Appendix H

ECOTOX Open Literature Reviews

Open Literature Summary

Chemical Name: Diquat dibromide

CAS NO: 85-00-7

ECOTOX Record Number and Citation: E014903

Paul, E. A., Simonin, H. A., Symula, J., and Bauer, R. W. (1994). The Toxicity of Diquat, Endothall, and Fluridone to the Early Life Stages of Fish. *J.Freshw.Ecol.* 9: 229-239 (Author Communication Used).

EcoReference No.: 14903
Chemical of Concern: EDT,FDE,DQTBr; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED(FDE,DQTBr).

Purpose of Review: Litigation/Endangered Species

Date of Review: November 19, 2010

Brief Summary of Study Findings:

The purpose of the study was to examine toxicity of three chemicals (diquat dibromide, endothall, and fluridone) to the early life stages of fish. Acute toxicity studies on several species and age classifications were conducted. Some studies were done with and without the presence of sediment in the test system. In addition, persistence of the chemicals in the presence of sediment was explored. In this review, only the results relevant to diquat dibromide will be discussed.

Methods

Static non-renewal toxicity tests (were conducted in order to approximate natural conditions following the herbicide treatment of a lake. The tests were conducted following Weber (1991) and Weber (1993), US EPA methods for measuring acute toxicity to aquatic organisms. The toxicity tests were conducted using 2-L glass jars containing 1500 ml of test solution, except for 84-d old walleyes which were tested in 20-L battery jars each containing 16 L of test solution. Test chambers were held in a thermostatically controlled water bath, and the temperature was monitored continuously. All concentrations were tested in triplicate with 10 fish in each replicate (except for 84-d old walleyes where concentrations were tested in duplicate). All test containers were continuously aerated, and fish were fed brine shrimp nauplii three times per day (except for 84-d old walleye which were fed zooplankton).

The test substance was Diquat HA (Valent, USA Corp), a formulation containing 240 g of diquat cation/L; all diquat concentrations are expressed as mg/L as cation.

Test concentrations for diquat were confirmed analytically at the beginning and conclusion of each test. Since no differences were found between initial and final concentrations, the initial analytically determined concentrations were used for all statistical calculations. All LC50s were calculated using the probit method or the trimmed Spearman-Karber method, with Abbott's correction for control mortality. NOAECs and LOAECs were calculated following procedures in Weber (1993) using the TOXSTAT computer program.

All toxicity tests were conducted at the NYSDEC Rome Field station. Water used in the tests was Rome Hatchery spring water, Delta Lake water, or South Sandy Creek water. Water quality data are presented in Table 1.

Table 1. Selected characteristics of dilution waters used in toxicity tests. (NA = not available; ranges of values in parentheses)

Water	pH	Alkalinity mg/L $CaCO_3$	Hardness mg/L $CaCO_3$
Rome Spring	7.71 (7.1-8.0)	114 (98-130)	132 (122-138)
Delta Lake	7.4 (7.1-7.8)	53 (38-69)	65 (46-81)
South Sandy Creek	7.2	NA	81

For the testing of the 8 to 10-d old walleyes, eggs were taken from NYSDEC Oneida Fish Hatchery, and the newly hatched fish were transported to the Rome Field station. These were held in 20-L battery jars and fed brine shrimp until they were 8 to 10-d old. Test temperature was 15.6° ± 0.5°C. The 41 to 43-d old walleyes were obtained from a rearing tank at the NYSDEC Rome Fish Hatchery. Since the test temperature and type of water were the same as the test conditions (Rome Spring water), no holding period was done. Test temperature was 16.1 ± 0.5°C. The 84 to 86-d old walleyes were obtained from rearing ponds at the NYSDEC South Otselic Fish Hatchery. These fish were transported to the Rome Field station and placed in 20-L battery jars containing 75% South Otselic water/25% Rome Spring Water. These walleyes were fed zooplankton three times per day. The fish were held for 5 d, and each day 25% of the water was exchanged for Rome Spring water. The toxicity testing was then conducted using Rome Spring water. Test temperature was 17.8 ± 0.5°C, which was the temperature of the rearing ponds.

