



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PREVENTION, PESTICIDES AND TOXIC SUBSTANCES
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MEMORANDUM

Subject: Occupational and Residential Exposure Assessment for the Use of Pyrethrin in Residential Mosquito Mister Systems

From: Timothy C. Dole, Industrial Hygienist
Reregistration Branch 1
Health Effects Division

Through: Matthew Lloyd, Industrial Hygienist
Reregistration Branch 1

Whang Phang, Senior Scientist
Reregistration Branch 1
Health Effects Division

To: Christine Olinger, Chemist
Reregistration Branch 1
Health Effects Division

Cathryn O'Connell, Chemical Review Manager
Reregistration Branch 2
Special Review and Reregistration Division

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The attached document addresses occupational and residential exposures and risks for the use of pyrethrins (PY) in residential mosquito mister systems.

1.0 Background and Purpose

This document addresses exposures and risks associated with the use of pyrethrins (PY) in residential mosquito mister systems. These systems were originally used in animal housing structures such as dairy barns to control flying insects. Recently, these systems have been adapted for use in residential sites including home yards to control mosquitoes. These systems are fed from a central holding tank and utilize an array of spray nozzles to automatically deliver a fine mist of dilute solution at specified intervals throughout the day. According to the Consumer Specialty Products Association (CSPA) Discussion Paper, the residential mosquito misting systems are designed to apply product to resting surfaces where mosquitoes seek harborage during non-feeding periods.

2.0 Mosquito Mister Use Patterns

Specific reference to “mosquito mister systems” is not made in the Pyrethrin Master Label (PPJV, 2003) though there is reference to use of PY in outdoor domestic sites as a general, crack-and-crevice, or spot surface spray. Four PY-containing products (EPA Reg. No. 1021-1785, 21165-24, 1021-1800, and 655-797) are identified in the CSPA discussion paper as being intended for use in mosquito mister systems. The following use information is from the CSPA discussion paper:

- Holding tanks or reservoirs are typically plastic with 30, 55, or 250 gallon capacity;
- Nozzle height is approximately 8 – 10 feet (i.e., off the ground);
- Nozzle spacing is approximately 10 – 15 feet apart along fences or foliage (i.e., perimeter separation);
- Automatic releases are set for 2 to 4 times per day for 30 to 60 seconds per event;
- The nozzle flowrate is 0.84 gallons per hour (0.014 gallons per minute)
- Systems can be activated manually by homeowners.
- The initial droplet size is 20 to 50 microns.

Table 1 below shows the application parameters used to assess exposures and risks associated with mosquito mister systems. These parameters are based upon the Riptide ULV label (1021-1785) because it has the highest application rate and because it has specific use instructions for mosquito mister systems. This label was approved on March 30, 2005.

Table 1 – Application Parameters for Mosquito Mister Systems							
Product	Percent Pyrethrin	Spray Dilution ^A (percent)	Nozzle Flow Rate (GPM)	Nozzle coverage (ft ² /nozzle)	Spray Duration per Spray (minutes)	Application Rate per Spray ^B (lb ai/1000 ft ²)	Application Rate per Spray ^C (lb ai/1000 ft ³)
Riptide ULV (1021-1785)	5.0	0.093	0.0098	100	1.0	0.00076	0.000095
A. Spray Dilution (Percent) = Percent Pyrethrin in product (5.0) * Dilution Rate (1 gallon of product + 54 gallons of water)							
B. Application Rate (lb ai/1000 ft ²) = $\frac{\text{Spray Dilution}/100 * \text{Nozzle Flowrate (0.0098 GPM)} * (8.35 \text{ lb water/gallon}) * 1000 \text{ ft}^2}{\text{Nozzle Coverage (100 ft}^2\text{)}}$							
C. Application Rate (lb ai/1000 ft ³) = $\frac{\text{Application Rate (0.00076 lb ai/1000 ft}^2\text{)}}{\text{Release Height (8 feet)}}$							

3.0 Hazard Identification

The endpoints that were used to assess exposures from mosquito misters are listed in Table 2 and they were taken from the pyrethrin human health risk assessment.

