Assessment of Occupational Exposure to Malathion and Bifenthrin in Mosquito Control Sprayers Through Dermal Contact

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Objective: *To assess occupational exposure of malathion and bifenthrin concentrations by dermal contact and urinary 3-(2-chloro-3, 3, 3-trifluoro-1-propenyl)-2, 2-dimethyl-cyclopropanecarboxylic (TFP) acid, health symptoms developed and the relationship between bifenthrin concentrations and TFP acid in urine of the mosquito control sprayers.*
Material and Method: *The aerosols of these two pesticides were collected using 100 cm^2 cotton patches attached on the skin of upper legs of 54 volunteer of mosquito control sprayers. Their urine samples were also collected before and after application.*
Results: *These subjects exposed to average malathion and bifenthrin concentrations of 0.18 and 0.32 $\mu g/cm^2$, respectively. After application, the average concentration of urinary TFP acid in the sprayers was 39.22±50.77 mg/g creatinine ranging from 0.58 to 261.19 mg/g creatinine. A significant difference was found between urinary TFP acid levels before and after application ($p<0.001$) but the bifenthrin concentrations through dermal contact and urinary TFP acid levels were not significantly correlated ($p>0.05$).*
Conclusion: *The mosquito control sprayers had dermal contact with smoke of malathion and bifenthrin and some sprayers developed health symptoms after exposure. They should use protective clothing made of plastic, nylon or polyester to protect sprayers from skin contact.*

Keywords: *Malathion, Bifenthrin, TFP acid, Mosquito control sprayers*

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The malathion and bifenthrin pesticides usually absorbed into the body of sprayers through dermal contact during application[1,2]. These two pesticides have low vapor pressure ($5.03x10^{-6}$ mmHg for Malathion, $1.81x10^{-7}$ mmHg for Bifenthrin at 25°C) and the concentrations used are typically low. In addition, the dermal exposure is the main route of direct contact with these pesticides and upper legs are found highest exposure into the spraymans' body (60-80%)[3-5].

After exposure into the human body, both malathion and bifenthrin pesticides are rapidly metabolized by cleavage the central ester linkage, mainly in the liver, and leading to different detoxified metabolites. They are eliminated in urine at a half-life of 4-6 hours. The urinary metabolites are malathion dicarboxylic acid (MDA) for malathion and 3-(2-chloro-3, 3, 3-trifluoro-1-propenyl)-2, 2-dimethyl-cyclopropanecarboxylic acid (TFP) for bifenthrin. These metabolites can be used as biomarker for biological monitoring of the mosquito control sprayers[3,6,7]. Adamis et al used mixed pesticides of pirimiphosmethy, dimethoate and permethrin as co-formulated formulas of organophosphate and synthetic pyrethroid for pest/insect control used in greenhouse tomato spraying application[19]. The workers were assessed for occupational exposure to these pesticides by dermal contact and inhalation. Smith et al used the chlorpyrifos and bifenthrin as a mixed solution for the protection of buildings against termite infestation but they did not study of dermal contact to these pesticides in workers[7]. This is the first study of occupational

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exposure to malathion and bifenthrin by dermal contact in mosquito control application, for disease-vector control in the community.

The objective of the present study aimed to assess dermal contact to malathion and bifenthrin pesticides, to determine urinary TFP acid metabolites and health symptoms and to assess the relationship between bifenthrin concentrations and TFP acid in urine of the mosquito control sprayers.

Material and Method

Study design

A cross sectional study was performed to assess occupationally dermal contact to malathion and bifenthrin pesticides in the mosquito control sprayers and to determine the bifenthrin metabolite as TFP acid in urine samples. The present study was approved by the ethics committee for human research, Faculty of Public Health, Mahidol University, MUPH2010-106.

Chemicals and reagents

Malathion (98.7% purity), bifenthrin (99.0% purity), 3-(2-chloro-3, 3, 3-trifluoro-1-propenyl)-2, 2-dimethyl-cyclopropanecarboxylic acid or TFP acid (97.0% purity), fluoranthene (99.0% purity) were purchased from Chem service, Japan.

