ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
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South Dakota Toxaphene Use Study

June - September 1975

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
AND
REGION VIII
DENVER, COLORADO

OCTOBER 1975

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

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National Enforcement Investigations Center
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Denver, Colorado

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I. INTRODUCTION

During the spring of 1975, the State of South Dakota reported an infestation of cutworms which threatened the sunflower production in twenty-three counties. To suppress the cutworm population and prevent the projected damage to 20,000 ha (50,000 acres) of crop, the State requested a special exemption from the Environmental Protection Agency (EPA) to use toxaphene.* Pursuant to Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act, the EPA granted an exemption, allowing South Dakota to use toxaphene from 4 June to 15 July to control the cutworms.

On 11 June 1975, the National Enforcement Investigations Center (NEIC) was requested by the Enforcement Division, EPA Region VIII, Denver, Colorado, to investigate the environmental impact of toxaphene spraying in South Dakota. The request [Appendix A] lists the exemption restrictions set forth by the EPA Pesticide Registration Division, Washington, D. C.

Following the request from EPA Region VIII, NEIC conducted a field investigation in Brown and Spink Counties, South Dakota. The principal objectives of the study were to:

1. Assess the short-term effects of toxaphene on the ecosystem adjacent to fields being sprayed to control cutworms.

2. Determine the efficacy of using toxaphene to control cutworms in young sunflower plants.

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* *The name* Toxaphene *is registered for common usage.*--Merck Index, 8th Ed.

II. SUMMARY AND CONCLUSIONS

On 4 June 1975, EPA issued a 42-day permit to South Dakota, allowing the State to use toxaphene on the commercial sunflower crop to control a cutworm infestation. The NEIC was asked by EPA Region VIII to help its Pesticides Branch monitor the application of toxaphene, assess the environmental impact of it, and determine how effectively toxaphene controlled cutworms.

A field investigation began in June 1975 at two areas adjoining the James River in Brown County, South Dakota. A reference area, where use of toxaphene was prohibited, was selected near the Sand Lake National Wildlife Refuge. Another area 30 km (18 mi) south, which included toxaphene-treated fields and adjacent wetlands, was used to monitor the environmental effects of toxaphene.

The June study showed that toxaphene provided adequate control of cutworms on young sunflower plants. Also, measurable amounts of toxaphene (0.1 to 0.51 µg/g) were found in minnows collected from nearby streams. Surveillance of the area by EPA and U. S. Fish and Wildlife Service revealed no other environmental impact.

The second phase of the toxaphene use study was conducted in July 1975, following a fish kill near the Sand Lake Refuge reference area. NEIC reported the probable cause of the kill to be a lack of oxygen in a reach of the James River. Chemical analyses of vital organs removed from the fish confirmed the fact that toxaphene did not kill the fish.

The final phase of the study was completed in September 1975. Neither harm nor detectable residues from toxaphene were apparent in fish or crayfish from the treated area.

III. STUDY AREA

SOUTH DAKOTA SUNFLOWER BELT

The sunflower belt begins near the northeastern border of South Dakota and extends south and west through the James River Valley. Its gently undulating terrain is elevated 274 to 427 m (900 to 1,400 ft) above sea level.[1] Much of the area is dotted with ponds or lakes, lying adjacent to extensive marshlands -- 280,000 ha (700,000 acres) of wetlands. A portion of the sunflower production area is drained by the James River.

Commercial sunflower production in South Dakota began about 1966. The crop is grown principally for vegetable oil but has other uses, including confectionaries and bird seed. Young sunflower plants are annually subjected to a barrage of insect pests. One of the most troublesome is the larvae of a moth known as cutworm (*Chorizagrotis* sp). This insect larvae feeds on the sunflower stems and leaves, often cutting the plant off near the soil. Many of these larvae have infested fields and have been responsible for complete crop failure.

