IMPROPER LABELLED CONCENTRATION OF PESTICIDE FORMULATION, A CAUSE OF AN ENVIRONMENTAL HEALTH PROBLEM

ความเข้มข้นของยาฆ่าแมลงที่ไม่ถูกต้องตามฉลาก ซึ่งอาจก่อให้เกิดปัญหาต่ออนามัยสิ่งแวดล้อม

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ABSTRACT

This study was to determine the concentration of active ingredient and the volume of pesticides in commercial products. The limit of percentage of active ingredient was based on FAO recommendation. The actual volume was measured and compared with the label. Three groups of pesticides, cypermethrin, monocrotophos and mevinphos were analyzed by gas chromatography. Ten from twelve brands of cypermethrin contained the active ingredient within FAO limit but the exact volume of all brands were less than the labelled amount. Only one out of eleven brands of monocrotophos had the active ingredient within the FAO limit (98.70%). The other average contents were only 58.40% of the label (0-86.23%). Two of these products had the same volume as the label. For mevinphos, twelve brands were analyzed. Only one contained the active ingredient in the limit (98.96%). The average concentrations of the others were 76.12% of the label (0-93.38%). None of these satisfied the volume labelled. It was concluded that these commercial pesticides contained less active ingredient and volume than the declared amount on the label.

บทคัดย่อ

ในวงการเกษตรกรรม เกษตรกรมักนิยมใช้ยาฆ่าแมลงในปริมาณมากกว่าที่กำหนดไว้ในฉลาก ทั้งนี้เพื่อหวังผลในการฆ่าแมลงให้มีประสิทธิภาพสูงสุด โดยคิดว่าการใช้ตามฉลากที่ระบุไว้จะไม่ได้ผลในการฆ่าแมลงเท่าที่ควร และแมลงบางชนิดอาจมีความต้านทานต่อยาฆ่าแมลงชนิดนั้น ๆ

ได้ ด้วยเหตุผลดังกล่าวที่ยังไม่แน่ชัดนัก ทำให้ต้องศึกษาถึงปริมาณของสารออกฤทธิ์ (active ingredient) ในสูตรสำเร็จของยาฆ่าแมลงที่มีจำหน่ายอยู่ในท้องตลาดว่าตรงกับที่กำหนดไว้ในฉลากหรือไม่ โดยอาศัยหลักเกณฑ์ขององค์การอาหารและเกษตรแห่งสหประชาชาติ (FAO) นอกจากนี้ ยังวัดปริมาตรของยาฆ่าแมลงเทียบกับที่ระบุไว้ในฉลากของยาฆ่าแมลงแต่ละตัวอย่างด้วย การวิเคราะห์หาปริมาณของยาฆ่าแมลงทำโดยใช้เครื่องก๊าซโครมาโตกราฟ โดยแบ่งชนิดของยาฆ่าแมลงออกเป็น 3 กลุ่มใหญ่ ๆ คือ ไซเปอร์เมตทริน โมโนโครโตฟอส และเมวินฟอส ผลจากการวิเคราะห์ กลุ่มไซเปอร์เมตทริน มีปริมาณของสารออกฤทธิ์ตรงตามกำหนดของ FAO อยู่ 10 ตัวอย่างจาก 12 ตัวอย่าง ส่วนอีก 2 ตัวอย่างมีปริมาณสารออกฤทธิ์ 85.9 และ 92.56% และปริมาตรของทุกตัวอย่างต่ำกว่าที่ระบุไว้ในฉลากทั้งสิ้น กลุ่มโมโนโครโตฟอสมีเพียงตัวอย่างเดียวจาก 11 ตัวอย่าง ที่ตรงตามกำหนดของ FAO (98.70% ของสารออกฤทธิ์ที่ระบุไว้) ส่วนอีก 10 ตัวอย่างมีปริมาณของสารออกฤทธิ์โดยเฉลี่ยเพียง 58.40% เท่านั้น คือ ระหว่าง 0–86.23% และมีปริมาตรตรงตามกำหนดในฉลากเพียง 2 ตัวอย่าง สำหรับกลุ่มเมวินฟอส มีเพียงตัวอย่างเดียวจาก 12 ตัวอย่าง ซึ่งมีปริมาณของสารออกฤทธิ์ตรงตามกำหนด (98.96% ของสารออกฤทธิ์ที่ระบุไว้) ส่วนอีก 11 ตัวอย่างมีค่าเฉลี่ย 76.12% ของที่กำหนดในฉลาก คือ ระหว่าง 0–93.38% และปริมาตรของทุกตัวอย่างไม่ตรงตามที่กำหนดไว้ในฉลาก สรุปผลการทดลองว่ายาฆ่าแมลงส่วนใหญ่ ปริมาณของสารออกฤทธิ์และปริมาตรต่ำกว่าที่ระบุไว้ในฉลาก เกษตรกรจึงใช้ยาฆ่าแมลงในปริมาณที่มากกว่าคำแนะนำวิธีการใช้ที่ระบุไว้ในฉลาก ในกรณีที่เกษตรกรใช้ยาฆ่าแมลงบางชนิดซึ่งมีค่าใกล้เคียงกับที่ระบุไว้ในฉลากโดยใช้ในปริมาณ 3 ถึง 4 เท่าของที่แนะนำ จะทำให้เกิดอันตรายอย่างยิ่งต่อเกษตรกรเอง และยังส่งผลกระทบต่อสิ่งแวดล้อมต่าง ๆ ทำให้กลายเป็นปัญหาสำคัญเกี่ยวกับอนามัยสิ่งแวดล้อม

