ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

EPA-330/2-76-038

PESTICIDE USE OBSERVATIONS LEFLORE COUNTY, MISSISSIPPI

(JULY 25–AUGUST 7, 1976)

ENFORCEMENT INVESTIGATIONS CENTER
DENVER, COLORADO

DECEMBER 1976

Environmental Protection Agency
Office of Enforcement
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I. INTRODUCTION

Throughout the cotton belt of the United States, there are one or more major insect pests that must be controlled annually if cotton is to be grown profitably. Contemporary cotton production requires the use of more insecticides than any other single crop.[1] This intense and widespread use of insecticides on cotton could create environmental and human health problems that may be more devastating than the pest damage itself. For these reasons, it is essential that a monitoring program be adopted by pesticide regulatory agencies to observe and enforce good pest control practices by cotton growers.

With this background, EPA Region IV and the National Enforcement Investigations Center (NEIC) conducted the second in the series of National Pesticide Use Observation studies in the cotton belt of Mississippi. Study objectives were:

1. Observe and evaluate pesticide handling, application and disposal practices at a Mississippi Delta cotton farm.

2. Ascertain whether pesticide use is consistent with instructions on the label.

3. Develop methods, transfer technology and establish criteria needed to document environmental hazards and the proper use of pesticides.

4. Determine appropriate Agency actions needed to minimize occupational health risks and environmental damage caused by pesticide use.

A study site in Leflore County, Mississippi was selected by EPA Region IV and State officials. The site is near Morgan City, about 46 km (25 mi) southwest of Greenwood. Traditionally, Leflore County has had the highest production of cotton in the state of Mississippi. In 1976, more than 102,000 acres in this County were planted in cotton.[2]

Pesticides were applied by aircraft to the study site on July 29 and August 4, 1976, respectively. During both applications, a mixture of the insecticides methyl parathion and galecron was sprayed. Pre-application, application and post-application activities were evaluated by a team of EPA observers from NEIC, Region IV and the Pesticide and Toxic Substances Enforcement Division. Use practices, environmental impact, and monitoring technology are described in this report.

II. SUMMARY AND CONCLUSIONS

In July and August 1976, the second study of the National Pesticide Use Observation Program was conducted by NEIC at a cotton farm in Leflore County, Mississippi. During the 12-day study, an EPA observation team evaluated activities associated with two commercial aerial applications of methyl parathion and galecron on cotton to control an infestation of bollworms and boll weevils.

GENERAL CONCLUSIONS

The use observation study in Mississippi revealed exemplary clean-up and disposal practices; however, deficiencies were documented in handling and application of the insecticides.

Pesticide use was inconsistent with the label instructions.

The most valuable techniques used to document the practices and environmental effects of the aerial applications were: on-site evaluations by trained observers; spray droplet cards to determine pesticide drift; and water quality sampling to determine pesticide translocation by surface runoff from the target field.

The study indicated a need for the EPA and State officials to: a) determine and define the protective apparel and equipment essential for pesticide handling and use operations, and require the use of such apparel and equipment; b) review and update pesticide labels more frequently; c) regulate more closely farm residents' activities during and after pesticide applications; d) continue to study environmental effects of repeated pesticide applications on non-target organisms.

SPECIFIC CONCLUSIONS

1. During pre-application, human health hazards were observed. Workers handling and mixing pesticides were not wearing complete safety apparel and bystanders were allowed in the mixing area without protective equipment and clothing.

2. Meteorological instruments were not available to assist the applicator in determining conditions such as local wind speed and direction, relative humidity and air temperature. Nevertheless, good weather conditions prevailed, which proved to be an important factor in minimizing pesticide drift.

3. Activities were practiced by the commercial applicator which were inconsistent with the pesticide label instructions. These included the aerial application of pesticides 1) at an unapproved dosage rate, 2) while unprotected persons were in the drift area, and 3) during irrigation runoff from the target field.

4. A review of the Staplcotn® Methyl Parathion 4EC label revealed errors in the recommended waiting periods between application and re-entry or harvesting as specified by the *Code of Federal Regulations*, Part 170, Title 40, July 1975.

5. Kromecote cards were excellent for immediate detection of methyl parathion and galecron drift. Vertically placed cards appeared to be better detectors of drift than horizontal cards, and both were better than magnesium-oxide-coated microscope slides for evaluating drift.

6. From analyses of the Kromecote cards and the magnesium-oxide-coated slides, it was estimated that 25 to 35% of the pesticide drifted off the target field. During the first aerial application, the pesticide

mixture drifted northeast at least 100 m (330 ft) into a pasture and into Bear Creek. During the second aerial application, drift was to be southwest into a soybean field and into Mossy Lake.

7. A fluorescent dye was added to the methyl parathion and galecron mixture in an attempt to obtain additional pesticide drift information. Fluorescent analysis of ambient air samples failed to show any dye concentrations. The mylar sheet technique also was unsuccessful in collecting measurable amounts of dye used to trace the pesticide drift. The reason for failure is believed to be the low concentration of tracer dye (200 ppb) used.

