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RICE TUNGRO VIRUS—ITS SPREAD

BY

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Professor Purkayastha, Professor Samajpati, Dishtinguished colleagues, ladies and gentlemen :

I consider it an honour and previlage to present this brief address on the occasion of 33rd Annual General Meeting of the Indian Mycological Society founded as yearly as 1954 by my two teachers. I will try to explain a few important points regarding spread of the tungro virus of rice which sometimes appear in epidemic form and cause serious losses to the crop.

Virus diseases are usually evident following the change in the ecological relationship of the host plants. Rice Tungro Virus (RTV) is such an example. The disease was recorded in India (Raychaudhuri, 1967; John, 1968) when the rice cultivar Taichung Native I was introduced to augment the rice production in the country, i.e. eastern U.P., north Bihar and West Bengal, specially on cultivars such as TN-I and its other crosses during 1969, 1970, 1971. Evidently, this was the result of the change in ecological balance due to the introduction of new cultivars for paddy fields (Raychaudhuri, 1984).

Rice Tungro Virus is considered to be one of the most widespread diseases in most of the south and southeast Asian countries, at time, causing extensive damages in the form of epidemic in Indonesia, India, Philippines, Malaysia, etc.

The Role of the Vectors

Lowe and Nandi (1973) concluded that dwarf cultivars of rice allowed earlier, and larger population of vectors per plant than cultivars with normal height. The population levels of the two important vectors of the virus; *Nephotettix virescens* (distant) and *Nephotettix nigropictus* (Motsch), are related to the high humidity, absence of heavy rains, regular and light showers and overcast days; the vector population is low at the beginning of monsoon and subsequently reaches its peak within three weeks, provided the condition remains favourable. Based

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on one observation, the spread of RTV depends on the timing of peak population of the vectors in isolated areas. The virus infection appears only after the vector population reaches a level of two adults per plant and the spread of disease occurs when four or more adults per plant are present, (Lowe and Nandi, 1973). Observations at I.A.R.I. during the artificially induced epidemic indicated both the infection and spread occurred in susceptible cultivars by even less number of vectors per plant. In India, leaf hopper population generally reaches its peak in the middle of late Kharif season (monsoon crop) i.e. September and October.

Rice Tungro Virus and its spread in India

The vector population estimated on the basis of daily sweeps at Delhi indicated gradual build-up to a detectable level from July onwards, and reaching its peak during September and October (Mishra *et al.*, 1972). The vector population declined in the winter months and almost disappeared during January and February. In West Bengal, the vector population fluctuates similarly, being minimum during March and April. Mukhopadhyay *et al.*, (1984) estimated the vector population using light traps and observed maximum vector population during May to August in 1969-1971 when the dwarf cultivars were being introduced in the country. Coupled with the favourable climatic conditions, i.e. early pre-monsoon rains, the build-up of vector population in other rice growing areas of western UP, north Bihar and West Bengal reached its peak in early July. This could have been the cause of RTV epidemic in Bihar and U.P. in 1969. In Purnea District of Bihar, the vector population was detected on the standing rice crops and surrounding perennial woods as early as May (Mishra, 1977). The pattern of the development of vector population was different in 1970 and 1971, during which time the vector population reached its peak in the later part of the crop season, resulting in less occurrence of RTV epidemic.

Around Delhi, the vectors survive through the non rice growing seasons on perennials like *Palypogon monspeliensis* and *Hemarthria compressa* etc (Basu *et al.*, 1976; Mishra *et al.*, 1974; observation by authors). Early influx of the leaf hopper vectors have been occurring around much endemic pockets. Such endemic pockets, either isolated or scattered may have served to harbour vector population and also as a focal inoculum point for the spread of the virus in vast rice growing areas during 'Tungro years'. However, RTV might previously go unnoticed in these pockets due to the ecological balance achieved in this region because of the absence of susceptible rice cultivars, virulent strains of the virus, and/or the survival of inoculum on symptomless hosts. Therefore, epidemic of RTV around these pockets might have been the result of the change on the ecological balance during 'Tungro years' in West Bengal and the eastern areas of U.P.

The population build-up of the vectors also varies with the paddy cultivars (Mukhopadhaay *et al.*, 1976). According to Mitra and John (1973), *indica* types are more resistant to leaf hopper infestation than *japonica* types. Lakshman and Mishra recently recorded differences in the efficiency of transmission ability of different vector ecotypes. West Bengal ecotype of *Nephotettix virescens* was more efficient in having higher percentage of active transmitters and longer retention period than U.P. ecotype. *Nephotettix nigropictus* (Motsch) also transmitted the disease but less efficiently. A very interesting phenomenon of selective transmission of RTV 4 strain but not RTV 3 was observed in case of this vector (Niazi *et al.*, 1977).

Virus Strains

Identification of RTV isolates from different geographical regions indicated the occurrence of virulent strains (on the dwarf paddy cultivars) in endemic regions of West Bengal, whereas milder strain in nonendemic regions of Western U.P. During the studies at I.A.R.I., these District strains of the virus were detected from four isolates collected from different parts of north and north-west India. The isolates collected from Dhamaiktol and Tarkeshwar (West Bengal) were identified as RTV 3 (S-4), from Mostipur (U.P.) as RTV 4 (S-2) and from Aligarh (western U.P.) as the new RTV 4 (S-6) by Mishra *et al.* (1977). Basu *et al.* (1978) suggested a key for identifying all the strains of RTV.

