Bull. Environ. Contam. Toxicol. (1986) 37:350–354

Bulletin of Environmental Contamination and Toxicology

Acute Toxicity of Hydrothol 191 to Phytoplankton and Rainbow Trout

James E. Mudge, Terry E. Northstrom, and T. Brock Stables

Environmental Programs, Washington Public Power Supply System, P.O. Box 968, Richland, WA 99352

At Washington Public Power Supply System Nuclear Plant No. 2 (WNP-2), two concrete basin spray ponds are provided for emergency cooling water. Each pond is 76 m square, 4 m deep and holds approximately 6.5 million gallons of water. Algal growth may result in power plant condenser and basin fouling if not properly controlled. Hydrothol 191* has been used at other non-power producing projects for algae control (Corbus 1982; Liquori et al. 1983). The purpose of the study was to evaluate the effectiveness of Hydrothol 191 as an algacide for the spray ponds. In addition, we wanted to determine it's acute toxicity to a recreationally important and sensitive game fish found in the Columbia River. This evaluation was done in the event that hydrothol was accidentally released to the Columbia River from the spray ponds.

For licensing in the State of Washington, hydrothol is considered a general use pesticide when used in a closed system (not released to the environment or allowed to degrade), and does not require a license application permit. However, if releases can occur, it's use is restricted and a pesticide application permit is required, along with relevant toxicity data.

MATERIALS AND METHODS

Phytoplankton samples were collected by tow-net from the WNP-2 spray ponds in October 1983. Dominant algal genera in the collected spray pond water were Cyclotella, Euglena, Fragilaria, Nitzschia, and Pediastrum. The organisms were transferred into six glass containers, each containing 1.6 L of spray pond water. A control and five Hydrothol 191 concentrations; 0.1, 0.25, 0.50, 1.00 and 2.0 mg/L were tested. The hydrothol was directly added, using micropipets, to spray pond (i.e. Columbia River) water which contained phytoplankton.

At test initiation, prior to adding hydrothol, a Levy-Hausser chamber was used to make triplicate total live phytoplankton counts (number/mL) on 1-mL samples from each container. After a

*Also named mono (N, N-dimethylalkylamine) salt of 7-oxabicylo (2,2,1) heptane-2, 3-dicarboxylic acid.

five-day exposure, counts were performed similarly to initiation for each concentration. During the test, photoperiod for all containers corresponded with local day length (11 h).

Water quality analyses, according to American Public Health Association (1980), were run at test initiation and termination. Temperature averaged 20.5°C while pH varied from 6.9 in the highest concentration to 7.5 in the lowest concentration.

A 96-h static bioassay of Hydrothol 191 was performed in November 1983 using steelhead trout (Salmo gairdneri). A representative group (n=20) of fish were measured for length and weight (Table 1). The mean and standard deviation for fish fork length and wet weight are 13.0 ± 1.2 cm and 25.07 ± 7.14 g, respectively. A control and five hydrothol concentrations were tested: 0, 0.42, 0.74, 1.30, 2.28 and 4.00 mg/L. Water from the Columbia River was used for dilution in the test and for acclimation of the fish 2 wk prior to testing. Ten fish were exposed to each concentration. Fish loading averaged 1.47 g/L, thus aeration was necessary. Mortality checks were performed twice daily. Temperature, dissolved oxygen, pH and conductivity were measured daily in each tank (Table 1). Hardness was measured at the beginning of the test in representative tanks.