8. Post-application environmental sampling revealed measurable amounts (0.1 to 24.0 µg/l) of methyl parathion in nearby bodies of water (Mossy Lake, Bear Creek and drainage ditches). Singly or in combination, the contamination of these neighboring streams and lake was believed to be the result of spray drift and irrigation runoff.

9. Pesticide contamination appeared to adversely affect the fish population in drainage ditches. On-site observations revealed that ditches with water containing up to 0.6 µg/l methyl parathion had a thriving population of minnows. In a ditch where the methyl parathion in water was found to be 24.0 µg/l, no fish life was observed. Fish were also examined from the lake into which these ditches drain. No acute pesticide poisoning symptoms were detected in these lake fish.

III. DESCRIPTION OF THE STUDY AREA

The farm observed in this pesticide use study contained a 63.5 hectare (157 acre) cotton field [Fig. 1]. The target field was bordered by soybean fields, pasture, a lake, creek, ditches with flowing or standing water and residences. The southwest corner was separated from the rest of the field by a small north-south soybean field and an east-west strip containing farm buildings, a residence and an artesian well.

Forty-two stations were established to monitor pesticide dispersal and environmental effects [Table 1]. Samples were collected from all stations except 9, 15 and 21, which were established during the reconnaissance but were later eliminated. Eleven stations were located on the target cotton field; eighteen were off the field, two were in Bear Creek, four in Mossy Lake; and two each in a north-south ditch and an artesian-fed drainage ditch.

The NEIC observation team set up a meteorological laboratory on the west side of the cotton field near station 19 [Fig. 2]. Wind direction and average velocity, and air temperature at 2.4 m (8 ft) and 9.7 m (32 ft) (to determine temperature inversion) were monitored. Other meteorological information was obtained from the Greenwood municipal airport, located about 46.3 km (25 mi) northeast of the study site.

Channel catfish were held in cages in Bear Creek (stations 2 and 3), in an artesian-fed drainage ditch (station 20) and in Mossy Lake (stations 39, 40, 41 and 42) to monitor biotic effects of pesticide exposure.

