

Comparative Toxicities of Selected Acaricides against the Twospotted Spider Mite(*Tetranychus urticae* Koch) to Establish the Screening System for New Acaricidal Chemical Compounds

스크리닝체제 확립을 위한 점박이용애에 대한 몇가지 살비제의 약효비교

Jum Rae Cho, Young Ho Choi, No Joong Park and Kwang Yun Cho

조점래 · 최용호 · 박노중 · 조광연

ABSTRACT The comparative toxicities of selected acaricides against the twospotted spider mite, *Tetranychus urticae*, were investigated. The ovicidal and adulticidal activities of selected acaricides were examined under different developmental stages. Fenpyroximate showed high activity throughout all developmental stages of mites. The oviposition inhibition effect of fenpyroximate was more highly effective than that of cyhexatin. At 100 ppm concentration, the effect of fenpyroximate on the residual oviposition inhibition was persistent during 25 days with 85% level, while the effect of cyhexatin gradually decreased, and then decreased to 40% at 25 days after treatment. Fenpyroximate at 100 ppm showed 100% knockdown activity within 3 hours while cyhexatin showed only 91% knockdown activity within 24 hours after treatment. Most of selected acaricides had no systemic activity, but metasystox at 800 ppm had 100% of the systemic activity at 24 hours after treatment. For the influence of temperature on the activity, fenpyroximate showed stable activity and no temperature-dependent in comparison with other selected acaricides.

KEY WORDS Twospotted spider mite, fenpyroximate, cyhexatin, hexythiazox, toxicity

초 **특** 점박이용애에 대한 몇가지 살비제들의 각 발육단계에 따른 살란·성충효과를 조사하였다. fenpyroximate는 발육 전단계에 걸쳐 높은 효과를 보였다. Fenpyroximate의 산란억제효과는 cyhexatin보다 훨씬 좋았다. 100ppm 농도 수준에서 약제잔효로 인한 산란억제효과는 fenpyroximate경우 85% 수준으로 25일동안 지속한 반면에 cyhexatin의 효과는 점차 감소하여 처리 25일 후 40% 정도로 감소했다. 또한 100ppm농도 수준에서 fenpyroximate의 속효성은 3시간만에 100%의 살성충력을 보였지만 cyhexatin은 24시간이 지난 후에도 91% 정도의 살성충력을 보여주었다. 공시된 대부분의 살비제가 침투이행성을 보여주지 않았지만 metasystox는 800ppm 농도 수준에서 처리 후 24시간에 100% 살성충효과를 나타냈다. 각기 다른 온도에 대하여 fenpyroximate는 다른 살비제와 비교했을 때 안정된 약효를 보였다.

검 **색** **어** 점박이용애, fenpyroximate, cyhexatin, hexythiazox, 약효

The twospotted spider mites, which belong to Tetranychidae, are distributed widely in the world and are the most important families and species of phytophagous mites in economic terms (Lunkenheimer 1983). They cause severe damage to crops. Injury to crops by spider mites has markedly increased in the last few decades because of the use of nonspecific insecticides which eliminate the natural enemies of mites and the rapid development of resistance to registered acaricides (Kashara et al. 1991).

To cope with this problem, some acaricides have been developed and used before and after 1980. Hexythiazox, flubenzimine and clofentezine were introduced. All of them are effective against ovo- and larval stages but they are not active against adult mites (March 1976, Neal et al. 1986, Sakaituru 1987). Sunmite, developed by Nissan Chemical Industries, Ltd., is highly active against all developmental stages of mites. Fenpyroximate, introduced into the world market in 1990, is highly effective against all developmental stage of mites, even resistant stains. But many acaricides have almost disappeared from the market within five years after their introduction because mites quickly develop resistance. Moreover, binapacryl and plictran were withdrawn from the world market (Hattori 1990). For this reason, the discovery of new acaricides which have different modes of action from existing acaricides were earnestly desired.

This study was undertaken to investigate the comparative toxicities of selected acaricides to establish the screening system for new acaricidal chemical compounds.

