

Special Report

RESISTANCE OF RICE VARIETIES AGAINST GREEN RICE
LEAFHOPPER, *NEPHOTETTIX CINCTICEPS* UHLER

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Introduction

The green rice leafhopper, *Nephotettix cincticeps* Uhler, is one of injurious pests of rice throughout this country except Hokkaido. The leafhopper usually causes direct damage by sucking the sap during the heading and fruiting stages of rice in north-eastern parts, and it causes the direct damage as well as indirect damage by transmitting yellow dwarfs and dwarf diseases during the seedling and tillering stages in the southwestern parts. The use of insecticides is the only practical measure to control this pest at present.

Varietal difference of resistance in rice plants against the green rice leafhopper was first recorded by Inoue¹⁾ in 1966. It was found that the rate of survival of the leafhopper nymphs released on certain indica rice varieties was low. However, varietal difference and characteristics of the resistance were not fully studied. Suppression of the leafhopper population and damage through the use of the resistance of rice varieties is considered to be the ideal control measure. Thus, studies on varietal difference and characteristics of the resistance of rice against the green rice leafhopper have been carried out since 1969.^{2),3)} Attention has been paid to the type of resistance, commonly known as antibiosis, which brings about less survival of the leafhoppers. The present paper outlines some of the results obtained in the studies under way at the Tohoku National Agricultural Experiment Station.

Screening of Varieties for Resistance against the Green Rice
Leafhopper

Approximately a hundred rice varieties or strains of various plant types and origins were evaluated as to their resistance on the basis of the rate of nymphal survivals.

Table 1. Varietal difference of resistance to green rice leafhopper.

Rice varieties	Plant types	Resistant*	Moderate	Susceptible**	Total
Japanese paddy rice	japonica	0	0	42	42
Japanese upland rice	japonica	0	0	10	10
Foreign rice	japonica	0	0	9	9
Foreign rice	intermediate	0	0	7	7
Foreign rice	indica	14	3	10	27

Based on the rate of nymphal survivals.

* 10% or less of the nymphs survived.

** 50% or more survived.

Newly hatched nymphs were caged.

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Hatched fresh nymphs were caged on individual rice plants by using cages made of fine mesh gauze during the tillering and the heading stages of rice in paddy field plots, and their survivals were recorded when all of them died or became adults. In these tests, a small number of nymphal survivals were found only in foreign rice indica varieties (Table 1). About a half of the indica varieties tested were resistant, and the remainders moderate or susceptible. These resistant varieties were from China, Indo-China, Indonesia, and the Philippines. A few adult insects only emerged on the resistant indica varieties. It appears that the indica rice varieties possess considerably the resistance which brings about the low survival of the pests. Japanese paddy rice varieties and strains tested were all susceptible. Some of Japanese rice varieties and strains bred out by crossing with the resistant indica rice varieties were expected to be resistant. However, all of them tested were susceptible. Japanese upland rice varieties tested were also all susceptible. Moreover, foreign japonica and intermediate rice varieties tested were all susceptible.

Growth and Survival of the Nymphs on Susceptible and Resistant Varieties

Based on results obtained in the above screening tests of varietal resistance, some of resistant indica rice varieties and susceptible japonica ones were used in a series of investigation on characteristics of the varietal resistance.

Growth and survival of the nymphs on the susceptible and resistant rice varieties were investigated by releasing hatched fresh ones on individual plants. Investigations were carried out on rice seedlings in glass test tubes under 25°C in the laboratory, and on rice plants from the tillering to the fruiting stages in pots and field plots by using the cages. Records were made on the growth and survival by transferring the nymphs to fresh plants at intervals until all died or became adults. In these tests, it was ascertained that the nymphs suffered distinctly different mortality on different varieties, and fewer survivals were recorded on resistant indica varieties. Similar survival rates of the nymphs were recorded when released on plants of different ages ranging from the seedling stage to fruiting in each variety.