Smallmouth bass were collected from approximately 30 nests as sac fry from South Sandy Creek in the Town of Ellisburg, Jefferson County, New York. These fry were held in weighted plastic jars with openings covered with nylon mesh, placed in 20-L plastic buckets, and transported to the Rome Field Station at a constant temperature. Upon return to the laboratory the plastic buckets containing the sac fry were held at 17.2 ± 0.5°C, and fish began to "swim up" within 3 to

4 h. The young smal1mouth bass were fed newly hatched brine shrimp. Toxicity testing with these smallmouth bass (age 6-8 d post swim-up) was conducted during the following week. Test conditions were the same as the first test except that the smal1mouth bass had been acclimated (25% exchange/d) to Delta Lake water.

Largemouth bass were collected from Long Pond, Chenango County, New York. These fish were collected with a fine-mesh seine as "schooling" feeding fry, approximately 9 to 13-d post swim-up. The same transport technique was used as with the smallmouth bass. At the Rome Field station, the plastic buckets containing the largemouth bass were held at 17.2 ± 0.5°C. Fish were fed brine shrimp three times/day and were acclimated to Delta Lake water (25% exchange/d). The bass were held for 5 days prior to testing. Testing began at age 14 to 18-d post swim-up.

Results

LC50s, NOAECs, and LOAECs are provided in the Tables 2 and 3. For diquat dibromide, results are reported as mg cation/L using initial measured concentrations. For the 96-hr data, younger walleye were more sensitive to diquat than older walleye were. The difference in toxicity across tested species and ages was less than one magnitude. (0.75 to 4.9 mg cation/L).

Table 2. LC50s and associated 95% confidence intervals for diquat, endothall, and fluridone. (SMB = Smallmouth Bass, LMB = Largemouth Bass, and NA = not available)

			LC50 (mg/L) (95% CI)			
Chemical	Species	Age (d)	24 h	48 h	72 h	96 h
Diquat	Walleye	8-10	2.9 (2.3-3.5)	1.6 (1.2-1.9)	1.0 (0.76-1.2)	0.75 (0.29-0.86)
	Walleye	41-43	3.1 (2.5-4.1)	1.9 (1.6-2.2)	1.6 (1.5-1.8)	1.5 (1.4-1.7)
	Walleye	84-86	7.8 (6.6-9.3)	4.9 (4.4-5.6)	4.9 (4.3-5.5)	4.9 (4.3-5.5)
	SMB	6-8	110 (98-120)	28 (22-34)	10 (8.5-12)	3.9 (2.9-5.0)
	LMB	9-13	15 (13-17)	11 (9.7-11)	8.0 (6.8-9.7)	4.9 (4.2-5.8)
Endothall	Walleye	8-10	66 (42-140)	30 (24-37)	27 (22-33)	16 (11-21)
	Walleye	41-43	140 (100-1000)	73 (58-100)	62 (49-80)	54 (42-68)
	SMB	< 1	> 91 (NA)	60 (54-69)	59 (55-64)	47 (42-54)
	LMB	9-13	> 400 (NA)	280 (NA)	170 (150-190)	130 (120-150)
Fluridone	Walleye	8-12	3.6 (3.2-4.1)	2.8 (2.4-3.1)	2.3 (2.0-2.6)	1.8 (1.4-2.0)
	SMB	4-8	19 (17-21)	11 (9.7-13)	9.5 (8.5-11)	7.6 (6.9-8.7)
	LMB	10-14	16 (NA)	16 (NA)	14 (13-16)	13 (12-15)

Table 3. NOAECs and LOAECs (mg/L) for diquat, endothall, and fluridone. (SMB = Smallmouth Bass and LMB = Largemouth Bass)

Chemical/ Species	Age (d)	24 h NOAEC	24 h LOAEC	48 h NOAEC	48 h LOAEC	96 h NOAEC	96 h LOAEC
Diquat							
Walleye	8-10	0.93	2.0	0.93	2.0	0.48	0.93
Walleye	41-43	0.90	1.9	0.90	1.9	0.90	1.9
Walleye	84-86	4.4	8.4	2.6	4.4	2.6	4.4
SMB	6-8	68	130	14	34	1.6	3.4
LMB	9-13	7.1	18	7.1	18	1.8	3.6
Endothall							
Walleye	8-10	5.7	11	5.7	11	5.7	11
Walleye	41-43	45	91	23	45	23	45
SMB	<1	45	91	23	45	23	45
LMB	9-13	200	400	100	200	50	100
Fluridone							
Walleye	8-12	1.2	2.0	1.2	2.0	0.78	1.2
SMB	4-8	8.7	19	6.2	8.7	4.5	6.2
LMB	10-14	12	21	12	21	9.6	12

Description of Use in Document: Quantitative

Rationale for Use: This study provides the most sensitive LC_{50} for freshwater fish.

