

US EPA ARCHIVE DOCUMENT

DATA EVALUATION RECORD

CASE: GS0333

FENAMIPHOS

CONT-CAT: 01 GUIDELINES: 71-4

MRID:- 121290

Lamb, D.; Carsel, M.; Toll, P.; et al. (1982) Fenamiphos Reproduction Study with Mallard Duck: Study No. 81-675-01, 82225. (Unpublished study received December 16, 1982 under 3125-283; submitted by Mobay Chemical Corp., Kansas City, MO; CDL:071291-C).

REVIEW RESULTS:

VALID X INVALID _____ INCOMPLETE _____

GUIDELINE: SATISFIED X PARTIALLY SATISFIED _____ NOT SATISFIED _____

DIRECT RVW TIME = START DATE: END DATE:

REVIEWED BY: Richard W. Felthousen

TITLE: Wildlife Biologist

ORG: EEB/HED

LOC/TEL: 557-1392


SIGNATURE:  DATE: 12/04/86

APPROVED BY: O. Gutenson

TITLE: Acting Registration Standard Coordinator

ORG: EEB/HED

LOC/TEL:

SIGNATURE:  DATE: 12/21/87

This bioassay is scientifically sound and demonstrates that dietary exposures as low as 8 ppm can adversely effect reproduction in waterfowl. This study fulfills the data requirement for an avian reproduction study.

DATA EVALUATION RECORD

1. Chemical: Namacur
2. Formulation: Technical (90%)
3. Citation: Lamb, D.W. and Carsel, M.A. 1982. Fenamiphos Reproduction Study with Mallard Duck. Reference Tox. 305; AC 82225. Mobay Chemical Corporation (EPA Accession No. 071291).
4. Reviewed By: Charles A. Bowen II
Fisheries Biologist
Ecological Effects Branch
Hazard Evaluation Division (TS-769)
5. Date Reviewed: March 3, 1983.
6. Test Type: 14-Week Avian Reproduction Study
 - A. Test Species: Mallard Duck (Anas platyrhynchos)
7. Reported Results:

Fenamiphos significantly reduced measured feed consumption and eggshell production when present at 16 ppm in the diet but not at lower (4 ppm, 8 ppm) concentrations. The no-significant-effect level, based on mortality, gross lesions, eggshell thickness, egg production, embryo and hatchling survival, was 8 ppm.

8. Reviewer's Conclusion:

This bioassay is scientifically sound and demonstrates that chronic technical Namacur dietary exposures as low as 8 ppm can adversely effect reproduction in waterfowl. This study will fulfill the requirement for an avian reproduction study of Mallard Duck.

9. Test Procedures:

Pen-reared male and female mallard ducks were obtained from Whistling Wings, Hanover, Illinois. They were 19 weeks old when the study was initiated and their weight range was: males - 1.07 to 1.57 kg, females - 0.88 to 1.35 kg.

The birds were housed one male and one female per cage. A three-week observation and acclimation period was observed.

Fifty-six males and fifty-six females were randomly assigned to a control group and to three test groups. Each group had 14 cages with one male and one female per cage.

Pairs of birds were housed in Beacon Steel batteries. Temperature and humidity were maintained at 69 to 74°F and 35 to 60° respectively. For the first 6 weeks the birds were kept under a regime of 7.5 hours of light per day for maximum egg production. The photoperiod was then increased to 17 hours light per day for the duration of the study. The birds received at least 6 foot candles of illumination. There were no environmental deviations that affected the study. Food and water were available ad libitum.

Fenamiphos was administered to the birds at 4, 8 and 16 ppm in their diet. A solution of fenamiphos in acetone and corn oil was placed in a separatory funnel and was added to the feed slowly while mixing in a 30-quart bowl of a Hobart Mixer, Model D-300T. Acetone, which evaporated before the feed was presented to the birds, was also used as a rinsing agent for the glassware used in the preparation.