Table 2 – Endpoints Used for Assessing Occupational and Residential Risks for Pyrethrin			
Exposure Scenario	Dose Used in Risk Assessment	Level of Concern (LOC) for Risk Assessment	Study and Toxicological Effects
Incidental Oral – Short-Term (1-30 days)	NOAEL= 20 mg/kg/day	Residential MOE = 300 Occupational MOE= N/A	Acute neurotoxicity study in rats LOAEL = 63 mg/kg/day based on tremors in females
Incidental Oral - Intermediate-Term (1- 6 months)	NOAEL= 6.4 mg/kg/day	Residential MOE = 100 Occupational MOE = N/A	Two generation reproduction study in rats LOAEL = 65 mg/kg/day based on decreased F1b pup body weight/body-weight gain during lactation
Dermal Exposure - Short, Intermediate & Long Term	No endpoint for this exposure scenario was identified following repeated [21 day] dermal exposure to rabbits at the limit dose.		
Inhalation - Short-Term	NOAEL= 7.67 mg/kg/day	Residential MOE = 100 Occupational MOE = 100	Subchronic inhalation toxicity study in rats LOAEL = 25.56 mg/kg/day based on tremors, labored breathing, hyperactivity, secretory signs, matted coat, decreased body weight/body-weight gain
Inhalation - Intermediate & Long-Term	LOAEL= 2.56 mg/kg/day	Residential MOE = 1000 Occupational MOE = 100	Subchronic inhalation toxicity study in rats LOAEL = 2.56 mg/kg/day based on respiratory tract lesions

4.0 Occupational and Residential Handler Exposures

Handler Exposures, Assumptions and Unit Exposure Data

Handler exposures are expected to occur when persons add the product to holding tanks and fill the tanks with water. The task can be conducted either by occupational handlers who service multiple residences per day or by residential handlers who service their own tanks. Occupational handler exposure durations are expected to be short-term (1-30 days), and intermediate-term (1-6 months). Long-term (> 6 months) exposures are not expected for this particular use. Residential handler exposure duration is expected to be short term only because the tanks are filled at two week to one month intervals.

The following assumptions and factors were used in estimating handler risks:

- Average adult body weight is 70 kg;
- Baseline inhalation represents no respiratory protection;
- Inhalation unit exposures used for this scenario is from “Open Mixing/Loading Liquids” scenario from Pesticide Handler Exposure Database Surrogate Guide (PHED Ver. 1.1);
- The spray dilution is from the Riptide ULV label as listed in Table 1;
- Holding tank size (55 gallons or 250 gallons) is from the CSPA Discussion paper;

- Occupational Handlers fill 5 holding tanks per day.
- Residential Handlers fill 1 tank per day.

Handler Risk Estimates

The MOEs for both occupational and residential handlers are presented in Table 3. These MOEs exceed the target MOEs of 100 and 1000 for short and intermediate term exposures, respectively, and indicate that the risks are not of concern.

Table 3 - Handler Inhalation Exposure and MOEs During Mosquito Mister Tank Filling						
Spray Dilution (Percent PY)	Tank size (gallons)	Number of Tanks Filled Per Day	Amount of ai handled per day ^A (lbs)	Daily Dose ^B (mg/kg/day)	Inhalation MOE ^C	
					Short Term Exposures ^D	Intermediate/ Long Term Exposures ^D
Occupational Handlers						
0.093	55	5	2.1	0.000036	210,000	71,000
	250	5	9.7	0.00017	45,000	15,000
Residential Handlers						
0.093	55	1	0.43	0.0000074	1,000,000	N/A
	250	1	1.9	0.000033	230,000	N/A

A. Amount ai handled per day = (Dilution rate/100) * Density of water (8.35 lb/gallon) * Tank Size * Number of Tanks Serviced per Day

B. Daily Dose (mg/kg/day) = $\frac{[\text{Amount of ai handled per day (lb)} * \text{Unit Exposure (1.2 ug/lb ai handled)}]}{1000 \text{ ug/mg} * \text{Body Weight (70 kg)}}$

C. MOE = NOAEL / Daily Dose where the NOAEL = 7.67 mg/kg/day for short term exposures and 2.56 mg/kg/day for intermediate long term exposures

D. The target MOEs are 100 for short term exposures and 1000 for intermediate/long term exposures

5.0 Outdoor Bystander Inhalation Exposure

Exposure Factors and Assumptions

The following assumptions and factors were used in estimating inhalation risks to outdoor residential bystanders from exposure to pyrethrin:

- Average body weights are 70 kg (adult) and 15 kg (toddler);
- The application rate is from the Riptide ULV label (see Table 1);
- Inhalation rates are assumed to be 1.0 m³/hour (adult, light activities) and 0.7 m³/hour (toddler, light to moderate activities);
- Nozzle height is assumed to be 8 feet from the ground;
- The initial concentration is based upon instantaneous release and mixing into a fixed space with a height of 8 feet.
- The average concentration is based upon the initial concentration divided by a dilution factor of 100 from the fogger SOP.
- The exposure duration is assumed to be 5 hours per day for adults and 3 hours per day for toddlers.
- The exposure is assumed to encompass 2 spray events that occur in the morning or evening.

Risk Estimates

The risk estimates for outdoor inhalation exposures are summarized in Table 4 and the calculations are included in appendix B. All of the short term MOEs are greater than the target MOE of 300 which means that the short term risks are not of concern. The intermediate term MOE for toddlers is less than the target MOE of 1000 which means that the intermediate term risk is of concern.

