Open Literature Summary

Chemical Name: Dimethoate (O,O-dimethyl S-(methylcarbamoylmethyl) phosphorodithioate)

CAS NO: 60-51-5

ECOTOX Record Number and Citation: 45202909

Grande, M., S. Andersen, and D. Berge. 1994. Effects of Pesticides on Fish: Experimental and Field Studies. *Norwegian Journal of Agricultural Sciences*. Supplement no. 13: 195-209. ISSN 0802-1600.

Purpose of Review: Registration Review

Date of Assessment: 05/02/09

Brief Summary of Study Findings:

The objectives of the study were to determine the effects of dimethoate and other commonly used agricultural pesticides in Norway on Norwegian fish species under typical environmental conditions, and to measure concentrations of pesticides in fish from areas affected by agriculture. Dimethoate had significant effects on the early life stages of the fish tested, but did not significantly affect older fish. Dimethoate was not detected in the sediments or fish sampled from two lakes in Norway.

Materials and Methods

The test material was dimethoate (trade name Rogor L 20), an organophosphorus insecticide, and was delivered from the Norwegian Plant Protection Institute as a solution. No further information was provided on the purity or physico-chemical properties. The test material was stored in dark glass bottles at 10°C.

Laboratory Tests
Acute toxicity and early life stage toxicity was assessed in different fish species.

Test organisms were as follows:

Acute toxicity:
Brown trout (*Salmo trutta*), 1.9 g mean weight, OFA-Grenland strain
Atlantic salmon (*Salmo salar*), 1.1 g mean weight, DOFA-Lierelva strain
Arctic charr (*Salvelinus alpinus*), 2.1 g mean weight, SNERTA-Korssjoen, Roros
Lake charr/Lake trout (*Salvelinus namaycush*), 1.8 g mean weight, NIVA-Lake Superior strain

Early life stage toxicity:
Zebrafish (*Brachydanio rerio*)
Brown trout (*Salmo trutta*), 1.9 g mean weight, OFA-Grenland strain

A preliminary test was conducted as a flow-through test, but no further information was provided. Definitive tests were reported as being mainly conducted as semi-static with daily renewals.

Laboratory water pumped from 3 m depth in a lake nearby was used. Details of the water composition and parameters are listed below in Table 1.

Table 1. Laboratory water parameters.

Parameter		Parameter	
pH	6.3	Ca, mg/l	3.7
Conductivity, mS/m at 25°C	3.2	Mg, mg/l	0.41
Colour, mg Pt/l	21	Na, mg/l	1.1
COD, (perm.no.), mg O/l	4.0	K, mg/l	0.35
Total nitrogen, µg N/l	300	Cd, µg/l	0.30
NO_3, µg N/l	180	Cu, µg/l	2.0
Total phosphorous, µg P/l	4.5	Zn, µg/l	<10
Cl, mg/l	1.3	Pb, µg/l	1.0
Hardness, mg $CaCO_3$/l	11	Al, µg/l	110

Short term tests were conducted for 4 days in glass aquaria (10 L), each containing 7 fish and the appropriate test concentration. Experiments were conducted in a temperature-controlled room at 10 ± 1°C. Glass sinters provided slight aeration. Fish were observed several times a day, and reactions and time of death were recorded. The LC_{50} values were calculated graphically.

Reproduction tests with the brown trout were conducted from the eyed egg stage to hatching and the yolk-sac period, and for a few days following the swim-up stage. Fifty eggs were placed on a net that was suspended 2 cm above the bottom of the glass aquaria (3 L) on a frame. Two liters of the solution was renewed daily without disturbing the eggs. An air pump provided slight aeration, and the temperature was 9.5 ± 1°C during the experiments (duration up to 45 days). Eggs and fry were observed daily for mortality. Eggs were considered dead when they were white or opaque, and yolk-sac fry were considered dead when they did not react to prodding with a glass tube and no heart beats were visible.

The early life stage test with zebrafish was conducted with a standardized method described by Dave et al. (1987). Newly fertilized eggs were placed in Petri dishes with a series of test concentrations and tested as semi-static with daily renewals. Tests were concluded once the larvae had absorbed the yolk sac after *ca.* 12 days.

Field Tests

Field tests were conducted for analysis of pesticides in sediments and fish. The eutrophic Akersvatnet Lake and oligotrophic Foksetjern Lake were chosen as the test sites. Morphometric and hydrological data for both lakes as well as physical/chemical data are presented in Tables 2 and 3.

Table 2. Morphometric and hydrological data for Akersvatnet and Foksetjern lakes.