INTRODUCTION

About 16,700 tons of pesticides, a cause of health problems in Thailand, were imported in 1983. The majority of them was insecticides. It must be considered that these insecticides will be less harmful if it is used properly. From the experience in the field, it was found that Thai farmers used more pesticides than the recommended dose to control insects effectively. Some of them dispensed 2 or more kinds of pesticides together to get an additive effect. The results from using more pesticides than recommended dose would be a direct hazard to the farmers themselves and the environment. From this point of view, it could be summarized that :

1. The use of higher amount of pesticides than the recommended dose might be hazardous to the farmers themselves. The toxicity may be acute or chronic.

2. The farmer uses more pesticide than necessary. The cost of control will then be increased. As a result, the cost of products will be higher.

3. Widespread use of pesticides will affect human health. The ecological disruption will occur, and non-target organisms and wildlife will be affected.

If the concentration of pesticide used by farmers is correct as stated in the label, it should be adequate to kill insects. In fact, from the experience of the farmers, they found that it was not always true. They have to use more pesticide than the recommended dose which they thought it will be high enough to kill insects. To make insecticide more effective, sometimes they use the concentration which is 2 to 4 times higher than the labelled dose. They also claimed that insects in that area are resistant to these pesticides. The question is whether the concentration of pesticides in the containers are the same as written on the label.

According to the fact that the farmers normally use more pesticides than recommended dose, the analysis of the concentration of commercial products of pesticides which are available in the markets become a necessity. The results of which could be further stipulated and certain measured implemented to correct such a malpractice performed by pesticide dealers.

MATERIALS AND METHODS

Materials

Commercial brands of pesticides were collected from different provinces such as Lop Buri, Nakhon Sawan, Phetchabun and Bangkok. The organophosphates, monocrotophos and mevinphos, collected include 23 brands which were used in this study. Twelve brands of pyrethroid group were also collected and analysed. The 3 groups of pesticide standards and samples were :

1. Monocrotophos [dimethyl (E)-1-methyl-2-methylcarbamoylvinyl phosphate] and 11 brands of samples
2. Mevinphos (2-methoxy-carbonyl-1-methylvinyl dimethyl phosphate) and 12 brands of samples
3. Cypermethrin [(S,R)- α -cyano-3-phenoxybenzyl-(1R, 1S, cis, trans)-2, 2-dimethyl-3-(2, 2-dichlorovinyl) cyclopropanecarboxylate] and 12 brands of samples

Reagent

Acetone (AR grade)

Apparatus

Gas chromatograph (Varian Techtron Model 3700 equipped with CDS 111 and recorder).