Table 4 – Pyrethrin Inhalation MOEs Following Mister Operation					
Population	Spray Dilution (percent)	Initial Air Concentration (mg/m ³)	Average Air Concentration (mg/m ³)	Inhalation Dose (mg/kg/day)	MOE
Short Term Exposures					
Adults	0.093	3.0	0.030	0.0022	3500
Toddlers				0.0042	1800
Intermediate Term Exposures					
Adults	0.093	3.0	0.030	0.0022	1200
Toddlers				0.0042	600

6.0 Incidental Oral Exposure

Exposure Factors and Assumptions

The following assumptions were used in conjunction with the standard SOP assumptions for estimating risks to outdoor incidental oral exposure to PY:

- It is assumed that no dissipation occurs throughout the day;
- Postapplication is assessed on day zero for all incidental oral scenarios (i.e., the toddler could be exposed to turfgrass immediately after one entire day of automatic mister application);
- Exposure duration is assumed to be 2 hours per day.

Risk Estimates

The risk estimates for outdoor incidental oral exposure to toddlers are summarized in Table 5 and the calculations are included in appendix B. All of the MOEs are greater than the target MOE of 300 which means that the risks are not of concern.

Table 5 - Pyrethrin Incidental Oral Ingestion Risks to Toddlers Following Mister Application								
Application Rate (lb ai/1000 ft ²)	Hand to Mouth Exposures		Object to Mouth Exposures		Soil Ingestion Exposures		Aggregate Exposures	
	Daily Dose (mkd)	MOE	Daily Dose (mkd)	MOE	Daily Dose (mkd)	MOE	Daily Dose (mkd)	MOE
0.030	0.0020	10000	0.00049	41000	0.0000066	3000000	0.0025	8000
mkg = mg/kg/day								

5.0 Overall Risk Summary

The handler MOEs for both occupational and residential exposures exceed the target MOEs and are not of concern. The short term inhalation MOEs for bystander exposure during mister operation exceed the target MOE for both adults and toddlers and are not of concern. The intermediate term inhalation MOE of 600 for toddlers does not exceed the target MOE of 1000 and is of concern. All of the incidental oral MOEs are greater than the target MOE of 300 and are not of concern.

6.0 Risk Characterization and Recommendations for the Risk Assessment

The exposure durations used in the short-term inhalation exposure (5 hours/day for adults, 3 hours/day for toddlers) represent the 95th percentile values for time spent outdoors at a restaurant/picnic area (USEPA, 1997). During this exposure period the individual is assumed to be exposed to 2 spray events each lasting a period of 1 minute. Although this spray duration is considered reasonable, lower spray durations (i.e., 20- or 30-second durations) may be more representative of actual system rates, particularly for intermediate exposure durations. Standard label language for use rates could provide a more refined risk assessment. Currently, the labels do not specify the spray duration and contain the statement “Set system timer to operate in accordance with equipment directions”.

Risks were calculated based on automatic applications of 4 sprays per day. It was noted in the CSPA discussion paper that the systems can be manually activated by the homeowner to apply additional sprays. Although re-filling and maintenance costs would likely deter homeowners from excessive use, label language indicating appropriate daily spray cycles should be considered.

Three of the labels (655-797, 1021-1785, 1021-1800) cited in the CSPA discussion paper have the following label language “automatic systems must be programmed so as not to activate and/or release pesticides when people, pets and food or feed are present”. These labels were approved in 2004 and 2005. The fourth label (21165-24) does not have the label language and was approved in 2002. It is recommended that all of labels used for mosquito mister systems be updated to include the above label language.

7.0 References

Consumer Specialty Products Association, c/o Pyrethrin Steering Committee/Joint Venture and Piperonyl Butoxide Task Force II. Discussion Paper: Intermittent Aerosols, Residential Mosquito Mistars, and Dairy Barn Mistars. July 22, 2005.

Pyrethrin Joint Venture. Pyrethrin Master Label. February 26, 2003.

US Environmental Protection Agency (US EPA). Office of Pesticide Programs (OPP). Pesticide Handler Exposure Database (PHED) Version 1.1 Surrogate Exposure Table. August 1998.

US EPA OPP. Science Advisory Council for Exposure, Policy 12: Recommended Revisions to the Standard Operating Procedures for Residential Exposure Assessments. February 22, 2001.

US EPA OPP. Standard Operating Procedures for Residential Exposure Assessments. April 5, 2000.

US EPA National Center for Environmental Assessment. Exposure Factors Handbook. 1997.