		Akersvatn	Foksetjern
Drainage area	km^2	14	0.73
Altitude	m	14	64
Area of lake	km^2	2.3	0.13
Volume	m^3	$14.5 \cdot 10^6$	-
Maximum depth	m	13	-

Table 3. Physical and chemical parameters for Akersvatnet (1984) and Foksetjern (1993) lakes.

	Akersvatn	Foksetjern
pH	7.2	6.5
Conductivity mS/m	23	5.9
Turbidity, FTU	4.7	0.6
COD, mg O/l	4.5	
Ca, mg Ca/l	15	5.5
Tot.N mg N/l	1.1	
Tot. P µg P/l	36	4

Sediments were sampled using a plastic core sampler to depths of 8 m (Akersvatnet) and 5 m (Foksetjern). The study authors only analyzed the upper 2 cm of the cores at the Norwegian Plant Protection Institute with gas chromatography (GC). The limit of detection was 1 µg/kg. Fish were caught using gillnets, and three carnivorous species were examined: perch (*Perca fluviatilis*), pike (*Esox lucius*), and pike perch (*Lucioperca lucioperca*; Table 6).

Table 4. Number of fish sampled and mean weights.

Species	Akersvatn		Foksetjern	
	No. anal.	Mean weight, kg	No. anal.	Mean weight, kg
Pike	2	2.91	6	966
Perch	16	0.361	9	513
Pike perch	15	0.953	-	-

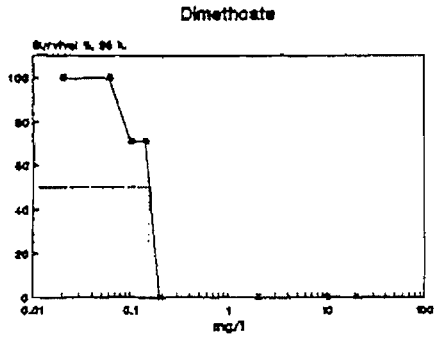
Analyses of the fish were conducted using the muscles and livers. Muscle samples of similar weights (16-249 g, dependent on fish size and number of fish) from each fish were mixed with other samples and homogenized. The same procedure was repeated with the livers of the fish. Analyses of the muscle and liver were performed at the National Laboratory for Agricultural Chemistry (Uppsala, Sweden).

Results

Laboratory Tests

The 4 day LC_{50} value for acute toxicity of brown trout was 0.13 mg/L; increases in concentrations of dimethoate led to sudden decreases in survival at *ca.* 0.09 mg/L (Figure 1). The 4 day LC_{50} value for acute toxicity of minnows was 1.8 mg/L. Small differences in tolerance were found for the three salmonid species tested (no further information provided).

Figure 1. Dose-response curve of brown trout.



The study authors reported that dimethoate did not greatly affect hatching of trout or zebrafish, but did affect fry survival at 50 µg/L for trout and 25 µg/L for zebrafish (Figures 2 and 3). The NOAEC and LOAEC values for trout survival were 0.02 and 0.05 mg/L, respectively (Table 5). The NOAEC and LOAEC values for zebrafish survival were 0.0125 and 0.025 mg/L, respectively. The NOAEC values for the hatching of both species was the highest concentration tested, indicating no effect at any test level.

Figure 2. Hatching and survival of trout eggs and fry.