In 1975, about 26,000 ha (65,000 acres) in South Dakota were cultivated with sunflowers. In May a cutworm outbreak threatened the commercial sunflower crop. The State requested and received permission from the EPA to apply toxaphene (an organochlorine insecticide) to control the cutworm infestation in 23 counties of northeastern South Dakota. The EPA restricted the applicators to minimize environmental damage to wetlands adjacent to the sunflower fields. NEIC conducted the toxaphene monitoring program described in this report to specifically measure the environmental impact.

BROWN AND SPINK COUNTY STUDY AREA

Brown and Spink Counties lie in the James River Valley. The river flows southward, dividing each county into approximately equal halves. More than 10,000 ha (25,000 acres) of sunflowers are grown in the two counties; the majority of crop is produced adjacent to the James River.

A reference area at the northern boundary of Sand Lake National Wildlife Refuge in Brown County was selected for the field evaluation. The Refuge is comprised of wetlands used by migratory waterfowl as a major breeding area. Contributing to the selection of the reference area was the fact that it was not subjected to aerial spraying of toxaphene. Also, since the area lay north of the sunflower belt, runoff water from toxaphene-treated fields did not flow into the reference area wetlands.

The study area selected to monitor environmental effects of toxaphene application included treated fields and a portion of the James River and its principal tributaries south of Sand Lake Refuge in Brown and Spink Counties. This portion of the study area was directly subjected to aerial spraying of toxaphene. Furthermore, water runoff from the fields drained into the streams being monitored for pesticide contamination.

SAMPLING STATIONS, SCHEDULES AND METHODS

Ten sampling stations were established to monitor toxaphene. One station was in the reference area at the northern boundary of Sand Lake Refuge (Station 01). The remaining 9 stations were in the toxaphene-treated fields in Brown and Spink Counties and in the James River and its tributaries. From these sampling stations, fish, invertebrates, water, sediment, aquatic vegetation and soil were collected [Fig. 1].