RESULTS AND DISCUSSION

Representative algal genera in the spray pond water were Pediastrum, Nitzschia, Fragilaria, Cyclotella and Euglena. A 120-h LC50 of 1.5 mg/L Hydrothol-191 was estimated based on total phytoplankton counts (Figure 1). Prior to test initiation, phytoplankton counts were made on all containers and averaged $2.8 \pm 0.4 \times 10^4$ cells/mL. The test water was collected from the spray pond (Columbia River water) and distributed in 1.6-L aliquots to six containers. At test initiation, Hydrothol 191 was added to five of the six containers. Nutrient and light conditions were not varied during the test. Photoperiod for all containers corresponded with local day length and light measurements near the surface of the containers was 75 lm. After 5 days, the control tank had a total phytoplankton count approximately 300 percent greater than at test initiation, indicating tank conditions suitable for growth. Our LC50 value is slightly lower than the 2.0 mg/L reported by Walker (1963) for 19 species of aquatic vegetation. In contrast, Otto and Bartley (1973) found after a week, median lethal concentrations from 1.0 to 5.0 mg/L for three species of green algae. Our results indicate that 0.1 mg/L was not effective in controlling phytoplankton growth; however, at 2.0 mg/L the number of phytoplankton per mL was reduced approximately 60% (initially 2.3×10^4 cells/mL versus 1.0×10^4 cells/mL after 5 days). Obviously, there are some algal species which are resistant to hydrothol but the overall quantity in the WNP-2 spray ponds would be reduced by addition of this compound at 2.0 mg/L. The amount and duration of the reduction would depend upon the growth pattern of the resistant algal species. We did not see growth enhancement of resistant