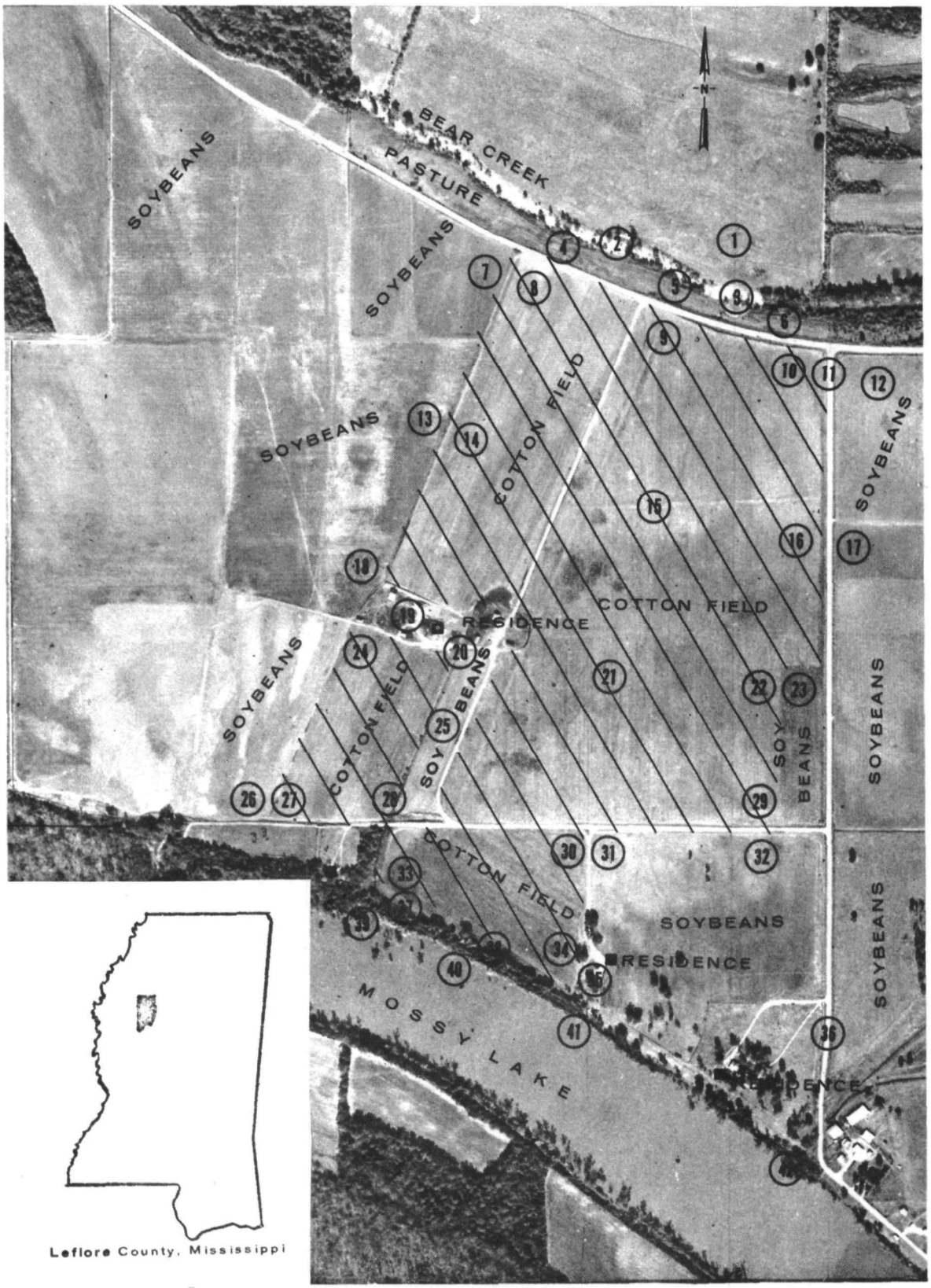

Figure 1. Sampling Sites, Leflore County, Mississippi, July-August 1976

Table 1

SAMPLES COLLECTED FROM A COTTON FIELD
Leflore County, Mississippi

Station No.	Air	Mylar	MgO Slides	Kromecote Cards	Vegetation	Soil	Water	Aquatic Plants	Sediment	Fish
1		✓	✓	✓	✓	✓				
2										✓
3							✓		✓	✓
4		✓	✓	✓	✓	✓				
5	✓									
6		✓	✓	✓	✓	✓				
7	✓	✓	✓	✓	✓	✓				
8						✓				
10	✓	✓	✓	✓	✓	✓				
11							✓		✓	
12	✓	✓	✓	✓		✓				
13		✓	✓	✓	✓	✓				
14						✓				
16						✓				
17		✓	✓	✓	✓	✓				
18	✓	✓	✓	✓		✓				
19	✓	✓	✓	✓		✓				
20							✓	✓	✓	✓
22						✓				
23	✓	✓	✓	✓		✓				
24						✓				
25		✓	✓	✓		✓				
26		✓	✓	✓	✓	✓				
27						✓				
28							✓	✓	✓	
29						✓				
30						✓				
31		✓	✓	✓	✓	✓				
32		✓	✓	✓		✓				
33						✓				
34						✓				
35	✓	✓	✓	✓		✓				
36							✓	✓	✓	
37		✓	✓	✓	✓	✓				
38						✓				
39							✓		✓	✓
40							✓		✓	✓
41							✓		✓	✓
42							✓		✓	✓

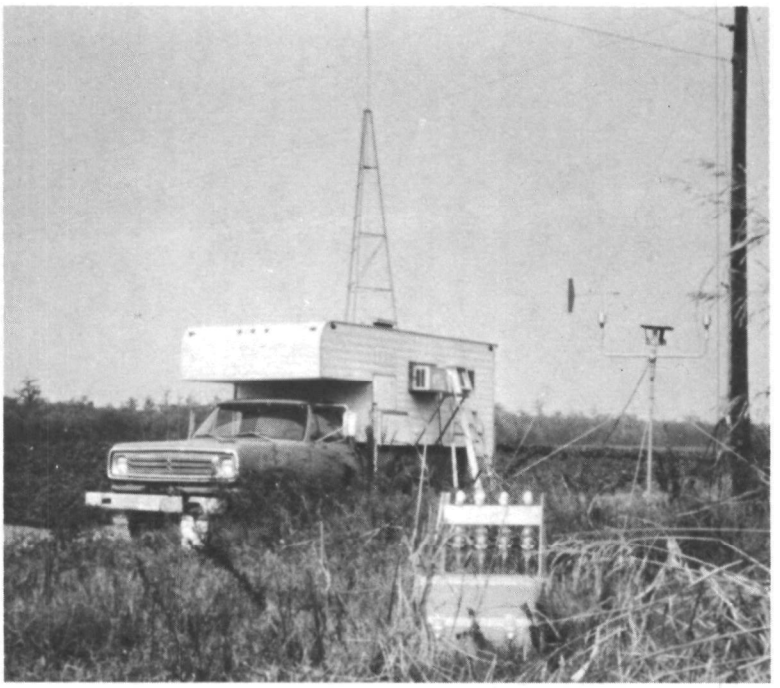

Figure 2. Mobile meteorological laboratory with air sampling impinger system in foreground.

IV. RESULTS AND DISCUSSION

INSECT INFESTATION ASSESSMENT

On July 25 an agricultural consultant employed by the farmer examined the cotton field. The terminals and "squares" (future bolls) on 100 cotton plants were examined. This examination showed an infestation of boll weevil (*Anthonomus grandis*) and bollworm (*Heliothis* sp). Tarnished plant bugs (*Lygus lineolis*) were observed also. The southernmost portion of the cotton field had the largest insect population. To control the infestation, the consultant recommended aerial application of a mixture of Methyl Parathion 4EC* and Galecron 4EC**. The methyl parathion was suggested to kill the existing insect pests; galecron, an ovicide, was recommended to prevent hatching of the eggs of these pests.