Limitations of Study:

- No raw data reported. Reviewer was unable to verify the statistical analyses; however, the author did provide information on methods used (Abbott's correction if control mortality, and either probit or trimmed Spearman-Karber method for LC_{50} determination).
- The number of test concentrations used and the value of the nominal and/or measured test concentrations not provided. The study author did indicate there were no differences between initial and final measured concentrations, but did not state if measured concentrations were similar to nominal concentrations. A subset of the measured concentrations is available in Table 3 where the NOAECs and LOAECs are reported. For example, in the 8-10 day old walleye study, there were at least three test concentrations with mean measured values of 0.48, 0.93, and 2.0 mg cation/L.
- Acclimation/holding periods shorter than recommended. Study author stated that tests were conducted following (Weber 1993) (an EPA test guideline). This guideline does state that control survival must be at least 90% for test results to be considered acceptable.
- Test vessels were aerated and dissolved oxygen was not reported, but since there was no loss of chemical over the time interval of the study, the potential impact was minimal.

- Fish were fed during the test. There is the potential that the test material would bind to the provided food and the exposure route would be modified to include ingestion. However, since test concentrations in the water were constant over time, the impact would be minimal. In addition, the build-up of food and metabolic wastes and resulting oxygen demand, are common in static test systems; however, this would be minimized since the system was aerated.
- Other water quality characteristics (TOC, etc.) were not provided. Since this water was from the hatcheries where these fish were regularly raised, it should not be impeding fish health and growth.

References:

Weber, C. I. 1991. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 4th ed. EPA 600/4-90-027. U.S. Environmental Protection Agency Washington, D.C.

Weber, C. I. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 4th ed. EPA 600/4-90-027F. U.S. Environmental Protection Agency,
Washington, D.C.

Reviewer: Christine Hartless, EFED/ERB2

Secondary Reviewer: Christina Wendel, EFED/ERB2

Open Literature Review Summary

Chemical Name: Diquat Dibromide

CAS No: 85-00-7

MRID Record Number and Citation:

Mayer, F. L. Jr. and Ellersieck, M. R. (1986). Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. *Resour.Publ.No.160, U.S.Dep.Interior, Fish Wildl.Serv., Washington, DC* 505 p. (USGS Data File).

EcoReference No.: 6797

MRID 400980-01.

Purpose of Review: Litigation/Endangered Species

Date of Review: 9/15/10

Summary of Study Findings:

The "Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals" summarizes and interpret results from multiple acute toxicity tests conducted at the Columbia National Fisheries Research Laboratory. The purpose of this DER is to summarize the effects of diquat dibromide on acute freshwater fish and invertebrates. All toxicity tests for freshwater fish and invertebrates for diquat dibromide are reported as static tests in the Mayer and Ellersieck data summary sheet.

Methods:

All toxicity tests were conducted at the Columbia National Fisheries Research Laboratory between 1965 and 1984. Specific bioassay methodologies (e.g., test vessel size, water treatment, culturing practices, etc.) were not outlined in the study report. Tests were conducted using a product containing 35.3% ai (diquat dibromide). The material was described as a liquid concentrate in the summary tables, and it was described as Reglone (EUP) in some raw data sheets. It was assumed that the nominal test concentrations reported in the raw data sheets were the concentrations of the ai (diquat dibromide).

Toxanal2009 statistical program was used to determine toxicity (LC_{50}'s) of freshwater fish and invertebrates (output attached). These statistical analyses were only conducted for studies in which a 50% mortality rate was reached. If a 50% mortality was not reached in any test concentrations, the LC_{50} was established as > highest test concentration. The reviewer converted

the endpoints from mg ai/L to mg cation/L assuming 53.6% of the ai is the cation. These results are reported below.

Description of Use in Document (QUAL, QUAN, INV): See table below for use of each study.

Rationale for Use:. Raw data were provided.

Limitations of Study:

For all studies except for the black bullhead, no details were provided pertaining to any sub-lethal effects observed during the course of the 96-hour acute toxicity tests. Analytical verification of test material concentrations was not conducted. The dissolved oxygen levels throughout the tests were not specified.

