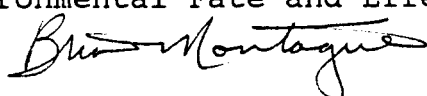
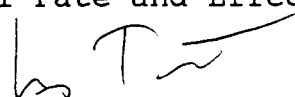


**Data Evaluation Report
Ecological Effects Branch**

1. **Chemical:** Imazapyr
2. **Test Material:** Received at laboratory labeled as AC243,997, Lot No. AC4866-62, 99.5% purity active ingredient: (2,-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imadazol-2-yl]-3-pyridine carboxylic acid.
3. **Study Type:** 28-Day Early Life Stage Test with rainbow trout, Oncorhynchus mykiss.
4. **Study Identification:**
 - Study Director:** Ward, Scott G.
 - Study Laboratory:** Environmental Science and Engineering, Inc., Gainesville, Florida
 - Study Dates:** April 8, to June 10, 1988
 - Study Identification:** ESE No. 87384-0600-2130
 - Sponsor:** American Cyanamid
 - EPA Identification:** MRID 413158-04
5. **Reviewed by:** Brian Montague, Fisheries Biologist
Ecological Effects Branch
Environmental Fate and Effects Division
 5/20/92
6. **Approved by:** Les Touart, PhD Supervisory Biologist
Ecological Effects Branch
Environmental Fate and Effects Division
 5/20/92
7. **Conclusions:** The study was conducted in a scientifically sound manner and does provide some information which could be used in risk assessment. However due primarily to poor control embryo survival it does not completely satisfy requirements for life stage testing with a freshwater fish species. Imazapyr produced a significant reduction in hatching success when compared to the control embryos that did hatch successfully. Larval survival of rainbow trout at 92.4 ppm measured concentration was also significantly below controls. This is contrary to the conclusions reached by the study author. A 15% reduction in hatch success was seen at 43.1 mg/L. This might have been greater if control embryo survival had been above the 70% minimum. The NOEL for larval survival only is therefore estimated to be 43.1 mg/L and the MATC > 43.1 < 92.4 mg/L. Wet wt, Dry wt., and total length did not appear to be affected at dosages as high as 92.4 mg/L. The MATC for embryo survival is not determinable due to poor control performance.
8. **Recommendations:** N/A



9. **Submission Purpose:** Submitted to support registration of Imazapyr herbicide on 12/5/89.

10. **Study Design and Protocol:** Protocol is ESE's own but is closely patterned after ASTM's proposed 1987 protocol draft for conducting fish early life-stage testing.

Test species were rainbow trout, Onchorhynchus mykiss obtained from Bertey's Resort in Valley, Washington. Eggs and milt were received on March 30, 1988 and fertilized upon receipt. Fertilized eggs were placed in a flow-through incubator at 10°C until initiation of the study on April 8, 1988.

Test stock solutions were prepared by addition of 197.89 gms of test material to 100 liters of dilution water (well water from ESE's own well, pre-aerated and cooled to 10°C). New test solutions were prepared for each diluter cycle by addition of 100 ml of this stock solution to 1.869 L of dilution water in the diluter mixing box. The diluter was a Mount & Brungs design used to deliver five concentrations decreasing by a factor of 0.5 at each level. The nominal concentrations utilized were 6.2, 12.5, 25, 50 and 100 mg/L. Diluter function was checked daily and samples were removed for analysis on days 0, 6, 13, 17, 24, 31, 38, 45, 52, 59 and 62 during the test.

Test vessels were glass aquaria maintained at a volume of 6.0 liters of test solution. Two screened retention chambers were suspended in the vessels. A self-starting siphon provided a 4 cm fluctuation of water levels to allow solution exchange within the retention chambers. The flow rate utilized provided 12 volume additions per day. A water bath maintained test vessels at 10°C. Photoperiod was 16D/8N with 15-minute transition.

Twenty-five pre-eyed embryos were randomly distributed to each retention chamber nine days after fertilization. Live embryos were counted daily and dead eggs discarded until 50% had reached eyed embryo stage. At this time embryos were thinned to 20 per replicate chamber (40/tank). These were observed daily until all living embryos had hatched. Beginning at three days post-hatch the new fry were fed trout mash daily until study termination. Survival and behavior were recorded daily. At termination length, wet weight, and dry weight were determined for each surviving fish.