The control group received a diet containing 1% corn oil. Fresh batches of diet were prepared weekly and stored in the freezer until used. The diet was available ad libitum. After 1 week, all uneaten diet was destroyed and freshly mixed feed was offered to the birds. The test diet was administered for 3 weeks prior to the onset of egg laying and during egg laying.

All adult birds were observed daily throughout the study for clinical signs and mortality. Body weights were recorded at weeks 0, 2, 4, 6, and 19 of the study. A weighed amount of feed was offered weekly to each group, and the feed remaining at the end of the week was weighed to determine the weight of feed consumed.

The hens started laying eggs during the fourth week of the study, and eggs were collected daily until week 19. The eggs were stored at 60°F and 65% relative humidity. All the eggs were washed.

Eggs were candled before being set. The eggs were placed in an incubator. All of the eggs were candled on day 14 of incubation to measure fertility and on day 23 to measure embryo survival. On day 23 incubation, the eggs were allowed to hatch.

Throughout incubation, the temperature was maintained at 99.5°F with a wet bulb humidity index of 84°F. The eggs were rotated automatically each hour through day 23 of incubation. When the eggs were transferred to the hatcher, rotation was discontinued, the temperature was lowered to 99.0°F and the wet bulb humidity index was raised to 89°F.

All hatchlings were removed from the hatcher on day 29 of incubation. They were weighed and placed according to test group in Beacon Steel Brooders maintained at 100°F from hatching to day 14 of brooding. The ducklings were given food and water ad libitum. Ralston Purina Puramycin was added to their water for the first 3 days. At 14 days of age, they were weighed and sacrificed.

On one day in the 8th, 10th, 12th, 14th, and 16th weeks of egg laying, all eggs laid that day were used to measure eggshell thickness. They were opened at the waist and the contents were thoroughly washed out. The shells were allowed to dry for at least 48 hours at room temperature. The average thickness of the dried shell plus the membrane at the waist was determined by measuring at three points around the waist using a micrometer calibrated to 0.01 mm units.

Gross postmortem examination was conducted on the bird that died during the study. At the end of the study all birds were sacrificed by carbon dioxide asphyxiation, a gross post mortem examination was conducted and the brains were frozen for later analysis. Brains from five males and females from each test group were analyzed for cholinesterase activity.

10. Statistical Analysis

Values were subjected to an analysis of variance followed by Duncan's New Multiple Range Test (SAS Version). All significant differences were expressed at the 95% confidence limit.

11. Results and Discussion

One duck, a female receiving 16 ppm dietary fenamiphos, died during the study; another in that group was thin for 3 weeks but recovered. One female in the 4 ppm group had transient ataxia. One control and one 4 ppm female had decreased activity.

At necropsy, incidental lesions such as pale livers, congested visceral organs and testicular atrophy were seen infrequently without apparent relationship to concentration. Some lesions were seen more frequently among the 16 ppm ducks: tapeworms, gizzard enlargement, firm pancreas, yolk peritonitis and emaciation.

The 16 ppm consumed significantly less feed than the other groups and a few females in that group lost substantial amounts of body weight.

The 16 ppm group laid significantly fewer eggs than the other groups. They were not significantly different in their cracking of fertility rates, but significantly fewer embryos survived to 3 weeks. The number of viable 3-week embryos which hatched was slightly reduced but the difference was not statistically significant. The survival rate to 2 weeks was not concentration-related. The weight of hatchlings was statistically less in the 16 ppm group but the difference is too small to have any biological significance.

The number of live 14-day old ducklings produced in the 4, 8, and 16 ppm groups were 90, 75, and 12% respectively of the number produced in the control group.

Brain cholinesterase activity in the treated groups was 3 to 16% less than control values. Depressions of this magnitude are not considered biologically significant.

Eggshells were significantly thinner than control shells in the 8 ppm group the third week and in the 8 and 16 ppm groups the seventh week. The 4 ppm eggshells were significantly thicker during week five. These seem to be random difference except that the 16 ppm eggs consistently had slightly thinner shells than control eggs.