Primary Reviewer: Christine Hartless, Ph.D, Wildlife Biologist, EPA/ EFED/ERB2

Species (fish)	% ai	96-hr LC_{50} (from Mayer and Ellersieck), mg ai/L	96-hr LC_{50} (calculated by reviewer)*		Toxicity classification (based on cation concentration)	Water temp (°C)	pH	Hardness (mg/L)	Study Classification and comments
			mg ai/L	mg cation/L					
Yellow perch (*Perca flavescens*)	35.3	60	59 (PR)	32	Slightly toxic	12	7.5	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	178	148 (PR)	79	Slightly toxic	12	8.5	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	230	171 (MA)	92	Slightly toxic	22	7.5	44	Quantitative
Black bullhead (*Ameiurus melas*)	35.3	170	176(MA)	94	Slightly toxic	12	7.5	44	Quantitative (author noted abdomen swelling and hemorrhaging in all jars)
Bluegill sunfish (*Lepomis macrochirus*)	35.3	200	199 (PR)	107	Practically non-toxic	17	7.5	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	450	424 (BN)	227	Practically non-toxic	12	8.0	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	508	453 (PR)	243	Practically non-toxic	12	8.0	170	Quantitative
Goldfish	35.3	> 100	>100	>54	Slightly toxic	18	7.1	44	Qualitative (24-hr study)
Rainbow trout (*Salmo gairdneri*)	35.3	>100	>100	>54	Slightly toxic	13	7.1	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	245	>200	>107	Practically non-toxic	12	7.5	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	498	>450	>241	Practically non-toxic	12	6.5	44	Quantitative
Bluegill sunfish (*Lepomis macrochirus*)	35.3	870	>720	>386	Practically non-toxic	12	8.0	300	Quantitative
Black bullhead (*Ameiurus melas*)	35.3	24.6	--			12	9.5	44	Invalid (high pH)
Bluegill sunfish (*Lepomis macrochirus*)	35.3	115	--			12	9.5	44	Invalid (high pH)
Bluegill sunfish (*Lepomis macrochirus*)	35.3	248	--	--	--	7	7.5	44	Invalid (low water temp)
Yellow perch (*Perca flavescens*)	35.3	23.5	-- --	-- --		12	9.5	44	Invalid (high pH)

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Species (fish)	% ai	96-hr LC_{50} (from Mayer and Ellersieck), mg ai/L	96-hr LC_{50} (calculated by reviewer)*		Toxicity classification (based on cation concentration)	Water temp (ºC)	pH	Hardness (mg/L)	Study Classification and comments
			mg ai/L	mg cation/L					
Species (invertebrate)									
Apple snail (*Pomocea paludosa*)	35.3	1.8	2.1 (PR)	1.1	Slightly toxic	22	7.3	40	Supplemental
Grammarus fasciatus	35.3	>100	>100	>54	Slightly toxic	15	7.4	272	Supplemental
* PR=probit, MA=moving average, BN=binomial									

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christine  diquat  snail
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CONC.     NUMBER        NUMBER        PERCENT       BINOMIAL
          EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 10        10            10            100           9.765625E-02
 5.6       10            8             80            5.46875
 3.2       10            8             80            5.46875
 1.8       10            6             60.00001      37.69531
 1         10            1             10            1.074219
 .56       10            0             0             9.765625E-02
 .32       10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT 1 AND 10 CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 1.617156


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 6         .1282789      2.115241      1.518946      3.08772


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H             GOODNESS OF FIT PROBABILITY
    4                   .1517572      1                           .5081644

SLOPE   =               3.275648
95 PERCENT CONFIDENCE LIMITS = 1.999586    AND    4.551709

INTERCEPT=-1.030347

LC50 =    2.06323
95 PERCENT CONFIDENCE LIMITS =  1.499502 AND  2.842572

         LC25 =         1.284204
95 PERCENT CONFIDENCE LIMITS =  .8025318 AND  1.736562

         LC10 =         .8381016
95 PERCENT CONFIDENCE LIMITS =  .4236944 AND  1.202565

         LC05 =         .6492131
95 PERCENT CONFIDENCE LIMITS =  .2846027 AND  .9804335
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christine  diquat  BLACK BULLHEAD
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CONC.    NUMBER        NUMBER        PERCENT       BINOMIAL
         EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 200      10            6             60.00001      37.69531
 100      10            1             10            1.074219
 75       10            1             10            1.074219
 50       10            1             10            1.074219
 30       10            0             0             9.765625E-02
 20       10            3             30            17.1875
 10       10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT  10  AND +INFINITY CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 176.2669


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 1        .7206816      176.2668      130.2738      743.1811


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H            GOODNESS OF FIT PROBABILITY
    5                   3.308529      2.828063                    1.474226E-02

SINCE THE PROBABILITY IS LESS THAN 0.05, RESULTS CALCULATED
USING THE PROBIT METHOD PROBABLY SHOULD NOT BE USED.