11. **Reported Results:** Test concentrations were stable for 61 of the 62 days of the study. On day 36 test solutions were improperly prepared and resulted in an increase of twice the intended dose levels to a high of 229 mg/L in the 100 mg/L test dosage. This was rectified by the following day. Mean

measured concentrations for the entire study period were 6.59, 12.1, 24.0, 43.1, and 92.4 mg/L and ranged from 92 to 105% of the nominal estimated concentrations. Water temperatures ranged from 9 to 12°C and averaged $10.7 \pm 1.0^\circ\text{C}$. However, no temperatures were reported for 16 of the 62 days. Dissolved oxygen ranged from 9.1 to 13.0 mg/L (83 - 124% saturation). The pH ranged from a low of 7.1 to 7.9 for all test levels. Hardness ranged from 210 to 293 mg/L as CaCO_3 and conductivity from 30 to 355 microhms/Cm. Treatment means for hatching success were 42.5% for 92 mg/L, 51.3% for 43.1 mg/L, 53.8% for 24 mg/L, 66.3% for 12.1 mg/L, 71.8% for 6.59 mg/L and 61.2% for control vessels. Survival of hatch was 92.5% for controls, 82.5% for 6.599 ppm, 90% for 12.1 ppm, 85% for 24 ppm, 90% for 43.1 ppm, and 71.9% for the 92.4 ppm test concentrations after 62 days of exposure. Mean length in mm, dry weight, and wet weight in mg are listed in the table below along with values reported above.

Growth and Hatch/Survival - means of Parameters					
Measured Conc.	Length (mm)	Wet Wt. mg.	Dry Wt.	% Hatch	% Hatch Surv.
Controls	24.4	153.4	22.3	61.2	92.5
6.59 mg/L	22.2	167.9	24.1	71.8	82.5
12.1 mg/L	22.5	167.2	29.3	66.3	90
24.0 mg/L	23.1	182.0	27.8	53.8	85
43.1 mg/L	23.4	156.2	27.2	51.3	90
92.4 mg/L	22.9	191.3	32.3	42.5	71.9

12. **Study Author's Conclusions:** "Exposure to concentrations ≤ 92.4 mg/L did not significantly reduce the hatching success of rainbow trout embryos.....mean time to hatch (hatch being ≤ 90 percent of embryos hatched of total hatched) was 21 to 22 days for all treatments and the controls.....No abnormalities in embryonic development were observed for any treatment....Exposure to mean measured concentrations of AC 243,997 ≤ 92.4 mg/L did not significantly decrease survival of juvenile rainbow trout.....No abnormalities in juvenile development were observed in any treatment.....All average lengths of exposed rainbow trout were reduced from control fish, however no exposed fish were statistically smaller than the control fish on either a wet weight or dry weight basis.....The lack of a concentration relationship with mean lengths and the lack of corroboration of growth effects on a weight basis appear to discount the

significance of the effect on length.....statistical comparison of the control duplicates found that Replicate A fish were significantly larger than Replicate B fish..... it is apparent that duplicate A fish significantly skewed the treatment mean and resulted in a statistical aberration of effect....The MATC value for rainbow trout embryos and fry exposed for 62 days to AC 243,997 is >92.4 mg/L based on the lack of statistical significance associated with hatching, survival and growth."

13. Reviewer's Discussion: The study generally followed acceptable protocol although some notable deviations occurred during the study in control performance, diluter concentration delivery, measurement of water temperature parameters, and reporting requirements. Larval survival of control organisms was adequate.

1. The study has not mentioned the exact times to hatch only the time to reach 90% hatch success which was 20-23 days for all replicates.

2. The time to swim-up is not included for fry which were successfully hatched.

3. During day 36 diluter stock solutions were accidentally prepared at twice the required dosage and added to test vessels. This was flushed within 6 hours and did not appear to lead to any long lasting effect on the test organisms.

4. Temperature data for the control vessels were reported for 46 of the 62 days of exposure. No explanation of the missing values is provided. Temperature should be monitored at least every 24 hours in at least one test vessel. Maximum variation reported for any 24 hr period was 2°C.

5. Hardness was much higher than recommended, but did not appear to affect results as survival of control larvae was 90%.

6. Twenty five of 156 residue samples were not measured or not reported. Some were lost due to a refrigerator failure and breakage. Though some of the samples did show residue levels 20% below the mean average measured concentration for that dose level this was not felt to have been consistent enough to have interfered with the results. Recovery levels were good for all treatment levels.

7. ASTM guidelines state that if more than a third of the control embryos die within the first 48 hours of the test it is recommended that the test be restarted. Hatch success was only 61% for the control embryos in this study.

8. ASTM states that an early life stage test is unacceptable if survival of controls is less than 70% from the time

embryos are thinned. Survival of controls after thinning of pre eyed embryos to 20 eyed embryos per replicate ranged from 55-70% with a mean survival of 61.2% hatch success.

9. Overall survival of each test chamber is determined by multiplying the percent of survival to time of thinning by the percent of survival to the end of testing. The study authors have not provided data to indicate the percent of survival prior to thinning of the pre-eyed embryos.