MATERIALS AND METHODS

Mites

The towspotted spider mite, *Tetranychus urticae* Koch, was reared on kidney bean plants placed in small tray of water. Kidney bean plants placed in small tray of water so as to prevent movement of mites and dryness of kidney bean plants. Insectary conditions were maintained at $25 \pm 1^\circ\text{C}$, 50~60% RH and a photoperiod of 16:8(L:D)

Adulticidal tests

Excised kidney bean leaf-disks (3 cm in diameter) were placed on water-soaked cotton wool fitted into petridish (ϕ 5.5×H 2 cm). 30 female adults were placed on leaf-disk, and then prepared test solutions were sprayed. Chemicals of technical grade were dissolved in 5ml acetone (100%), then formulated to the proper concentration in Triton X-100 (100 ppm). The petridish were held at $25 \pm 1^\circ\text{C}$, 50~60% RH and a photoperiod of 16:8(L:D) and mortality was evaluated at 48h. The criterion for death was the failure of the mites to move their two legs when lightly prodded with a fine brush. After applying at 100 ppm test solution, the knockdown activity was evaluated as a mortality depending on hours after treatment, using leaf-disk spraying method. At same formulation mentioned above the systemic effect was examined using soli-drench method. The relationship between temperature and activity was studied under three different temperature conditions (15°C, 25°C and 30°C). The oviposition inhibition effect was examined depending on diferent concentration. Also, residually oviposition inhibition effect was examined depending on days after treatment.

Ovicidal tests

More than 30 female adults were placed on leaf-disk for egg deposition, then removed after

3 hours for oviposition. Number of eggs laid on leaf-disk were counted and the leaf-disk was placed on the water-soaked cotton wool fitted into petridish and held at $25 \pm 1^\circ\text{C}$, 50~60% RH and photoperiod of 16:8 (L:D). Unhatched eggs were counted at 6 days after treatment. The effect of egg development at the time of treatment was investigated. Data were subjected to probit analysis using "QUOT 10" program created by D.J. Finney(1982).

RESULTS AND DISCUSSION

Adulticidal and Ovicidal Activity

Table 1 shows the adulticidal activity of dicofol, cyhexatin and fenpyroximate against *T. urticae*. SS is the susceptible strain reared in laboratory and RS is the resistant strain selected periodically with dicofol in laboratory. Fenpyroximate was highly effective against the susceptible strains more than other selected acaricides, even resistant strains. Table 2 shows the ovicidal activity of dicofol, tetradifon and fenpyroximate. The results demonstrate that fenpyroximate shows highly effective against eggs of mites, even resistant strains. From the results shown in Table 1 and 2 we can conduct advanced test if our new chemical compounds is highly effective more than commercial acaricides (Cho 1987).

The acaricidal activity against *T. urticae* at different developmental stages is different from various kinds of acaricides. The results, shown in Figure 1, indicate that fenpyroximate is highly effective against all developmental stages more than other selected acaricides. In case of dicofol, the results were different from those obtained by Yamada et al. (1987). In their studies, the same applying method was used to all developmental stages of mites. But in this

Table 1. The adulticidal activity of three commercial acaricides against *T. urticae* adult

Acaricides	LC ₅₀ (ppm)	
	SS(95% FL) ^a	RS(95% FL) ^{b,c}
Dicofol	33.7(28.62-39.70)	507.3(403.12-640.77)
Cyhexatin	4.9(4.18-5.61)	28.26(22.21-35.81)
Fenpyroximate	1.7(1.44-1.85)	3.0(2.41-3.69)

^a SS : Susceptible strain

^b RS : Resistant strain selected succesively with dicofol

^c () : 95% fiducial limit

Table 2. The ovicidal activity of three commercial acaricides against *T. urticae* egg

Acaricides	LC ₅₀ (ppm)	
	SS(95% FL) ^a	RS(95% FL) ^{b,c}
Dicofol	34.0(27.13-42.57)	1043.3(729.55-1505.82)
Tetradifon	0.5(0.41-0.62)	0.6(0.50-0.78)
Fenpyroximate	0.09(0.08-0.20)	-

^a SS : Susceptible strain

^b RS : Resistant strain selected succesively with dicofol

^c () : 95% fiducial limit

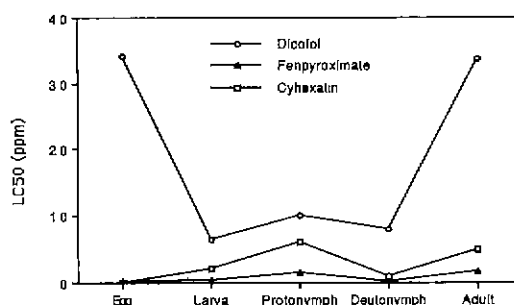


Fig. 1. Toxicity of dicofol, fenpyroximate and cyhexatin against the twospotted spider mite, *T. urticae* at different developmental stages.

experiment adults were treated with leaf-disk spraying method. And larvae, protonymphs and deutonymphs were treated with leaf-insect body dipping method. When compared with the results obtained in our laboratory, the leaf-insect body dipping method was more susceptible. It seems to be due to increased susceptibility to

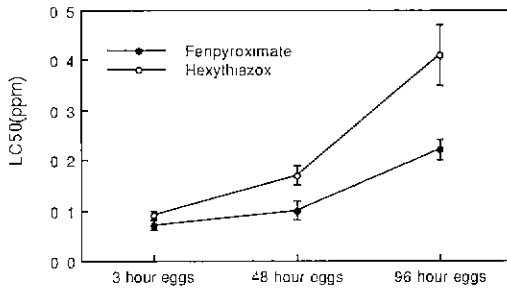


Fig. 2. The ovicidal effects of hexythiazox and fenpyroximate at the time of treatment depending on egg development of *T. urticae*.

dicofol in larval, protonymphal and deutonymphal stages and be due to the applying method. But this difference remains to be clarified. Thus the applying method should be considered for screening new acaricidal chemical compounds.

