Plant Spacing to Reduce Rice Tungro Incidence

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ABSTRACT

Shukla, V. D., and Anjaneyulu, A. 1981. Plant spacing to reduce rice tungro incidence. Plant Disease 65:584-586.

Rice cultivars Taichung Native 1 (TN1), Pankaj, and Ratna were planted at spacings of 10 × 10, 10 × 15, 15 × 15, 15 × 20, and 20 × 20 cm. Disease incidence generally increased with increase in plant spacing. Differences in disease incidence among the spacings were more pronounced in the tolerant cultivar Ratna than in the susceptible and highly susceptible cultivars Pankaj and TN1, respectively. Grain yields were significantly higher in the 10 × 10 and 10 × 15 cm spacings than in the wider spacings for cultivars Pankaj and Ratna, but differences in yields were not significant among spacings in TN1. The adult leafhopper population (*Nephotettix virescens*) was fairly uniform in all spacings, but the nymph population was slightly higher in the closer spacings.

In recent years, greater emphasis has been placed on controlling plant diseases, including those caused by viruses, through cultural practices. Manipulating the space between plants reduces the incidence of viral diseases such as beet mosaic (7), beet yellows (2), cauliflower mosaic (3), and groundnut rosette (4).

Rice tungro virus (RTV) disease is economically important because of its destructive nature and epidemic occurrences. Efforts to control the disease have included use of resistant varieties (1) and of insecticides (6). The effects of spacing between plants on RTV disease incidence are reported here.

MATERIALS AND METHODS

Rice (*Oryza sativa*) cultivars Taichung Native 1 (TN1) (highly susceptible), Pankaj (susceptible), and Ratna (tolerant) are highly susceptible, susceptible, and tolerant to RTV disease, respectively. Seedlings were planted in five spacings, 10 × 10, 10 × 15, 15 × 15, 15 × 20, and 20 × 20 cm, arranged in a randomized block design with three replications. The plot for each treatment was 3 × 3 m.

Ammonium sulphate, 40 kg/ha, super phosphate, 40 kg/ha, and muriate of potash, 60 kg/ha, were applied to the puddled field before transplantation of 30-day-old seedlings. Two top dressings of ammonium sulphate at 20 kg/ha were made 30 and 60 days after transplantation. The field was continuously flooded with a 5-cm layer of water.

Five days after the other seedlings were planted, one 30-day-old RTV-diseased plant of *O. sativa* 'Jaya' (5) was planted in the middle of each plot to serve as an inoculum source. Sowing (14 August) and transplantation (14 September) were timed to coincide with the natural occurrence of the leafhopper vector *Nephotettix virescens*.

Disease incidence and vector populations were determined at weekly intervals starting 12 days after transplantation. Sampling procedures were as described previously (6) and involved five observations for disease incidence and six for vector populations. The entire plot was harvested and the yield determined. Disease incidence data were analyzed by the least significant difference method after transforming the percentage values into angular values. Grain yield data were

Table 1. Spread of rice tungro virus in three rice cultivars at different plant spacings

Cultivar spacing (cm)	Disease incidence (% infection)[a] Days after transplantation 19	26	33	40	47
Taichung Native 1					
10 × 10	4 a	15 a	37 a	94 a	100 a
10 × 15	5 ab	15 a	50 b	95 a	100 a
15 × 15	4 a	15 a	52 b	95 a	100 a
15 × 20	6 bc	21 b	59 c	95 a	100 a
20 × 20	7 c	21 b	63 d	99 b	100 a
Pankaj					
10 × 10	4 a	12 a	24 a	81 a	95 ab
10 × 15	5 a	15 ab	29 ab	85 a	94 a
15 × 15	5 a	16 abc	34 b	90 b	96 ab
15 × 20	4 a	17 abc	34 b	87 ab	96 ab
20 × 20	5 a	21 c	42 c	98 c	98 c
Ratna					
10 × 10	3 a	9 a	23 a	43 a	69 a
10 × 15	3 a	11 ab	26 b	50 b	76 b
15 × 15	4 ab	12 b	24 b	68 c	79 bc
15 × 20	5 ab	17 c	27 bc	72 c	80 c
20 × 20	6 b	17 c	30 c	78 d	83 d

[a] Values in a column followed by the same letter are not significantly different ($P = 0.05$).

