chowdhury *et al.*, 1996). Feeding behaviour (Biswas *et al.*, 1997) movement of GLH (Tarafder and Chowdhury, 1997) differ within the rice varieties. Less movement and prolonged feeding of GLH has been found in tungro susceptible varieties. Mukhopadhyay and Chowdhury (1973) have performed detailed study on the epidemiology of the disease and established a non-persistent relationship of the virus with its vector and also found wide variation in the rate of virus acquisition from the inoculation test to different rice varieties. GLH survives better on aged seedlings of susceptible varieties than on young seedlings and they preferres to move from younger seedlings to older seedlings irrespective of variety (Mukhopadhyay and Chattopadhyay, 1975) Acquisition of virus, life span of GLH and feeding behaviour of GLH also have been found to vary within the rice varieties. In GLH susceptible variety uptake of virus is more as observed in transmission studies (Khan and Chowdhury, 1983; 1985, Biswas *et al.*, 1997).

Management of tungro disease

Use of resistant varieties and vector control by insecticide till now is one of best method to control RTD. However, some cultural methods have also been recommended to minimize the spread of disease. Chemical control of tungro vectors has been intensively studied by different workers in India since it out breaks (Rao and Anjaneyulu, 1979, Shukla and Anjaneyulu 1980; Mukhopadhyay *et al.*, 1986). Prophylactic applications of pesticides are more justified to prevent the entry of GLH from nearby fields of tungro infected areas. In some areas of West Bengal and in also other states there are overlapping crop sequence of rice which facilitates the perpetuation of RTD between the crop and season and in such cases prophylactic spray is much more useful to minimize the disease incidence. Proper management of seed bed is the most effective and economic. Two seed-bed application and one field application with a systemic insecticides in case of susceptible varieties and one seedbed and one time field application help to minimize infection in the field planted with resistant variety (Chakraborty, 1985, Chakraborty *et al.*, 1985).

The use of tungro resistant variety is the most effective method to control the RTD. Time to time many tall indica and high yielding rice varieties have been tested and those varieties show maximum level of tungro resistance for couple of years and become susceptible few years after intensive cultivation. It suggests that the varieties bred for tungro resistance are actually resistant to GLH rather than virus.

Adjustment of planting time may influence the incidence of RTD. Early planting of rice may reduce tungro disease due to low vector population. In case of late planting application of pesticides is unavoidable. Removal of infected stubbles, weeds by ploughing immediately after harvest, simultaneously removal of infected plants, if found in the rice fields, help to minimise the spread of disease. Application of nitrogenous fertilizer is sometimes useful in compensating the losses when infection takes place particularly at late stage of crop.

OTHER RICE VIRUS DISEASES

Occurrence of other rice virus diseases from India is only limited to only three and they are rice grassy stunt, rice ragged stunt and rice necrosis mosaic. Incidence of those three diseases are only sporadic and research information is only limited to symptomatology and transmission.

Rice grassy stunt virus (RGSV) has been first reported from India by Raychaudhuri *et al.* (1967) based on the symptoms and transmission studies. At present time incidence of disease is very low and a minimum attention has been paid on studying the disease epidemielogy, virus characterization and on management practices RGSV is transmitted by brown plant hopper, *Nelaparvata lugens* in propagative manner (Ghosh *et al.*, 1979).

Hibino (1979) has reported the presence of Rice grassy stunt virus in India and this virus is also transmitted by *N. lungens.* Incidence is very sporadic and except reporting no other information is presently available.

Rice necrosis mosaic virus is transmitted by soil borne fungi this has been reported by Ghosh (1980) from India but the disease not caused any serious loss.

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