Instrumentation

Gas chromatography mass spectrometry: HP 5890 series II plus and HP-5MS capillary columns (30 mx0.25 mm ID, 0.25 μm bonded film of 5% -Phenyl- 95% -Dimethylpolysiloxane, J&W Scientific, USA). The operating temperature for the injector was 250°C and a transfer line temperature of 280°C. The initial column temperature of 100°C was held for 1 min, then ramped at 6°C/min to 150°C and finally ramped at 15°C/min to 230°C and maintained for 11 min. The mass spectrometer used was a HP 5972 (Hewlett-Packard) at an ionization energy of 70 eV and the electron multiplier voltage at 2581V (+700 rel).

Calibration curve of malathion and bifenthrin

A five concentrations of 5, 15, 25, 35 and 45 μg/ml of mixed standard of malathion and bifenthrin were prepared and 100 μl of each concentration was mixed with 100 μl of 5 μg/ml fluoranthene (Internal Standard). One μl was injected into the GC/MS. The peak area of malathion and bifenthrin the peak area of fluoranthene (IS) was plotted against the concentrations of malathion and bifenthrin of three replicate determinations.

Calibration curve of TFP acid in urine

Five milliliters of the pooled urine samples were pipetted into test tubes; one ml of HCl (4 mole/l), 200 μl of fluoranthene (IS) and 200 μl of 10, 20, 30, 40 and 50 μg/ml of TFP acid were added. The mixture was incubated in a water bath at 90°C for 60 min; the mixture was cooled down. Afterward, 5 ml of n-hexane was added, and the mixture was shaken vigorously for 10 min in a test tube shaker and centrifuged for 10 min (2,000 rpm). The upper layers of n-hexane extract was removed by pipetting into a vial and evaporated to 100 μl using a gentle stream of nitrogen. One microliter of each analytical solution was injected into the GC/MS[7-9]. The calculated relative peak area ratio [the peak area of TFP acid/the peak area of fluoranthene (IS)] was plotted against the concentration of TFP acid of three replicate determinations.

Accuracy and precision of the TFP acid in urine

The known concentrations of TFP acid in urine were prepared at concentrations of 15, 30 and 45 μg/ml. The solutions were analyzed as described above. The percent recovery and coefficient of variation of the three replicate determinations were calculated.

Detection limit of the method

The TFP acid in urine at low concentrations of 1, 2, 3, 4 and 5 μg/ml were analyzed the same as the urine samples. The detection limit of the method was calculated following the National Institute for Occupational Health and Safety (NIOSH)[10].

Application in the field

Subjects

The inclusion criteria was male and age ranging 18-60 years old without serious contagious diseases and working as mosquito control sprayers of Preventive Medical Unit, Royal Thai Army who worked related to the pest/insect control in Bangkok and the vicinity areas. It is the policy of Preventive Medical Unit, Royal Thai Army for all workers to be monitor for bifenthrin metabolites in their bodies. All 54 subjects in different work shift of mosquito control sprayers were recruited.

Sample collection

The subjects were interviewed with questionnaire consisting of general characteristics (sex, age, marital status, smoking, alcohol drinking and personal disease), working and exposure characteristics (working duration, frequency, experiences, use of

personal protective equipment) and health effects (respiratory and other health symptoms) from application of pesticides. The urine samples were collected in polyethylene bottles 30-60 min before and after working period. The 108 cotton patches (10 x 10 cm) were placed on the skin of upper legs of subjects before working. They were then removed immediately after work and put in zip lock bags and kept on dry ice at a temperature of -18°C during transportation to the laboratory. All samples were stored at -20°C in a refrigerator until analysis.

Analysis of air samples

The cotton patches were put in a 100 ml of the erlenmeyer flask. Thirty milliliter of ethyl acetate and 200 µl of fluoranthene (IS) were added and the samples were shaken for 15 minutes in a vortex mixer. The extract was decanted into a round bottle flask through a filter paper No. 5. The erlenmeyer flasks were then shaken with 2 sequential volumes of 20 ml ethyl acetate for 15 minutes in a vortex mixer. The ethyl acetate layers were combined and evaporated to 1-2 ml in a rotary evaporator at a water bath temperature of 40°C. The ethyl acetate residue was transferred to a vial and evaporated to dryness under a gentle stream of nitrogen. The residue was dissolved in 1 ml of acetone-n-hexane (30:70) and quantitative analysis by a GC/MS[3,11].

