Occurrence of Chlorothalonil, Its Transformation Products, and Selected Other Pesticides in Texas and Oklahoma Streams, 2003–2004

Scientific Investigations Report 2008–5016

U.S. Department of the Interior
U.S. Geological Survey

Occurrence of Chlorothalonil, Its Transformation Products, and Selected Other Pesticides in Texas and Oklahoma Streams, 2003–2004

By William A. Battaglin, Kathryn Kuivila, Kim Winton, and Michael Meyer

Scientific Investigations Report 2008–5016

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2008

About USGS Products

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

About this Product

For more information concerning this publication, contact:
William Battaglin, Research Hydrologist
Box 25046
Denver Federal Center
MS 415
Denver, CO 80225-0046
(303) 236-4882

Or visit the Research on Pesticides in the Environment Web site at:
http://co.water.usgs.gov/midconherb/

This publication is available online at:
http://pubs.usgs.gov/sir/2008/5016/

Publishing support provided by:
Denver Publishing Service Center, Denver, Colorado
Manuscript approved for publication, September 2007
Edited by Mary A. Kidd
Layout by Sharon Powers

Suggested citation:

Battaglin, W.A., Kuivila, K., Winton, K., and Meyer, M., 2008, Occurrence of chlorothalonil, its transformation products, and selected other pesticides in Texas and Oklahoma streams, 2003–2004: U.S. Geological Survey Scientific Investigations Report 2008–5016, 9 p.

Contents

Figures

Tables

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	264.2	gallon (gal)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Mass	
gram (g)	0.03527	ounce (oz)
kilogram (kg)	2.205	pound (lb)
metric ton (mt)	1.102	ton, short (2,000 lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Occurrence of Chlorothalonil, Its Transformation Products, and Selected Other Pesticides in Texas and Oklahoma Streams, 2003–2004

By William A. Battaglin, Kathryn Kuivila, Kim Winton, and Michael Meyer

Abstract

The primary purpose of the study described in this report was to determine if the fungicide chlorothalonil (2,4,5,6-tetrachloroisophthalonitrile), three of its transformation products, or selected other pesticides are transported to surface water after use on peanuts or other crops in Texas and Oklahoma. The results summarized here are part of a larger study that includes data from sites in Alabama, Florida, and Georgia. Chlorothalonil is classified as a probable carcinogen, and the 4-hydroxy of chlorothalonil transformation product is more soluble, more stable, and, for some species, more toxic than its parent compound. In 2003, water samples were collected from three surface-water sites in Texas and two surface-water sites in Oklahoma; in 2004, samples were collected from the two Oklahoma sites. Chlorothalonil was not detected in any of the 20 samples analyzed. The 4-hydroxy of chlorothalonil transformation product was detected in three samples collected in 2004, with a maximum concentration of 0.018 microgram per liter (μg/L); the other two transformation products (diamide chlorothalonil and 1-amide-4-hydroxy chlorothalonil) were not detected in any sample. In addition, 19 samples were analyzed for as many as 109 other pesticides and transformation products. Atrazine was detected in 13 samples and had a maximum concentration of 0.122 μg/L. Deethylatrazine was detected in 10 samples and had a maximum concentration of 0.04 μg/L. Metolachlor was detected in eight samples and had a maximum concentration of 0.019 μg/L. Fifteen other pesticides or pesticide transformation products also were detected. In general, concentrations of pesticides were less than concentrations that are commonly observed in Midwestern streams. The results indicate that the use of chlorothalonil on peanut crops has not resulted in substantial contamination of the studied streams in Texas and Oklahoma.

Introduction

In 2003 and 2004, the U.S. Geological Survey (USGS) conducted a study to determine if the fungicide chlorothalonil (2,4,5,6-tetrachloroisophthalonitrile) or three of its transformation products are transported to surface water after use on peanuts or other crops in five southern States (Scribner and others, 2006). Chlorothalonil has a wide variety of beneficial uses, including agricultural, home and garden, industrial, and vector control of fungi, and it is used extensively for disease control in peanuts, potatoes, turf, and many fruit and vegetable crops.