Appendix A – Pyrethrin Residential Post-Application Inhalation Risks Following Outdoor Mister Release									
Population	Spray Dilution (percent)	Application Rate per 1 Minute Spray (lb ai/1000 ft ²)	Application Rate per 1 Minute Spray (lb ai/1000 ft ²)	Daily Exposure Spray Duration ^D (minutes)	Application Rate per Daily Exposure ^E (lb ai/1000 ft ³)	Initial Air Concentration (mg/m ³)	Average Air Concentration (mg/m ³)	Inhalation Dose ^K (mg/kg/day)	MOE ^L
Short Term Exposures (Target MOE =100)									
Adults	0.093	0.00076	0.000095	2.0	0.00019	3.0	0.030	0.0022	3500
Children								0.0042	1800
Intermediate/Long Term Exposures (Target MOE = 1000)									
Adults	0.093	0.00076	0.000095	2.0	0.00019	3.0	0.030	0.0022	1200
Children								0.0042	600

A. Application Rate (lb ai/1000 ft² per min. of spray) = $\frac{\text{Spray Dilution (percent)} * 1000 \text{ ft}^2 * \text{Nozzle Flowrate (0.0098 GPM)} * \text{Density of Water (8.35 lb/gallon)}}{100 * \text{Nozzle Coverage Area (100 ft}^2\text{)}}$

B. Application Rate (lb ai/1000 ft³) = $\frac{\text{Application Rate per 1 minute spray (0.00076 lb ai/1000 ft}^2\text{)}}{\text{Release Height (8 feet)}}$

C. Daily Spray Exposure Duration = Spray Duration (1 minute per spray) * Spray events per exposure period (2 events)

D. Application Rate per Daily Exposure = Application Rate per Minute Spray (0.000095 lb ai/1000 ft³) * Daily Exposure Spray Duration (2 minutes)

E. Initial Air Concentration = $[\text{Application Rate (lb ai/1000 ft}^3\text{)} * 454000 \text{ mg/lb}] / 28.3 \text{ m}^3$ (Note: 1000 ft³ = 28.3 m³)

F. Average Air Concentration = Initial Air Concentration (mg/m³) / Fogger Dilution Factor (100)

G. Inhalation Dose (mg/kg/day) = $\frac{\text{air concentration (mg/m}^3\text{)} * \text{Exposure time (5 hrs/day for adults, 3 hrs/day for children)} * \text{breathing rate (1 m}^3\text{/hr, 0.7m}^3\text{/hr)}}{\text{BW (70 kg, 15 kg)}}$

H. MOE = NOAEL/Dose; where the NOAEL is 7.67 mg/kg/day for short term exposures and 2.56 mg/kg/day for intermediate/long term exposures.

Appendix B - Pyrethrin Post-Application Incidental Ingestion Risks to Toddlers Reentering Treated Lawns											
Application Rate per Spray ^A (lb ai/1000 ft ²)	Application Rate per Day ^B (lb ai/1000 ft ²)	Hand to Mouth Exposures			Object to Mouth Exposures			Soil Ingestion Exposures			Aggregate Exposures
		TTR (µg/cm ²)	Daily Dose (mkd)	MOE	TTR (µg/cm ²)	Daily Dose (mkd)	MOE	Soil Residue (µg/g)	Daily Dose (mkd)	MOE	Aggregate MOE
0.0076	0.030	0.074	0.0020	10000	0.30	0.00049	41000	1.0	0.0000066	3000000	8000

Application Rate per spray = Taken from Table 1.

Application Rate per day = Application rate per spray (0.0076 lb ai/1000 ft²) * 4 sprays per day

Hand To Mouth Exposures:

Daily Dose (mg/kg/day) = (TTR * SEF * SA * Freq * ED * 0.001 mg/ug) / BW
 Where: TTR = Turf Transferable Residue for Hand to Mouth Exposures = 5% of Application Rate
 SEF = Saliva Extraction Factor (50%)
 SA = Surface Area of Two Fingers (20 cm²)
 Freq = Frequency of Hand to Mouth Events (20 events per hour)
 ED = Exposure Duration (2 hours per day)
 BW = 15 kg for a toddler

Object to Mouth Dose Exposures:

Daily Oral Dose (mg/kg/day) = (TTR * SA * 0.001 mg/ug) / BW
 where: DFR = Turf Transferable Residue for Object to Mouth Exposures = 20% of Application Rate
 SA = Surface Area of grass or toy mouthed by toddler (25 cm² day)

Soil Ingestion Exposures:

Daily Oral Dose (mg/kg/day) = (SR * IgR * CF1) / BW
 where: SR = Application Rate * 1/cm * 0.67 cm³/g soil [1/cm is fraction of ai available in uppermost cm of soil]
 IgR = Ingestion Rate of soil (100 mg/day)
 CF1 = Weight unit conversion factor (0.000001 g/ug)

Short Term MOE = Short Term Oral NOAEL (20 mg/kg/day)/Daily Oral Dose (mg//kg/day)

Aggregate MOE = 1/(1/MOE HTM + 1/MOE OTM + 1/MOE SI)

***All of the MOEs exceed the target MOE of 300**