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Attached please find the EAB review of...

Reg./File No.: 201-142

Chemical: Dicrotophos

Type Product: Insecticide

Product Name: Bidrin

Company Name: Shell Oil Company

Submission Purpose: Applicator exposure study

ZBB Code: _____

ACTION CODE: 660

Date In: 6/6/86

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Deferrals To:

 Ecological Effects Branch

 Residue Chemistry Branch

 Toxicology Branch

X Benefits and Use Division

Monitoring study requested by EAB: / /

1.0 INTRODUCTION

Shell Oil Company has submitted an applicator exposure study in support of the reregistration of the dicrotophos product, Bidrin 8 Insecticide (Registration Number 201-142). Bidrin 8 is a water miscible formulation containing dicrotophos at 0.5 lb ai/gal, and is a restricted use pesticide registered for use on cotton. Label instructions require protective gloves and clothing; a respirator is required during commercial or prolonged exposure in spray mixing and loading operations.

2.0 MATERIALS AND METHODS

Four field sites located in Mississippi were treated with dicrotophos at 0.2 lb ai/A in May, 1985. Two sites were treated aerially and two using ground boom equipment. For each aerial application, exposure was separately monitored for a mixer/loader and a pilot. One farm worker mixed, loaded and applied dicrotophos at each of the two remaining sites. All workers wore short-sleeved shirts and trousers; protective clothing worn is described in Sections 2.1 and 2.2.

2.1 Aerial Application

At Site 1, 80 lb of dicrotophos was aerially applied to 400 acres at a final spray concentration of 0.1 lb ai/gal. There were three replicates, each consisting of two mixing/loading and application operations. Average times for completing each tank mix and application were 5 and 22 minutes, respectively. Dicrotophos was mixed in a 300 gallon tank equipped with agitators and pumped onto the plane using a flexible hose. Spray booms on the plane contained eight Uni-miser nozzles operating at 30 psig.

The mixer/loader wore rubber gloves, goggles, and a half-face cartridge respirator equipped with organic vapor cartridges, with the exception of the first mix load when no protective equipment was worn. The pilot wore a flying helmet and goggles. During the first and second replicates, the pilot flew through spray drift when applying both batches of dicrotophos. Splashing of dicrotophos during pouring by the mixer/loader was noted for all three replicates.

A total of 480 acres was treated at Site 2, using 96 lb of dicrotophos at a final concentration of 0.1 lb ai/gallon. Three replicates were performed, each consisting of one mixing, loading and application operation. Mixing/loading and application operations averaged 4 and 32 minutes, respectively. Dicrotophos was mixed in a 300 gallon tank and loaded onto the plane with flexible hose. Spray boom nozzles on the plane

(eight Micronair nozzles) operated at 22 psig. Protective clothing worn was the same as that described above for Site 1. On the third replicate, the pilot flew through spray drift; splashing during mixing was not reported.

2.2 Ground Boom Application

Three separate field plots were treated at Site 3, totaling 120 acres. A total of 24 lb of dicotophos was applied at a spray mix concentration of 0.013 lb ai/gal. Each of the three replicates performed consisted of mixing, loading and applying two tankfuls of dicotophos by one worker. Mixing/loading and spraying averaged 6 and 38 minutes, respectively. Rubber gloves, goggles, and a half-face cartridge respirator were worn during mixing and loading only.

Dicotophos was mixed in a 320 gallon tank located on a John Deere Hi-Cycle applicator (closed cab) equipped with a 60-foot spray boom (38 flat-fan nozzles, 30 psig, 18 inches above ground level). No incidental contact with the pesticide was reported.

At Site 4, two separate fields totaling 40 acres were treated with 8 lb of dicotophos at a final spray concentration of 0.04 lb ai/gal. There were four replicates, each consisting of one mixing, loading and spraying operation. The average time for mixing and loading was 4 minutes; application averaged 39 minutes. Protective clothing worn during mixing and loading was the same as previously described for Site 3.