ENVIRONMENTAL ASSESSMENT

On July 27, 1976, soil, vegetation, and water were collected to establish background levels prior to the insecticide application [Table 2].

A few hours before the July 29, 1976 pesticide application, air and drift sampling devices were placed in and at varying distances from the target field. Four types of sampling gear were used: an air sampler, using the Greenburg-Smith impinger system [Fig. 2]; Kromecote cards, set horizontally; magnesium-oxide-coated slides, and mylar sheets [Fig. 3]. Each technique is described in detail in the Appendix.

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* *EPA Registration No. 8648-12*

** *Galecron® trademark of CIBA-GEIGY Corp.; EPA Registration No. 8192-7*

Table 2

WATER, SOIL, VEGETATION AND AIR ANALYTICAL RESULTS (METHYL PARATHION)[†]
July-August 1976

Station No.	Location	Type Sample	1st Application Background July 27	1st Application Application July 29	1st Application Residue July 31	2nd Application Application August 4	2nd Application Residue August 6
3	Bear Creek	Water	N.D.[††]	--	3.1	2.6	2.6
11	Ditch		0.3	--	1.0	N.D.	0.6
20	Artesian-fed ditch		N.D.	--	N.D.	--	0.2
28	Artesian-fed ditch		0.3	--	0.1	24.0	0.3
36	Ditch		0.5	--	0.3	--	8.0
39	Mossy Lake		N.D.	--	0.3	--	0.2
40	Mossy Lake		N.D.	--	N.D.	1.0	N.D.
41	Mossy Lake		N.D.	--	0.1	--	0.1
42	Mossy Lake		N.D.	--	0.3	--	0.2
6	Pasture	Soil	N.D.	--	0.007	--	--
6	Pasture	Vegetation	0.17	--	0.92	--	--
10	Cotton Field	Soil	N.D.	--	0.11	--	--
10	Cotton Field	Vegetation	0.09	--	1.3	--	--
19	Near residence	Soil	N.D.	--	0.008	--	--
5	Pasture	Air	--	4.4	--	--	--
7	Soybeans		--	1.6	--	2.1	--
10	Cotton field		--	6.2	--	2.2	--
12	Soybeans		--	2.4	--	0.2	--
18	Soybeans		--	1.2	--	4.9	--
19	Near Residence		--	1.6	--	4.6	--
23	Soybeans		--	1.2	--	1.9	--
35	Near Residence		--	1.2	--	0.4	--

† *Values in water expressed as mg/l; in soil and vegetation as µg/g; and in air as µg of methyl parathion*
†† *None detected*

Figure 3. (*l* to *r*) Mylar sheet, Kromecote card, and magnesium-oxide-coated slides.

Impinger units were placed in the Northeast corner of the cotton field (station 10) and at seven locations bordering the field (stations 5, 7, 12, 18, 19, 23 and 35) [Fig. 1, Table 1]. Spray drift evaluation stations were selected to monitor potential contamination of the surrounding area.

FIRST APPLICATION

Preparation

Before the pesticide was applied to the cotton on July 29, personnel from NEIC, EPA Region IV, and the State observed the pesticide handling, mixing and loading by the commercial applicator.

The pesticides were delivered to the applicator's mixing and loading site by a distributor shortly before they were used. A pesticide label was obtained by the EPA for later examination.

The Staplcotn® Methyl Parathion 4EC label stated: "Workers entering treated fields within 24 hours of application should wear protective clothing(5)." This label was registered on May 3, 1972. At that time, the re-entry time for methyl parathion was 24 hours. Two years later, in the *Federal Register*, Vol. 39, No. 92 (May 10, 1974) and subsequently in the *Code of Federal Regulations*, Part 170, Title 40 (July 1, 1975), "a re-entry time of at least ... 48 hours" is indicated for methyl parathion. The "(5)" on the label after "clothing" is an error according to officials in the EPA Pesticide and Toxic Substances Enforcement Division. It should be (7), which indicates one must wait seven days between application and harvest. This label needs to be reviewed and corrected as soon as possible.

During pesticide mixing and loading, employees of the aerial applicator wore a variety of safety clothes. All wore caps, trousers, shirts and boots. In addition, some wore gloves and canister-type respirators. The aircraft pilots' protective gear consisted of a crash helmet and a respirator. Both Company and non-Company individuals were present without complete safety gear during the mixing and loading operation.

The protective clothing worn by EPA personnel during the mixing and loading operation consisted of the canister-type respirator, goggles, disposable cap or hard hat, a full front apron, long-sleeved coverall, gloves, and boots [Fig. 4].