12. Study Author's Conclusions:

Fenamiphos significantly reduced measured feed consumption and egg production when present at 16 ppm in the diet but not at lower concentrations. Body weight was maintained in most ducks even at the highest concentration, but more lesions were found among birds in the 16 ppm groups sacrificed at the end of the study than controls or the other groups.

Eggshells were slightly thinner from the 16 ppm hens. While cracking and fertility were apparently unaffected by the compound, embryo and hatchling survival were reduced by the 16 ppm concentration. Total live duckling production as a percent of control production was 90, 75, and 12% respectively, in 4, 8, and 16 ppm groups.

The no-significant-effect level, based on mortality, gross lesions, eggshell thickness, egg production, embryo and hatchling survival, was 8 ppm.

13. EEB Statistical Analysis

The authors data were examined using analysis of variance followed by Duncan's New Multiple Range Test and chi-square test of independence. Specific programs and their functions are outlined below:

Name
ARSINM

one way analysis of variance and Duncan's New Multiple Range Test. Test examines survival as a percentage. See Appendix I for printout of the parameters tested.

Bird Anova

One way analysis of variance and Duncan's New Multiple Range Test. Examines reproductive output per hen. See Appendix II for printout of the parameters tested.

trtab

A chi-square statistic that examines frequency data obtained from control and three treatment levels (2-way table). See Appendix III for prints of the parameters tested.

Results from the statistical measures employed are outlined below:

Reproductive parameter tested	ARSINM	Bird Anova	trtab
Eggs Laid	-not tested	P<.0001 16 ppm group significant difference	X ² = 274 P<.0001 16 ppm group largest contribution to X ²
Eggs cracked	-not tested	P<.0468 16 ppm group significant difference	-not tested

Reproductive parameter tested	ARSINM	Bird Anova	trtab
Eggs set	P<0.002 no significant difference between groups	P<.0001 16 ppm group significant difference	-not tested
Viable embryos	P<0.9499 no significant difference between group	P<.0001 16 ppm group significant difference	-not tested
Live embryos	P<0.057 no significant different between group. D mean suggest 16 ppm effect	P<.0001 16 ppm group significant difference	-not tested
Normal hatching	P<0.9903 no significant different between group	P<.0016 16 ppm group significant difference	$\chi^2 = 9.566$ Prob = 0.01226 16 ppm group contribution to χ^2 significant difference square suggests

Both trtab and bird anova programs indicate that fenamiphos reduces the number of eggs set and the viability of mallard embryos. Bird anova indicates that reproductive parameter for the 16 ppm group were significantly different. ARSINM proved to be the least sensitive statistical method used because it failed to detect any difference in the means of the 16 ppm group and controls.

14. Reviewer's Conclusions

The conclusion drawn by the author are supported by the statistical procedures cited earlier. No deviations from EPA recommended protocols were noted.

15. Validation Status: Core

16. Category Repairability: N/A

Chloroform analysis method

Results from RTA 6 Analysis

PROC FREQTABLES STATUS*TRT / CHISQ CELLCHIZIWEIGHT NUM1

9. TABLE OF STATUS BY TRT ^{MAI} Allare Reproduction (81-675-a)
 Chi-square statistic of alive and dead chicks after 14 days.

STATUS	TRT	CHI-SQ	TRT1	TRT2	TRT3	TOTAL
FREQUENCY						
CELL CHIZI						
PERCENT						
ROW PCT						
COL PCT						
CON						
ALIVE		279	251	201	34	765
At 14 days		2.2	0.3	0.0	3.2	
		14.41	12.96	10.38	1.76	39.51
		36.47	32.81	26.27	4.44	
		43.19	38.15	39.03	29.06	
DEAD		367	407	314	83	1171
Dead = eqq set - 14 days		1.4	0.2	0.0	2.1	
		18.96	21.02	16.22	4.29	60.49
		31.34	34.76	26.81	7.09	
		56.81	61.85	60.97	70.94	
TOTAL		646	658	515	117	1936
		33.37	33.99	26.60	6.04	100.00

contribution to χ^2 suggest that 16 ppm treatment effected chick survival to 14 days

