Note

Insecticidal Activity of Pyrethroids against the Green Rice Leafhopper, *Nephotettix cincticeps* Uhler*

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Insecticidal activities of pyrethroids were evaluated in terms of topical toxicities against a susceptible (S) strain and a Rop-c strain having multiple resistance to organophosphates and carbamates. Against the S strain, pyrethroids showed comparable or higher insecticidal activities than conventionally used malathion, carbaryl or MTMC. Pyrethrins and fenpropathrin were highly effective. LD₅₀ values of tetramethrin, permethrin and fenpropathrin in the Rop-c strain were somewhat higher than those in the S strain, but the insecticidal activities of pyrethrins, allethrin and resmethrin against the Rop-c strain were comparable to those against the S strain. Fenvalerate was 4.3 times more effective to the Rop-c strain than to the S strain.

INTRODUCTION

In many parts of western Japan, the green rice leafhopper, *Nephotettix cincticeps* Uhler, has developed multiple resistance to organophosphorus and carbamate insecticides. The number of insecticides which can be practically used for its control has decreased. It is urgent in such circumstances to develop insecticides which are effective to this multiple resistant strain (Rop-c), to which cross-resistance will not be exhibited. Pyrethroid insecticides are different from organophosphates or carbamates mode of action. Some of the recently developed pyrethroids show potent insecticidal activity to insect pests of Lepidoptera, Diptera and Hemiptera, and are known to be effective to strains resistant to organophosphates and carbamates.^{1,2)} The authors studied the insecticidal activities of pyrethroids against the green rice leafhopper and found these to be highly effective against the Rop-c strain of this insect pest.

MATERIALS AND METHODS

A susceptible (S) strain and an organophosphate and carbamate-resistant (Rop-c) strain were used in the present study. The S strain was collected in a field in Sendai City, Miyagi Prefecture in 1970 and reared successively in the laboratory free of contact with any insecticide. The Rop-c strain was collected in Masaki-cho, Ehime Prefecture in 1975 and reared up to two to three generations free of insecticide. These insects were reared on rice seedlings under 25±1°C and 16 hr illumination per day.

LD₅₀ values of 12 insecticides including pyrethroids, organophosphates and carbamates as listed in Table 1 in the S and Rop-c strains were evaluated using the topical application method. The insecticides were diluted with acetone to appropriate concentrations, and topically applied at a volume of 0.5 µl per insect to the abdomen of female adults 3 to 5 days after emergence. Treated insects were given rice seedlings and were kept at 25°C. Mortality counts were made after 24 hr.

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Table 1 Purity of insecticides tested.

Common name	Purity (%)
Pyrethrins	67.7
Allethrin	83.8
Resmethrin	94.0
Tetramethrin	98.0
Permethrin	92.4
Fenpropathrin	97.0
Fenvalerate	94.8
Malathion	95.5
Diazinon	95.0
Fenitrothion	97.3
Carbaryl	99.3
MTMC	100

RESULTS AND DISCUSSION

LD₅₀ values of organophosphorus and carbamate insecticides in the S and Rop-c strains of the green rice leafhopper were shown in Table 2. The resistance levels in the Rop-c strain to these insecticides are also listed.

The LD₅₀ values of the organophosphates and carbamates were much higher in the Rop-c strain than in the S strain. The Rop-c strain showed about 480- and 300-fold resistance to malathion and fenitrothion, respectively, and 24-, 42- and 14-fold resistance to diazinon, carbaryl and MTMC (*m*-tolyl methylcarbamate).

The LD₅₀ values of pyrethroids in the two strains were shown in Table 3. Against the S strain, pyrethroids showed comparable to or higher insecticidal activities than conventionally used malathion, carbaryl or MTMC. Pyrethrins and fenpropathrin were highly effective. In the Rop-c strain, the LD₅₀ values of tetramethrin, permethrin and fenpropathrin were three to four times as large as those in the S strain. However, pyrethrins and most of the synthetic pyrethroids showed potent insecticidal activities against the Rop-c strain. Toxicities of pyrethrins, allethrin and resmethrin against the Rop-c strain were as strong as those against the S strain. Heterogeneity in suscepti-

Table 2 LD₅₀ values of organophosphorus and carbamate insecticides to susceptible (S) and Rop-c strains of the green rice leafhopper.