The mixing and loading activities were observed by EPA and recorded as follows. Seventy-two liters (19 gallons) of methyl parathion (44.4%) and 18 liters (4.75 gal) of galecron (48.5%) were pumped and poured simultaneously into a mixing vat which had a capacity of approximately 227 liters (60 gal). A fluorescent tracer dye, Rhodamine WT, was added. The mixture of the pesticides and dye was pumped into another pre-mix tank where water was added. Then the mixture was pumped into the aircraft tank. The final volume of diluted pesticide (153 gal) was attained by pumping additional water into the aircraft tank.

This mixture provided an aerial application rate of 1.5 liters/hectare (1 gal/acre), which is inconsistent with the Staplcotn® Methyl Parathion 4EC label dosage of "2 to 5 gallons of water per acre" when applied by aircraft. The actual active ingredient of 0.47 liters (1 pint) per acre of methyl parathion was applied as specified on the label. The application rate of galecron was in compliance with its registered label.

During the aircraft loading activity, pesticide formulation samples were collected for comparison with labeling and other applicable regulations [Fig. 4]. Later analysis of these samples revealed that the formulations were chemically in compliance with State and Federal regulations.

Figure 4. Pesticide inspectors from the State of Mississippi and EPA collect pesticide formulation samples.

Application

Observations

The aircraft used for the pesticide application was a Cessna Ag Wagon equipped with a 22-nozzle spray boom. The nozzle orifice and core combination was D6 with a 45 spinner. The orifice diameter was 0.094 inch. This configuration of aircraft and spray equipment is designed to apply low volumes of liquid at a high rate of speed.

The first pesticide application began at 8:15 a.m. (CDT) and was completed at 8:57 a.m. on July 29.

On-site air temperatures varied from 25.6 to 26.7°C (78 to 80°F). No temperature inversion was observed. The wind ranged from 0 to 6.4 km/hr (4 mph) from the SW. The weather report from the Greenwood Municipal Airport gave temperatures ranging from 24 to 25.6°C (75 to 78°F), wind varying from SSW to WSW, and relative humidity 94 to 100%.

Passes over most of the cotton field were made in a north-south direction, parallel to the rows of cotton, at about 2 m (7 ft). The southernmost portion of the field was sprayed in an east-west or west-east direction. A spray swath about 18 m (60 ft) wide occurred with about a 3 m (10 ft) overlap on each pass. Before completing the application, the north and south edges of the field were bordered by east-west and west-east passes.

A tractor was operated on the field, near station 28, throughout the entire first application. The tractor operator was without protective clothing. It is stated on the Staplcotn® Methyl Parathion 4EC label: "Remove unprotected persons and domestic animals from operating and adjacent areas where insecticide may drift; prohibit re-entry until drift and vapor dissipate." Also in the *Code of Federal Regulations*,

Part 170, Title 40 (July 1, 1975) it is stated that: "When workers are expected to be working in a field treated or to be treated with a pesticide, appropriate and timely warning to such worker shall be given. The warning may be given orally and/or by posting warning signs at the usual points of entrance to the field. . ."

Clean-Up Activities

After loading the pesticide into the aircraft, several clean-up procedures were used by the applicator. Disposable items (paper towels, gloves, etc.) were burned on-site. The mixing vat was rinsed with clean water [Fig. 5]. The sprayer was then turned upward to rinse empty pesticide containers in an inverted position. All rinse water was pumped into labeled containers and stored until that particular solution is used again. Rinsed five-gallon containers were taken to the city of Greenwood landfill site to be buried [Fig. 6]. Rinsed 55-gallon drums were retained for sale to a cooperage company.

After the insecticide application, the plane was washed by first dumping the pesticide residue from the hopper into a portable vat [Fig. 7]. A hose was attached to the vat and to one end of the spray boom [Fig. 8] and a fresh water source was coupled to the other end. The water forced material out of the boom, through the hose, and into the vat. Next, the spray valve was opened so that the water back-flushed the strainers, valves and pumps. The hopper was washed and rinsed into the vat. The pesticides and rinse water captured in the vat were pumped into labeled containers and stored as described previously.

Post-First Application

As during pre-application, environmental samples (soil, vegetation, water and sediment) were collected from areas of potential pesticide

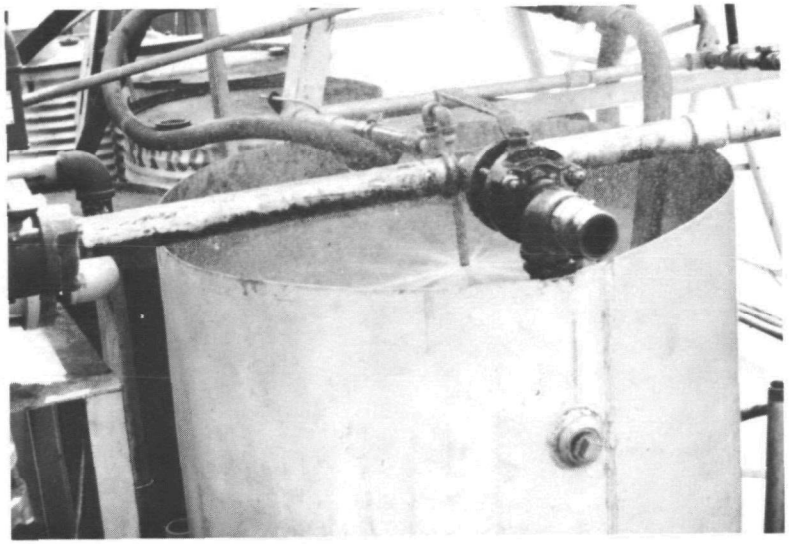

Figure 5. Rinsing pesticide mixing vat after pesticide application.