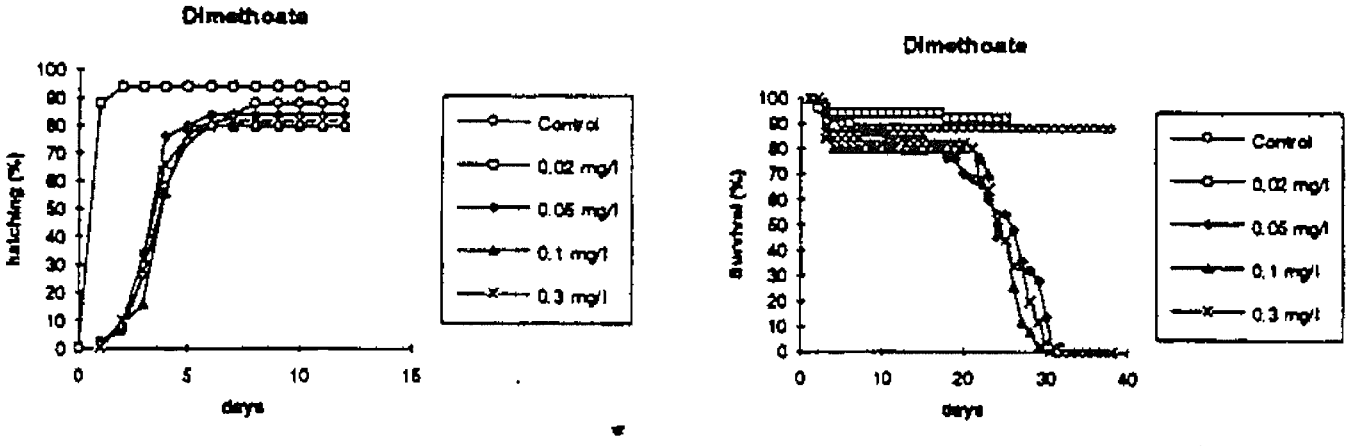


Figure 3. Hatching and survival of zebrafish eggs and fry.

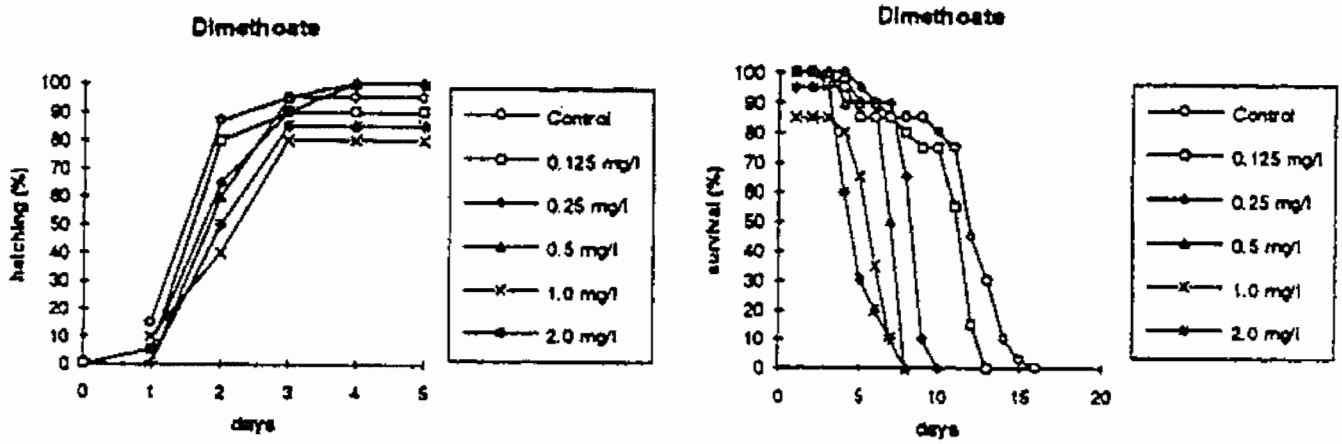


Table 5. Egg hatching and yolk sac fry survival of trout and zebrafish.

Substance/fishspecies	Hatching		Survival	
	NOEC	LOEC	NOEC	LOEC
Dimethoate				
Trout	0.3		0.02	0.05
Zebrafish	0.2		≈ 0.0125	0.025

Field Tests

Dimethoate was not found above the detection limit in the sediments of either lake. Further, dimethoate was not found above the detection limit in the muscles or liver of the fish (0.005 mg/kg muscle; 0.03-0.2 mg/kg in liver).

In conclusion, the study authors state that the concentrations of dimethoate and the other pesticides tested that led to acute toxicity were so high as to only be able to occur by accident in small natural water bodies in Norway. Further, the study authors concluded that dimethoate would not cause direct harm to freshwater fish under normal use in Norway. However, based on calculations incorporating maximum concentrations in Nordic surface water and the 4-day LC_{50} value [(max water conc./LC50)*10^{-4}], dimethoate has a value above 1.0. Alabaster and Lloyd (1982) suggest that if the value is above 1.0, there is no guarantee that aquatic organisms will not be harmed. Longer-term studies would need to be conducted to address this.

Description of Use in Document:

Rationale for Use:

Limitations of Study:

The physicochemical properties and the purity of the test material were not reported.

The pH of the test solutions throughout the experimental period was not reported.

Raw data were not provided for any species or endpoint assessed; therefore, the reviewer could not independently confirm the results.

Laboratory and field test conditions were not adequately described.

The study authors did not report toxicity values for Atlantic salmon (*Salmo salar*), Arctic charr (*Salvelinus alpinus*), or Lake charr or trout (*Salvelinus namaycush*).

Reviewer: Moncie Wright, Staff Scientist, Cambridge Environmental, Inc.

Secondary Reviewer: