Adjustment of Planting Date to Reduce Rice Tungro Disease

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ABSTRACT

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The possibility of reducing the incidence of rice tungro disease by adjusting the date of planting was studied with cultivars Taichung (Native) 1, Pankaj, Ratna, and IR 20 in the field. Disease incidence was higher in Taichung (Native) 1 and Pankaj than in Ratna and IR 20. Disease incidence was very low in January, February, June, and July plantings and high in September, October, November, and December plantings. Vector populations (*Nephotettix virescens*) also were larger during later plantings. The number of leafhoppers (adults, nymphs, and eggs) was positively correlated with maximum and minimum temperatures, rainfall, relative humidity, maximum disease incidence, and rate of infection and was negatively correlated (only nymphs) with amount of sunshine.

Because rice tungro virus (RTV) disease is economically important, any effort to reduce its incidence may be practical. Previously, we showed that the incidence of disease could be reduced by growing resistant rice cultivars, using insecticides, adjusting plant spacing, and managing nitrogen and water (2,11).

Altering the dates of planting or harvesting may enable a crop to avoid virus vectors or increase the resistance to infection (4). This has been successful for virus diseases such as groundnut rosette (12), sugar beet curly top (14), sugar beet and beet yellows (3,6), and potato leafroll (5). Planting dates can also be adjusted to reduce RTV disease.

MATERIALS AND METHODS

The incidence of rice tungro and populations of *Nephotettix virescens* (Distant) were monitored at Cuttack, India, for 2 yr, beginning in October 1976. Seedlings of the rice cultivars Taichung (Native) 1 (TN1), Pankaj, Ratna, and IR 20 were sown in raised nursery beds on the first day of every month. Subsequently, 30-day-old seedlings were transplanted at 15 × 20 cm spacings in 3-m^2 plots in puddled soil. Plots, replicated three times, were arranged in a randomized block design. All plots were fertilized at 60 kg N, 40 kg P_2O_5, and 40 kg K_2O per hectare and continuously flooded with a 5-cm layer of water.

Disease incidence and vector population were estimated weekly from 12 to 61 days after transplantation. Diseased plants were identified by orange leaf discoloration and extreme stunting in TN1, yellow leaf discoloration and moderate stunting in Pankaj and Ratna, and light green leaf discoloration and slight stunting in IR 20. To assess vector populations, 20 hills were selected at random in each plot and the number of adults in each hill were counted. The plants were then shaken individually and nymphs that fell on the water were counted. Five plants selected at random from each plot were uprooted and dissected, and the number of leafhopper eggs in each was determined by using a binocular stereomicroscope.

Disease incidence data were used to calculate the rate of RTV infection per day (r) in each planting (13).

Maximum and minimum temperatures, rainfall, relative humidity, and hours of sunshine recorded weekly at the Central