Figure 6. Landfill disposal site for empty pesticide containers.

Figure 7. Pesticide residue is dumped from plane hopper into a portable vat.

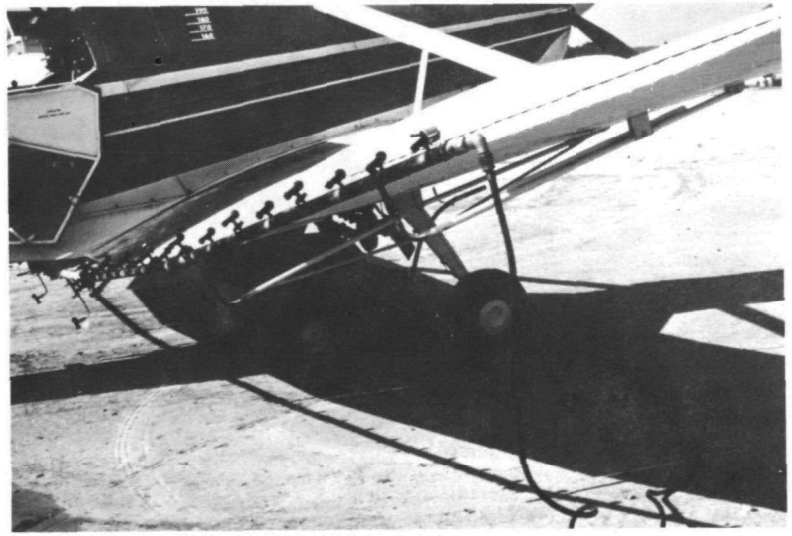

Figure 8. Cleanup of pesticide spray boom.

contamination for chemical analysis. Analysis was limited to detection of methyl parathion only.

Methyl parathion was found in several water samples [Table 2]. This insecticide was not detected in samples collected from Bear Creek on July 27 before the first application [Table 2]. On July 31, 48 hours after the first application, Bear Creek water contained 3.1 µg/l methyl parathion. Mossy Lake samples ranged from not detectable before to 0.3 µg/l forty-eight hours after application. All the ditches sampled contained some methyl parathion prior to and after the first application of pesticides.

Background vegetation samples from the cotton field and a nearby pasture contained methyl parathion concentrations of 0.09 to 0.17 µg/g. This indicated drift from other field applications. Following the application on the target field, vegetation samples at the same sites ranged from 0.92 to 1.3 µg/g.

No detectable amounts of methyl parathion were found in background soil samples and low concentrations were measured after the first application (0.007 to 0.11 µg/g).

An air sample collected in ethylene glycol by an impinger system, operated in the northeast corner of the cotton field (station 10), contained 6.2 µg of methyl parathion. Air samples collected by impinger systems situated off the target field, along the east (station 23), west (station 18) and south (station 35) borders, contained 1.2 µg of methyl parathion. An air sample from an impinger system located in a pasture north or downwind from the cotton field, contained 4.4 µg methyl parathion.

Drift deposits were collected on magnesium slides, Kromecote cards, and mylar sheets [Table 3]. The number of droplets per square centimeter on the slides ranged from 28 at station 10, located in the northeast

Table 3

IMPINGEMENT OF DROPLETS ON MAGNESIUM OXIDE SLIDES AND KROMECOTE CARDS
July-August 1976

Station No.	1st Application (droplets/cm^2)		2nd Application (droplets/cm^2)		
	Slides	Kromecote (Horizontal)	Slides	Kromecote (Horizontal)	Kromecote (Vertical)
1	3	4	0	<1	--
4	3	1	<1	<1	<1
6	5	6	0	<1	<1
7	4	1	2	<1	<1
10	28	39	11	9	33
12	4	4	<1	<1	<1
13	12	<1	1	2	<1
17	1	4	<1	<1	<1
18	--	0	2	9	5
19	7	4	9	10	2
23	2	8	<1	<1	--
25	4	2	--	4	1
26	1	0	3	7	--
28	--	--	--	4	--
31	1	4	1	2	2
32	1	<1	0	<1	<1
35	0	0	3	<1	--
37	<1	0	2	12	10
38	0	0	2	11	21
38a	--	--	--	4	--
$\bar{x}$	4.5	4.2	2.2	3.7	5.4

corner of the field, to 3 at station 1, located on the northern bank of Bear Creek about 100 m (330 ft). Measurements of pesticide spray drops deposited on the slides, cards and sheets revealed that the average volume median diameter (VMD)* was 154 μ on the target field and 53 μ for droplets that drifted beyond the field.