Accepted for publication 5 November 1980.

0191-2917/81/07058403/$03.00/0

used directly for analysis. Progress curves of the disease were developed (9).

RESULTS AND DISCUSSION

Transplanted rice seedlings were free from RTV disease before the inoculum was introduced. The virus began spreading from the source plant within 2 wk after transplantation. Virus spread was most rapid in TN1, followed by Pankaj and Ratna (Fig. 1). Differences in disease incidence in various spacings were greatest 33 days after transplanting TN1 and Pankaj and 40 days after transplanting Ratna (Table 1). TN1, and Ratna plants in the 10 × 10 and 10 × 15 cm spacings showed significantly less disease than those in wider spacings. In Pankaj, disease incidence was significantly lower in the 10 × 10 than in 20 × 20 cm spacing. In general, disease incidence increased with increase in space between plants. Differences in disease incidence were more pronounced in Ratna than in Pankaj and TN1.

The seeding to grain maturity interval was 120, 150, and 118 days in TN1, Pankaj, and Ratna, respectively. Grain yields of TN1 plants were not significantly different among the different spacings. Yields of Pankaj and Ratna were significantly higher in the 10 × 10 and 10 × 15 cm spacings (Table 2), indicating that close spacings are advisable when these cultivars are grown in areas where tungro is a problem.

Adult leafhopper populations did not differ appreciably among the different spacings of all three cultivars. The average numbers of adult leafhoppers in 20 hills in the different spacings were 30–33 in TN1, 30–31 in Pankaj, and 30–34 in Ratna. The nymph population was greater than the adult population during the experiment. The average nymph populations per 20 hills in the different spacings were 50–56 in TN1, 58–67 in Pankaj, and 52–59 in Ratna. In Pankaj and Ratna, the nymph population was slightly greater in the 10 × 10 cm spacing than in others, probably because the microclimate was more favorable for reproduction.

Our results agree with other findings that closer plant spacings reduce the incidence of some viral diseases (2–4,7).

Table 2. Grain yields of three rice cultivars at different plant spacings

Cultivar spacing (cm)	Yield (g/plot)[a] Taichung Native 1	Pankaj	Ratna
10 × 10	417 a	1,210 b	2,200 ab
10 × 15	342 a	1,287 b	2,750 b
15 × 15	371 a	774 a	1,933 a
15 × 20	371 a	587 a	1,800 a
20 × 20	353 a	580 a	1,617 a

[a]Each figure is an average of three 3 × 3 m plots. Values in a column followed by the same letter are not significantly different ($P = 0.05$).

Vanderplank (8) expressed the opinion that viruses spread at a slower rate in dense than in sparse plantings. Because viruses cause systemic disease, only one infection is needed for an entire plant to become infected. Wider spacing usually results in larger plants than close spacing, and a large plant is more likely to become infected because of its large surface area. A larger plant has more tissue for virus multiplication and vector feeding, so the chances of virus spread from it are greater than from a smaller plant. Because vector populations did not differ appreciably among spacings, differences in plant size may account for differences in RTV disease incidence.