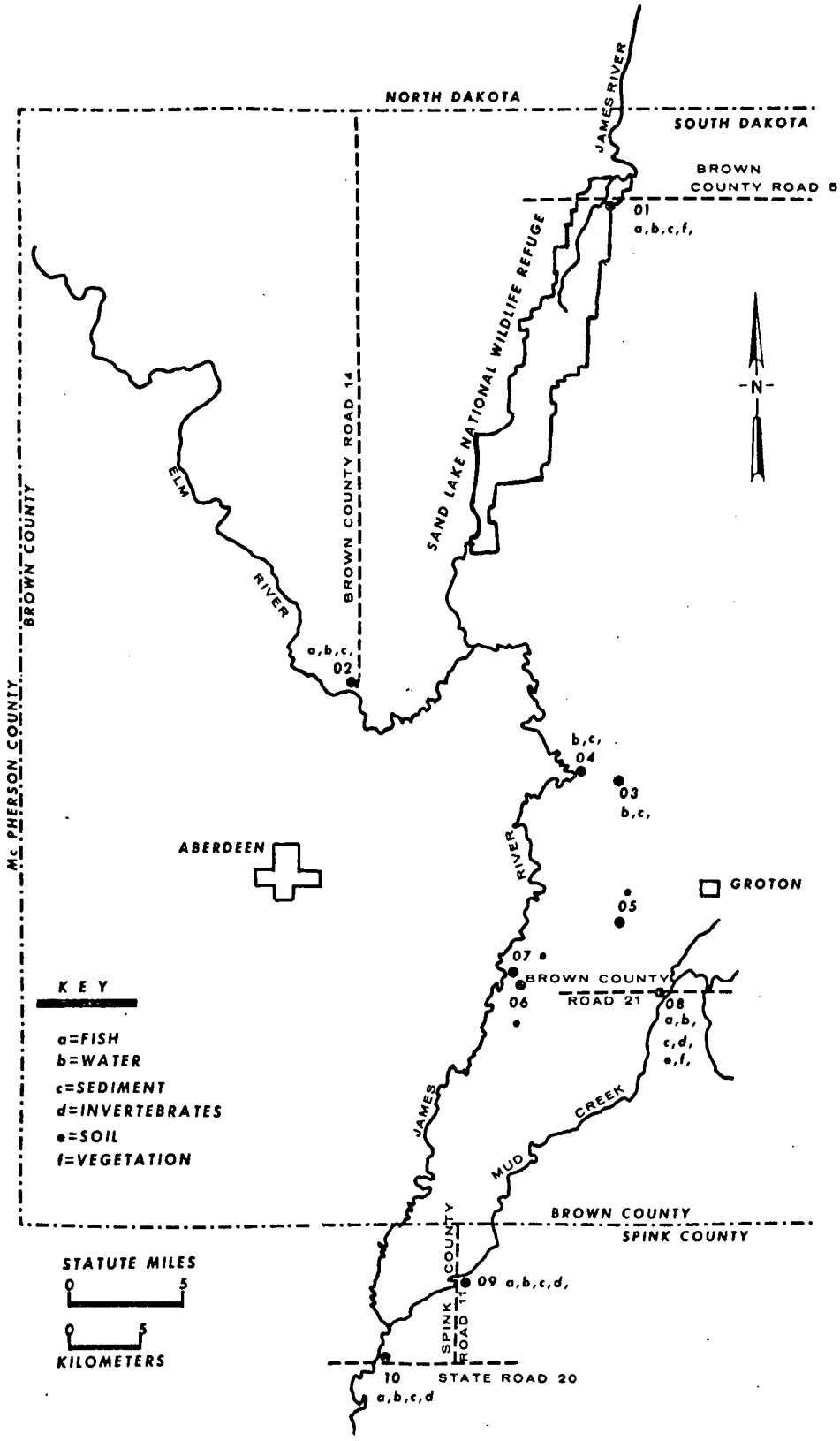

Figure 1. Sampling Station Locations, Brown and Spink Counties, South Dakota

From 25-27 June 1975, toxaphene applications were monitored, and the efficacy of toxaphene for control of cutworms on young sunflower plants was evaluated. When a fish kill occurred near the reference area on 5 July, fish were collected on 9 July for examination at NEIC. On 2-3 September, the possibility of short-term translocation of toxaphene from treated sunflower fields into the surrounding environment was investigated.

Grab sampling techniques (one sample per station per sampling period) were used to collect water, soil, sediments and biota for pesticide analyses. Times and types of samples were varied to correlate with toxaphene-spray applications and rain-runoff periods. Detailed methods for field sampling and analyses are presented in Appendices B and C.

IV. STUDY FINDINGS

An infestation of cutworms (*Chorizagrotis* sp) was discovered in the commercial sunflower crop of Brown County, South Dakota on 1 June 1975.[2] Three days later (4 June 1975) the EPA granted a special permit to the State to use a toxaphene formulation to suppress the cutworm population and to reduce the threat of severe sunflower crop destruction. Immediately, an intensive pesticide spraying program began on cutworm-infested sunflower fields throughout Brown County as well as the northeast corner of South Dakota. As shown in Figure 2, farmers and commercial applicators applied toxaphene in 12 counties with air and ground equipment at the EPA specified rate of 2.3 kg/ha (2 lb/acre).

JUNE 1975 STUDY

NEIC began a field monitoring program in Brown County, South Dakota on 25 June 1975. Approximately 99% of the planned toxaphene applications on sunflower fields in the county were completed by that time.[3,4]

Following aerial pesticide application, samples of water, sediment, soil and biota were collected from and adjacent to treated fields and from the reference area in Sand Lake Refuge. Analysis of these samples [Table 1] showed measurable amounts of toxaphene in field soils (Station 5: 0.32 µg/g) and minnows from nearby streams (Stations 2, 8 and 9: 0.12, 0.51 and 0.10 µg/g). Environmental Protection Agency and U. S. Fish and Wildlife Service personnel* inspected these areas. They

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* *Robert R. Johnson, Manager, Waubay National Wildlife Refuge, South Dakota; William Bair, Manager, Sand Lake National Wildlife Refuge, South Dakota*