To further evaluate drift, Rhodamine WT dye solution added to the pesticide spray mixture was also monitored with the Greenburg-Smith air sampler and mylar sheets. No measurable amount of dye was found in the Greenburg-Smith impingers or on the mylar sheets.

SECOND APPLICATION

Preparation and Application

The pesticides methyl parathion and galecron were applied a second time, August 4, six days after the first application (July 29, 1976).

Mixing and loading operations were similar to those for the first application.

During the second application, the wind varied from 0 to 1.6 km/hr (1 mph) from the NE. The day was cooler -- 22.2 to 23.9°C (72 to 75°F) -- than it was during the first application -- 25.6 to 26.7°C (78 to 80°F). No temperature inversion was observed. At the Greenwood Municipal Airport, air temperatures ranged from 22.2 to 25.6°C (72 to 78°F) and relative humidity varied from 72 to 74%.

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* *VMD is that volume which divides the distribution of droplet diameters into two equal parts about the median or 50% cumulative point.*

Observations

The flight pattern during the second application was different from the first in that the entire field including the southernmost portion (originally applied with east-west and west-east passes), was sprayed from north-south or south-north passes. The second application was five minutes shorter than the first; it began at 8:00 a.m. and was completed 37 minutes later at 8:37 a.m.

During the application, occupied vehicles moved across the field roads and on adjacent roads.

Environmental Sampling

On August 4, 1976 after the second pesticide application, selected environmental samples were again analyzed for methyl parathion. Results revealed 24 µg/l of methyl parathion in irrigation water draining from the treated cotton field (station 28). Use of methyl parathion on an irrigated field is inconsistent with the label requirements which state: "keep out of any body of water" and "do not apply where runoff is likely to occur."

Station 28 was in an artesian-fed drainage ditch about 300 m (1,000 ft) downstream from station 20. The latter station is adjacent to the north edge of the cotton field and methyl parathion concentrations at this site ranged from below detectable limits on July 27 to 0.2 µg/l on August 6, 1976. Seven observations were made at these two sites from May until August 1976. On all seven occasions, fish were present at station 20; whereas, downstream at station 28 no fish were present in the same artesian-fed drainage ditch. In another ditch, east and south of the cotton field (station 36), the methyl parathion concentration in the water was 8.0 µg/l, higher than at any other site on August 6, 1976. Station 36 is about 300 m (1,000 ft) from the target field. There was no flow in this ditch during the application or sampling periods.

As shown in Table 2, air samples collected from the impinger system contained methyl parathion concentrations in the solvent ranging from 0.4 µg in the southeast corner of the field (station 35) to 4.9 µg west of the target field (station 18).

Drift deposits recorded on magnesium-oxide-coated slides and Kromecote cards are reported in Table 3. Drift (droplets) was recorded as far away as 100 m (330 ft) on the downwind side of the target field (SW) at station 26. Droplets were detected on Kromecote cards set out for the second application at the water's edge of an artesian-fed drainage ditch near station 28 and at the shoreline of Mossy Lake near station 40 [Table 2]. The presence of methyl parathion was verified in the analyses of water collected from both stations 28 and 40 [Table 2]. The VMD for the second application was calculated to be 123 µm on the target field and about 50 µm for the droplets that drifted beyond the field.

No drift information was obtained from the use of the dye tracer. Dye was not detected in either the impinger systems or on the mylar sheets.

After the second application, channel catfish which had been exposed from May 11 to August 6 were analyzed for acetylcholinesterase inhibition. There was no change in the acetylcholinesterase activity of the fish brain, no inhibition, or indication of pesticide poisoning in Mossy Lake. Unfortunately fish cages at station 20 in the artesian-fed drainage ditch, and at stations 2 and 3 in Bear Creek, were missing or destroyed.

V. EVALUATION

Observations by EPA of the two aerial pesticide applications led to the conclusions that pesticides were subject to drift from the cotton field as a result of: 1) airplane turbulence, 2) meteorological conditions, and 3) droplet size and nature. Pesticide droplets in the air appeared to be transported by the combined forces of turbulence, wind speed, and gravity.

Drift from wind can be minimized by applying pesticides only at times of low wind velocity. The wind velocity during the first and second applications varied from 0 to 6.4 km/hr (4 mph), thus minimizing the drift.

The amount of drift is also related to the size and nature of the spray droplets.[1] Droplet data obtained from magnesium oxide slides revealed that the average droplet size at a station off the field was nearly 70% smaller than that of droplets falling on the field. The slides were also useful in determining the true drop size and the average volume median diameter (VMD) of the sprayed droplets. The VMD is used in measuring the potential drift of droplets sprayed on the cotton field, and was calculated to be 154 μ and 123 μ for the first and second applications, respectively. It was also estimated that 25 to 35% of the pesticide drifted off the field to measured distances of 100 m (330 ft) downwind. An undetermined amount of the drift was deposited in Bear Creek and Mossy Lake.