Method

1. The volume of each commercial products was measured by using measuring cylinder.

2. The specific gravity of the samples was determined by using hydrometers and was reported at 30°C.

3. The active ingredient of the pesticide in the sample was determined by gas chromatograph. The operating condition of the instruments were shown in Table 1.

The standard of pesticide was weighed to the nearest 0.2 g. It was transferred into 50 ml volumetric flask and was made up to the volume with acetone. Standard and sample solution 5 μl were injected into GLC. The calculation was done as follows.

For external standard

Basic Formula

$$\text{Amount} = \text{Area} \times \text{CF}$$

From CDS 111

$$\text{Amount} = \text{Area} \times \text{CF} \times \frac{\text{Scalar}}{10{,}000}$$

$$\text{CF} = \text{Calculation Factor}$$

$$= \frac{\text{Amount ext. st.} \times 10{,}000}{\text{Area ext. std.}}$$

$$\text{Scalar} = \text{multiplication factor for unit conversion}$$

From the result of CDS 111, each sample solution content was calculated as %W/W and %W/V by the following equations :

$$\%W/W = \frac{C \times V}{m}$$

$$\%W/V = \frac{C \times V \times \rho}{m}$$

where C = Concentration of pesticides in sample solution % W/V

V = Volume of sample solution used (ml)

m = mass of original sample (g)

ρ = density of original sample

RESULTS

The analysis of the active ingredient of the pesticides in 3 groups revealed that among cypermethrin group, 10 from 12 brands contained the active ingredient within FAO limit.[3] Only 2 of them had the concentration below the FAO Limit (Table 2, Figure 1). The actual volume of all brands was less than the labelled amount (Table 3). Among monocrotophos, only one brand had the active ingredient within the FAO limit (Table 4). The concentration was 98.70% of the label (Table 8). Others had concentrations ranged from 0-86.20% of the label. The average contents were only 58.40% of the label. Two of these products had no monochrotophos appeared on the chromatogram (Figure 2). From 11 brands of monocrotophos group, only 2 had the same volume as the labels (Table 5).

Among mevinphos, twelve brands were analyzed. Only one contained the active ingredient within the FAO limit (Table 6). Its exact content was 98.96% of the label (Table 8). The average concentration of the others were 76.12% of the label. The contents ranged from 0-93.38% of the label. One product had no mevinphos appeared on the chromatogram (Figure 3). None of these products satisfied the volume labelled (Table 7).

DISCUSSION

From this study, it is found that the active ingredient in some commercial products which are available in the markets contained less active ingredient as stated on the label. The majority of them are mevinphos and monochrotophos groups. Unfortunately, these 2 groups of pesticides are very popular in the country. Two out of eleven commercial brands of monochrotophos, namely, Azodren and Kegan, contained no active ingredient. Eight brands contained less active ingredient than the label. Only one brand contained the active ingredient as the label. When farmers follow the recommended dose, the killing effect will not be effective. For mevinphos, Thanaphos contained no active ingredient. Only one out of twelve contained the same active ingredient as the label. Ten out of twelve contained the active ingredient less than the labels. In a normal practice the farmers will fail to obtain the killing effect from these pesticides. Normally, the farmers dispense more pesticide than the recommended dose that appeared on the label. When they mix 2 to 4 times of the labelled amount, it will then be effective. It is concluded that farmers have to dispense more pesticide than labelled dose because most of the commercial products contain less amount of active ingredient than the labels. Some of them also mixed 2 or more pesticides together to get better effect. They do not know that the products they are using do not contain the same amount of pesticide as shown on the label.