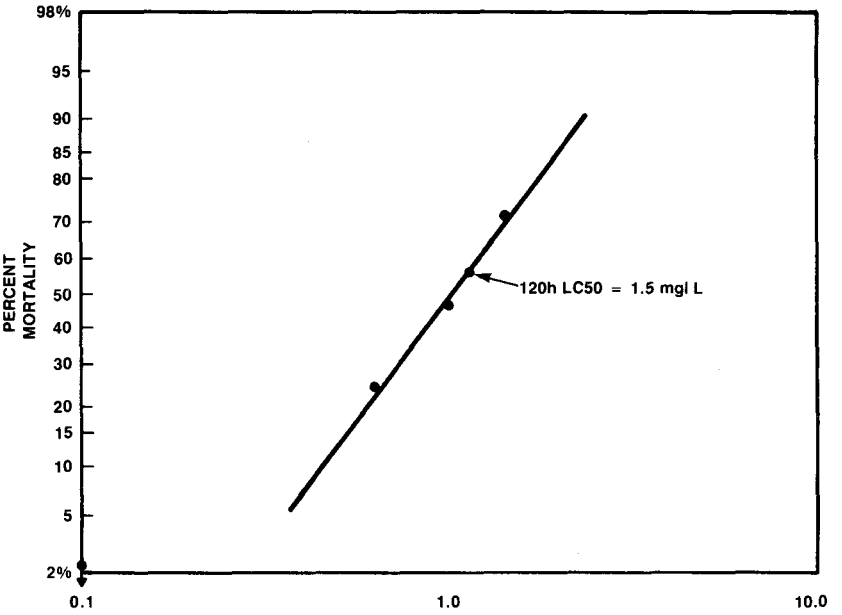

FIGURE 1 TOTAL PHYTOPLANKTON (counts per mL) MORTALITY VERSUS CONCENTRATION OF HYDROTHOL 191

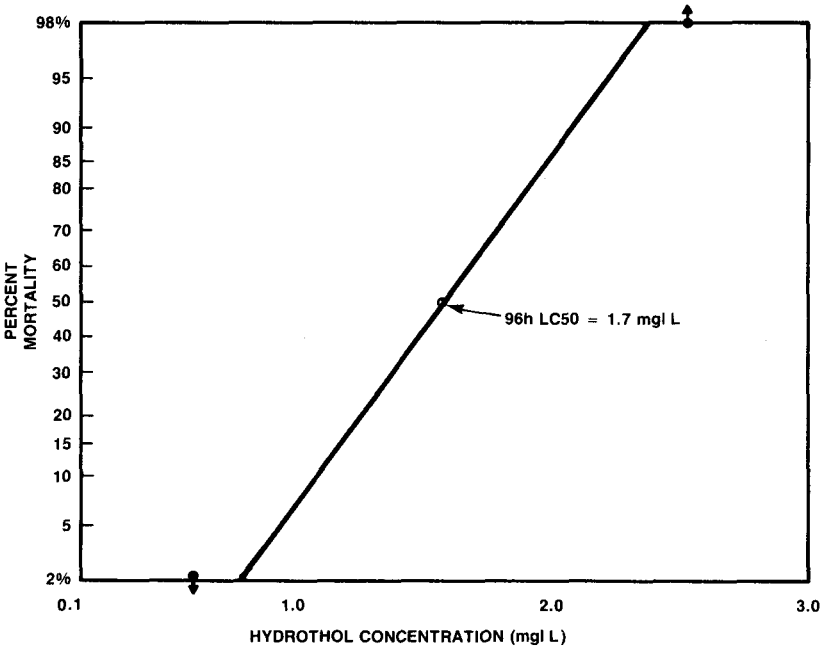

FIGURE 2 RAINBOW TROUT MORTALITY VERSUS CONCENTRATION OF HYDROTHOL 191

Table 1. Chemical Characteristics of Water in Test Tanks

	N	X	SD
Temperature, °C	20	15.3	1.6
Dissolved Oxygen (DO), mg/L	20	8.0	1.1
pH, SU	20	7.8+	0.2
Conductivity @ 25°C	20	208	31
Hardness, mg/L $CaCo_3$	4	62	0.8

+ = Median Value

algal species in any of the containers which would indicate the hydrothol effect was algistatic.

The 96-h LC50 for rainbow trout was estimated at 1.7 mg/L (Figure 2). Our value is slightly higher than the 1.3 mg/L reported by Penwalt Corporation (personal communication with McGaughey 1983) for rainbow trout. However, our value is lower than the range of no mortality values (3.0 to 55.0 ppm) reported by other workers for bluegill (Lepomis macrochirus), smallmouth bass (Micropterus dolimeui), green sunfish (Lepomis cyanellus), goldfish (Carassius auratus) and chinook salmon (Oncorhynchus tshawytscha) (Holmberg and Lee 1976; Yeo 1970; Liquori et al. 1983; Berry 1984). Finlayson (1980) reported a 96-h LC50 for golden shiner (Notemigonus crysoleucas) of 1.6 mg/L. Water quality conditions (i.e., hardness) for Finlayson's test are comparable to those in the Columbia River.

In conclusion, it appears that Hydrothol 191 may afford good control of phytoplankton which foul power plant water systems. However, based on our results, water dosed at 0.5 - 2.0 mg/L should be retained until degradation occurs (i.e., 10-14 days per Woon and Mason 1969) to avoid fish mortality.

REFERENCES

American Public Health Association (1980) Standard methods for the evaluation of water and wastewater. New York, New York.

Berry CR (1984) Toxicity of the herbicides diquat and endothall to goldfish. Environ Poll 34:251-258

Corbus FG (1982) Aquatic weed control with endothall in a salt river project canal. J Aquat Plant Manage 20:1-3

Finlayson BJ (1980) Acute toxicities of the herbicides komeen and hydrothol-191 to golden shiner. Bull Environ Contam Toxicol 25:676-681

Holmberg DJ, Lee GF (1976) Effects and persistence of endothall in the aquatic environment. J Water Poll Cont Fed 48:2738-2746

Liquori VM, Zakour HR, Landolt ML, Felton SP (1983) Toxicity of endothall to juvenile chinook salmon. In: Bishop WE, Cardwell RD, Heidolth BB (ed) Aquatic toxicology and hazard assessment sixth symposium. Philadelphia, Pennsylvania, p 530

Otto NE, Bartley TR (1973) Aquatic weed control studies. US Dept Inter Res Rep 2:17-19
Walker CR (1963) Endothall derivatives as aquatic herbicides in fishery habitats. Weeds 11:226-232
Woon GW, Mason GW (1969) Endothal as an aquatic herbicide. Proc 22nd NZ Weed Pest Cont Conf 22:30-35
Yeo RR (1970) Dissipation of endothall and effects on aquatic weeds and fish. Weed Sci 18:282-284
Received July 19, 1985; accepted October 19, 1985.