The combined factors of high humidity and moderate air temperature reduce the evaporation rate of the water-based pesticide droplets and thus the drift potential. During the applications, the relative humidity ranged from 72 to 100% and the air temperatures from 22.2 to 26.7°C (72 to 80°F).

Some research indicates that the collection efficiency of magnesium-oxide-coated slides is low and the data are skewed toward larger sizes, thus making VMD measurements questionable.[3] A current effort is being made in the Department of Entomology at the University of Georgia to standardize field methods for determination of insecticide spray droplet size.

Kromecote cards appear to be superior to magnesium-oxide-coated slides where quick interpretation and response is required, as in enforcement investigations. Based on the number of droplets per square centimeters, Kromecote cards appeared to be more efficient collecting devices than magnesium-oxide-coated slides; Kromecote cards were impinged an average of $3.7/cm^2$ while magnesium-oxide-coated slides were impinged $2.2/cm^2$. Vertical Kromecote card droplet counts averaged greater than either horizontal cards or slides, 5.4, 3.7 and $2.2/cm^2$, respectively. Other workers have also observed that fewer droplets are deposited on cards placed horizontally than those placed vertically above vegetation.[4] Horizontal Kromecote cards were better than slides in spite of being closer to the ground and farther below the height of the cotton plants [Table 3].

Rhodamine WT dye used as a tracer in the pesticide mixture at a concentration of 200 µg/l was not detected in the impinger systems or on the mylar sheets. The literature indicates that another dye, Rhodamine B, at a concentration of 0.1% is satisfactory.[5] Lower concentrations of Rhodamine WT may be satisfactory since it does not degrade as rapidly as Rhodamine B, which undergoes fading at non-constant rates depending on the exposure to sunlight. However, the extremely low concentration of 200 µg/l used in this study was below detectable limits. Further tests should be made using higher concentrations of Rhodamine WT dye.

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APPENDIX

DESCRIPTION OF SAMPLING TECHNIQUES AND METHODS

A number of techniques were used to determine spray drift. Kromecote cards (4 x 5 in.) were placed horizontally and vertically on stands in the fields. The vertical cards were placed higher than both horizontal cards and the MgO slides. Vertical Kromecote cards were wrapped around the outside of a plastic cylinder marked and positioned facing the four cardinal directions. After a pesticide spray application, Kromecote cards must be exposed to UV light in order to develop visible spots.

Another technique used to sample the drift droplets was the magnesium oxide coated microscope slide.

A slide is coated by burning a strip of magnesium beneath it. The impinged spray droplets leave visible crater on the magnesium oxide coated slide. The droplet-caused craters were measured to the nearest micron at 100X magnification; up to 200 craters on a slide were measured. The slide with the most droplets was selected at each site. The data were used to compute the VMD.

Air samples were collected by using the Greenburg Smith impinger. This system contains a pump that draws the air through an impinger. The air flow is controlled and measured and after a pre-set time interval the air flow is switched from one impinger to another. Each unit was numbered and assigned to a station and was used only at that station. Air flow rates were set for 1 ft^3/min. Pesticide-free aluminum foil was used to cover the air intake tubes prior to the sample collection. The air sampling units switched automatically from one impinger to the next after three hours and off at the end of twelve hours. Each impinger contained 100 ml of ethylene glycol in which pesticides are trapped.

A five ml sample from a 25 ml subsample of ethylene glycol, containing trapped pesticides, was poured into matched cuvettes and fluorescence was measured. The sample was then returned to the original container to make up a 100 ml sample to be taken to Denver NEIC laboratory for pesticide analysis.

Another method used to collect the insecticide and dye mixture was mylar sheets. These sheets, 10.2 x 30.5 cm x 5 mil thick, were placed on a stand about 0.5 m above the ground. Dye retained on mylar sheets would be evidence of spray drift. To determine the presence of dye, each sheet was washed with 100 ml of 95% ethyl alcohol. In the Mississippi study, no dye was detected.

Environmental samples (soil, water, etc.) were collected by standard methods.

DESCRIPTION OF ANALYTICAL METHODS

Water samples were serially extracted using 100 + 50 + 50 ml of methylene chloride. Extracts were combined and passed through a sodium sulfate column to eliminate free water and concentrated to approximately 6 ml in a Kuderna-Danish evaporative concentrator. The extract was then exchanged into acetone.

The extracts were cleaned up using a Florisil column eluted with 15% ethyl ether in hexane. Fifty ml fractions were collected and methyl parathion eluted in fractions 3, 4, 5 and 6. The extracts were concentrated to 10 ml on a hot plate under a gentle stream of air and analyzed on a gas chromatograph equipped with an electron-capture detector.

Soil and vegetation samples were extracted twice with 100 ml of methylene chloride. The extracts were combined, backextracted with 200 ml of water, passed through a sodium sulfate column and concentrated to approximately 6 ml in a Kuderna-Danish evaporative concentrator. The

extract was then exchanged into acetone.

The cleanup and analysis were identical to those described above for the water samples.