STATISTICS FOR 2WAY TABLES

CHI-SQUARE 9.566 DFM 3 PROBNO.0226
 CONTINGENCY COEFFICIENT 0.070
 CRAMER'S V 0.070
 LIKELIHOOD RATIO CHISQUARE 9.751 DFM 3 PROBNO.0208

Significant

Results from TetTab Analysis

PROC FREQTABLES STATUS*TRT / CHISQ CELLCHIZIWEIGHT NUM1

STATUS TRT TABLE OF STATUS BY TRT

Mallard reproduction (Study # 81-675-01)

Chi-Square statistic of obtained and expected egg laid frequencies.

EXP	558	558	558	558	TOTAL
FREQUENCY	11.6	14.2	0.5	110.8	2230
CELL CHIZI	12.50	12.50	12.50	12.50	50.00
PERCENT	25.00	25.00	25.00	25.00	100.00
ROW PCT	43.30	42.64	48.54	77.81	
COL PCT					
CON					
IR1	730	750	591	159	2230
IR2	11.6	14.2	0.5	110.8	2230
IR3	16.37	16.82	13.25	3.57	50.00
IR4	32.74	33.63	26.50	7.13	
IR5	56.70	57.36	51.46	22.19	
TOTAL	1268	1308	1149	717	4460
STATISTICS	28.87	29.32	25.75	16.07	100.00

Large contribution to χ^2 suggest that libpm treatment effect on egg production

significant = the number of eggs laid within each group is not equal

274.066 D.F. 3 PROBMO.0001

CHI-SQUARE
PHI
CONTINGENCY COEFFICIENT
CRAMER'S V
LIKELIHOOD RATIO CHISQUARE
287.371 D.F. 3 PROBMO.0001

Mallard Duck Reproduction Study (81-675-01)

OBS	TRT	EL	EC	ES	VE	LE	NH
1	A	19	1	17	16	16	3
2	A	46	1	41	23	18	5
3	A	56	3	49	48	46	31
4	A	47	4	38	35	29	23
5	A	20	0	17	17	10	5
6	A	52	5	43	43	36	12
7	A	46	1	42	42	37	33
8	A	52	2	45	45	39	17
9	A	54	0	49	49	47	20
10	A	52	0	47	40	36	12
11	A	91	1	85	85	82	69
12	A	59	1	54	0	0	0
13	A	74	8	63	57	51	32
14	A	62	1	56	31	29	24
15	B	70	1	64	25	15	4
16	U	52	2	45	43	41	19
17	B	70	1	64	62	60	54
18	B	25	0	24	7	6	1
19	B	60	3	52	17	16	5
20	B	57	3	49	48	47	37
21	B	50	4	42	34	26	8
22	B	76	4	67	67	57	17
23	B	36	5	27	27	22	14
24	B	33	2	27	24	22	10
25	B	49	1	44	43	38	16
26	B	53	0	49	49	46	33
27	B	81	4	72	40	34	13
28	B	38	1	32	32	29	29
29	C	42	1	36	35	33	13
30	C	34	2	29	26	23	14
31	C	29	1	25	24	23	18
32	C	40	1	35	34	25	17
33	C	62	0	57	49	43	11
34	C	58	2	52	49	35	18
35	C	18	1	15	14	10	5
36	C	71	4	62	49	48	31
37	C	37	2	31	13	8	6
38	C	43	3	35	22	15	13
39	C	24	1	20	13	12	11
40	C	44	0	39	33	27	7
41	C	49	0	45	43	38	33
42	C	40	2	34	29	22	11
43	U	19	1	15	15	14	12
44	O	17	1	13	13	12	7
45	U	14	0	10	5	0	0
46	O	2	2	0	0	0	0
47	O	0	0	0	0	0	0
48	U	6	1	2	2	2	1
49	O	16	0	14	14	7	0
50	O	2	0	1	1	0	0
51	O	11	0	7	7	4	1
52	U	10	1	7	7	2	2
53	U	10	0	7	7	4	2
54	O	19	2	14	14	2	1
55	O	27	1	22	13	11	8
56	O	6	0	5	0	0	0

dropped

1

ANALYSIS OF ES/EL (Eggs set / Eggs Laid)