Analysis of various parameters by the Agency did not show complete statistical agreement with the study author's conclusions. The reduction in hatch success was felt to be significant at the 92 ppm level. The level at which no observed effect could be claimed was felt to be 43 ppm for larval survival. Though length was slightly affected in larvae this was not felt to have been high enough to be conclusive as only one replicate of the controls appeared to display significant increase over treatment fish.

Adequacy of Study:

Classification: Supplemental - useful data concerning effects to surviving larval stages can be discerned as survival of controls following hatch was 92.5%.

Rationale: Survival of control embryos following thinning is below 70%. Temperature was not properly reported.

Repairability: Not repairable.

Hatch Success ~~IMAZAPYR~~
 Survival Trout Larvae ~~Triclopyr~~
 File: tricsurv.rbw Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	controls	2	22.000 ^A	26.000 ^B	24.000
2	6.59	2	25.000 ^B	30.000 ^A	27.500
3	12.1	2	24.000 ^k	30.000 ^B	27.000
4	24	2	20.000 ^B	23.000 ^A	21.500
5	43.1	2	20.000 ^k	21.000 ^B	20.500
6	92.4	2	16.000 ^A	18.000 ^B	17.000

Hatch Success ~~IMAZAPYR~~
 Survival Trout Larvae ~~Triclopyr~~
 File: tricsurv.rbw Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	controls	8.000	2.828	2.000
2	6.59	12.500	3.536	2.500
3	12.1	18.000	4.243	3.000
4	24	4.500	2.121	1.500
5	43.1	0.500	0.707	0.500
6	92.4	2.000	1.414	1.000

Hatch Success ~~IMAZAPYR~~
 Survival Trout Larvae ~~Triclopyr~~
 File: tricsurv.rbw Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	163.417	32.683	4.310
Within (Error)	6	45.500	7.583	
Total	11	208.917		

Critical F value = 4.39 (0.05,5,6)
 Since $F < \text{Critical } F$ FAIL TO REJECT H_0 : All groups equal

Survival Trout Larvae Triclopyr
 File: tricsurv.rbw Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	controls	24.000	24.000		
2	6.59	27.500	27.500	-1.271	
3	12.1	27.000	27.000	-1.089	
4	24	21.500	21.500	0.908	
5	43.1	20.500	20.500	1.271	
6	92.4	17.000	17.000	2.542	

Dunnett table value = 2.83 (1 Tailed Value, P=0.05, df=6,5)

Survival Trout Larvae ~~Triclopyr~~ *Imazapyr*

File: tricsurv.rbw

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	controls	2			
2	6.59	2	7.793	32.5	-3.500
3	12.1	2	7.793	32.5	-3.000
4	24	2	7.793	32.5	2.500
5	43.1	2	7.793	32.5	3.500
6	92.4	2	7.793	32.5	7.000

Survival Trout Larvae ~~Triclopyr~~ *Imazapyr*

File: tricsurv.rbw

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	163.417	32.683	4.310
Within (Error)	6	45.500	7.583	
Total	11	208.917		

Critical F value = 4.39 (0.05,5,6)

Since F < Critical F FAIL TO REJECT Ho:All groups equal

Survival Trout Larvae Triclopyr

File: tricsurv.rbw

Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

TRANSFORMED MEAN CALCULATED IN

GROUP	IDENTIFICATION	MEAN	ORIGINAL UNITS	T STAT	SIG
1	controls	24.000	24.000		
2	6.59	27.500	27.500	-1.271	
3	12.1	27.000	27.000	-1.089	
4	24	21.500	21.500	0.908	
5	43.1	20.500	20.500	1.271	
6	92.4	17.000	17.000	2.542	

Bonferroni T table value = 3.14 (1 Tailed Value, P=0.05, df=6,5)

Survival Trout Larvae ~~Triclopyr~~ *IMAZAPYR*
File: tricsurv.rbw Transform: NO TRANSFORM

BONFERRONI T-TEST		TABLE 2 OF 2		Ho:Control<Treatment	
GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	controls	2			
2	6.59	2	8.655	36.1	-3.500
3	12.1	2	8.655	36.1	-3.000
4	24	2	8.655	36.1	2.500
5	43.1	2	8.655	36.1	3.500
6	92.4	2	8.655	36.1	7.000

Survival Trout Larvae ~~Triclopyr~~ *IMAZAPYR*
File: tricsurv.rbw Transform: NO TRANSFORM

ANOVA TABLE				
SOURCE	DF	SS	MS	F
Between	5	163.417	32.683	4.310
Within (Error)	6	45.500	7.583	
Total	11	208.917		

Critical F value = 4.39 (0.05,5,6)
Since F < Critical F FAIL TO REJECT Ho:All groups equal