Analysis of TFP acid in urine samples

Five milliliters of the urine samples were put into the test tube; one ml of HCl (4 mol/l), 200 µl of fluoranthene (IS) and 200 µl of acetone were added. The mixture was incubated in a water bath at 90°C for 60 min. After the mixture was cool down, 5 ml of n-hexane was added, and the mixture was shaken vigorously for 10 min in a test tube shaker and centrifuged for 10 min (2,000 rpm). The upper layers of n-hexane extract was removed by pipetting into a vial and evaporated to 100 µl by using a gentle stream of nitrogen. One microliter of each analytical solution was injected into the GC/MS.

Statistical analysis

Percentage, mean and standard deviation were used for describing the demographic and working characteristics, concentrations of malathion, bifenthrin and bifenthrin metabolite and respiratory and other health symptoms. Paired t-test was used for analyzing the differences of TFP acid metabolite levels in urine samples before and after working period. The Pearson correlation between the bifenthrin concentration from dermal contact and TFP acid metabolite in urine samples was analyzed. The differences of TFP acid metabolite levels between workers having symptoms and did not have symptoms were compared by independent t-test.

Results

Chromatograms of malathion, bifenthrin, TFP acid

Chromatograms of standard TFP acid, malathion, fluoranthene (IS) and bifenthrin at 10 µg/ml each are presented in Fig. 1. The retention times of TFP acid, malathion, fluoranthene and bifenthrin were 6.95, 15.76, 16.87 and 23.98 min, respectively.

Calibration curves of malathion and bifenthrin in air

The calibration curve parameters of malathion and bifenthrin are presented in Table 1. The standard curve displayed linear relationship between peak area ratios of malathion and bifenthrin divided by fluoranthene (internal standard) versus malathion and bifenthrin concentrations at the correlation coefficients of 0.9985 and 0.9997, respectively.

Calibration curve of urinary TFP acid

The calibration curve parameters of urinary TFP acid showed a linear relationship at the correlation coefficient of 0.9991 (Table 1). The chromatogram of urinary TFP acid in urine of a mosquito control sprayer is presented in Fig. 2.

The accuracy, precision and detection limit of the method for analysis of urinary TFP acid

The accuracy of the method for analysis of urinary TFP acid ranged from 99.9 to 100.8% at concentrations of 15, 30 and 45 µg/ml TFP acids in

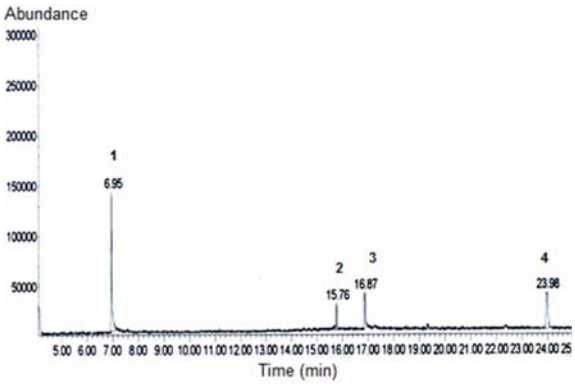

Fig. 1 Chromatogram of TFP acid (1), malathion (2), fluoranthene (3) and bifenthrin (4).

urine for between-day assay and the relative standard deviations (% RSD) were in the range of 0.9 to 1.4% (Table 2). The detection limit of TFP acid in urine was 0.23 µg/ml.

Characteristics of subjects

The 54 subjects were male; their average age was 38.2 years old (Table 3). The 16.7% of subjects had diseases of hypertension (7.4%), high cholesterols (3.7%) and low back pain (5.6%).

Exposure characteristic

They sprayed pesticide for 3-4 hours/day (Table 4). Their average working experience was 11.2 years ranging from less than a year to 30 years.