SLOPE   =               1.196799
95 PERCENT CONFIDENCE LIMITS =-.9801021    AND    3.3737

INTERCEPT=-3.047126

LC50 =    351.6116
95 PERCENT CONFIDENCE LIMITS =  73.43795  AND  +INFINITY

         LC25 =         96.04541
95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

         LC10 =         29.86805
95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

         LC05 =         14.84729
95 PERCENT CONFIDENCE LIMITS = 0 AND   70.42454
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christine  diquat  BLG
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CONC.    NUMBER        NUMBER        PERCENT       BINOMIAL
         EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 800      10            10            100           9.765625E-02
 600      10            10            100           9.765625E-02
 400      10            10            100           9.765625E-02
 300      10            10            100           9.765625E-02
 200      10            1             10            1.074219
 100      10            3             30            17.1875
 50       10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT 50 AND 300 CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 234.6956


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 4        .1388659      171.4882      129.5763      213.7948


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H            GOODNESS OF FIT PROBABILITY
    5                   .9313404      3.062814                    9.101033E-03

SINCE THE PROBABILITY IS LESS THAN 0.05, RESULTS CALCULATED
USING THE PROBIT METHOD PROBABLY SHOULD NOT BE USED.

SLOPE   =               4.648225
95 PERCENT CONFIDENCE LIMITS = .1624098    AND    9.13404

INTERCEPT=-10.49902

LC50 =    181.4329
95 PERCENT CONFIDENCE LIMITS =  .9474866 AND  419.9077

         LC25 =         129.8993
95 PERCENT CONFIDENCE LIMITS =  1.071054E-04 AND  220.2943

         LC10 =         96.16071
95 PERCENT CONFIDENCE LIMITS =  2.17432E-08 AND  170.1949

         LC05 =         80.32281
95 PERCENT CONFIDENCE LIMITS =  1.301812E-10 AND  150.319
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christine diquat BLG

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CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB.(PERCENT)
600	10	10	100	9.765625E-02
300	10	0	0	9.765625E-02
150	10	0	0	9.765625E-02
90	10	0	0	9.765625E-02
60	10	0	0	9.765625E-02
30	10	0	0	9.765625E-02

THE BINOMIAL TEST SHOWS THAT 300 AND 600 CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 424.2642

WHEN THERE ARE LESS THAN TWO CONCENTRATIONS AT WHICH THE
PERCENT DEAD IS BETWEEN 0 AND 100, NEITHER THE MOVING AVERAGE
NOR THE PROBIT METHOD CAN GIVE ANY STATISTICALLY SOUND RESULTS.

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christine  diquat  BLG
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CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB.(PERCENT)
800	10	10	100	9.765625E-02
600	10	10	100	9.765625E-02
400	10	10	100	9.765625E-02
200	10	6	60.00001	37.69531
100	10	1	10	1.074219
60	10	2	20	5.46875
30	10	0	0	9.765625E-02

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THE BINOMIAL TEST SHOWS THAT 30 AND 400 CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 176.2669


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
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SPAN	G	LC50	95 PERCENT CONFIDENCE LIMITS	
5	7.606563E-02	141.6891	105.1429	188.8993

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RESULTS CALCULATED USING THE PROBIT METHOD
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ITERATIONS	G	H	GOODNESS OF FIT PROBABILITY
4	.1572871	1	.4000014

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SLOPE   =               3.786718
95 PERCENT CONFIDENCE LIMITS = 2.284927    AND    5.288509