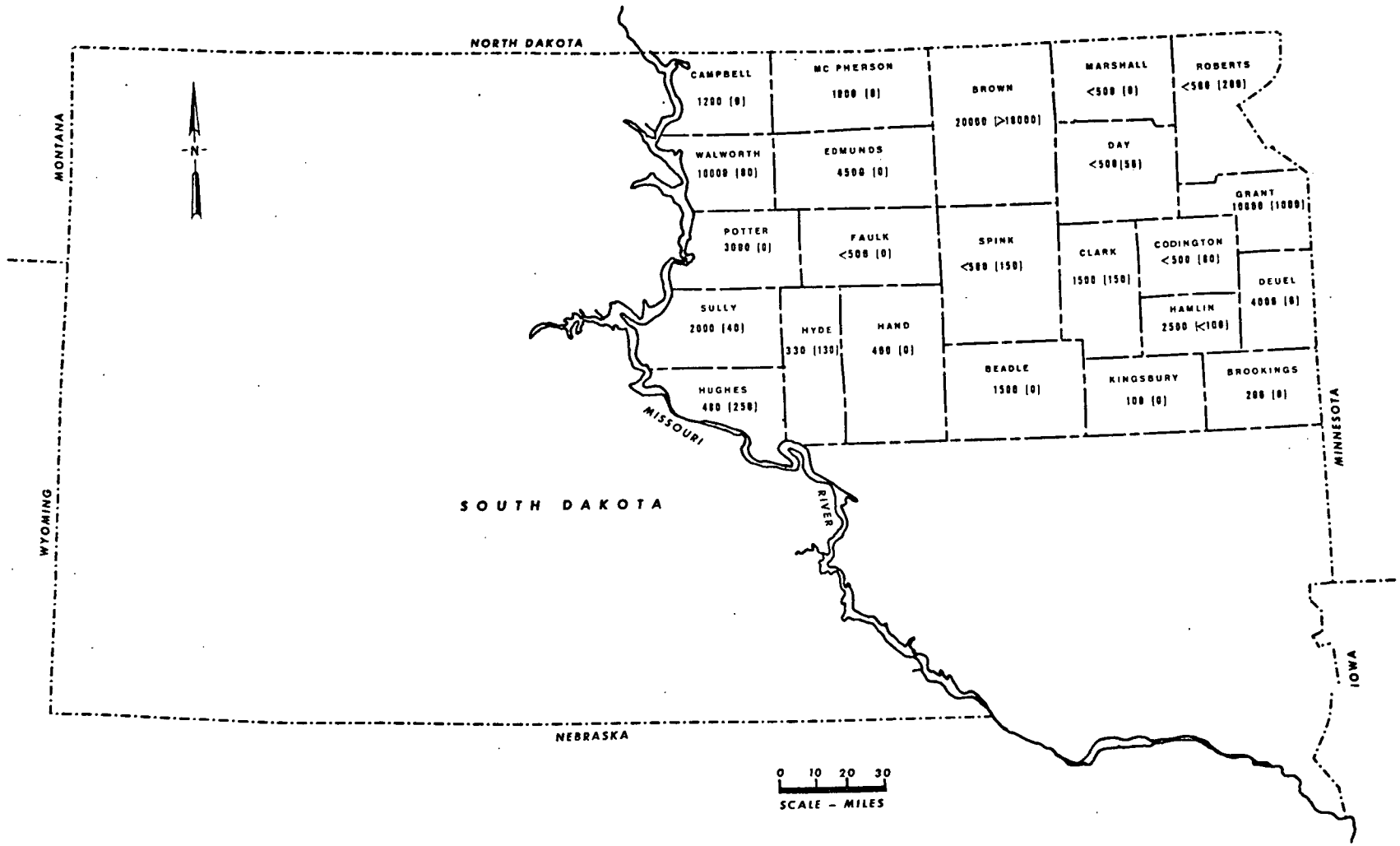

Figure 2. Acreage Cultivated in Sunflowers in South Dakota and Treated with Toxaphene ( ) as Authorized by the E P A,(June 4 – July 15, 1975)