Less than approximately 5 percent of the released nymphs only reached the adult age on the resistant Phillipine variety Tadukan and the Indo-China variety Te-tep. On the other hand, more than about 50 percent became adults on susceptible Japanese varieties. It was shown that adults which survived from hatched fresh nymphs on resistant varieties were less than approximately 10 percent of those on susceptible varieties (Table 2). The number of the nymphs reduced largely during the first instar

Table 2. Survival of green rice leafhopper nymphs on different rice varieties.

Rice varieties	Plant types	Percentage of Survival			
		Seedlings (2nd leaf stage)	Seedlings (4th leaf stage)	Plants during tiller to fruiting	Plants during fruiting
Towada	japonica	65.3 (100)	50.6 (100)	80.7 (100)	90.0 (100)
Fujisaka No. 5	japonica	60.9 (93)	—	—	80.0 (89)
Hatsunishiki	japonica	65.2 (100)	—	—	76.7 (85)
Tadukan	indica	5.6 (9)	0 (0)	0.7 (1)	0 (0)
Te-tep	indica	0 (0)	0 (0)	2.0 (2)	0 (0)
Charnack	indica	20.4 (31)	—	—	36.7 (41)

Newly hatched nymphs were caged.

period soon after the caging on resistant varieties. Furthermore, the nymphs on resistant varieties, when survived, showed long duration of the nymph period (Table 3).

Table 3. Development of green rice leafhopper nymphs on different rice varieties.

Rice varieties	Mortality		Nymphal duration in days	
	During 1st instar	Nymphal period	Female	Male
Towada	26.3	34.7	19.3	17.3
Fujisaka No. 5	21.7	39.1	18.0	16.2
Hatsunishiki	26.1	34.8	18.1	16.5
Tadukan	84.3	94.4	24.0	23.0
Te-tep	88.0	100	—	—
Charnack	61.2	79.6	23.3	20.1

Newly hatched nymphs were caged on rice seedlings at the 2nd leaf stage.

Longevity and Fecundity of the Adults on Susceptible and Resistant Varieties

Longevity and fecundity of the adults on susceptible and resistant rice varieties were investigated by releasing newly emerged ones on individual plants. The methods used were similar to those used for the nymphs. Investigations were made on the survival and number of eggs produced until all the adults died. In these tests, the adults exhibited distinctly different longevity and fecundity on different varieties, and fewer eggs were laid on resistant indica varieties. Similar fecundity of the adults were recorded when released on plants of different ages ranging from the seedling to the fruiting

Table 4. Fecundity of green rice leafhopper adults on different rice varieties.

Rice varieties	No. of eggs laid per female adult			
	Seedlings (2nd leaf stage)	Seedlings (4th leaf stage)	Plants during tiller to fruiting	Plants during fruiting
Towada	87.2 (100)	38.5 (100)	213.2 (100)	72.6 (100)
Hatsunishiki	—	32.9 (87)	271.7 (127)	—
Tadukan	0.2 (0.2)	0 (0)	9.4 (4)	0 (0)
Te-tep	1.1 (1)	0 (0)	9.3 (4)	—

Newly emerged adults were caged.

Table 5. Longevity and fecundity of green rice leafhopper adults on different rice varieties.

Rice varieties	Percentage of adults which laid eggs	Longevity of female adults in days
Towada	92.0	22.4
Tadukan	7.7	9.8
Te-tep	3.8	12.0

Newly emerged adults were caged on rice seedlings at the 2nd leaf stage.

stage in each variety. Less than approximately 10 eggs per female adult were laid on the resistant indica varieties Tadukan and Te-tep. It was shown that eggs laid by adults which were released on resistant varieties were less than approximately 5 percent of those on susceptible varieties (Table 4). Longevity of the adults became lower and the percentage of the adults which laid eggs reduced largely on resistant varieties (Table 5).

