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The Thiazoles, A New Class of Insecticide for the Control of Resistant Diamondback Moths[1,2]

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Abstract : A recently introduced experimental insecticide - SN72129, belongs to a new class of chemical with insecticidal action, was tested against both the laboratory-bred and field collected resistant diamondback moths in this study. The result showed that the effectiveness of this new chemical is universal to all tested diamondback moths in spite of their already presented resistance to other insecticides. The information indicates that SN72129 bears a different mode of action and thus suffers no cross effect from all existing insecticide resistances.

Introduction

The most difficult aspect in the chemical control of diamondback moth, *Plutella xylostella* (L.), is the insect usually develops resistance to a significant level rapidly and makes the continuing use of the same chemical becomes uneconomical[2,3,5]. After twenty years of chemical control, the diamondback moth has become resistant to most insecticides in Taiwan[1,4,6,8,9]. A new insecticide which could deprive all existing resistance problems in diamondback moth is definitely needed if the chemical control is still the only way to control this pest in the near future. Recently, an experimental insecticide SN72129, belongs to the thiazoles[10], has been tested against the resistant diamondback moth in our laboratory. Many aspects on the insecticidal action of SN72129 were rather unique and this compound also demonstrated its ability to counterattack the current resistance problems. This report will emphasize the examined characters of this new chemical in dealing with resistant strains of diamondback moth from the known origins.

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Materials and methods

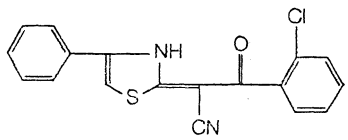
A. The chemical-SN72129* and its properties [10] :

Chemical names :

IUPAC : 3-(2-chlorophenyl)-3-oxo-2(4-phenyl-2, 3-dihydrothiazole-2-ylidene)-propiononitrile

Chemical abstracts (9th Cl) : 2-chloro-B-oxo-(4-phenyl-2(3H)-thiazolylidene)-benzene propanenitrile

Structural formula :



Empirical formula : $C_{18}H_{11}ClN_2OS$

Molecular weight : 338.84

Melting point : 182-183°C

Appearance : Buff coloured powder

Odour : Faint

Solubility :

n-hexane	approx. 160mg/100ml
toluene	approx. 410mg/100ml
dichloromethane	approx. 3.6g/100ml
acetone	approx. 1.5g/100ml
ethyl acetate	approx. 630mg/100ml
isopropanol	approx. 190mg/100ml
methanol	approx. 420mg/100ml
water	approx. 1mg/100ml

Vapour pressure : $P_{25} < 10^{-10}$ Torr

*SN72129 is formulated as 50% w/w wettable powder and supplied by Schering company.

B. Insect materials :

Total of seven field and five laboratory-bred strains of resistant diamondback moths have been tested against two susceptible strains and the descriptions for them are :

(1) Field strains : Collected from Chia-li, Feng-shan, Hua-lien, Lu-chu, Ma-tou, Ping-tung and Ta-hu in 1984.

(2) Laboratory-bred resistant strains : They were bred from the parental susceptible I-lan ('80) strain. Their final characters of resistance to particular insecticide used for the selection were listed in Table 1.

(3) Two susceptible strains : The I-lan ('80) and ('83) strains.

C. Testing methods :

The testing method is similar to the usual spraying method adapted in this laboratory [5]. Various concentrations of formulated insecticides were diluted in distilled water and sprayed through a Potter spray tower. Seven concentrations of each insecticide within the range of LC_{10} and LC_{95} were selected for testing. Usually forty to sixty 3rd instar DBM larvae in three replicates were tested for each concentration. The dosage-

Table 1. The resistance ratios of five laboratory-bred resistant diamondback moths strains to their correspondent selecting insecticides.

Strains*	Resistance ratio
Carbofuran-resistant	20.0
Fenvalerate-resistant	10.0
Mevinphos-resistant	5.0
Profenofos-resistant	13.4
Prothiofos-resistant	7.1

*all five strains were bred from the same parental I-lan ('80) strain, a native susceptible strain in Taiwan [5]

mortality response were analyzed in probits. The susceptibilities of different DBM to insecticides were compared at both LC_{50} and LC_{75} levels.

The insect mortality of each treatment was counted 24 hours after the spray; the post-treatment holding temperature and relative humidity were controlled at 25±1°C and 85±10% respectively.

Results

The background information of 7 resistant and 2 susceptible diamondback moth strains to 15 commonly used insecticides were listed in Table 2. The complicated resistance of field collected strains provides a suitable testing material for detecting the possible cross-resistance from other insecticides. The LC_{50}, LC_{75} and slope of dosage-mortality response of all tested diamondback moth strains in regard to SN72129 were reported in Table 3.