Table 1

ANALYTICAL RESULTS OF TOXAPHENE USE STUDY IN BROWN AND SPINK COUNTIES, SOUTH DAKOTA
June 1975

Station No.	Location	Type of Sample †	Toxaphene Concentration (µg/g)
	Reference Area		
01	James R., Brown Co. Hwy 5	Sediment	<0.2
		Water	<0.8 µg/l
		Fathead minnow	<0.1
		N. pike (kidney)	<0.9
		Aquatic vegetation	<0.2
	Toxaphene Sprayed Area		
02	Elm R. Brown Co. Hwy 14	Sediment	<0.1
		Water	<0.9 µg/l
		Fathead Minnow	0.12
		W. Crappie (liver)	<1.0
03	Pond, W. side S. 28 Putney Twp	Sediment	<0.3
		Water	<0.9 µg/l
04	Drain, SW of SE Sec 30 Putney Twp	Sediment	<0.1
		Water	<0.8 µg/l
05	Sunflower field SW of SW Sec 28 Henry Twp	Soil	0.32
06	Sunflower field NE 1/4 Sec. 10, E. Gem Twp.	Soil	<0.1
07	Ditch west of field NE 1/4 Sec 10, E. Gem Twp	Soil	<0.1
08	Sunflower field 1/4 mile west of Mud Cr. Brown Co. Hwy 21	Soil	<0.1
08	Ditch from field west of Mud Cr. Brown Co. Hwy 21	Soil	<0.1
08	Mud Ck., W. Hanson Twp. Brown Co. Hwy 21	Sediment	<0.1
		Water	<0.8 µg/l
		Fathead Minnows	0.51
		Crayfish	<0.2
		Aquatic Vegetation	<0.2
09	Mud Ck, Spink Co. Hwy 11	Sediment	<0.1
		Water	<0.8 µg/l
		Fathead Minnows	0.10
		Crayfish	<0.2
10	James R., S. Dakota Hwy 20	Sediment	<0.1
		Water	<0.8 µg/l
		Bullhead (kidney)	<0.77
		Carp ††	<0.2
		Crayfish	<0.2

† *Solid phase of sediment samples analyzed*
†† *Young-of-the-year*

found that toxaphene provided control of cutworms on sunflowers. And they found no fish and wildlife mortalities or substantial decline in species or wildlife numbers.

JULY 1975 STUDY

On 5 July 1975, a fish kill occurred in the James River near the Sand Lake National Wildlife Refuge. The kill, in the reference area used by NEIC for the toxaphene study, was investigated by an NEIC senior fishery biologist. The NEIC biologist joined a team of scientists from the State of South Dakota and the U. S. Fish and Wildlife Service. The team surveyed the affected reach of the James River and estimated 600 fish were killed, principally northern pike. Because water samples collected and analyzed at various points along the James River revealed a low dissolved oxygen level (2.0 mg/l), oxygen deficiency was suspected to be the cause of the kill.

Live fish (perch and northern pike) were collected on 9 July, preserved by freezing and returned to NEIC for further examination. External and internal examination of fish showed no gross abnormalities. Whole-body, young-of-the-year yellow perch were analyzed for toxaphene residue, and kidneys were removed from the larger fish, northern pike, and also analyzed for toxaphene; however, no toxaphene was detected [Table 2].

SEPTEMBER 1975 STUDY

On 2-3 September, fish samples were collected at four sites [Table 3]. In June, fathead minnows collected at Station 08 in Mud Creek contained 0.51 µg/g toxaphene. However, in September Mud Creek was dry at Station 08 and no fish were collected there. Downstream at Mud Creek Station 09 and at all other locations no toxaphene was detected in any of the fish.