From the farmers' experience, when they used higher amount of pesticide, they had the symptom of pesticide toxicity. In addition, the pesticide residue will be left in the environment more than when normally used. Wongphanich[4] reported that 33.3% of pesticide poisoning was found among the farmers who were engaged in dispensing of the pesticide. This would agree with our study in the case when the farmers dispense larger amount of pesticide which contain the specified amount of active ingredient as labelled. It would be more hazardous to them. Besides, such practices will interfere with the environment. Large amount of pesticides from sprayed crops and vegetables will be accumulated in the body of the consumers, and those left in soil and water will adversely affect the wildlife and the environment.

We recommend that the quality control of commercial products must be exercised and regulated. The active ingredient in each product should be certified before selling in the market. Restriction on the sale of highly toxic pesticides in a number of developing country must be performed.[1] The enforcement by law between the government and industry in the responsibility to the farmers should be established.[2]

CONCLUSION

The active ingredient of pesticides, mevinphos and monochrotophos, from the commercial products which are available in the markets contained less active ingredients than the actual concentrations which are stated on the labels. Farmers usually dispense 2 to 4 times of the labelled amount to obtain better effect. Some of them experienced pesticide poisoning. The result from improper use of these products will be a health hazard to the farmers. It also leads to the deterioration of the environment.

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Table 1. Condition of the instrument

	cypermethrin*	monocrotophos	mevinphos
Column			
Material	Glass	Glass	Glass
Length × ID	1.0 m × ¼″	2.0 m × ¼″	2.0 m × ¼″
Stationary phase	3% OV 101	3% OV 101	3% OV 101
Solid support	Chromosorb W-HP, 80/100	Chromosorb W-HP, 80/100	Chromosorb W-HP 80/100
Detector	FID	FID	FID
Temperature (°C)			
Column oven	250	190	145
Injection port	270	210	160
FID	270	250	250
Carrier Gas	Nitrogen	Nitrogen	Nitrogen
Flow rate	30 ml/min	14 ml/min	25 ml/min
Attenuator	× 4	× 8	× 4
Injection volume	5 μl	5 μl	5 μl

* The injection end of column cannot be plugged by the quartz wool, because the decomposition of "cypermethrin" during analysis will appear.[3]

Table 2. Content of cypermethrin

No.	Trade name	Sp. Gr.	Declared percentage of active ingredient in formulation	Detected percentage of active ingredient in formulation	Acceptable[3] limits of percentage of active ingredient
1.	Champ	0.9573	25*	25.43% W/W	23.5-26.5
2.	Cymbush	Non-detectable	25*	23.14% W/W(0)	23.5-26.5
3.	Cyper	0.9513	25% W/V	24.60% W/V	23.5-26.5
4.	Cypersect	0.9513	25*	24.88% W/W	23.5-26.5
5.	Matang	0.9513	25% W/V	24.52% W/V	23.5-26.5
6.	Mix-25	Non-detectable	25% W/V	25.00% W/V	23.5-26.5
7.	Nurelle	0.9940	25% W/V	23.47% W/V	23.5-26.5
8.	Sherpa	0.9597	25% W/V	24.52% W/V	23.5-26.5
9.	Ripcord	0.9113	15% W/V	14.13% W/V	14.1-15.9
10.	Tack-D	1.0753	15% W/V	14.25% W/V	14.1-15.9
11.	Cymbush-D	0.8943	10% W/V	8.59% W/V(0)	9-11
12.	Nurelle	0.9273	10% W/V	10.40% W/V	9-11

