333

North American Journal of Fisheries Management 6:129–130, 1986

MANAGEMENT BRIEFS

Persistence of Rotenone in Ponds at Different Temperatures

P. A. GILDERHUS, J. L. ALLEN,
AND V. K. DAWSON

National Fishery Research Laboratory
Post Office Box 818
La Crosse, Wisconsin 54602, USA

Abstract.—Two ponds were treated with liquid rotenone (5% rotenone), one with 3 mg/L at 24°C and the other with 2 mg/L at 0°C (concentrations of active rotenone were 0.15 and 0.10 mg/L, respectively). Water samples were collected and analyzed by high-performance liquid chromatography. The concentration of rotenone declined to 0.02 mg/L in 48 h in warm water and in 11 d in cold water. The half-life of rotenone was calculated at 13.9 h in warm water and 83.9 h in cold water.

Rotenone has been used for fish population control in the USA since the mid-1930s. In its various formulations, the chemical is currently the most widely used fish toxicant in the USA (Schnick 1974). Standards for the registration of pesticide chemicals have been raised in the past decade in terms of requirements for safety, efficacy, and residue data, and all previously registered pesticides are required to conform to the more rigid standards. As part of the effort to meet requirements for continued registration, data are being developed on the persistence of rotenone in aquatic ecosystems. Small-scale range-finding studies were done in warmwater and cold-water ponds to determine how long sampling should be continued during more comprehensive residue studies. The present study involved higher treatment concentrations and utilized more advanced methods of analysis than those used by earlier investigators.

The warmwater phase of the study was conducted during September 1980 in a 0.04-hectare pond with a mean depth of 1.1 m (pH 8.9; temperature 24°C) at the La Crosse (Wisconsin) National Fishery Research Laboratory. Water was collected just below the surface at three places in the pond at each sampling time.

The cold-water study was done in March 1981 in an 0.83-hectare pond with a mean depth of 1.2 m (pH 8.5) at the Genoa (Wisconsin) National Fish Hatchery. Water was collected just below the surface at two places and from the bottom at a location near maximum depth. The water temperature at the time of treatment was 0°C. An ice cover formed on the pond within 12 h after treatment and remained for 5 d. The ice then melted and and the water temperature rose to 6°C by day 10 and to 8°C by day 14.

Both ponds were treated with a liquid formulation containing 5% rotenone. The target treatment rates were 0.15 mg/L of rotenone (3 mg/L of formulation) in the warmwater pond and 0.10 mg/L of rotenone (2 mg/L of formulation) in the cold-water pond. The chemical was applied with a boat bailer—from a boat in the cold-water pond, and with the motor attached to the stopboards in the warmwater pond. Caged fathead minnows (*Pimephales promelas*) were used in the warmwater pond and fingerling rainbow trout (*Salmo gairdneri*) in the cold-water pond to determine when the treated water had became nontoxic to these species.

Analyses of rotenone in the water were done by buffering the water to pH 5, concentrating the sample on a Waters Associates Sep-Pak®[1] or Baker-10 C_{18} extraction column and eluting with high-performance liquid chromatography-grade methanol (Dawson et al. 1983). Concentrations were determined by a Varian Model 5000, high-performance liquid chromatograph equipped with a reverse-phase column; the carrier solvent was methanol: water (80:20) moving at 1 ml/min, and detection was by ultraviolet light at 295 nm. The Baker 10® manifold and C_{18} extraction columns were used for the cold-water study, allowing for more convenient extraction of larger water samples; therefore, lower concentrations of rotenone were detected than in the warmwater test. Average percent recoveries ± SE of five replicate samples of pond water fortified with rotenone (0.1 mg/L) were 97.6 ± 1.6 and 97.3 ± 1.3 for the Waters and Baker systems, respectively.

[1] Use of trademarks does not imply U.S. Government endorsement of commercial products.

TABLE 1.—Mean concentrations (mg/L ± SE[a]) of rotenone in water sampled from ponds at selected intervals after treatment.[b]

Post-treatment time	Cold-water pond	Warmwater pond
Hours		
1	0.113 ± 0.026	0.160 ± 0.010
3	0.125 ± 0.019	0.157 ± 0.003
6	0.101 ± 0.003	0.137 ± 0.007
12	0.092 ± 0.005	0.067 ± 0.003
24	0.090 ± 0.0009	0.040 ± 0.000
30		0.033 ± 0.003
36		0.022 ± 0.002
48	0.072 ± 0.004	0.022 ± 0.002
72	0.075 ± 0.008	<0.010
Days		
4	0.060 ± 0.003	<0.010
5	0.054 ± 0.002	
6	0.039 ± 0.001	
7	0.035 ± 0.0009	
9	0.032 ± 0.0009	
10	0.026 ± 0.0007	
11	0.023 ± 0.0009	
14	0.006 ± 0.003	
15	0.009 ± 0.002	
16	0.004 ± 0.002	
18	0.002 ± 0.0008	

[a] Average of three analyses.
[b] Treatment rates were 0.10 mg/L of rotenone in the cold-water pond and 0.15 mg/L in the warmwater pond.

As expected, rotenone degraded much faster in warm water than in cold water. The concentration in the warmwater pond dropped precipitously from 0.16 mg/L to 0.022 mg/L in 36 h (Table 1). Mortality of fathead minnows placed in a cage 48 h after treatment was 100% within 24 h, indicating that the treated water was still acutely toxic to fish. By 72 h after treatment, the concentration had declined to less than 0.01 mg/L and all caged fathead minnows placed in the pond at that time survived.

The concentration of rotenone declined much more slowly in cold water; 11 d were required for it to decrease from 0.10 mg/L to 0.02 mg/L. The treated water was still toxic to rainbow trout on day 14 after treatment, even though the concentration was only 0.006 mg/L. The mortality of rainbow trout placed in a cage on day 16, when the concentration was 0.004 mg/L, was only 30% in 48 h. Sampling was stopped on day 18, when the concentration had reached 0.002 mg/L.

The half-life of rotenone in the water was calculated to be 13.9 h in warm water (24°C) and 83.9 h in cold water (0°C). Although the concentrations of rotenone, water temperatures, and other conditions were not exactly comparable, our results roughly agree with those of Wright (1957) and Post (1958). Our study more precisely defined the concentrations at which the rotenone became nontoxic to fish under pond conditions. The slower degradation in cold water was expected, but the details learned from these studies will help in the sampling design of more comprehensive studies that consider residues in sediments and organisms as well as in water.

References

Dawson, V. K., P. D. Harmon, D. P. Schultz, and J. L. Allen. 1983. Rapid method for measuring rotenone in water at piscicidal concentrations. Transactions of the American Fisheries Society 112:725–727.

Post, G. 1958. Time versus water temperature in rotenone dissipation. Proceedings of the Annual Conference Western Association of Game and Fish Commissioners 38:279–284.

Schnick, R. A. 1974. A review of the literature on the use of rotenone in fisheries. U.S. Fish and Wildlife Service Literature Review 74-01. NTIS (National Technical Information Service) PB-235 440/AS, Springfield, Virginia.

Wright, T. W. 1957. The rates of dissipation of certain rotenone preparations, their residual effects on bluegill production, and their effects on populations of fish food organisms. Master's thesis. Alabama Polytechnic Institute, Auburn.