Table 2

TOXAPHENE ANALYSIS FROM FISH COLLECTED IN THE AREA OF A FISH KILL
North and South Dakota - July 1975

Location	Type of Sample	Toxaphene Concentration (µg/g)
James R., Dickey Co. Hwy 5 N. Dak.	Northern pike (kidney)	<0.50
James R., Brown Co. Hwy 5 S. Dak.	Northern pike (kidney)	<1.7
	Yellow perch†	<0.2
	Yellow perch†	<0.2

† *Young-of-the-year*

Table 3

ANALYTICAL RESULTS OF TOXAPHENE USE STUDY IN BROWN AND SPINK COUNTIES, SOUTH DAKOTA
September 1975

Station No.	Location	Type of Sample	Toxaphene Concentration (µg/g)
	Reference Area		
01	James R., Brown Co. Hwy 5	Carp (viscera)	<0.5
	Toxaphene Sprayed Area		
02	Elm R., Brown Co. Hwy 14	W. Crappie (viscera)	<0.4
09	Mud Ck., Spink Co. Hwy 11	Carp (viscera)	<0.3
		Fathead Minnows	<0.3
		Crayfish	<0.3
10	James R., S. Dakota Hwy 20	Carp (viscera)	<0.2
		Bullhead	<0.2

REFERENCES

1. Westin, F. C., L. F. Puhr and G. J. Buntley, 1967. Soils of South Dakota. Soil Survey Series No. 1; Agronomy Dept. S. Dakota State Univ., Brookings, S.Dak., 32 p.

2. Berndt, Wayne, S. Dakota State Univ., Brookings, S.Dak. Personal Communication (verbal) to John Hale, Environmental Protection Agency, Denver, Colo. [June 17, 1975].

3. Caven, James, Aberdeen Flying Service, Aberdeen, S.Dak. Personal Communication (verbal) to John Hale, Environmental Protection Agency, Denver, Colo. [June 25, 1975].

4. De Hoog, Marvin, Brown County Agricultural Extension Agent. Personal Communication (verbal) to John Hale, Environmental Protection Agency, Denver, Colo. [June 26, 1975].

Appendix A

EPA Region VIII Request to NEIC

11 June 1975

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Section 18 Exemption DATE: June 11, 1975

FROM: David A. Wagoner, Director
8AH
Ivan W Dodson, acting

TO: Thomas P. Gallagher, Director

Pursuant to Section 18 of the FIFRA, EPA has granted an exemption to the State of South Dakota on June 4, 1975 to use a toxaphene formulation to suppress populations of cutworms destroying young plants on 50,000 acres of the commercial sunflower crop in South Dakota. The exemption is subject to the following restrictions:

1. The dosage rate shall not exceed 2.0 pounds per acre actual toxaphene.

2. Treated acreage shall not exceed 50,000 acres.

3. The counties to be treated are limited as follows: Beadle, Brookings, Brown, Campbell, Clark, Codington, Day, Deuel, Edmunds, Faulk, Grant, Hamlin, Hand, Hughes, Hyde, Kingsbury, Marshall, McPherson, Potter, Roberts, Spink, Sully, and Walworth.

4. Leaves and stalks are not to be used for livestock feed.

5. The South Dakota Cooperative Extension Service must supervise any aerial application to avoid or minimize drift to non-target areas.

6. No toxaphene applications are permitted on or near reservoirs, rivers, streams or wetlands. This will reduce probability of contamination of domestic water supplies as well as minimize impact of toxaphene on waterfowl.

7. This exemption will expire July 15, 1975.

8. The South Dakota Cooperative Extension Service will collect data on efficacy, residues, and environmental impact of toxaphene spray program. Pesticide personnel of EPA Region VIII shall be informed of the times and places of toxaphene applications so that monitoring activities of EPA can be coordinated with those of the Cooperative Extension Service.

9. A residue level not to exceed 7.0 ppm in or on sunflower seeds has been determined to be adequate to protect public health. The Food and Drug Administration, DHEW, has been advised of this action. Sunflower seeds not to exceed this level may be offered in interstate commerce.

However, it should be emphasized that sunflower seeds harvested from acreages treated with toxaphene must be used for oil and are excluded from use for confectionaries, bird seed or any non-oil use.

Due to the magnitude of the exemption, the potential for misuse and environmental effects and the need for data in order to evaluate expected future use of toxaphene in this manner, I feel that it is important to thoroughly investigate a few large toxaphene applications to sunflowers. Whatever support that you can provide to assist in this effort would be appreciated.