*Not mentioned as W/V or W/W

(0) Active ingredient is below FAO limit

Table 3. Measured volume of cypermethrin

No.	Trade name	Labelled volume (ml)	Actual volume (ml)	% Difference of volume	Price (baht)
1.	Champ 25%	500	465	−7.0	628/500 ml
2.	Cymbush 25%	100	98	−2.0	150/100 ml
3.	Cyper 25% W/V	500	476	−4.8	600/500 ml
4.	Cypersect 25%	500	494	−1.2	650/500 ml
5.	Matang 25% W/V	500	485	−3.0	670/500 ml
6.	Mix-25 25% W/V	100	97	−3.0	150/100 ml
7.	Nurelle 25% W/V	500	477	−4.6	600/500 ml
8.	Sherpa 25% W/V	500	482	−3.6	650/500 ml
9.	Ripcord 15% W/V	500	490	−2.0	380/500 ml
10.	Tack-D 15% W/V	500	487	−2.6	475/500 ml
11.	Cymbush-D 10% W/V	500	490	−2.0	350/500 ml
12.	Nurelle 10% W/V	500	485	−3.0	300/500 ml

Table 4. Content of monocrotophos

No.	Trade name	Sp. Gr.	Declared percentage of active ingredient in formulation	Detected percentage of active ingredient in formulation	Acceptable[3] limits of percentage of active ingredient
1.	Azodrin	1.0913	60% W/V	59.22% W/V[(A)]	57.5-62.5
2.	Barasol	1.1324	60% W/V	48.36% W/V	57.5-62.5
3.	Mophos	1.1531	60% W/V	51.74% W/V	57.5-62.5
4.	Azodren	1.0874	56% WSC	0 % W/W	53.5-58.5
5.	Monocron	1.1394	56% W/V	47.77% W/V	53.5-58.5
6.	Novaren	1.1533	56% W/V	43.20% W/V	53.5-58.5
7.	Nuvacron	1.1393	56% WSC	28.33% W/W	53.5-58.5
8.	Crotophos	1.1193	55% W/W	34.79% W/W	52.5-57.5
9.	Kegan	0.9733	55% W/W	0.04% W/W	52.5-57.5
10.	Mocron	1.1194	55% W/W	38.45% W/W	52.5-57.5
11.	Novaren	1.0874	40% W/V	28.39% W/V	38.0-42.0

WSC = Water Soluble Concentrate

(A) Active ingredient is in FAO limit

Table 5. Measured volume of monocrotophos

No.	Trade name	Labelled volume (ml)	Actual volume (ml)	% Difference of volume	Price (baht)
1.	Azodrin 60% W/V	500	500	0	120/500 ml
2.	Barasol 60% W/V	1000	980	−2.0	165/1000 ml
3.	Mophos 60% W/V	1000	850	−15.0	–
4.	Azodren 56% WSC	500	475	−5.0	110/500 ml
5.	Monocron 56% W/V	1000	1000	0	200/1000 ml
6.	Novaren 56% W/V	500	488	−2.4	110/500 ml
7.	Nuvacron 56% W/V	500	477	−4.6	120/500 ml
8.	Crotophos 55% W/W	500	480	−4.0	100/500 ml
9.	Kegan 55% W/W	500	470	−6.0	120/500 ml
10.	Mocron 55% W/W	500	480	−4.0	95/500 ml
11.	Novaren 40% W/V	500	505	+1.0	–

Table 6. Content of mevinphos* (E&Z isomer)

