Note

Difference in Susceptibility to Imidacloprid of the Populations of the Small Brown Planthopper, *Laodelphax striatellus* FALLÉN, from Various Localities in Japan

Shinzaburo SONE, Yumi HATTORI,
Shin-ichi TSUBOI and Yuichi OTSU

*Nihon Bayer Agrochem K.K., Yuki
Research Center, Yuki, Yuki 307, Japan*

(Received February 24, 1995;

Accepted May 26, 1995)

INTRODUCTION

Imidacloprid, 1-[(6-chloro-3-pyridinyl)methyl]-*N*-nitro-2-imidazolidinimine, is one of a new class of insecticides, highly active against leaf and planthoppers.¹⁾ Electrophysiological and biochemical studies on the mode of action of imidacloprid clarified that it acts as an agonist on nicotinic acetylcholine receptors in the post synaptic membranes.²⁻⁵⁾

No cross resistance against imidacloprid has been observed on any field insect populations which have developed resistance against other commercial pesticides.

It is valuable to know the original susceptibility of the pest to imidacloprid before it is widely used. In this study, we tested susceptibility of the small brown planthopper populations collected from various areas in Japan to four insecticides including imidacloprid.

MATERIALS AND METHODS

1. Insects

Different strains of the small brown planthopper, *Laodelphax striatellus* FALLÉN, were used in this study. S-strain was collected in Tokyo area in 1960's and has been reared without pressure of any insecticide. N-strain was collected in Nagasaki pref. in 1972 and has been reared under continuous pressure of 500 ppm malathion and 500 ppm propoxur sprayed weekly. Field strains were collected in various areas in Japan (Table 1) and reared in our laboratory without insecticidal pressure. Experiments were performed with 2–4 day old female adults.

2. Insecticides

Propoxur, disulfoton, ethofenprox and imidacloprid were synthesized at Yuki Research Center (Nihon Bayer Agrochem K.K.). Purity of them was higher than 95%. Stock solutions of the chemical were prepared in acetone. Imidacloprid 10% WP was used in the spray test.

3. Test Methods

3.1 Topical application

Test solution (0.2 μ l) was topically applied on the pronotum of the insects with a topical applicator (Burkard Manufacturing Co., Ltd., England) under light anesthesia with CO₂. Ten insects were kept in a Petri dish (90 mm in diameter) with wet filter paper. Mortality was determined 24 hr after application, and LD₅₀ was calculated by probit analysis. Correlation coefficients between LD₅₀ values to insecticides were calculated. Every experiment was repeated 3–4 times.

Table 1 Collecting site of the small brown planthopper in Japan.

Strain	Locality	Date
Yamagata	Amanuma town, Yamagata Pref.	Sept. 18, 1991
Nagano	Obuse town, Nagano Pref.	Sept. 10, 1991
Toyama	Daimon town, Toyama Pref.	Aug. 28, 1992
Hyogo	Kakogawa city, Hyogo Pref.	June 26, 1991
Yamaguchi	Kumage town, Yamaguchi Pref.	June 5, 1992
Fukuoka	Chikugo city, Fukuoka Pref.	May 16, 1991
Nagasaki	Isahaya city, Nagasaki Pref.	May 28, 1992
Miyazaki	Kitagawa town, Miyazaki Pref.	May 19, 1992
Kagoshima	Kokubu city, Kagoshima Pref.	May 20, 1992

3.2 Spray test

Rice seedlings about 3 cm high were sprayed with 10 ml of a water solution of imidacloprid using a spray gun, then ten female adults of the small brown planthopper were attached to the seedlings. The seedlings were covered by a plastic box (60 mm in diameter, 85 mm height) with metal screen on the top and kept at 16L8D, 25°C and 60% relative humidity. Mortality was determined 4 days after application. Every experiment was repeated 4 times.

RESULTS

Susceptibilities of the small brown planthopper collected from various areas in Japan to four insecticides were shown in Table 2. In general, the insects collected from northern parts of Japan showed relatively high susceptibility to the insecticides, but the insects collected from southern parts were less sensitive to the chemicals tested. Most strains of the small brown planthopper were resistant to an organophosphate, disulfoton and a carbamate, propoxur. Calculated resistance ratios for propoxur and disulfoton were 10–360 and 5–48, respectively. The carboxyesterase activities of these strains were on high levels commonly observed in resistant leafhoppers and planthoppers (data not shown).^{6,7)} All the field strains tested showed high sensitivity to ethofenprox and imidacloprid. Our laboratory strain (N-strain) showed a somewhat lower sensitivity to imidacloprid, and its resistance ratio was 18.

Mortality of N-strain and some field strain after foliar spray application of imidacloprid at the concentration of practical use was shown in Table 3. N-strain, which showed slightly lower sensitivity to imidacloprid by topical application, can be thoroughly controlled even at one forth of the concentration of practical use.

Correlation coefficients between the LD₅₀ values of the insecticides were shown in Table 4. Though LD₅₀ values of imidacloprid in the tested strains were small and lay within a narrow range (0.12–2.17 µg/g insect), correlation between the LD₅₀ values of imidacloprid and that of propoxur or disulfoton was significant, but the correlation between imidacloprid and ethofenprox was not significant.

DISCUSSION

Any notable low sensitivity to imidacloprid was not observed in the field populations of the small brown planthopper collected from various areas in Japan, whereas high resistance development was observed to organophosphates and carba-

Table 2 Susceptibility of the small brown planthopper populations collected from various area in Japan to 4 insecticides by topical application.