ACKNOWLEDGMENTS

We are grateful to H. K. Pande, Director, Central Rice Research Institute, Cuttack, for suggestions; S. C. Mathur, Head, Division of Plant Pathology, for

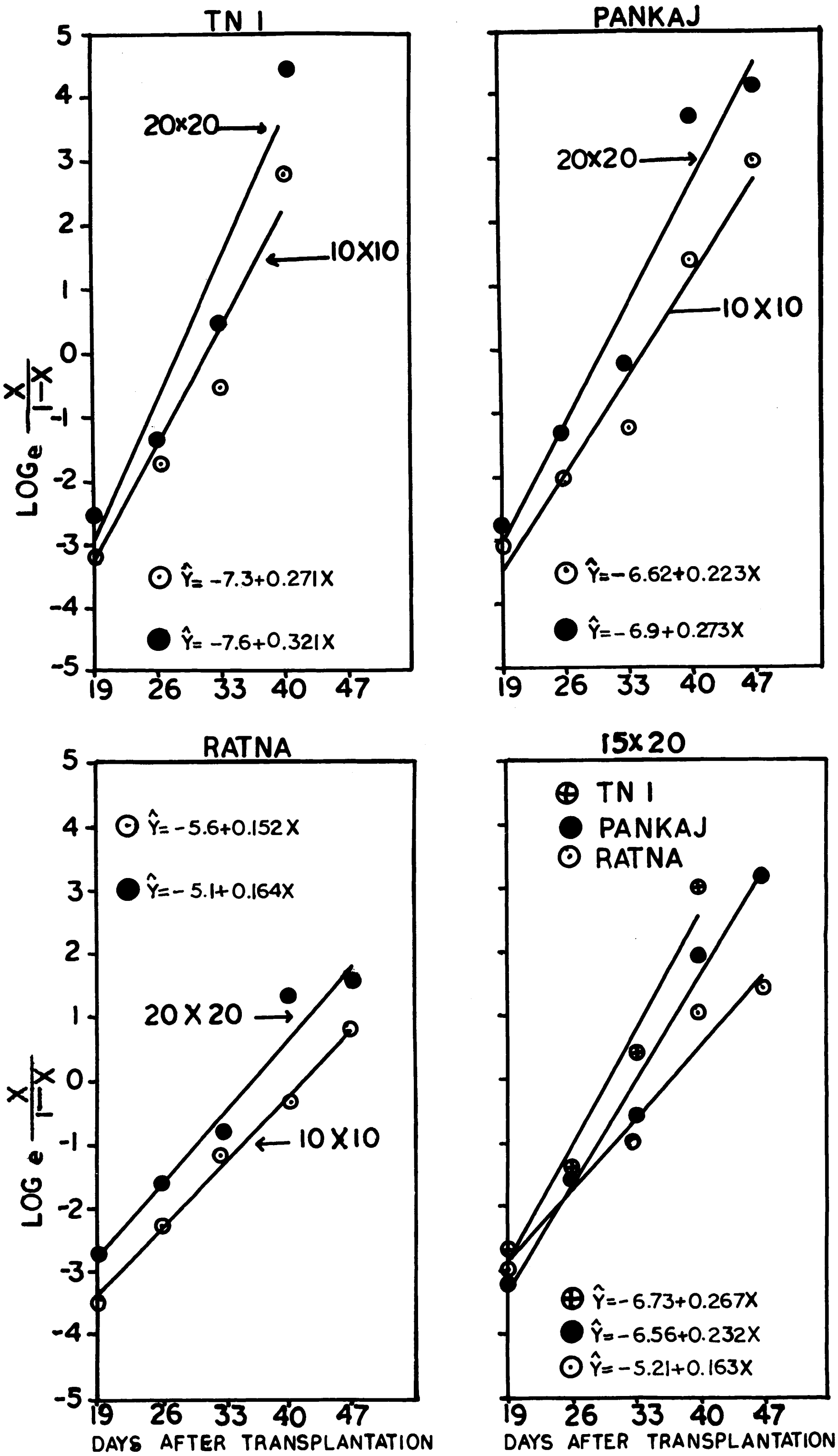

Fig. 1. Progress of tungro virus disease in two spacings of rice cultivars Taichung Native 1 (TN1), Pankaj, and Ratna.

providing facilities; and A. V. Surya Rao and P. Nayak for help in statistical analysis.

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