The purpose of this report is to summarize occurrence of chlorothalonil, its transformation products, and selected other pesticides in four Texas and Oklahoma streams. Three pairs of samples are used to compare nonstorm and storm-event pesticide flux. Data used in this report are available in Scribner and others (2006). Peanuts are the primary crop treated with chlorothalonil in Texas and Oklahoma, but it is also applied to onions, melons, cabbage, and other crops (National Agricultural Statistics Service, 2007).

Soybean rust is a devastating plant disease caused by fungal pathogens. Soybean rust was detected for the first time in the United States in November 2004, in Louisiana. In 2007, soybean rust was confirmed on soybean crops in 24 counties in Texas and 8 in Oklahoma (U.S. Department of Agriculture, 2007a). The use of fungicides on soybeans is expected to increase in areas where soybean rust spreads during the growing season, and chlorothalonil is one of only a few fungicides registered for use as a treatment of soybean rust. Hence, selected results from this study will provide a baseline of water-quality information collected prior to the use of fungicides to control soybean rust.

Chlorothalonil Use and Toxicity

Chlorothalonil is a broad spectrum, nonsystemic fungicide used to prevent foliar diseases on vegetable, field, and ornamental crops (Meisterpro, 2007). Chlorothalonil is used in agricultural, home and garden, and industrial settings, primarily on peanuts, potatoes, fruit, and turf. Chlorothalonil was first registered for use on food crops in the United States in 1970 and is historically one of the most heavily used fungicides with U.S. applications estimated at 5,245 metric tons

Peanut field near Eakly, Oklahoma (photograph by W. A. Battaglin).

per year (mt/yr) in 1992, 5,404 mt/yr in 1997, and 3,936 mt/yr in 2002 (Gianessi and Reigner, 2006). In 2002, the estimated use of chlorothalonil on peanuts in Texas was 50.0 mt, and the total use on all agricultural products was 85.4 mt. In Oklahoma the estimated use of chlorothalonil on peanuts was 10.3 mt, whereas the total use on all agricultural products was 18.8 mt (Gianessi and Reigner, 2006). Acres of harvested peanuts in 2002 (U.S. Department of Agriculture, 2007b) and the estimated annual application of chlorothalonil circa 2002 (Gianessi and Reigner, 2006) are shown in figures 1 and 2.

Chlorothalonil has the potential to contaminate water bodies adjacent to its point of use by spray drift, runoff, or sediment transport. Chlorothalonil previously has been detected in surface water (Scott and others, 2002; Wauchope and others, 2004), rainfall (Sakai, 2002), and air samples (McConnell and others, 1998) generally adjacent to agricultural areas where it was applied. The U.S. Environmental Protection Agency classifies chlorothalonil as a probable carcinogen with very high toxicity to fish and aquatic invertebrates (U.S. Environmental Protection Agency, 1999) but low toxicity to birds and mammals. Chlorothalonil has three primary transformation products (TPs): 4-hydroxy chlorothalonil, diamide chlorothalonil, and 1-amide-4-hydroxy chlorothalonil. Chlorothalonil is resistant to degradation by hydrolysis, volatilization, and microbial activity but may adsorb to sediments. Chlorothalonil TPs may be more persistent and mobile than chlorothalonil. The 4-hydroxy chlorothalonil TP is more toxic to birds but less toxic to fish and aquatic invertebrates than chlorothalonil (U.S. Environmental Protection Agency, 1999).

Sampling Sites and Sample Collection

Sampling sites (fig. 1, table 1) were selected on the basis of estimates of harvested peanut acreage (fig. 1), chlorothalonil use (fig. 2), watershed area, availability of streamflow data, and personnel safety. The five sites sampled on four streams in Texas and Oklahoma were part of a larger study by the USGS that included sites in Alabama, Georgia, and Florida (Scribner and others, 2006).

In general, samples were collected after the application of chlorothalonil on local peanut crops. Peanuts crops may be treated with chlorothalonil several times during the growing season. In several cases, samples were collected during or just after rainfall of sufficient intensity to produce runoff and a large increase in streamflow. Samples were collected using standardized protocols (Wilde and others, 1999) by wading or from bridges using the equal-width-increment method (Shelton, 1994). A complete description of sample-collection and quality-assurance protocols used for this study is provided in Scribner and others (2006). Site 1 was sampled three times