Survival Trout Larvae ~~Triclopyr~~ *IMAZAPYR*
File: tricsurv.rbw Transform: NO TRANSFORM

TUKEY method of multiple comparisons

		GROUP					
GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	0	0	0	0
				6	5	4	1
				3	2		

6	92.4	17.000	17.000	\
5	43.1	20.500	20.500	. \
4	24	21.500	21.500	. . \
1	controls	24.000	24.000	. . . \
3	12.1	27.000	27.000	 \
2	6.59	27.500	27.500	 \

* = significant difference (p=0.05)
 Tukey value (6,6) = 5.63

. = no significant difference
 s = 7.583

Survival Trout Larvae ~~Triclopyr~~ IMAZAPYR
 File: tricsurv.rbw Transform: NO TRANSFORM

WILLIAMS TEST (Isotonic regression model) TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	controls	2	24.000	24.000	26.167
2	6.59	2	27.500	27.500	26.167
3	12.1	2	27.000	27.000	26.167
4	24	2	21.500	21.500	21.500
5	43.1	2	20.500	20.500	20.500
6	92.4	2	17.000	17.000	17.000

Match Success
 Survival Trout Larvae ~~Triclopyr~~ IMAZAPYR
 File: tricsurv.rbw Transform: NO TRANSFORM

WILLIAMS TEST (Isotonic regression model) TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
controls	26.167				
6.59	26.167	0.787		1.94	k= 1, v= 6
12.1	26.167	0.787		2.06	k= 2, v= 6
24	21.500	0.908		2.10	k= 3, v= 6
43.1	20.500	1.271		2.12	k= 4, v= 6
92.4	17.000	2.542	*	2.13	k= 5, v= 6

s = 2.754

Note: df used for table values are approximate when v > 20.

Survival Trout Larvae ~~Triclopyr~~ IMAZAPYR
 File: tricsurv.rbw Transform: NO TRANSFORM

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	controls	24.000	24.000	16.000

2	6.59	27.500	27.500	20.500
3	12.1	27.000	27.000	19.500
4	24	21.500	21.500	10.500
5	43.1	20.500	20.500	8.500
6	92.4	17.000	17.000	3.000

Calculated H Value = 9.063 Critical H Value Table = 11.070
 Since Calc H < Crit H FAIL TO REJECT Ho: All groups are equal.

Survival Trout Larvae ~~Triclopyr~~ *IMAZAPYR*
 File: tricsurv.rbw Transform: NO TRANSFORM

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP					
				0 6	0 5	0 4	0 1	0 3	0 2
6	92.4	17.000	17.000	\					
5	43.1	20.500	20.500	.	\				
4	24	21.500	21.500	.	.	\			
1	controls	24.000	24.000	.	.	.	\		
3	12.1	27.000	27.000	.	.	.	.	\	
2	6.59	27.500	27.500	.	.	.	.	.	\

* = significant difference (p=0.05)
 Table q value (0.05,6) = 2.936

. = no significant difference
 SE = 3.593

IMAZAPYR

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	2	23.000	25.470	24.235
2	6.59 ppm	2	21.900	22.500	22.200
3	12.1	2	21.600	23.300	22.450
4	24	2	22.800	23.400	23.100
5	43.1	2	23.200	23.700	23.450
6	92.4	2	22.800	23.000	22.900

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Control	3.050	1.747	1.235
2	6.59 ppm	0.180	0.424	0.300
3	12.1	1.445	1.202	0.850
4	24	0.180	0.424	0.300
5	43.1	0.125	0.354	0.250
6	92.4	0.020	0.141	0.100

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	5.343	1.069	1.283
Within (Error)	6	5.000	0.833	
Total	11	10.343		

Critical F value = 4.39 (0.05,5,6)

Since $F < \text{Critical } F$ FAIL TO REJECT H_0 : All groups equal

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Control	24.235	24.235		
2	6.59 ppm	22.200	22.200	2.230	
3	12.1	22.450	22.450	1.956	
4	24	23.100	23.100	1.244	
5	43.1	23.450	23.450	0.860	
6	92.4	22.900	22.900	1.463	

Dunnett table value = 2.83 (1 Tailed Value, P=0.05, df=6,5)

Imazapyr~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Control	2			
2	6.59 ppm	2	2.583	10.7	2.035
3	12.1	2	2.583	10.7	1.785
4	24	2	2.583	10.7	1.135
5	43.1	2	2.583	10.7	0.785
6	92.4	2	2.583	10.7	1.335

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	5.343	1.069	1.283
Within (Error)	6	5.000	0.833	
Total	11	10.343		

Critical F value = 4.39 (0.05,5,6)