Use of personal protective device (PPD)

The mosquito control applicators used personal protective devices (except the gloves) such as mask (92.6%), shoes and protective clothing

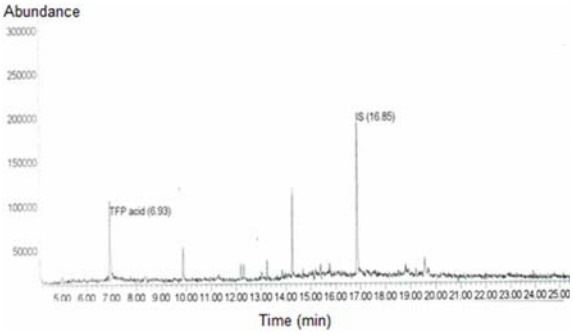

Fig. 2 Chromatogram of TFP acid metabolite in urine sample of applicators.

Table 1. Calibration parameters of malathion and bifenthrin on cotton patches and TFP acid in urine

Compound	Slope	Intercept	Correlation coefficient (r)
Malathion	0.1911	-0.0884	0.9985
Bifenthrin	0.1997	-0.1407	0.9997
TFP acid	0.1904	-0.0930	0.9991

Table 2. The accuracy and precision of the method for between-day assay of TFP acid in urine

Concentration (µg/ml)	Measured value	% Recovery	% RSD (n = 3)
15	15.1	100.8	1.4
30	30.0	99.9	1.3
45	45.1	100.3	0.9

Table 3. Characteristic of studied mosquito control sprayers

Characteristic	Numbers (n = 54)	Percentages (%)
Gender		
Male	54	100.0
Age group (years)		
<20	2	3.7
20-30	18	33.3
31-40	9	16.7
41-50	11	20.4
>50	14	25.9
Marital status		
Single	22	40.7
Married	32	59.3
Smoking		
Yes	18	33.3
Alcohol drinking		
Yes	34	63.0
Personal disease		
Yes*	9	16.7

* Hypertension, High cholesterols, Low back pain

Table 4. The working characteristics of studied mosquito control sprayers

Characteristic	Numbers (n = 54)	Percentages (%)
Working time (hr/day)		
3	13	24.1
4	41	75.9
Working frequency (day/week)		
1	7	13.0
2	40	74.1
3	4	7.4
4	3	5.6
Working experience (year)		
<1	3	5.6
1-10	29	53.7
11-20	13	24.1
>20	9	16.7
Use of personal protective devise (PPD)		
Mask	50	92.6
Gloves	-	-
Shoes	54	100.0
Clothing	54	100.0
Other*	26	48.2

* Hat, goggles and ear plugs

(Table 4). Additionally, they also used other safety devices such as hat (48.2%), goggle (48.2%) and ear plugs (48.2%).

Spraying characteristic

The spraying characteristic in the mosquito control application was smoke type (100%). The spraying was carried out with a portable sprayer (Super Hawk Model 2605; USA) at a pressure of 10 to 15 bars. The highest power of the sprayer was 30 hp-hr; the spraying flow rate of liquid solution ranged from 0 to 40 liter/hour and a diameter of pesticides aerosols ranging from 0.5 to 50 microns (Fig. 3). The concentration of the malathion and bifenthrin were 0.5 and 0.03% W/V, respectively. The flow rate of spraying mixed pesticides was recommended at 1.02 ml/m^2.

Health effects of subjects

A 59.3% of studied subjects developed health symptoms; they developed symptoms after 1-3 hours of pesticide spraying. The reported symptoms were skin and upper respiratory irritation (75.0%), dizziness-nausea (59.4%), headache (37.5%), short of breath (18.8%), chest tightness (12.5%) and hands and face numbness (3.1%) (Table 5). In addition, the tinnitus (6.3%) was an interactive effect from noise exposure of the sprayers in mosquito control application.

Fig 3. A mosquito control applicator is spraying pesticide as smoke.

The concentrations of malathion and bifenthrin in cotton patch collection

The mixed pesticides used consisted of 0.5% malathion and 0.03% W/V bifenthrin. Results showed that the mosquito control applicators exposed to average malathion concentration from working environment of 0.2±0.1 μg/cm^2 ranging from 0.1 to 0.6 μg/cm^2 while the bifenthrin concentration was at 0.3±0.2 μg/cm^2 ranging from 0.1-1.2 μg/cm^2.