No.	Trade name	Sp. Gr.	Declared percentage of active ingredient in formulation	Detected percentage of active ingredient in formulation	Acceptable[3] limits of percentage of active ingredient
1.	Phosdyne	0.9333	25**	21.59% W/W	23.5 -26.5
2.	Dithrinphos	0.9245	24% W/V	21.10% W/V	22.56-25.44
3.	Ecomax	0.9260	24**	15.10% W/W	22.56-25.44
4.	Grophos	0.9343	24% W/V	21.23% W/V	22.56-25.44
5.	Mevinphos[(a)]	0.9303	24% W/V	22.27% W/V	22.56-25.44
6.	Mevinphos[(b)]	0.9385	24% W/V	20.12% W/V	22.56-25.44
7.	Mevinphos[(c)]	0.9343	24**	17.71% W/W	22.56-25.44
8.	Ozo	–	24**	20.57% W/W	22.56-25.44
9.	Phosdrex	0.9270	24**	22.41% W/W	22.56-25.44
10.	Phosdrin	0.9329	24% W/V	23.75% W/V[(A)]	22.56-25.44
11.	Twinphos	0.9613	24**	19.72% W/W	22.56-25.44
12.	Thanaphos	1.0274	24**	0.00% W/W	22.56-25.44

(a),(b),(c) Products from different manufacturers

(A) Active ingredient is in FAO limit

* The calculation of total mevinphos content derive by multiplying the mevinphos (E) with $\frac{100}{60}$

** Not mentioned as W/V or W/W

Table 7. Measured volume of mevinphos

No.	Trade name	Labelled volume (ml)	Actual volume (ml)	% Difference of volume	Price (baht)
1.	Phosdyne 25%	500	470	-6.0	55/500 ml
2.	Dithrinphos 24% W/V	500	465	-7.0	55/500 ml
3.	Ecomax 24%	500	375	-25.0	55/500 ml
4.	Grophos 24% W/V	1000	995	-0.5	90/1000 ml
5.	Mevinphos[(a)] 24% W/V	500	470	-6.0	55/500 ml
6.	Mevinphos[(b)] 24% W/V	500	475	-5.0	55/500 ml
7.	Mevinphos[(c)] 24% EC	500	488	-2.4	60/500 ml
8.	Ozo 24%	100	87	-13.0	-
9.	Phosdrex 24% EC	1000	980	-2.0	90/1000 ml
10.	Phosdrin 24% W/V	500	499	-0.2	65/500 ml
11.	Twinphos 24% EC	500	437	-12.6	55/500 ml
12.	Thanaphos 24% EC	500	458	-8.4	60/500 ml

[(a), (b), (c)] Products from different manufacturers

Table 8. Percentage of detected active ingredient of pesticides as compared with labelled concentration

Cypermethrin		Monocrotophos		Mevinphos	
Trade name	% of active ingredient (detected)	Trade name	% of active ingredient (detected)	Trade name	% of active ingredient (detected)
Champ	101.72	Azodrin	98.70	Phosdyne	86.36
Cymbush	92.56	Barazol	80.60	Dithrinphos	87.92
Cyper	98.40	Mophos	86.23	Ecomax	62.92
Cypersect	99.52	Azodren	0	Grophos	88.46
Matang	98.08	Monocron	85.30	Mevinphos[(a)]	92.79
Mix-25	100.00	Novaren	77.14	Mevinphos[(b)]	83.83
Nurelle	93.88	Nuvacron	50.60	Mevinphos[(c)]	73.79
Sherpa	98.08	Crotophos	63.25	Ozo	85.71
Ripcord	94.20	Kegan	0.07	Phosdrex	93.38
Tack-D	95.00	Mocron	69.91	Phosdrin	98.96
Cymbush-D	85.90	Novaren	70.98	Twinphos	82.17
Nurelle	104.00			Thanaphos	0