Insecticide	S strain		Rop-c strain		RL ^{c)}
	LD ₅₀ ^{a)}	1/b ^{b)}	LD ₅₀	1/b	
Malathion	1.26	0.34	606	0.68	481
Diazinon	1.84	0.17	45	0.55	24
Fenitrothion	14.6	0.35	4345	0.51	298
Carbaryl	0.95	0.19	40	0.40	42
MTMC	4.92	0.22	70	0.47	14

a) μ g per gram of body weight of the female adult, b) heterogeneity in susceptibility, c) LD₅₀ in Rop-c strain/LD₅₀ in S strain.

Table 3 LD₅₀ values of pyrethroid insecticides to susceptible (S) and Rop-c strains of the green rice leafhopper.

Insecticide	S strain		Rop-c strain	
	LD ₅₀ ^{a)}	1/b ^{b)}	LD ₅₀	1/b
Pyrethrins	0.27	0.33	0.43	0.28
Allethrin	1.15	0.19	1.88	0.32
Resmethrin	0.50	0.19	0.73	0.43
Tetramethrin	0.53	0.25	1.69	0.50
Permethrin	0.32	0.31	1.21	0.36
Fenpropathrin	0.14	0.31	0.41	0.31
Fenvalerate	0.52	0.38	0.12	0.23

a) μ g per gram of body weight of the female adult, b) heterogeneity in susceptibility.

bility (1/b) in the Rop-c strain to allethrin, resmethrin and tetramethrin was much higher than that in the S strain, suggesting that a small percentage of individuals less sensitive to synthetic pyrethroids exists in the Rop-c strain. These results suggest that pyrethroids may be the insecticides alternatively used with organophosphates or carbamates.

An interesting result was obtained from the experiment using fenvalerate. The LD₅₀ value of this insecticide in the S strain was 0.52 µg/g of body weight, while that in the Rop-c strain was as small as 0.12 µg/g. This means that fenvalerate was 4.3 times more effective against the Rop-c strain than against the S strain. Tanaka *et al.*³⁾ and Ozaki and Kassai⁴⁾ found that the malathion-resistant strains of the green rice leafhopper and of the small brown planthopper have higher susceptibility to DDT and γ-BHC than the corresponding susceptible strains. According to Yamamoto *et al.*⁵⁾, *N*-propylcarbamate potently inhibited modified acetylcholinesterase of the carbamate-resistant green rice leafhopper. They also stated that there was a negative correlation between the level of *N*-methylcarbamate-resistance and inhibitory potency of *N*-propylcarbamate on acetylcholinesterase. Development of a compound to which resistant strains exhibit negatively correlated cross-resistance is most important for the insect pest control. In this connection, a negative correlation between the resistance to organophosphates or carbamates and the LD₅₀ values of fenvalerate in the green rice leafhopper observed in this study is of great practical interest. Further investigation is needed on the insecticidal activity of fenvalerate against the organophosphate- or carbamate-resistant strains of

the green rice leafhopper and the planthoppers.

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要 約

ピレスロイド系殺虫剤のツマグロヨコバイに対する殺虫力

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ツマグロヨコバイの感受性(S)とリン剤-カーバメート剤抵抗性(Rop-c)系統に対するピレスロイド系殺虫剤の殺虫力を検定した。S系統に対するピレスロイド系殺虫剤の殺虫力は、従来防除に使用されていた malathion, carbaryl や MTMC と同等かそれ以上であり、なかでも pyrethrins と fenpropathrin の殺虫力は高かった。tetramethrin, permethrin と fenpropathrin の Rop-c 系統に対する LD₅₀ 値は S 系統より高かったが、pyrethrins, allethrin と resmethrin の Rop-c 系統に対する殺虫力は S 系統に対するそれと差がなかった。fenvalerate の殺虫力は S 系統より Rop-c 系統に対して 4.3 倍高かった。