Figure 2 shows the effect of egg development at the time of treatment on hexythiazox and fenpyroximate efficacy. Less developed eggs of *T. urticae* were more susceptible to fenpyroximate and hexythiazox than eggs close to hatching. The results were similar to those obtained for *T. pacificus* (Hoy and Ouyang 1986). As shown in figure 2, the results suggest that the ovicidal activity for screening new chemical compounds will be greatly influenced by the timing of application with respect to egg development. Thus the stage of egg development should be considered to bioassay the ovicidal activity of new acaricidal chemical compounds.

Knockdown Activity and Oviposition Inhibition

The knockdown activity of cyhexatin and fenpyroximate at 100 ppm concentration, using leaf-disk spraying method, is shown in Figure 3. The knockdown activity of fenpyroximate was 100 % within 3 hours while cyhexatin only 91

% of the knockdown activity within 24 hours after treatment. This means that fenpyroximate shows more quick action than cyhexatin. But this result was less effective than that obtained for sunmite (Hirata et al., 1988). Like this, because the knockdown activity is very important in comparison with the toxicity between new chemical compounds and other commercial acaricides, it will be considered for screening new chemical compounds.

The relationship between mortality and oviposition is shown in Figure 4. The adulticidal activity under different concentration showed in order of fenpyroximate > cyhexatin and oviposition inhibition effect showed in the same order. When applied at 10 ppm, fenpyroximate killed 100 % of adult mites within 4 hours. On the other hand, cyhexatin killed only 13% of adult mites within 24 hours (preliminary data).

The results, shown in Figure 5, indicate that the residual oviposition inhibition effect of fenpyroximate is more effective than that of cyhexatin. At 100 ppm concentration level, the residual oviposition inhibition of fenpyroximate was persistent during 25 days with an 85% level. But the effect of cyhexatin was gradually decreased, and then decreased to 40% at 25 days after treatment. Thus the oviposition inhibition by persistence of chemical compound in

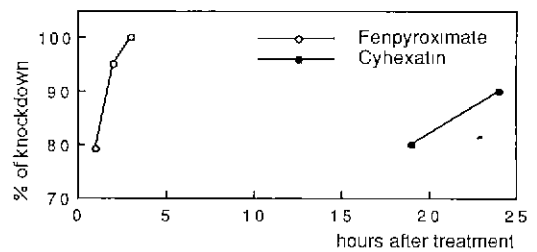


Fig. 3. The knockdown activity of fenpyroximate and cyhexatin against *T. urticae* adult 100 ppm, using leaf-disk spraying method.

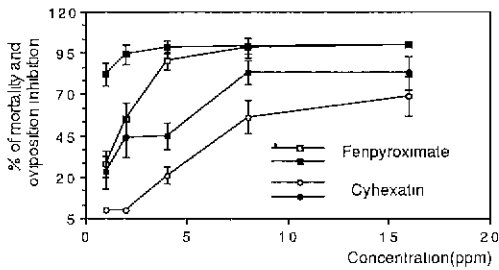


Fig. 4. The relationship between oviposition inhibition (dark) and mortality (white) on fenpyroximate and hexythiazox efficacy under different concentration against *T. urticae*

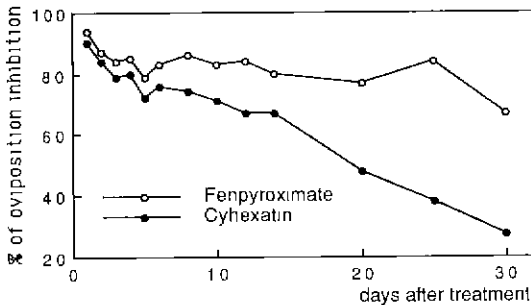


Fig. 5. Residually oviposition inhibition of fenpyroximate and cyhexatin against *T. urticae* adult at 100 ppm.

the chemical control of pest insects, especially mites, will be considered in the evaluation of the toxicity of new acaricidal chemical compounds.