Furthermore, changes in the body weight of newly emerged female adults after feeding on susceptible and resistant rice varieties were investigated by using the seedlings. It was found that the mated female adults caged on the resistant variety Tadukan lost weight while those caged on the susceptible variety Towada gained significantly (Fig. 1). It was also ascertained that females caged on the resistant variety Tadukan failed to develop the ovaries.

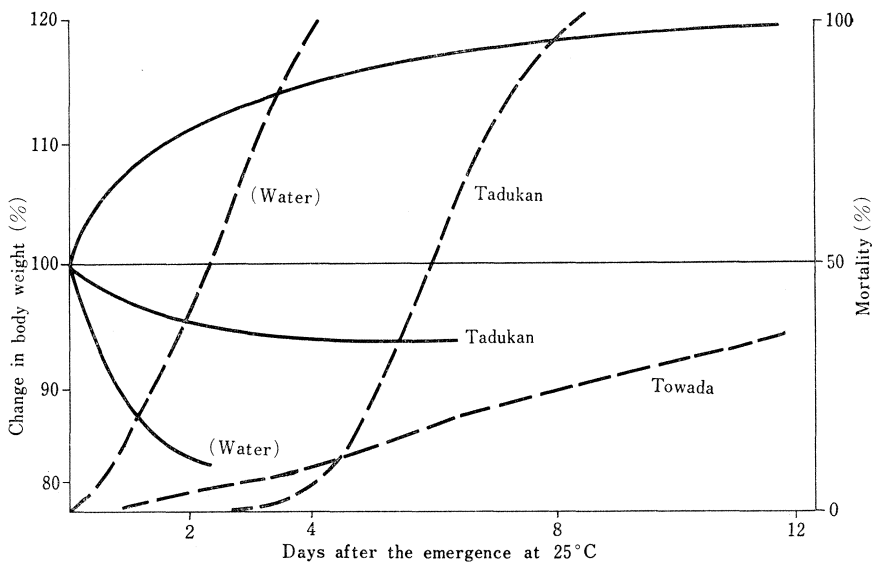


Fig. 1. Growth and survival of newly emerged green rice leafhopper female adults on susceptible and resistant rice varieties. Solid line shows change in body weight.

Summary

In the present studies, emphasis has been placed on investigating the nature of the resistance in rice varieties which exert an adverse influence on the growth and survival of the green rice leafhopper. The results obtained hitherto have shown that there exist indica rice varieties with the resistance which adversely affects the leafhopper feeding on them. Each of the resistant rice varieties intensely examined showed adverse effects on the leafhopper in almost the same pattern. Both nymphs and adults suffered higher mortality within a few days after the infesting, and then fecundity of female adults reduced largely on the resistant rice varieties throughout the whole plant growth period. Taking the results obtained into consideration, it appears that there are possibilities of suppressing the green rice leafhopper population and damage through the use of the varietal resistance of rice. Further studies, therefore, are needed.

Discussion

M. D. Pathak, IRRI: Has anyone looked at the susceptibility of the resistant variety to the viruses in Japan transmitted by *Nephotettix cincticeps*?

Answer: I do not know the detailed data on that question.

H. Ishikura, Japan: Dr. Okamoto, could you provide any information regarding susceptibility of the rice variety tested against particularly the Tadukan to the susceptibility to the virus diseases?

D. Okamoto, Japan: That variety is resistant to the stripe disease virus.

K. Sogawa, Japan: It has been observed that the hoppers could survive on the senescent leaves though they were resistant varieties. Have you observed this phenomena? What stage of plant did you use for your experiment?

Answer: I have shown you in the Tables 2 and 4. We used the seedling, tillering and booting stages.

K. Sogawa, Japan: How about the insect on the later tillering stage, or maturing stage of plant?

Answer: There is no detailed data on it.

References

1. Inoue, H. (1966): Larval development of the green rice leafhopper, *Nephotettix cincticeps* Uhler and the white back planthopper, *Sogatella furcifera* Horvath on Japonica and Indica rice varieties. *Odokon-Chugoku*. 8: 17-19.
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