INTERCEPT=-8.224415

LC50 =    148.5632
95 PERCENT CONFIDENCE LIMITS =  108.7517 AND  201.6778

         LC25 =         98.57996
95 PERCENT CONFIDENCE LIMITS =  62.98146 AND  131.5667

         LC10 =         68.14987
95 PERCENT CONFIDENCE LIMITS =  36.14919 AND  95.44784

         LC05 =         54.64175
95 PERCENT CONFIDENCE LIMITS =  25.57012 AND  79.87994
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christine  diquat  BLG
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CONC.    NUMBER        NUMBER        PERCENT       BINOMIAL
         EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 800      10            8             80            5.46875
 600      10            8             80            5.46875
 400      10            2             20            5.46875
 200      10            0             0             9.765625E-02
 100      10            1             10            1.074219
 60       10            2             20            5.46875
 30       10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT  30  AND +INFINITY CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 489.898


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 4        .2964245      485.007       346.8579      776.8878


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H            GOODNESS OF FIT PROBABILITY
    5                   1.106889      2.805761                    1.542765E-02

SINCE THE PROBABILITY IS LESS THAN 0.05, RESULTS CALCULATED
USING THE PROBIT METHOD PROBABLY SHOULD NOT BE USED.

SLOPE   =               1.926204
95 PERCENT CONFIDENCE LIMITS =-.1003319    AND    3.95274

INTERCEPT=-5.11724

LC50 =    453.5708
95 PERCENT CONFIDENCE LIMITS =  103.2793  AND  +INFINITY

         LC25 =         202.5231
95 PERCENT CONFIDENCE LIMITS = 0 AND   807.2831

         LC10 =         98.01552
95 PERCENT CONFIDENCE LIMITS = 0 AND   255.0577

         LC05 =         63.48714
95 PERCENT CONFIDENCE LIMITS = 0 AND   185.9352
************************************************************************
```

```
christine  diquat  BLG
************************************************************************
CONC.    NUMBER        NUMBER        PERCENT       BINOMIAL
         EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 200      10            5             50            62.30469
 125      10            1             10            1.074219
 70       10            0             0             9.765625E-02
 40       10            0             0             9.765625E-02
 20       10            0             0             9.765625E-02
 10       10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT  125  AND +INFINITY CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 200


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 1        1.077681      200           156.675      +INFINITY


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H             GOODNESS OF FIT PROBABILITY
    19                  .7900593      1                            .9999466

SLOPE   =               6.494119
95 PERCENT CONFIDENCE LIMITS = .7218027    AND    12.26644

INTERCEPT=-14.93318

LC50 =    199.2934
95 PERCENT CONFIDENCE LIMITS =  158.8518 AND  914.03

         LC25 =         156.9025
95 PERCENT CONFIDENCE LIMITS =  69.63839 AND  213.6241

         LC10 =         126.5159
95 PERCENT CONFIDENCE LIMITS =  12.05636 AND  158.7456

         LC05 =         111.2249
95 PERCENT CONFIDENCE LIMITS =  3.891738 AND  144.1561
************************************************************************
```

```
christine  DIQUAT  PERCH LC50
*********************************************************************
CONC.    NUMBER        NUMBER        PERCENT       BINOMIAL
         EXPOSED       DEAD          DEAD          PROB.(PERCENT)
 150000   10            8             80            5.46875
 75000    10            5             50            62.30469
 50000    10            6             60.00001      37.69531
 30000    10            2             20            5.46875
 20000    10            2             20            5.46875
 10000    10            0             0             9.765625E-02

THE BINOMIAL TEST SHOWS THAT  10000  AND +INFINITY CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.


AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 44226.14


RESULTS CALCULATED USING THE MOVING AVERAGE METHOD
   SPAN     G          LC50          95 PERCENT CONFIDENCE LIMITS
 3        .5233324      57294.44      29466.26      99734.19


RESULTS CALCULATED USING THE PROBIT METHOD
ITERATIONS             G              H             GOODNESS OF FIT PROBABILITY
    6                   .2419765      1                            .6780974

SLOPE   =               2.258167
95 PERCENT CONFIDENCE LIMITS = 1.14735    AND    3.368985

INTERCEPT=-10.77382

LC50 =    59026.2
95 PERCENT CONFIDENCE LIMITS =  40407.83 AND  100418.6

         LC25 =         29672.29
95 PERCENT CONFIDENCE LIMITS =  15319.05 AND  43148.26

         LC10 =         15977.36
95 PERCENT CONFIDENCE LIMITS =  5030.945 AND  25657.35

         LC05 =         11031.18
95 PERCENT CONFIDENCE LIMITS =  2495.69 AND  19462.1
*********************************************************************
```