Table 2. Regional variation of DBM susceptibilities to various insecticides in Taiwan (LC_{50}, in ppm)

Insecticide	IL ('80)	IL ('83)	HL	PT	MT	CL	TH	LC	FS
Mevinphos	70	100	500	320	360	280	300	270	420
Profenofos	100	120	1,010	580	960	860	1,200	1,450	680
Prophos	170	320	810	1,130	1,300	420	830	850	3,040
Cyanophenphos	190	100	770	1,320	1,160	1,430	2,600	1,670	3,360
Methidathion	270	560	1,030	1,010	1,380	790	990	1,300	640
Prothiofos	310	420	2,010	2,830	2,530	1,500	2,530	3,120	1,250
Mephosfolan	360	370	790	1,070	1,920	940	1,310	1,270	1,570
Phenthoate	670	280	630	770	1,920	890	960	4,200	1,520
Diethquinalphion	230	440	—	—	—	—	8,140	9,010	—
Decamethrin	4	12	130	50	290	160	270	340	600
Fenvalerate	9	41	430	90	820	510	1,260	830	780
Permethrin	14	16	220	50	220	140	440	530	740
Cypermethrin	19	41	220	100	260	150	270	250	370
Cartap	290	660	860	900	920	830	1,150	510	480
Carbofuran	120	150	680	820	640	690	720	1,410	1,020
SN 72129	60	102	178	128	121	48	104	105	87

Essentially, the SN72129 susceptibilities of both field and laboratory-bred resistant strains were indistinguishable. For the resistant strains, LC_{50} and LC_{75} were measured at 48-178 ppm and 116-477 ppm respectively. Similar ranges were obtained in the susceptible strains and the measurements of LC_{50} and LC_{75} were 60-102ppm and 125-198ppm respectively. No trend or difference in susceptibilities of tested diamondback moths showed signs of cross-resistance from the existing insecticides. The high and low reading in lethal concentrations were considered from normal experimental variations.

Table 3. Effective dosages of SN72129 against both susceptible and resistant DBM.

Insect used	LC_{50}, ppm	LC_{75}, ppm	Slope
Field-collect strains			
Chia-li str.	48.2	115.7	0.77
Feng-shan str.	87.4	255.1	0.63
Hua-lien str.	177.5	476.8	0.68
Lu-chu str.	104.6	299.5	0.64
Ma-tou str.	121.2	258.6	0.89
Ping-tung str.	127.8	287.3	0.83
Ta-hu str.	103.5	201.9	1.01
Lab.-bred resistant strains			
Carbofuran-resistant str.	127.1	312.3	0.75
Fenvalerate-resistant str.	50.8	155.0	0.60
Mevinphos-resistant str.	65.4	178.3	0.67
Profenofos-resistant str.	120.9	359.3	0.62
Prothiofos-resistant str.	65.1	130.9	0.96
Susceptible strains			
I-lan ('80) str.	59.5	124.8	0.91
I-lan ('83) str.	101.5	197.8	1.01

On the aspect of effectiveness of SN72129 on the diamondback moth, LC_{50} at 48-178ppm can be considered as a good control agent when it was compared to some other insecticides. The effectiveness of several commonly used control agents in Table 2 can serve as the comparative standards and are 70-100 ppm for mevinphos, 100-120 ppm for profenofos and 120-150ppm for carbofuran.

Discussion

The test for searching a new insecticide free from the effect of existing resistance in the diamondback moth should be very strict and careful. In this study, we collected 7 field strains as the materials with multiple resistance origins. For the second groups, five laboratory-bred strains of DBM with defined resistance to carbamate, organophos-

phorus and synthetic pyrethroid i.e., three major groups of insecticides, were used. The specially bred resistant strains will make the final analysis easier. Two susceptible strains of diamondback moth were the third testing group and both were collected from the same area except the collecting dates were three years apart.

The result of this study showed that all three groups of diamondback moths have similar SN72129 susceptibilities. The fact clearly demonstrated that SN72129 does not suffer any cross-resistance problems in the diamondback moth with either mixed resistances or defined resistance. We believed that the thiazoles must act differently from other traditional insecticides in killing the diamondback moth and that is why SN72129 is free from the cross resistance from all other insecticides.

The structure of SN72129 bears no resemblance to any existing insecticide group, particularly, no functional group on SN72129 can be recognized with a physiological significance at this time[7]. Although the mode of action of thiazoles is still unknown, it is obviously different from all known insecticides.

The effective dosage of SN72129 on the 24-hour mortality count is equivalent to that of mevinphos, profenofos and carbofuran. Other organophosphorus and cartap were less effective than SN72129. The synthetic pyrethroids are only effective against the susceptible strain but not the resistant strains in this study.

Judging from both the cross-resistance free character and the low level in effective dosage, SN72129 can serve as a useful control agent in the future pest control program to counter the current diamondback moth resistance problems.

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Thiazoles—適用於防治抗藥性小菜蛾之新殺蟲劑[1]

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摘　要

爲因應本省小菜蛾的抗藥問題，本所在各類新型殺蟲劑中尋得此種化學結構屬於 thiazoles 的藥劑，試驗代號爲SN72129。此殺蟲劑具有不受現用各類殺蟲劑交互抗性影響之特性，由田間採得七種混合抗藥品系及室內培養之五種專屬抗藥品系小菜蛾所測對該藥劑之感度，均與感性品系無異，顯示此藥劑對小菜蛾之殺蟲效果，與該蟲是否已對現用殺蟲劑產生抗藥性無關。

所得結果顯示：此新型殺蟲劑極有希望成爲未來防治本省小菜蛾的核心藥劑，可抒解目前小菜蛾抗藥性問題之困擾。

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