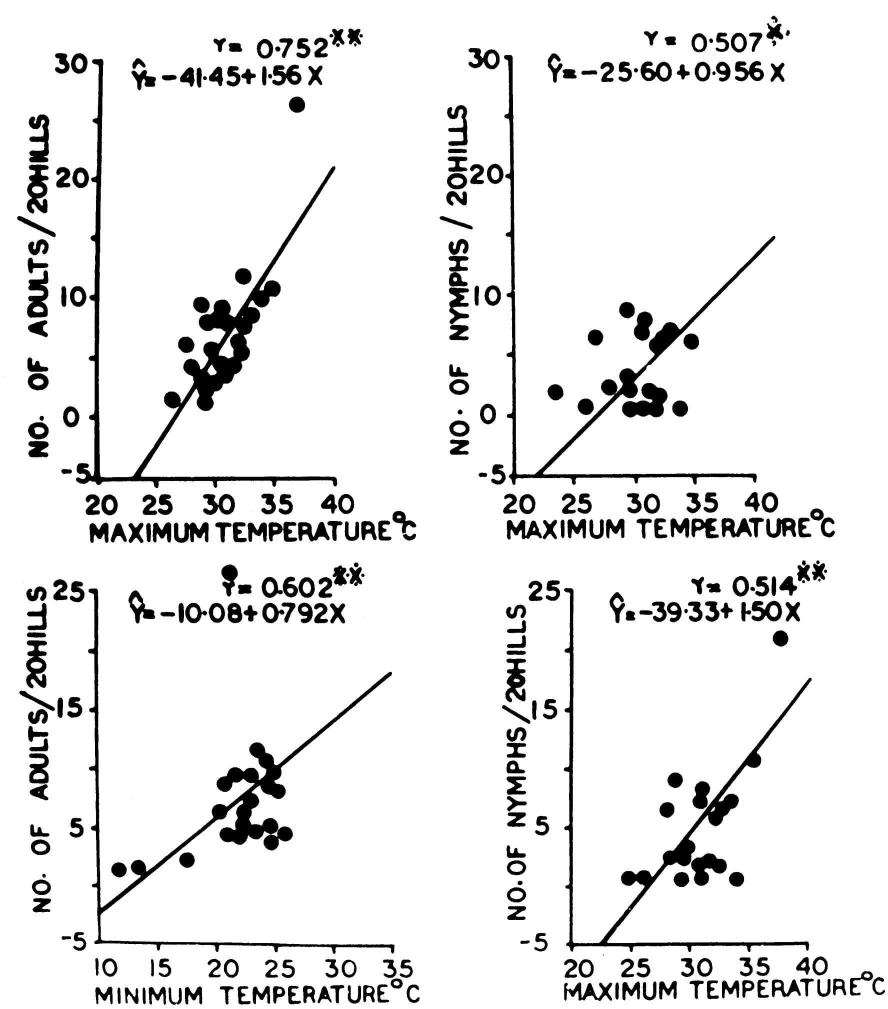

Fig. 1. Relationship between meterological factors and numbers of *Nephotettix virescens* adults and nymphs in Pankaj rice (upper diagrams) 0–30 and (lower diagrams) 30–60 days after transplantation.

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Table 1. Rice tungro virus infection per day (r) and maximum disease incidence in four cultivars at different planting dates

	TN-1		Pankaj		Ratna		IR 20	
Planting date	r	Incidence (%)	r	Incidence (%)	r	Incidence (%)	r	Incidence (%)
1976								
October	0.512	100	0.326	100	0.357	100	0.184	90
November	0.224	100	0.315	100	0.281	100	0.288	100
December	0.063	76	0.099	88	0.027	39	0.039	54
1977								
January	0.062	2	0.064	2	0.038	2	0.069	3
February	0.041	5	0.040	2	0.041	2	0.042	5
March	0.124	12	0.060	7	0.075	5	0.076	5
April	0.064	18	0.136	16	0.051	6	0.088	8
May	0.043	12	0.059	18	0.031	6	0.018	5
June	...	0	0.025	0	...	0	...	0
July	0.039	1	0.012	1	0.053	1	...	0
August	0.122	25	0.088	14	0.124	13	0.119	11
September	0.277	100	0.179	88	0.159	83	0.146	63
October	0.265	100	0.349	100	0.257	100	0.219	100
November	0.257	100	0.413	100	0.206	100	0.173	100
December	0.099	94	0.081	76	0.032	47	0.043	58
1978								
January	0.030	3	0.050	2	0.026	3	0.012	2
February	0.036	6	0.032	4	0.060	5	0.023	3
March	0.155	17	0.119	16	0.117	13	0.105	6
April	0.024	13	0.023	9	0.021	11	0.024	8
May	0.076	11	0.083	9	0.093	9	0.040	5
June	0.026	4	0.043	3	0.037	1	0.060	1
July	0.059	9	0.126	5	0.045	6	0.057	3
August	0.035	10	0.110	8	0.082	8	0.101	5
September	0.155	100	0.100	27	0.115	34	0.142	22
October	0.254	100	0.209	100	0.206	100	0.156	68

Table 2. Associations between *Nephotettix virescens* populations and meterological factors in Pankaj rice

	Correlation coefficient[a]					
	Tillering stage			Midtillering stage		
Meterological factor	Adults	Nymphs	Eggs	Adults	Nymphs	Eggs
Maximum temperature	0.752**	0.507*	0.282	0.515**	0.514**	0.598**
Minimum temperature	0.341	0.131	0.226	0.602**	0.737**	0.684**
Rainfall	−0.088	−0.019	0.096	0.307	0.639**	0.649**
Relative humidity	−0.033	−0.044	0.124	0.469*	0.628**	0.589**
Hours of sunshine	0.286	0.203	0.065	−0.201	−0.408**	−0.388

[a]* Significant at $P = 0.05$; ** significant at $P = 0.01$.