(a), (b), (c) Products from different manufacturers

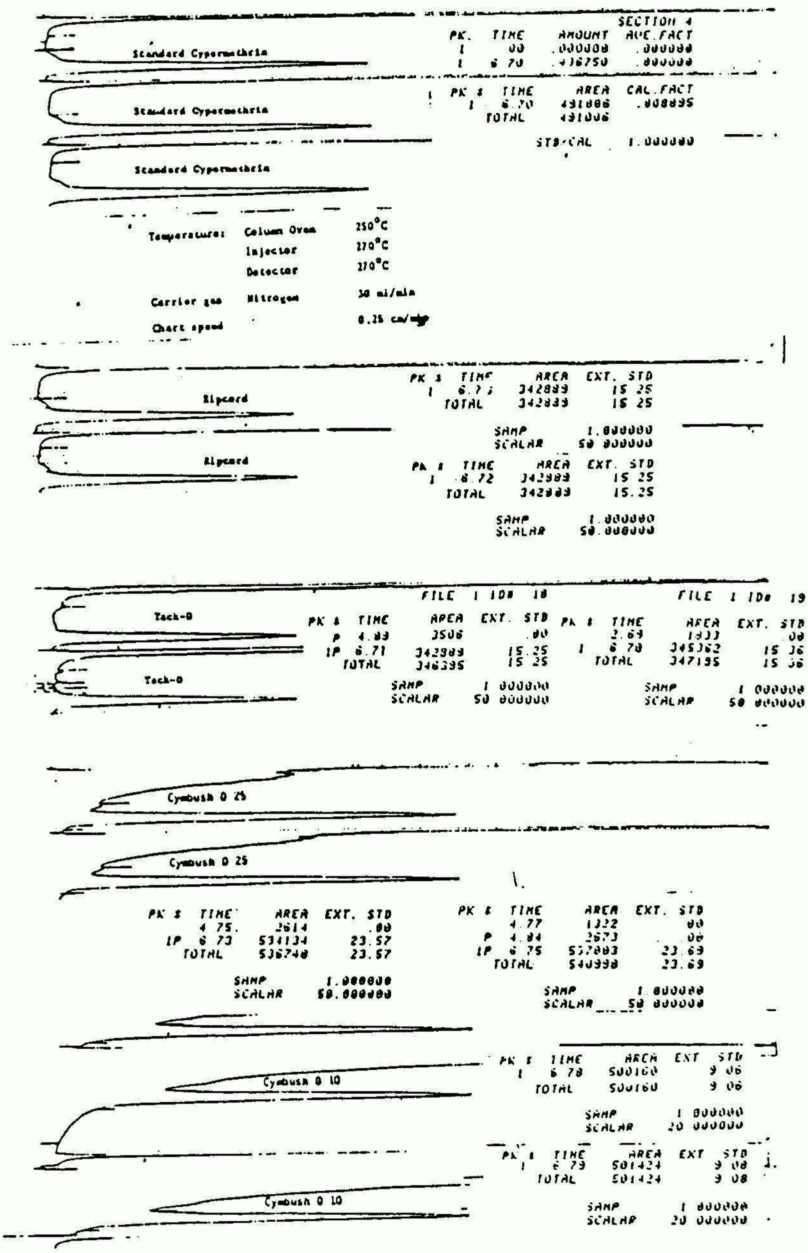

Fig. 1 Chromatogram of cypermethrin