The concentration of urinary TFP acid of mosquito control applicators

The majority of TFP acid concentration before working period was below the limit of detection (LOD = 0.23 μg/ml); whereas the average TFP acid concentration of the studied subjects after working period was 39.2±50.8 mg/g creatinine and ranging from 0.6 to 261.2 mg/g creatinine, as shown in Table 6.

The difference between urinary TFP acid levels before and after working periods

The determination of difference between urinary TFP acid levels before and after working periods was determined by paired t-test. There was significantly different between urinary TFP acid levels before and after working periods ($p<0.001$).

The relationship between bifenthrin concentrations from dermal contact and urinary TFP acid levels

The analysis of relationship between bifenthrin concentrations from workers' dermal contact and urinary TFP acid levels was determined by Pearson correlation (Table 6). The bifenthrin concentrations were

Table 5. The health effects of studied mosquito control sprayers

Health effects	Numbers (n = 54)	Percentages (%)
No	22	40.7
Yes	32	59.3
Symptom after working*		
Headache	12	37.5
Dizziness-nauseous	19	59.4
Irritation (skin, nose, throat)	24	75.0
Tightness of the chest	4	12.5
Short of breath	6	18.8
Hands and face numbness	1	3.1
Other (tinnitus)	2	6.3

* Subjects can answer more than one symptom

not significantly associated with urinary TFP acid levels (p = 0.719).

Discussion

Air sample collection

A 100% cotton patch was used for sampling of malathion and bifenthrin. This method was applied from the Organization for Economic Cooperation and Development, which was the guidance for the conduct of studies of occupational exposure to pesticides during application. The method of sampling is easy, low cost, uncomplicated and preferable for the studied subjects. The location of patches attached on skin of upper legs where the potential dermal contact was high[12,13].

Analysis of malathion and bifenthrin

The method of extracting malathion and bifenthrin from cotton patches by ethyl acetate solution described in this study was based on procedure published by Tuomainen et al[3] and Hirahara et al[11] for the determination of malathion from potential dermal contact of applicators and multi-residue screening of pesticides in agricultural products by GC/MS techniques, respectively.

Analysis of urinary TFP acid

The biomarker of bifenthrin exposure was 3-(2-chloro-3, 3, 3-trifluoro-1-propenyl)-2, 2-dimethyl-cyclopropanecarboxylic acid or TFP acid in mosquito control application. This metabolite has a short metabolic pathway and more stable than the other metabolites[24]. The analysis of this metabolite was carried out by liquid-liquid extraction techniques with n-hexane solution for determination of pyrethroid metabolites in urine by GC/MS[7-9].

Field application

General, working and exposure characteristics of studied subjects

The fifty-four studied mosquito control sprayers were males. The average working time of the studied subjects was 3.8±0.4 hours/day and most of their working time was 4 hours/day. The application time (240 min/day) were higher than the study of Smith PA et al[7] and Adamis Z et al[19]; they applied for 25 and 24.4 min/day, respectively. However, workers were taking a break for 30 min every two hours of the application for relaxation and personal activity. This break time may be useful for workers and may help reduce exposure to the pesticide during application. The majority of working frequency of subjects was 2 times/week/person. This may explain why the urinary TFP acid before working was not detected.

The working experience of studied subjects ranged from less than a year to 30 years with an average of 11.2±9.4 years. The spraying characteristics of pesticides in the present study was the smoke type whereas the majority of several studies were performed by mist sprayed[3,2,14]. The present study applied malathion and bifenthrin for disease vector control in the community while the other studies implemented pesticide spray for the pest/insect control in agricultural activities. However, the working and exposure characteristics of pesticides application for

Table 6. The concentration of urinary TFP acid of the mosquito control applicators

TFP acid metabolite	Concentration (mg/g creatinine in urine)					
	Before			After		
	n	Mean (SD)	Range	n	Mean (SD)	Range
Not-detectable	53	-	-	7	-	-
Detectable	1	0.3 (2.0)	-	47	39.2 (50.8)	0.6-261.2

Table 7. The relationship between bifenthrin concentrations from dermal contact and urinary TFP acid levels

Chemicals	Number (N)	Mean ± SD	Pearson correlation	p-value
Bifenthrin (μg/cm^2)	54	0.30±0.2	0.050	0.719
TFP acid (mg/g creatinine)	54	39.20±50.8		

both activities had similar profile.