Table 3. Associations between rice tungro incidence, rate of infection, and *Nephotettix virescens* populations in four rice cultivars

	Correlation coefficient[a] of leafhopper population and	
Cultivar	Maximum disease incidence	Rate of infection
TN1	0.708**	0.768**
Pankaj	0.574**	0.463*
Ratna	0.606**	0.548**
IR 20	0.476*	0.555**

[a]* Significant at $P = 0.05$; ** significant at $P = 0.01$.

Rice Research Institute in October and November 1976, and September, October, and November 1977, were used in correlation analyses to determine relationships between vector populations in Pankaj and meterological factors. Peak leafhopper populations occurred during these months. The relationships among maximum disease incidence, rate of RTV infection, and leafhopper numbers were also calculated by correlation analysis. Weekly data on vector populations were summarized by season, ie, monsoon (July to October), winter (November to February), and summer (March to June).

RESULTS

Generally, the disease incidence was higher in TN1 and Pankaj than in Ratna and IR 20 and was higher in all cultivars in September, October, November, and December than in other months. Disease incidence was lowest in January, February, June, and July (Table 1). The r values were lower in Ratna and IR 20 than in TN1 and Pankaj. For all cultivars, the r values were highest in September, October, and November plantings and lowest in December, January, February, April, May, June, and July plantings (Table 1).

Leafhopper populations differed little among the different rice cultivars. The numbers of adults, nymphs, and eggs were higher in the monsoon season than in the summer and winter. The population was either absent or very low during the summer. The leafhopper population was greater during the midtillering stage (30–60 days after transplantation) than during the tillering stage (0–30 days after transplantation). There were more nymphs and eggs than adults during midtillering, and adults were most numerous during tillering stage.

The numbers of adult and nymph leafhoppers began to increase in August and peaked during September, October, and November. The population declined during December and was absent during January, February, June, and July. The population was small during March, April, and May, especially in 1977.

The numbers of adults, nymphs, and eggs of *N. virescens* in Pankaj were positively correlated with maximum and minimum temperatures, relative humidity, and rainfall and negatively correlated (only nymphs) with hours of sunshine in the midtillering stage (Table 2, Figs. 1 and 2). In the tillering stage, however, adult and nymph populations were positively correlated only with maximum and minimum temperatures (Table 2, Fig. 1). Maximum disease incidence and r values were positively correlated with adult leafhopper populations in all four cultivars (Table 3).

DISCUSSION

Variations in RTV disease incidence during the year were governed mainly by the vector population and availability of virus inoculum. Correlation analysis indicated a close relationship (positive correlation) between disease incidence and populations of *N. virescens,* suggesting that RTV spread was due to this vector.

The disease incidence was lowest during January, February, June, and July, which correspond to the two main crop seasons of the region, ie, *kharif* (July planting) and *rabi* (February planting). Farmers in eastern India can avoid early RTV infection by planting early in *kharif* or late in *rabi* when vector populations are very low. Late plantings in *kharif* in 1969 (8) and 1973 (1) were severely damaged by RTV infection resulting in loss of crops on several thousand hectares. In Malaysia also, time of planting was an important contributing factor to the tungro outbreak in 1969 (9); the disease incidence was low among plants grown before mid-June and high in crops planted after late June.