Systemic Activity and Influence of Temperature

Most of selected acaricides had no systemic activity against adults of mites. But metasystox had systemic activity against *T. urticae* adults. As shown in Figure 6, the systemic activity of metasystox at 800 ppm showed 100% mortality at 24 hours after treatment, using soil-drench method. Because the systemic effect is major factor for evaluating the toxicity of new acaricidal chemical compounds, it seems to be considered.

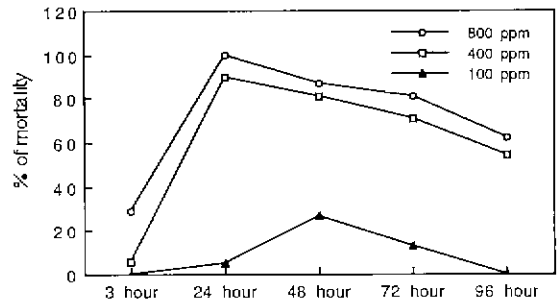


Fig. 6. The systemic effect of metasystox at different concentration against *T. urticae* adult.

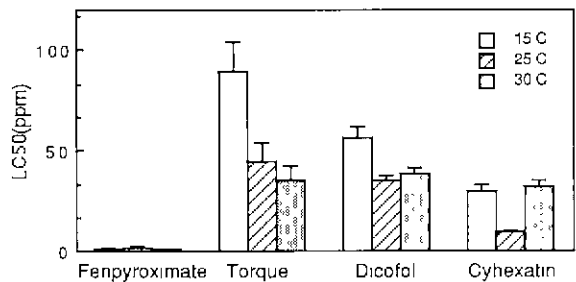


Fig 7. The miticidal activity of fenpyroximate, torque, dicofol and cyhexatin under three different temperature conditions against *T. urticae* adult.

Influence of temperature on the activity of fenpyroximate, torque, dicofol and cyhexatin was assessed. The results, shown in Figure 7, indicate that fenpyroximate has stable activity under various temperature condition and no temperature-dependent in comparison with other selected acaricides. In case of torque, is similar to that obtained by Fukuchi et al. (1990). Although torque, is similar organo-tin compound to cyhexatin, the effect of temperature on the activity was different. It seems to be due to mode of action and physicochemical difference between the two chemicals. But this difference remains to be clarified. Therefore, the acaricidal activity under different temperature conditions will be a major factor for evaluating new acaricidal chemical compounds.

In conclusion, in the evaluation of new acaricidal

chemical compounds will be considered the ovicidal and adulticidal activity depending on different developmental stages, effect of oviposition inhibition, residual activity, knockdown and systemic activity and influence of temperature, etc.

REFERENCE CITED

- Cho, K.Y. 1987. Establishment of the screening system for developing new chemical compounds, 844 pp. Korea Ministry of Science and Technology.
- Finney, D.J. 1982. "QUOT 10" for Probit Analysis (modified by Y.H. Song).
- Fukuchi, T., C.Nakazawa, Y. Kohyama & I. Okada. 1990. Characteristics and miticidal activity of MK-239, 5 pp. Mitsubishi Kasei Corporation, Research Center Report.
- Hattori, J. 1990. Miticide development top priority in Japan. Farm chemicals International, June: 33~36.
- Hirata, K., M. Kudo, J. Miyake, Y. Kawamura & T. Ogura. 1988. NC-129-a new acaricide, pp. 41~48. Brighton Crop Protection Conference, pest and disease.
- Hoy, M.A. & Y. Ouyang. 1986. Selectivity of the acaricides clofentezine and hexythiazox to the predator *Metaseiulus occidentalis* (Acari: Phytoseiidae). J. Econ. Entomol. 79: 1377~1380.
- Kasahara, I., N. Matsui, T. Yamada, M. Kaeriyama & K. Ishimitsu. 1991. Stereoselective synthesis and acaricidal activity of novel thiazolidinone, *In* Synthesis and Chemistry of Agrochemicals II (eds. D.R. Baker, J.G. Fenyes and W.K. Morberg), pp. 340~351, American Chemical Society, Washington.
- March, R.B. 1976. Properties and actions of bridged diphenyl acaricides. Environ. Health Prospect. 14: 83~91.
- Neal, J. W. Jr., M.S. McIntosh & K.M. Gott. 1986. Toxicity of clofentezine against the twospotted and carmine spider mite (Acari: Tetranychidae). J. Econ. Entomol. 79: 479~483.
- Sakaitsuru, Y. 1987. Development and market prosepct of new agrochemicals, 251 pp. CMC Ltd., Tokyo (*In* Japanese).
- Yamada, T., M. Kaeriyarma, N. Matsui & H. Yoneda. 1987. Development of a new miticide, hexythiazox. J. Pest. Sci. 12: 327~331.

(Received July 1, 1992)