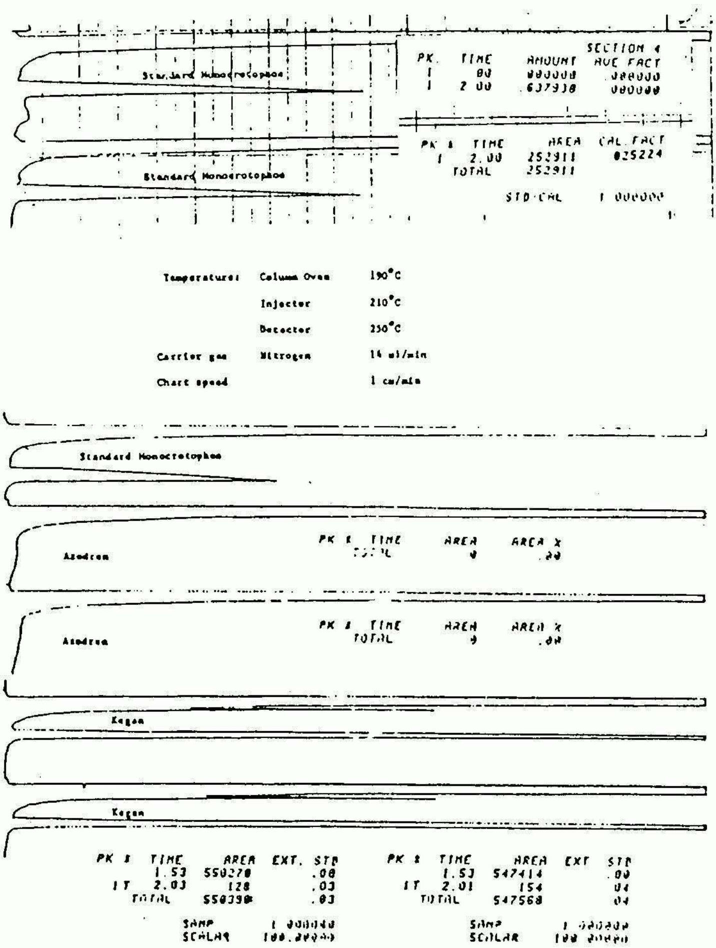

Fig. 2 Chromatogram of monocrotophos

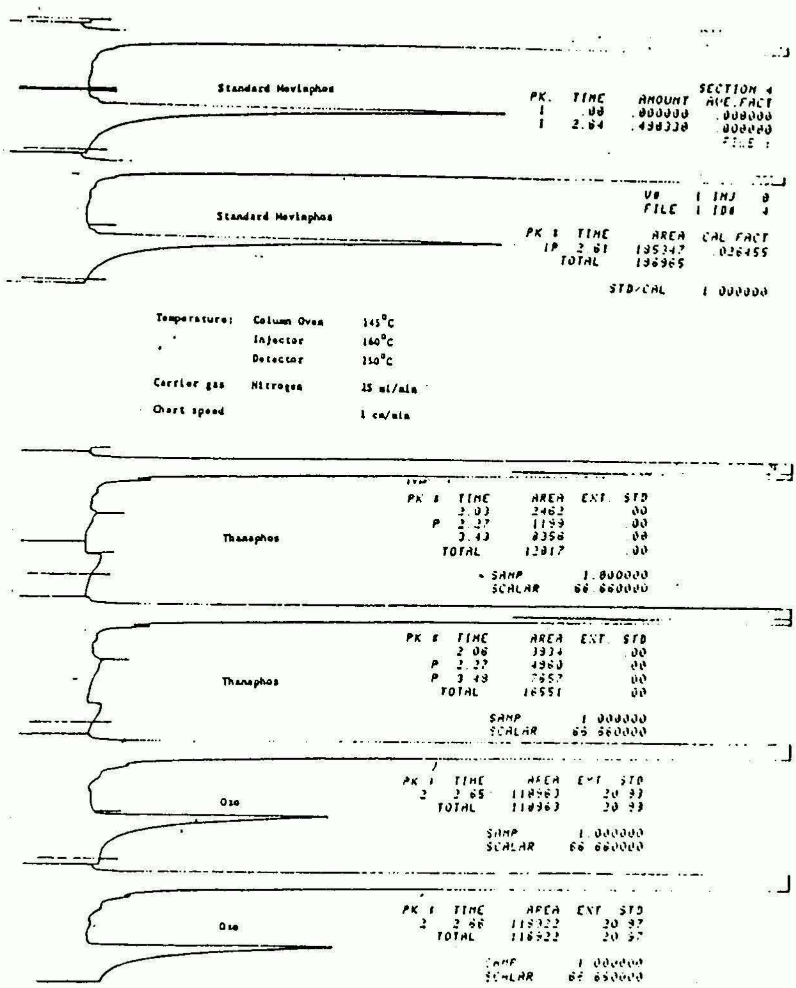

Fig. 3 Chromatogram of mevinphos