The high *N. virescens* populations in September and October appeared to be due to optimum temperatures, high

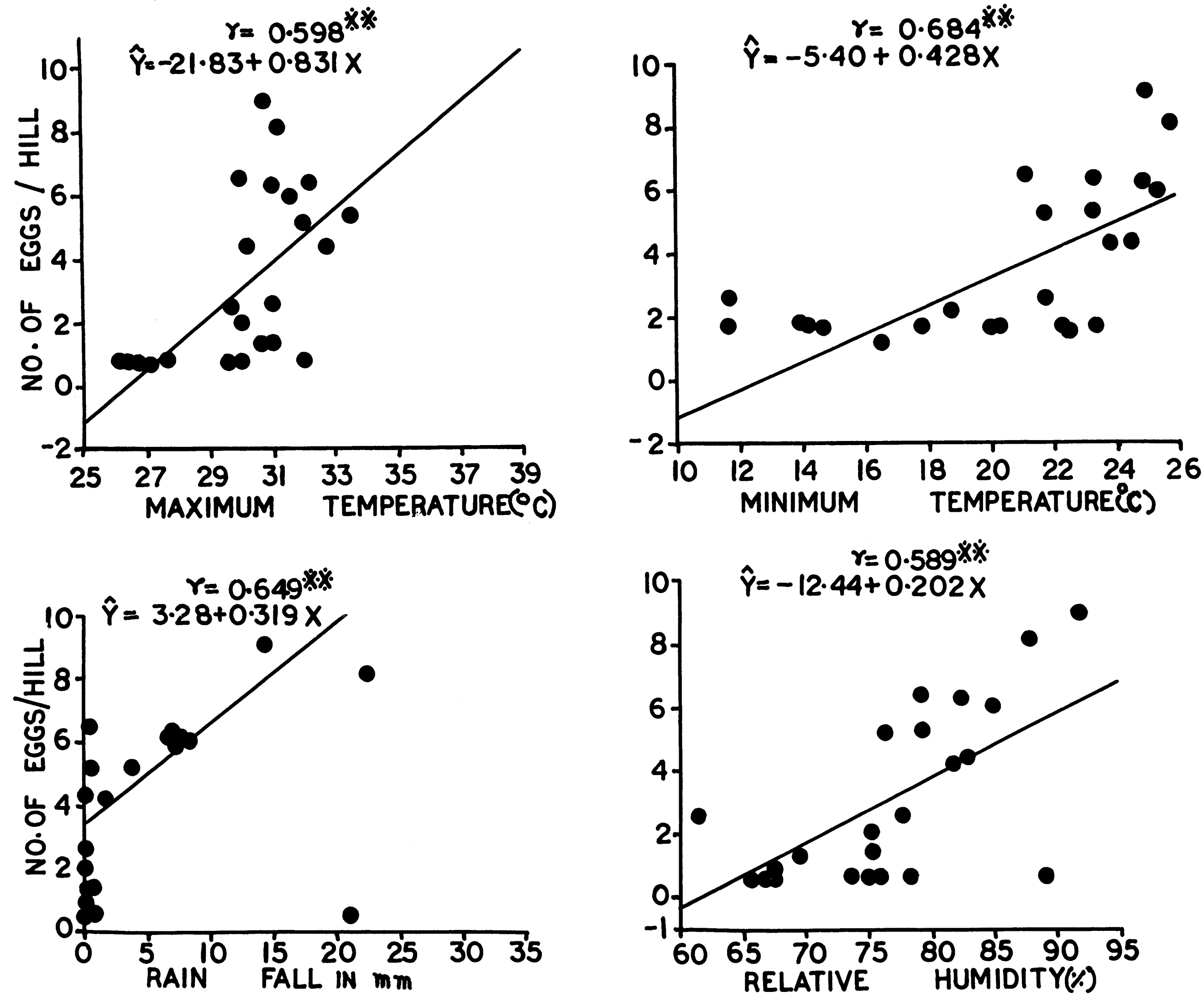

Fig. 2. Relationship between meterological factors and numbers of *Nephotettix virescens* eggs per hill in Pankaj rice 30–60 days after transplantation.

relative humidity after heavy rainfall, and reduced hours of sunshine. Rao and Anjaneyulu (10) reported that optimum maximal (31.8 C) and minimal (21.3 C) temperatures, high relative humidity (83.5%) after high rainfall, and reduced sunshine (5.2 hr) were favorable for oviposition and nymphal hatching of *N. virescens*. High relative humidity (80%) favored an increase in populations of green leafhoppers in phytotron studies at the International Rice Research Institute (7).

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