If you are able to participate in this investigation, program coordination should be through:

Ivan W. Dodson, Chief
Pesticides Branch

Robert W. Harding, Chief
Field Operations Section
Pesticides Branch

I hope that such a short notice does not present undue problems for your program.

Appendix B
Field Sampling Methods

FIELD SAMPLING METHODS

SEDIMENT

Samples were collected with an Eckman dredge. Each sample was placed in a glass wide-mouth quart bottle and sealed with a teflon lined lid. The glass bottles were properly labelled and refrigerated on crushed ice for shipment to the analytical laboratory at NEIC in Denver, Colorado.

WATER

Samples were collected in glass wide-mouth quart jars, sealed with a teflon-lined lid, labelled and preserved on crushed ice for shipment.

VEGETATION

Aquatic vegetation was collected by hand and wrapped in acetone-washed aluminum foil, labelled and preserved on crushed ice for shipment.

SOIL

Samples were collected with a metallic coring device capable of collecting a core sample 5 cm (2 in) in diameter by 7.5 cm (3 in) deep. Each sample was wrapped in acetone-washed aluminum foil, labelled and refrigerated on crushed ice for shipment.

FISH AND CRAYFISH

Specimens were collected with a 10.5 m (35 ft) seine with 6.3 mm (1/4 in) bar mesh. At each collection site, species were wrapped separately in acetone-washed aluminum foil, and properly labelled. Samples of fish and crayfish were preserved on crushed ice until the end of the day and then placed in a freezer. The frozen samples were returned to the NEIC laboratories in Denver for pesticide residue analyses.

Appendix C
Analytical Methods

ANALYTICAL METHODS

WATER

Approximately 1 liter of water was extracted in series with 150, 100, and 100 ml of hexane. The container of solvent was then placed on a hot plate under a gentle stream of air and evaporated to 10 ml. A 1 µl aliquot of the extract was analyzed on a gas chromatograph (GC) with an electron capture detector (EC) for toxaphene.

SOIL AND SEDIMENT

These were analyzed using a method developed by D. F. Goerlitz for the ASTM.* A 50 g portion of the sample is dried overnight in an oven to determine moisture content. All results are reported on the basis of dry weight. Another 50 g portion is extracted with a 40 ml acetone/80 ml hexane mixture, then re-extracted twice with a 20 ml acetone/80 ml hexane mixture. The sample is back-extracted three times with water and dried using sodium sulfate (Na_2SO_4). The extract is then evaporated to 10 ml in a Kuderna-Danish evaporative concentrator. After an alumina column cleanup, a 1 µl aliquot of the sample was analyzed on an EC/GC for toxaphene.

VEGETATION

Twenty grams of aquatic vegetation was put into a blender and extracted in series using 175 ml and 175 ml of hexane. The hexane extracts were combined and filtered through Whatman No. 1 filter paper. The sample was then evaporated to 10 ml on a hot plate under a gentle stream of air. A 1 µl aliquot of the extract was analyzed for toxaphene using an EC/GC.

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* *American Society for Testing and Materials*

FISH AND CRAYFISH

A 20 g sample of whole organism or a smaller amount of organs, was extracted in a blender using 175 ml and 175 ml of hexane. The hexane extracts were combined and filtered through a Whatman No. 3 filter paper. The hexane extract was evaporated to 15 ml on a hot plate under a gentle stream of air and then partitioned with four 25 ml portions of hexane-saturated acetonitrile. The acetonitrile was evaporated to dryness on the hot plate and 10 ml of hexane added. After an alumina column cleanup, a 1 µl aliquot of the extract was injected in an EC/GC and analyzed for toxaphene.

ALUMINA COLUMN CLEAN-UP

The 10 ml extracts were added to 2 x 15 cm columns of activated alumina deactivated with 3% water and pre-wetted with hexane. The columns were eluted with 10% ethyl ether in hexane and four 50 ml fractions were collected. Toxaphene elutes in fractions 1 through 3, with the majority eluting in fraction 2.