Host Plants

The virus in host plants also play an important role in the spread of RTV. The time scale spread of RTV infection in susceptible cultivars like TN-1, and N-136 was studied at I.A.R.I. It followed the normal sigmoid curve with the availability of a proper 'inoculum threshold' at the beginning of the crop season. Periodic counts of diseased plants and vector population indicated a positive relationship with the progress of the infection of RTV. As the expression of symptoms are generally evident only after an incubation period of 10-20 days, an approximate gap of 20 days between vector influx and appearance of disease was generally observed. Under field conditions, early infection with the virus resulted in a high mortality rate of the infected plants, whereas in late infection, especially when the plants were in the grain stages, no symptoms were evident; symptoms were later detected in ratoons from these late-infected plants. This further substantiated the speculation that late-infected plants serve as a source of inoculum for subsequent rice crops.

The recovery of orange yellow colour of leaves to more green with the increase in

nitrogen as a result of corresponding disease in virus concentration has been reported in the Annual Report of AICRIP (1970). No traceable virus could be picked up by viruliferous insects from completely recovered leaves. It may be taken as a prophylactic measure as with less virus concentration the spread of virus is also considered to be much reduced. Analysis of the disease progress curve in different rice cultivars revealed differential progress in epidemic. Cultivars like ARC 6636 (Assam collection), N 136 and TN-1, behaved as "fast tungro" types, which suggest fast development of virus inoculum, whereas cultivars like IET 1991, Pusa 2-22 and ARC 10596 are 'slow tungro' category.

Perpetuation of Inoculum on weeds

Detection of RTV from representative samples of grassy weeds collected from endemic regions of West Bengal, e.g. Dhaniakhali and Jaboi, during 'off season' survey' indicated the survival of the virus in these reservoir grassy hosts (such as *Eleusine indica* L. Gaertn. *Sporobolus tremulus* (Willd) Kuntz, *Hemarthria comorensis* L. P. R. E. and *Sorghum halepense* L. Pers., along with stubbles or left over stumps (Mishra *et al.*, 1974). This was further illustrated by simulating such conditions at I.A.R.I. A grass *Polypogon monspeliensis* (L.) Seaf. which occurs as a dominant acro-flora in the fields in the winter (throughout the country) and particularly in the experimental plots at IARI also served as an important reservoir host for both RTV and 'yellow dwarf' mycoplasma. The leaf hopper vector could also survive and oviposit on the grass. Details have been discussed in Epidemiology study of RTV at BCKVV, Kalyani, West Bengal (Mukhopadhyay, 1986).

Prasad Rao and John (1974) suggested major role of rice stubbles as reservoir hosts of RTV during off-season, although leaf hopper vector can thrive on many grass weeds. Anjaneyulu considered that stubbles and self-sown rice seedlings only are important to carry over infection in between the two crops in December, January, and May-June.

Experimental Epidemiology

In the studies on 'experimental epidemiology' a reliable method of field screening of rice varieties against RTV was developed by creating artificial epidemic (Raychaudhuri *et al.*, 1971). Staggered sowing of susceptible rice cultivar, TN-1 and dumping of viruliferous vectors resulted in raising the 'inoculum threshold'. During the course of these investigations, transplanted paddy was more affected than the broadcasted one due to spacing which probably facilitated uniform distribution of the leaf hopper vectors. Late sown crop in Delhi was more affected because of coinciding of the most susceptible stage of the crop with the peak in vector popula-

tion rise. The pattern of development of disease depend on external or internal source of infection (unpublished). Mukhopadhyay (1986) gave an excellent account of prediction of the peak appearance of ricegreen leaf hoppers.

Etiology

Electron micrographs of ultrathin sections of rice leaves infected with RTV 3 and RTV 4 strains revealed the association of two types of virions, i.e. bacilliform (127.9 x 20.4 nm) and spherical (25.5 nm) forms (Mishra *et al.* 1979). Attempts to purify the virus particles, however, resulted in isolation of spherical virus particles (Raychaudhuri *et al.*, 1969). The antiserum prepared from such purified preparation were non-specific. Saito (1977) indicated presence of these two types of virions in the case of isolates of RTV identified as S and T strains from the Philippines, Payakit Habang from Indonesia but not in the case of M strain of RTV from the Philippines and Waika disease of Japan. The association of these two types of virion in the S and T strains of RTV and other tungro like viruses in different parts of southeast Asia suggests a thorough investigation of the role of two virions in the development of tungro disease symptoms in respect of strainal varieties and symptom expression on different cultivars is necessary.

Conclusions

The account of rice tungro virus epidemic in India is just an attempt to focus the effects of changing pattern of crop cultivation which brings out changes in the ecological balances in nature, resulting in the occurrence of some of the deadly diseases like tungro. Although a lot of work has been done during the last decade, there still remain much to be investigated. For instance, our knowledge is still meagre in respect of many important aspects as the extent of strain variations in the region, their epidemiological potentialities, the mode of perpetuation under different ecoclimates and the factors governing such devastating epidemics, etc.

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