Dicotophos was mixed in a 125 gallon tank located on an open cab International Harvester. Application was made with a 6-row cultivator equipped with a spray boom (six TX-12 nozzles, 50 psig, 18 inches above ground level). Some direct spray contamination of the worker occurred during the fourth replicate.

2.3 PASSIVE DOSIMETRY

Dermal exposure was measured by placing sterile gauze pads (12-ply, 3 x 3 inches) on the worker's body in the following locations: the front and back of the head, inside and outside clothing on the chest, back, upper arms, thighs and ankles, and outside clothing on the forearms. Each pad was placed in a foil-covered holder with a circular opening providing a 25 cm² sampling area. Outside pads were placed on the worker's left side and inside pads on the right side for the first replicate, then alternated for each replicate thereafter. Hand exposure was measured using hand rinses in 200 ml of water containing detergent.

Dermal exposure values (except hands) were calculated by dividing the amount of dicotophos found on each gauze pad

(ug) by the surface area of the pad (25 cm²), and then multiplying the result by the surface area (cm²) of the body region which each pad represented. Body surface areas used are shown in Table 1.

Clothing penetration (%) was calculated by dividing the amount of dicotophos found on inside gauze pads by the amount found on outside pads (excluding head and forearm pads, and hand washes), then multiplying by 100 to obtain a percent penetration value.

2.4 INHALATION EXPOSURE

Respiratory exposure was measured with personal air pumps, using collection tubes containing Chromosorb 102 as the absorbent. Air samples were collected in the breathing zone of the workers at the rate of 1 liter/minute.

Respiratory exposure values were calculated by multiplying the amount of dicotophos collected (ug/m²) by a standard breathing rate (30 l/min) to obtain a total potential dose for each replicate.

2.5 ANALYTICAL METHODS AND QUALITY ASSURANCE PROCEDURES

All samples were frozen until analysis. Samples were extracted or partitioned twice with water and chloroform or chloroform only, exchanged to ethyl acetate, and concentrated. Dicotophos was quantified using GLC with a nitrogen-phosphorus detector. The sensitivity of the method was 0.01, 0.10, and 2.0 ug for Chromosorb, gauze pad, and hand rinse samples, respectively. Storage stability and laboratory and field recovery data are shown in Table 2.

3.0 REPORTED RESULTS

Dicotophos levels (average of replicate samples) on gauze pads and in hand rinse and air samples are shown in Table 3. Dermal exposure values (ug/body part) are shown in Table 4. The majority (61-97%) of the total dermal exposure to both mixer/loaders and applicators was to the hands and forearms. Clothing penetration was extremely variable, ranging from 0.2% for the mixer/loader at Site 2, to 84.8% for the mixer/loader at Site 1 (Table 5).

Reported values for respiratory exposure were low, accounting for <4% of the total worker exposure (Tables 3 and 4). However, using the method of calculation provided by the registrant, EAB was unable to duplicate the estimated respiratory exposure values (1.2-23.7 ug/replicate) presented in Table 4.

Total exposure was similar for mixer/loaders and applicators at Sites 1 and 2 (aerial application), ranging from 1.5 to 22.7 ug/lb ai applied, and higher for ground boom application (157 and 212 ug/lb ai applied). As shown in Table 6, these exposure values are in reasonable agreement with those in EAB's generic data base.

3.0 SUMMARY AND CONCLUSIONS

Exposure of mixer/loaders and applicators involved in aerial and ground boom application of dicotophos to cotton at 0.2 lb ai/A was measured using passive dosimetry. Exposure values are not corrected for dermal penetration. Total exposure is estimated to be 12 ug/lb ai handled for both mixer/loaders and pilots (average of six replicates for each worker type), and 1.9×10^{-2} ug/lb ai handled for mixer/loader/applicators using ground boom equipment (average of seven replicates). Of the total dermal exposure to all workers, 61-97% was to the hands and forearms.

Insufficient information was provided to allow EAB to confirm the reported respiratory exposure values; however, respiratory exposure comprised only a small proportion of total worker exposure to dicotophos.