The personal protective devices (PPD) such as mask, shoes, clothing, hat, goggle and ear plug were used to protect workers' health from pesticide application. The cotton clothing could not protect workers from dermal contact because the smoke can pass through the cotton to contact with the skin of workers. In general, the clothing was considered as the first component for protection against pesticides contact with the skin. In addition, workers did not use rubber gloves during application. The workers should use clothing such as nylon and polyester to protect skin contact with pesticides. Malathion and bifenthrin may be absorbed through every part of body, which has direct contact with aerosol of application and may affect subjects' health in the long term.

Health effects of studied subjects

After malathion and bifenthrin application, they developed symptoms after 1 to 3 hours of spraying. These symptoms were irritation (skin and upper respiratory tract), dizziness-nausea, headache, short of breath, chest tightness and numbness (hands and face). This study agreed with the study of Zhang et al[15] that the symptoms were similar to other pesticides' exposure[16,17].

The concentration of malathion and bifenthrin from dermal contact

Organophosphate and synthetic pyrethroid pesticides were usually used as co-formulated formula to increase efficiency of mosquito and other disease-vector controls[16]. The average concentrations of malathion and bifenthrin on the patches were 0.2 ± 0.1 and 0.3 ± 0.2 µg/cm^2, respectively. The concentration of bifenthrin was detected at higher concentration than malathion at approximately 2 times in each patch, although the ratio of malathion concentration was higher than bifenthrin approximately 20 times. This is probably because the bifenthrin is a stable chemical; it can resist photolysis while malathion is not so stable[17,18].

This is the first study of occupational exposure to malathion and bifenthrin by dermal contact in mosquito control application for disease-vector control in the community. However, our study was similar to the study of Adamis et al that they used the mixed pesticides of pirimiphosmethy, dimethoate and permethrin as co-formulated formulas of organophosphate and synthetic pyrethroid for pest/insect control used in greenhouse for tomato spraying application. The workers were assessed of occupational exposure to these pesticides by dermal contact and inhalation. The result of that study found that dermal contact concentration was several times higher than the breathing concentration. The hands, arms and legs were found highest dermal contact into the spraymans' body[19].

The concentration of urinary TFP acid

In current study, most urinary TFP acid before working was not detected. The majority of pyrethroid metabolites were accumulated in the human body for 2.5 days[20]. After application, average urinary TFP acid was 0.6 to 261.2 mg/g creatinine. The biological exposure index (BEIs) for TFP acid was not available. This biomarker may not be able to use as a specific metabolite of bifenthrin exposure if bifenthrin pesticide was co-formulated with some synthetic pyrethroid such as lambda-cyhalothrin and tefluthrin. These pyrethroids can be metabolized to TFP acid in urine[21,22].

The relationship between of bifenthrin concentrations from dermal contact and urinary TFP acid levels

There was no significant relationship between bifenthrin concentrations dermal contact and urinary TFP acid levels ($p > 0.05$). This is may be caused by the less number of cotton patches used in this study, which was not sufficient to assess bifenthrin concentrations. The urinary TFP acid concentration of workers may come from other confounding factors which were not controlled before the present study, such as pesticide exposure in house which may have ingredient of bifenthrin on products used[23].

The comparison between urinary TFP acid and health symptoms of studies subjects

The comparison between average urinary TFP acid and health symptoms of mosquito control sprayers was determined by Independent t-test. These symptoms consisted of headache, dizziness-nausea, irritation (skin, nose, throat), chest tightness, short of breathing and numbness (hands, face). The results showed that urinary TFP acid was not significantly different with health symptoms ($p>0.05$). This may be explained that majority of health symptoms were not caused by bifenthrin exposure but may be caused by effect of malathion. It is because the ratio of malathion concentration used was higher than bifenthrin (approximately 20 times). However, this result was similar to the study of Zhang Z et al found that twenty-nine

sprayers who exposed to pyrethroid (deltamethrin, fenvalerate and methamidophos) in cotton growers had developed health effects such as headache, nausea and abnormal facial sensations but not significant correlation between these symptoms and urinary pyrethroid concentrations[15].