Since F < Critical F FAIL TO REJECT Ho:All groups equal

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

TRANSFORMED MEAN CALCULATED IN

GROUP	IDENTIFICATION	MEAN	ORIGINAL UNITS	T STAT	SIG
1	Control	24.235	24.235		
2	6.59 ppm	22.200	22.200	2.230	
3	12.1	22.450	22.450	1.956	
4	24	23.100	23.100	1.244	
5	43.1	23.450	23.450	0.860	
6	92.4	22.900	22.900	1.463	

Bonferroni T table value = 3.14 (1 Tailed Value, P=0.05, df=6,5)

Imazapyr

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

BONFERRONI T-TEST

TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Control	2			
2	6.59 ppm	2	2.869	11.8	2.035
3	12.1	2	2.869	11.8	1.785
4	24	2	2.869	11.8	1.135
5	43.1	2	2.869	11.8	0.785
6	92.4	2	2.869	11.8	1.335

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	5.343	1.069	1.283
Within (Error)	6	5.000	0.833	
Total	11	10.343		

Critical F value = 4.39 (0.05,5,6)

Since F < Critical F FAIL TO REJECT Ho:All groups equal

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

TUKEY method of multiple comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP
				0 0 0 0 0 0
				2 3 6 4 5 1

2	6.59 ppm	22.200	22.200	\
3	12.1	22.450	22.450	. \
6	92.4	22.900	22.900	. . \
4	24	23.100	23.100	. . . \
5	43.1	23.450	23.450	 \
1	Control	24.235	24.235	 \

* = significant difference (p=0.05)

. = no significant difference

Tukey value (6,6) = 5.63

s = 0.833

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	24.235	24.235	18.500
2	6.59 ppm	22.200	22.200	5.000
3	12.1	22.450	22.450	10.000
4	24	23.100	23.100	14.500
5	43.1	23.450	23.450	19.000
6	92.4	22.900	22.900	11.000

Calculated H Value = 5.636

Critical H Value Table = 11.070

Since Calc H < Crit H FAIL TO REJECT Ho:All groups are equal.

~~Triclopyr~~ Rainbow Trout 62 Day Length

File: triclen.rbw

Transform: NO TRANSFORM

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP					
				0 2	0 3	0 6	0 4	0 5	0 1
2	6.59 ppm	22.200	22.200	\					
3	12.1	22.450	22.450	. \					
6	92.4	22.900	22.900	. . \					
4	24	23.100	23.100	. . . \					
5	43.1	23.450	23.450	 \					
1	Control	24.235	24.235	 \					

* = significant difference (p=0.05)

. = no significant difference

Table q value (0.05,6) = 2.936

SE = 3.593

~~Triclopyr~~ Mean Wet Weight Rainbow Trout 62 Day

File: C:TRICRNW.WWT

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

MA22Pyr

~~Triclorpyr~~ Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	controls	2	153.100	153.700	153.400
2	6.59 ppm	2	145.700	186.400	166.050
3	12.1	2	155.600	180.200	167.900
4	24	2	180.000	184.100	182.050
5	43.1	2	136.200	178.600	157.400
6	92.4	2	176.900	207.100	192.000

~~Triclorpyr~~ Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	controls	0.180	0.424	0.300
2	6.59 ppm	828.245	28.779	20.350
3	12.1	302.580	17.395	12.300
4	24	8.405	2.899	2.050
5	43.1	898.880	29.981	21.200
6	92.4	456.020	21.355	15.100

~~Triclorpyr~~ Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	2166.590	433.318	1.042
Within (Error)	6	2494.310	415.718	
Total	11	4660.900		

Critical F value = 4.39 (0.05,5,6)

Since $F < \text{Critical } F$ FAIL TO REJECT H_0 : All groups equal

~~Triclorpyr~~ Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	controls	153.400	153.400		
2	6.59 ppm	166.050	166.050	-0.620	
3	12.1	167.900	167.900	-0.711	
4	24	182.050	182.050	-1.405	
5	43.1	157.400	157.400	-0.196	
6	92.4	192.000	192.000	-1.893	

Dunnett table value = 2.83 (1 Tailed Value, P=0.05, df=6,5)

Triclopyr Mean Wet Weight Rainbow Trout 62 Day

File: tricrnbw.wwt

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	controls	2			
2	6.59 ppm	2	57.701	37.6	-12.650
3	12.1	2	57.701	37.6	-14.500
4	24	2	57.701	37.6	-28.650
5	43.1	2	57.701	37.6	-4.000
6	92.4	2	57.701	37.6	-38.600

Triclopyr Mean Wet Weight Rainbow Trout 62 Day

File: tricrnbw.wwt

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	2166.590	433.318	1.042
Within (Error)	6	2494.310	415.718	
Total	11	4660.900		