These exposure estimates are based on a total of six replicates each for mixer/loaders and applicators performing aerial application of dicotophos, and seven replicates for mixer/loader/applicators using ground boom equipment. The use of six to seven replicates for each exposure situation is only marginally acceptable; currently, EAB requires 15 replicates (5 replicates each at 3 sites).

The effect of open and closed tractor cabs on worker exposure could not be assessed since mixer/loader and applicator exposures were not separately monitored during ground boom application. In addition, interior and exterior dermal pads were alternated between left and right extremities with each replicate. Since some dermal exposures have shown a tendency to be higher on one side of the body, it is advisable to use both interior and exterior pads on both arms and legs.

Exposure estimates as provided in this review are derived from a field study, and reflect worker exposure resulting from a single application operation. EAB defers to the Benefits and Use Division as to the use pattern of dicotophos to provide

information regarding the frequency and duration of exposure. Upon receipt of appropriate usage information from BUD, EAB can provide daily, weekly, or annual exposure estimates for dicrotophos.

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Table 1. Body surface areas.

Patch location	Body area represented	Body surface area (cm ²)
Front, rear head	Face	650
Outer chest	Front of neck ^a	150
Outer back	Back of neck	110
Inner chest	Chest & stomach	3550
Inner back	Back	3500
Inner upper arm	Upper arms	1320
Inner forearm	Forearms	1210
Inner thigh	Thighs	2250
Inner ankle	Lower legs	2380
Hands	Hands	820

^a Including "V" of chest.

Table 2. Recovery (%) of dicotophos from fortified samples.

Sample	Storage stability ^a	Laboratory recovery ^b	Field recovery ^c
Chromosorb	--	--	103
Patch	101	97	101
Soapy water	106	89	117
Water	99	89	--

^a Average recovery from duplicate samples spiked with 6.25 ug of dicotophos and stored under unspecified conditions for 63 days.

^b Patch samples spiked at the 1.25 and 6.25 ug level; water samples at 10 and 50 ug.

^c Collection tubes, patches, and water spiked with 6.25, 6.25, and 12.5 ug of dicotophos.

Table 3. Dicrotophos levels (ug/replicate)^a on gauze pads, and in air and hand rinse samples.

	SITE 1		SITE 2		SITE 3	SITE 4
	M/L	A	M/L	A		
<u>Respiratory:</u>	0.26	0.03	0.02	0.01	0.05	0.05
<u>Dermal:</u>						
<u>Inside:</u>						
Back	0.11	0.10	0.10	0.10	0.12	0.12
Chest	0.60	0.10	0.10	0.10	0.12	0.12
Upper Arm	0.23	0.10	0.10	0.10	0.15	0.11
Upper Leg	0.10	0.10	0.10	0.10	0.10	0.14
Lower Leg	0.10	0.10	0.10	0.10	0.10	0.69
<u>Outside:</u>						
Head (front)	0.85	2.1	0.19	0.10	4.1	0.87
Head (back)	0.27	0.69	0.41	0.10	0.50	2.1
Back	0.11	0.31	0.16	0.10	0.18	3.2
Chest	0.26	0.21	13.2	0.10	0.55	2.6
Upper Arm	0.10	0.17	0.16	0.10	0.34	6.4
Lower Arms (total)	4.5	0.46	31.2	0.21	15.1	19.3
Upper Leg	0.59	0.33	133.	0.30	1.7	20.0
Lower Leg	0.10	0.16	1.2	0.10	1.1	79.6
<u>Hand:</u>						
Right	223	451	48.3	6.8	725	575
Left	263	1264	380	75.3	2539	462

^a Values shown are the average of replicate samples; dermal values are in ug/25 cm².