Strain	LD ₅₀ (µg/g insect)			
	Propoxur	Disulfoton	Ethofenprox	Imidacloprid
S	1.9 (1.5–2.5, 2.5)	6.2 (4.2–9.0, 2.1)	0.23 (0.12–0.33, 1.6)	0.12 (0.10–0.15, 4.6)
N	896 (556–1317, 1.7)	682 (573–802, 6.0)	1.40 (1.06–1.99, 2.9)	2.17 (1.71–2.74, 3.5)
Yamagata	40 (30–51, 3.7)	169 (117–235, 2.0)	1.38 (1.14–1.70, 5.2)	0.18 (0.13–0.25, 1.8)
Nagano	19 (16–24, 5.1)	31 (22–39, 3.4)	0.83 (0.64–1.08, 2.8)	0.18 (0.15–0.22, 4.0)
Toyama	27 (21–36, 3.0)	182 (142–246, 3.3)	0.71 (0.54–0.82, 5.8)	0.14 (0.10–0.18, 3.1)
Hyogo	212 (153–277, 3.0)	133 (92–351, 1.5)	0.21 (0.16–0.26, 3.6)	0.75 (0.50–0.99, 2.8)
Yamaguchi	174 (126–229, 2.8)	221 (176–278, 5.9)	0.70 (0.58–0.83, 5.7)	0.26 (0.19–0.35, 2.4)
Fukuoka	685 (504–940, 2.7)	216 (110–307, 2.5)	3.12 (2.27–3.97, 3.8)	0.25 (0.17–0.34, 2.6)
Nagasaki	173 (104–275, 1.4)	130 (78–180, 2.5)	1.34 (1.01–1.75, 2.8)	0.83 (0.62–1.08, 2.7)
Miyazaki	213 (111–332, 1.4)	298 (213–385, 3.1)	1.46 (1.21–1.79, 5.2)	0.73 (0.56–0.94, 2.9)
Kagoshima	322 (207–536, 1.5)	239 (195–298, 5.0)	0.88 (0.70–1.13, 2.6)	0.77 (0.62–1.01, 2.9)

The parenthesis indicated 95% fiducial limit and the slope of regression line.

Table 3 Efficacy of imidacloprid on the small brown planthopper by foliar spray.

	Concentration (% a.i.)	Mortality				
		N	Hyogo	Fukuoka	Miyazaki	Kagoshima
Imidacloprid	0.01	100	100	100	100	100
	0.0025	100	100	100	100	100

Table 4 Correlation coefficients between the LD₅₀ values of all tested populations on the four insecticides.

Insecticides	<i>r</i>
Propoxur-Disulfoton	0.815**
Propoxur-Ethofenprox	0.603*
Propoxur-Imidacloprid	0.736**
Disulfoton-Ethofenprox	0.313 ^{ns}
Disulfoton-Imidacloprid	0.860**
Ethofenprox-Imidacloprid	0.089 ^{ns}

Significant at *: 5%, **: 1% error level. ^{ns}: not significant.

mates in these strains. Our laboratory strain of the small brown planthopper reared under pressure of malathion and propoxur showed slightly lower sensitivity to imidacloprid. However, imidacloprid spray on the rice seedling at one forth concentration of the practical use killed 100% of the insects of this strain. Practically the small brown planthopper in Japan can be controlled well with imidacloprid.

The obtained LD₅₀ values of the insects from various localities of imidacloprid varied in a small range, but these LD₅₀ values of imidacloprid significantly correlated with the LD₅₀ values of disulfoton or propoxur. It seems that resistance mechanisms against organophosphates and carbamates may contribute to the reduction of sensitivity to imidacloprid in these strains.

It is important for estimation of possible resistance development in field populations of the small brown planthopper to elucidate the reasons of insensitivity to imidacloprid in N-strain of the small brown planthopper. Further studies are undertaken to clarify the lower sensitivity to imidacloprid in the laboratory strain of the small brown planthopper.

REFERENCES

- 1) A. Elbert, H. Overbeck, K. Iwaya & S. Tsuboi: Proc.; 1990 Brighton Crop Prot. Conf. Pests Dis., pp. 21-28, 1990
- 2) D. Bai, S. C. R. Lummis, W. Leicht, H. Breer & D. B. Sattelle: *Pestic. Sci.* **33**, 197 (1991)
- 3) M. Tomizawa & I. Yamamoto: *J. Pesticide Sci.* **17**, 231 (1992)
- 4) M. Y. Lui & J. E. Casida: *Pestic. Biochem. Physiol.* **46**, 200 (1993)
- 5) S. Sone, K. Nagata, S. Tsuboi & T. Shono: *J. Pesticide Sci.* **19**, 69 (1994)
- 6) H. Hama & T. Iwata: *Appl. Entomol. Zool.* **13**, 190 (1978)
- 7) H. Hama: *Jpn. J. Appl. Entomol. Zool.* **28**, 176 (1984)

要 約

日本各地で採集されたヒメトビウンカのイミダクロプリドに対する感受性

曾根信三郎, 服部ゆみ, 坪井真一, 大津悠一

イミダクロプリドは、クロルニコチル系の新規化合物で、ウンカ・ヨコバイ類に対し卓効を示す薬剤である。イミダクロプリドが、日本各地で広範囲に使用される前に、ヒメトビウンカにおける薬剤感受性を検定した。日本各地で採集されたヒメトビウンカにおいて、有機リン剤・カバメート剤に対する低感受性を示す系統が認められ、また、ピレスロイド剤に対し感受性の低くなった系統が認められたが、イミダクロプリドに対する低感受性は認められなかった。当研究室にてマラソン、プロポキサーで淘汰している系統において、イミダクロプリドに対し若干の感受性低下が認められたが、実用濃度の4分の1濃度で100%の死虫率を示した。これらのヒメトビウンカにおける感受性検定は、イミダクロプリドの抵抗性を検討する基礎となろう。