Critical F value = 4.39 (0.05,5,6)

Since F < Critical F FAIL TO REJECT Ho:All groups equal

Triclopyr Mean Wet Weight Rainbow Trout 62 Day

File: tricrnbw.wwt

Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

TRANSFORMED MEAN CALCULATED IN

GROUP	IDENTIFICATION	MEAN	ORIGINAL UNITS	T STAT	SIG
1	controls	153.400	153.400		
2	6.59 ppm	166.050	166.050	-0.620	
3	12.1	167.900	167.900	-0.711	
4	24	182.050	182.050	-1.405	
5	43.1	157.400	157.400	-0.196	
6	92.4	192.000	192.000	-1.893	

Bonferroni T table value = 3.14 (1 Tailed Value, P=0.05, df=6,5)

Triclopyr Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

BONFERRONI T-TEST		TABLE 2 OF 2		Ho:Control<Treatment	
GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	controls	2			
2	6.59 ppm	2	64.083	41.8	-12.650
3	12.1	2	64.083	41.8	-14.500
4	24	2	64.083	41.8	-28.650
5	43.1	2	64.083	41.8	-4.000
6	92.4	2	64.083	41.8	-38.600

Triclopyr Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

ANOVA TABLE				
SOURCE	DF	SS	MS	F
Between	5	2166.590	433.318	1.042
Within (Error)	6	2494.310	415.718	
Total	11	4660.900		

Critical F value = 4.39 (0.05,5,6)
Since F < Critical F FAIL TO REJECT Ho:All groups equal

Triclopyr Mean Wet Weight Rainbow Trout 62 Day
File: tricrnbw.wwt Transform: NO TRANSFORMATION

TUKEY method of multiple comparisons				
GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP
				0 0 0 0 0 0
				1 5 2 3 4 6

1	controls	153.400	153.400	\
5	43.1	157.400	157.400	. \
2	6.59 ppm	166.050	166.050	. . \
3	12.1	167.900	167.900	. . . \
4	24	182.050	182.050	 \
6	92.4	192.000	192.000	 \

* = significant difference (p=0.05)

. = no significant difference

Tukey value (6,6) = 5.63

s = 415.718

Triclopyr Mean Wet Weight Rainbow Trout 62 Day

File: tricrnbw.wwt

Transform: NO TRANSFORMATION

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	controls	153.400	153.400	7.000
2	6.59 ppm	166.050	166.050	13.000
3	12.1	167.900	167.900	14.000
4	24	182.050	182.050	18.000
5	43.1	157.400	157.400	8.000
6	92.4	192.000	192.000	18.000

Calculated H Value = 4.308

Critical H Value Table = 11.070

Since Calc H < Crit H FAIL TO REJECT Ho:All groups are equal.

Triclopyr Mean Wet Weight Rainbow Trout 62 Day

File: tricrnbw.wwt

Transform: NO TRANSFORMATION

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP						
				0	0	0	0	0	0	0
				1	5	2	3	4	6	
1	controls	153.400	153.400	\						
5	43.1	157.400	157.400	. \						
2	6.59 ppm	166.050	166.050	. . \						
3	12.1	167.900	167.900	. . . \						
4	24	182.050	182.050	 \						
6	92.4	192.000	192.000	 \						

* = significant difference (p=0.05)

. = no significant difference

Table q value (0.05,6) = 2.936

SE = 3.606

Dry Wt. Rainbow Trt. ~~Triclopyr~~ *Imazapyr*
 File: tridrywt.rbw Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Controls	2	21.900	22.800	22.350
2	6.59	2	21.900	26.600	24.250
3	12.1	2	28.400	30.300	29.350
4	24	2	26.900	28.800	27.850
5	43.1	2	25.200	29.400	27.300
6	92.4	2	30.700	34.200	32.450

Dry Wt Rainbow Trt. ~~Triclopyr~~
 File: tridrywt.rbw Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Controls	0.405	0.636	0.450
2	6.59	11.045	3.323	2.350
3	12.1	1.805	1.344	0.950
4	24	1.805	1.344	0.950
5	43.1	8.820	2.970	2.100
6	92.4	6.125	2.475	1.750

Dry Wt Rainbow Trt. ~~Triclopyr~~
 File: tridrywt.rbw Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	129.644	25.929	5.185
Within (Error)	6	30.005	5.001	
Total	11	159.649		

Critical F value = 4.39 (0.05,5,6)
 Since $F > \text{Critical } F$ REJECT H_0 : All groups equal

Dry Wt Rainbow Trt. ~~Triclopyr~~
 File: tridrywt.rbw Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Controls	22.350	22.350		
2	6.59	24.250	24.250	-0.850	
3	12.1	29.350	29.350	-3.130	
4	24	27.850	27.850	-2.459	
5	43.1	27.300	27.300	-2.213	
6	92.4	32.450	32.450	-4.516	