Table 4. Estimated worker exposure (ug/replicate) to dicrotophos.^a

	SITE 1		SITE 2		SITE 3	SITE 4
	M/L	A	M/L	A		
I. Respiratory	23.7	3.0	1.5	1.2	4.8	6.3
II. Dermal						
a. <u>Inside</u>						
Back	15.4	14.0	14.0	14.0	16.8	16.8
Chest	85.2	14.2	14.2	14.2	17.0	17.0
Upper Arm	12.1	5.2	5.2	5.2	7.9	5.8
Upper Leg	9.0	9.0	9.0	9.0	9.0	12.6
Lower Leg	9.5	8.5	9.5	9.5	9.5	65.7
b. <u>Outside</u>						
Head	14.6	36.3	7.8	2.6	59.8	38.6
Back (of neck)	0.48	1.4	0.70	0.44	0.79	14.1
Chest (front + "V" of neck)	1.6	1.3	79.2	0.60	3.3	15.6
Lower Arm	108.9	11.1	755	5.1	365	467
c. <u>Hands</u>	486	1715	428	82	3264	1037
Total µg/replicate, avg.	767	1819	1324	144	3758	1697
% Respiratory Exposure	3.1	0.2	0.1	0.8	0.1	0.4
% Hand Exposure	63.4	94.3	32.3	56.9	86.9	61.1
Total Exposure/lb AI applied, µg	9.6	22.7	13.8	1.5	157	212

^a Sample calculation (back): $\frac{0.11 \text{ ug}}{25 \text{ cm}^2} \times 3500 \text{ cm}^2 = 15.4 \text{ ug}$

Table 5. Clothing penetration.

	<u>Inner Patches</u> <u>(Total µg/Rep.)</u>	<u>Outer Patches</u> ⁽¹⁾ <u>(Total µg/Rep.)</u>	<u>Penetration</u> ⁽²⁾ <u>(%)</u>
Site 1 - Mixer/Loader	0.89	1.05	84.8
Site 1 - Applicator	0.25	1.91	13.1
Site 2 - Mixer/Loader	0.27	148	0.2
Site 2 - Applicator	0.25	0.50	50.0
Site 3	0.38	3.93	9.7
Site 4	1.01	106	1.0

(1) Does not include head patches, lower arm patches or hand wash samples.

(2) Penetration (%) = $\frac{\text{Total } \mu\text{g on Inner Patches}}{\text{Total } \mu\text{g on Outer Patches}} \times 100$

Average µg/replicate calculated using one-half the reported detectable limit (0.10 µg) where this value reported (per EPA Pesticide Assessment Guidelines, Subdivision K, p. 39 (5)(iii)).

Table 6. Comparison of exposure values from dicrotophos field study to those in EAB's generic data base.

Generic data base		Dicrotophos study	
		Pilots	
0.13 mg/hr (29 replicates)		$\frac{1819 \text{ ug}}{22 \text{ mins}} = \frac{82.7 \text{ ug}}{\text{min}}$	= 5.0 mg/hr (Site 1 - 3 replicates)
		$\frac{144 \text{ ug}}{32 \text{ mins}} = \frac{4.5 \text{ ug}}{\text{min}}$	= 0.27 mg/hr (Site 2 - 3 replicates)
		Mixer/loaders	
0.19 mg/lb ai (open pour-19 replicates)		0.01 mg/lb ai (Site 1 - 3 replicates)	
0.0046 mg/lb ai (closed pour-20 replicates)		0.013 mg/lb ai (Site 2 - 3 replicates)	
		Ground boom application ^a	
1.26 mg/hr (92 replicates)		$\frac{3758 \text{ ug}}{44 \text{ mins}} = \frac{85.4 \text{ ug}}{\text{min}}$	= 5.1 mg/hr (Site 1 - 3 replicates)
		$\frac{1697 \text{ ug}}{43 \text{ mins}} = \frac{39.5 \text{ ug}}{\text{min}}$	= 2.4 mg/hr (Site 2 - 4 replicates)

^a The generic data base value for ground boom represents applicators only; values of 1.45 and 1.26 mg/h represent mixer/loader/applicators using open and closed loading systems, respectively.