The malathion and bifenthrin are highly lipid-soluble pesticides and are absorbed into the body through skin contact. Therefore, the assessment of occupational exposure to the pesticides and their metabolites are extremely necessary for workers. The limitation of the present study is that the metabolites of malathion were not measured and the biological exposure indexes of bifenthrin and malathion metabolites were not available.

Conclusion

The mosquito control sprayers had dermal contact with smoke of malathion (0.2 $\mu g/cm^2$) and bifenthrin (0.3 $\mu g/cm^2$) and the average urinary TFP acid was 39.2 mg/g creatinine. Some sprayers developed health symptoms after exposure. They should use protective clothing made of plastic, nylon or polyester to protect from skin contact.

Potential conflicts of interest

None.

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การประเมินการรับสัมผัสสารมาลาไธออนและสารไบเฟนทรินทางผิวหนังจากการทำงานในกลุ่มกำลังพลฉีดพ่นยากำจัดยุง

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วัตถุประสงค์: ประเมินการสัมผัสสารมาลาไธออนและสารไบเฟนทรินจากการปฏิบัติงานโดยวิธีการสัมผัสทางผิวหนังตรวจวัดระดับ3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-cyclopropanecarboxylic (กรดทีเอฟพี) ในตัวอย่างปัสสาวะ อาการที่เกิดขึ้นและหาความสัมพันธ์ระหว่างความเข้มข้นของสารไบเฟนทรินกับระดับกรดทีเอฟพี ในปัสสาวะของผู้ฉีดพ่นยากำจัดยุง

วัสดุและวิธีการ: ละอองลอยของยาฆ่าแมลงทั้ง 2 ชนิด ถูกเก็บรวบรวมโดยใช้แผ่นผ้าฝ้ายขนาด 100 ตารางเซนติเมตร ปะติดบนผิวหนัง ณ ตำแหน่งขาส่วนบนของอาสาสมัคร กลุ่มผู้ฉีดพ่นยากำจัดยุง 54 รายเก็บตัวอย่างปัสสาวะก่อนและหลังการการฉีดพ่น

ผลการศึกษา: ผู้ฉีดพ่นยากำจัดยุงสัมผัสสารมาลาไธออนและสารไบเฟนทรินเฉลี่ย 0.18 และ 0.32 ไมโครกรัม/ตารางเซนติเมตร ตามลำดับ หลังการฉีดพ่นค่าเฉลี่ยความเข้มข้นของกรดทีเอฟพีในปัสสาวะของผู้ฉีดพ่นเป็น 39.22±50.77 มิลลิกรัม/กรัมครีอะตินีนอยู่ระหว่าง 0.58-261.19 มิลลิกรัม/กรัมครีอะตินีน พบความแตกต่างกันอย่างมีนัยสำคัญทางสถิติระหว่างระดับกรดทีเอฟพีในช่วงก่อนและหลัง การทำงาน ($p<0.05$) แต่ไม่มีความสัมพันธ์ อย่างมีนัยสำคัญทางสถิติระหว่างความเข้มข้นของสารไบเฟนทรินจากการสัมผัสทางผิวหนังกับระดับกรดทีเอฟพี ในตัวอย่างปัสสาวะ ($p>0.05$)

สรุป: ผู้ฉีดพ่นยากำจัดยุงสัมผัสสารมาลาไธออนและสารไบเฟนทรินทางผิวหนังและผู้ฉีดพ่นยาบางคน มีอาการต่อสุขภาพหลังการรับสัมผัส ผู้ฉีดพ่นยาควรสวมใส่ชุดป้องกันที่ทำด้วยพลาสติก ไนลอนหรือโพลีเอสเตอร์ เพื่อป้องกันการรับสัมผัสทางผิวหนัง