Dunnett table value = 2.83 (1 Tailed Value, P=0.05, df=6,5)

Dry Wt Rainbow Trt. Triclopyr

File: tridrywt.rbw

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Controls	2			
2	6.59	2	6.329	28.3	-1.900
3	12.1	2	6.329	28.3	-7.000
4	24	2	6.329	28.3	-5.500
5	43.1	2	6.329	28.3	-4.950
6	92.4	2	6.329	28.3	-10.100

Dry Wt Rainbow Trt. Triclopyr

File: tridrywt.rbw

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	129.644	25.929	5.185
Within (Error)	6	30.005	5.001	
Total	11	159.649		

Critical F value = 4.39 (0.05,5,6)

Since F > Critical F REJECT Ho:All groups equal

Dry Wt Rainbow Trt. Triclopyr

File: tridrywt.rbw

Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

TRANSFORMED MEAN CALCULATED IN

GROUP	IDENTIFICATION	MEAN	ORIGINAL UNITS	T STAT	SIG
1	Controls	22.350	22.350		
2	6.59	24.250	24.250	-0.850	
3	12.1	29.350	29.350	-3.130	
4	24	27.850	27.850	-2.459	
5	43.1	27.300	27.300	-2.213	
6	92.4	32.450	32.450	-4.516	

Bonferroni T table value = 3.14 (1 Tailed Value, P=0.05, df=6,5)

Dry Wt Rainbow Trt. Triclopyr
File: tridrywt.rbw Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 2 OF 2			Ho:Control<Treatment		
GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Controls	2			
2	6.59	2	7.029	31.4	-1.900
3	12.1	2	7.029	31.4	-7.000
4	24	2	7.029	31.4	-5.500
5	43.1	2	7.029	31.4	-4.950
6	92.4	2	7.029	31.4	-10.100

Dry Wt Rainbow Trt. Triclopyr
File: tridrywt.rbw Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	129.644	25.929	5.185
Within (Error)	6	30.005	5.001	
Total	11	159.649		

Critical F value = 4.39 (0.05,5,6)
Since F > Critical F REJECT Ho:All groups equal

Dry Wt Rainbow Trt. Triclopyr
File: tridrywt.rbw Transform: NO TRANSFORM

TUKEY method of multiple comparisons

		GROUP					
GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	0	0	0	0
				1	2	5	4
				3	6		

	Controls	22.350	22.350	\
2	6.59	24.250	24.250	. \
5	43.1	27.300	27.300	. . \
4	24	27.850	27.850	. . . \
3	12.1	29.350	29.350	 \
6	92.4	32.450	32.450	* \

* = significant difference (p=0.05)
 Tukey value (6,6) = 5.63

. = no significant difference
 s = 5.001

Dry Wt Rainbow Trt. Triclopyr

File: tridrywt.rbw

Transform: NO TRANSFORM

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Controls	22.350	22.350	4.500
2	6.59	24.250	24.250	6.500
3	12.1	29.350	29.350	17.000
4	24	27.850	27.850	14.000
5	43.1	27.300	27.300	13.000
6	92.4	32.450	32.450	23.000

Calculated H Value = 8.935 Critical H Value Table = 11.070
 Since Calc H < Crit H FAIL TO REJECT Ho: All groups are equal.

Dry Wt Rainbow Trt. Triclopyr

File: tridrywt.rbw

Transform: NO TRANSFORM

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP					
				0	0	0	0	0	0
				1	2	5	4	3	6
1	Controls	22.350	22.350	\					
2	6.59	24.250	24.250	. \					
5	43.1	27.300	27.300	. . \					
4	24	27.850	27.850	. . . \					
3	12.1	29.350	29.350	 \					
6	92.4	32.450	32.450	 \					

* = significant difference (p=0.05)
 Table q value (0.05,6) = 2.936

. = no significant difference
 SE = 3.599

Survival Trout Larvae-~~Triclopyr~~ Imazapyr
 File: Tricsurv.fry Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Controls	2	21.000	23.000	22.000
2	6.59	2	19.000	27.000	23.000
3	12.1	2	20.000	28.000	24.000
4	24	2	17.000	20.000	18.500
5	43.1	2	17.000	20.000	18.500
6	92.4	2	12.000	14.000	13.000

Survival Trout Larvae-~~Triclopyr~~ Imazapyr
 File: Tricsurv.fry Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Controls	2.000	1.414	1.000
2	6.59	32.000	5.657	4.000
3	12.1	32.000	5.657	4.000
4	24	4.500	2.121	1.500
5	43.1	4.500	2.121	1.500
6	92.4	2.000	1.414	1.000

Survival Trout Larvae-~~Triclopyr~~ Imazapyr
 File: Tricsurv.fry Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	164.667	32.933	2.566
Within (Error)	6	77.000	12.833	
Total	11	241.667		

Critical F value = 4.39 (0.05,5,6)
 Since $F < \text{Critical } F$ FAIL TO REJECT H_0 :All groups equal

Survival Trout Larvae-~~Triclopyr~~
 File: Tricsurv.fry Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Controls	22.000	22.000		
2	6.59	23.000	23.000	-0.279	
3	12.1	24.000	24.000	-0.558	
4	24	18.500	18.500	0.977	
5	43.1	18.500	18.500	0.977	
6	92.4	13.000	13.000	2.512	

Dunnett table value = 2.83 (1 Tailed Value, P=0.05, df=6,5)

Survival Trout Larvae-Triclopyr

File: Tricsurv.fry

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Controls	2			
2	6.59	2	10.138	46.1	-1.000
3	12.1	2	10.138	46.1	-2.000
4	24	2	10.138	46.1	3.500
5	43.1	2	10.138	46.1	3.500
6	92.4	2	10.138	46.1	9.000

Survival Trout Larvae-Triclopyr

File: Tricsurv.fry

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	164.667	32.933	2.566
Within (Error)	6	77.000	12.833	
Total	11	241.667		

Critical F value = 4.39 (0.05,5,6)

Since F < Critical F FAIL TO REJECT Ho:All groups equal

Survival Trout Larvae-Triclopyr

File: Tricsurv.fry

Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

TRANSFORMED	MEAN CALCULATED IN
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	IDENTIFICATION	MEAN	ORIGINAL UNITS	T STAT	SIG
1	Controls	22.000	22.000		
2	6.59	23.000	23.000	-0.279	
3	12.1	24.000	24.000	-0.558	
4	24	18.500	18.500	0.977	
5	43.1	18.500	18.500	0.977	
6	92.4	13.000	13.000	2.512	

Bonferroni T table value = 3.14 (1 Tailed Value, P=0.05, df=6,5)

Survival Trout Larvae-~~Triclopyr~~ *Imazapyr*
File: Tricsurv.fry Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 2 OF 2			Ho:Control<Treatment		
GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Controls	2			
2	6.59	2	11.259	51.2	-1.000
3	12.1	2	11.259	51.2	-2.000
4	24	2	11.259	51.2	3.500
5	43.1	2	11.259	51.2	3.500
6	92.4	2	11.259	51.2	9.000

Survival Trout Larvae-~~Triclopyr~~
File: Tricsurv.fry Transform: NO TRANSFORMATION

ANOVA TABLE				
SOURCE	DF	SS	MS	F
Between	5	164.667	32.933	2.566
Within (Error)	6	77.000	12.833	
Total	11	241.667		

Critical F value = 4.39 (0.05,5,6)
Since F < Critical F FAIL TO REJECT Ho:All groups equal

Survival Trout Larvae-~~Triclopyr~~
File: Tricsurv.fry Transform: NO TRANSFORMATION

TUKEY method of multiple comparisons				
GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP
				0 0 0 0 0 0
				6 5 4 1 2 3

	92.4	13.000	13.000	\
5	43.1	18.500	18.500	. \
4	24	18.500	18.500	. . \
1	Controls	22.000	22.000	. . . \
2	6.59	23.000	23.000	 \
3	12.1	24.000	24.000	 \

* = significant difference (p=0.05)
 Tukey value (6,6) = 5.63

. = no significant difference
 s = 12.833

Survival Trout Larvae-~~Triclopyr~~ *Imazapyr*
 File: Tricsurv.fry Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model) TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	Controls	2	22.000	22.000	23.000
2	6.59	2	23.000	23.000	23.000
3	12.1	2	24.000	24.000	23.000
4	24	2	18.500	18.500	18.500
5	43.1	2	18.500	18.500	18.500
6	92.4	2	13.000	13.000	13.000

Survival Trout Larvae-~~Triclopyr~~
 File: Tricsurv.fry Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model) TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
Controls	23.000				
6.59	23.000	0.279		1.94	k= 1, v= 6
12.1	23.000	0.279		2.06	k= 2, v= 6
24	18.500	0.977		2.10	k= 3, v= 6
43.1	18.500	0.977		2.12	k= 4, v= 6
92.4	13.000	2.512	*	2.13	k= 5, v= 6

s = 3.582

Note: df used for table values are approximate when v > 20.

Survival Trout Larvae-~~Triclopyr~~
 File: Tricsurv.fry Transform: NO TRANSFORMATION

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Controls	22.000	22.000	19.000