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPONSE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
EIGHTS				
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	16878.45827225	5626.15275742	7.89
ERROR	51	36352.97313320	712.60339477	PR > F
CORRECTED TOTAL	54	53231.43140545		
			<i>significant</i>	0.0002
MEAN SQUARE	C.V.	ROOT MSE	RESPONSE MEAN	
1317077	40.7965	26.69837813	65.44286828	<i>egg viability</i>

SOURCE	DF	TYPE I SS	F VALUE	PR > F
MODEL	3	16878.45827225	7.89	0.0002
SOURCE	DF	TYPE III SS	F VALUE	PR > F
MODEL	3	16878.45827225	7.89	0.0002

1. ANALYSIS OF ES/EL DATA

HARMONIC MEAN OF CELL SIZES=13.7359
 MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFF

DUNCAN	GROUPING	MEAN	N	TRT
	A	70.024	14	A
	A	69.477	14	B
	A	68.547	14	C
	A	52.822	13	D

1

No significant difference exist. means in 16 ppm group suggest that chemical affects percentage egg viability. (egg set / egg laid).

1. ANALYSIS OF ES/EI DATA

1614.

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
EL	14	52.14285714	18.36324566	19.00000000	91.00000000	4.90778384
ES	14	46.14285714	17.07386380	17.00000000	85.00000000	4.56317937
WT	14	52.14285714	18.36324566	19.00000000	91.00000000	4.90778384
Z	14	0.88143242	0.03650140	0.80851064	0.93406593	0.00975541
ARS	14	1.22264243	0.05564226	1.11787411	1.31111115	0.01487102
RESPONSE	14	70.02406668	3.18678408	64.02369905	75.09091142	0.85170387

----- TRTB -----

EL	14	53.57142857	16.81443650	25.00000000	81.00000000	4.49384718
ES	14	47.00000000	15.75778196	24.00000000	72.00000000	4.21144438
WT	14	53.57142857	16.81443650	25.00000000	81.00000000	4.49384718
Z	14	0.87310816	0.05191406	0.75000000	0.96000000	0.01387462
ARS	14	1.21308817	0.07876530	1.04719755	1.36943841	0.02105091
RESPONSE	14	69.47686813	4.51110359	59.97585975	78.43147234	1.20564315

----- TRTEC -----

EL	14	42.21428571	14.45512191	18.00000000	71.00000000	3.86329383
ES	14	36.78571429	13.45178611	15.00000000	62.00000000	3.59514106
WT	14	42.21428571	14.45512191	18.00000000	71.00000000	3.86329383
Z	14	0.86496343	0.03187974	0.81395349	0.91935484	0.00852022
ARS	14	1.19685111	0.04816458	1.12482667	1.28285291	0.01287253
RESPONSE	14	68.54692718	2.75851694	64.42200585	73.47248463	0.73724466

----- TRTD -----

EL	14	<u>10.35714286</u>	7.78170579	0	27.00000000	2.07974835
ES	14	8.35714286	6.61707747	0	22.00000000	1.76848834
WT	14	11.35714286	7.78170579	0	27.00000000	2.07974835
Z	13	0.64601173	0.24254579	0	0.87500000	0.06727010
ARS	13	0.92229116	0.31856343	0	1.20942920	0.08835360
RESPONSE	13	62.82212981	18.24499626	0	69.26730889	5.06025150

2

2. ANALYSIS OF VE/ES DATA

(Viable embryos / Egg set)

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPONSE
WEIGHT: WT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VAL
MODEL	3	5916.71289576	1972.23763192	0.
ERROR	50	845164.80551978	16903.29611040	PR >
CORRECTED TOTAL	53	851081.51841554		

Not significant - 11.941
chemical does not effect embryo development.

R-SQUARE	C.V.	ROOT MSE	RESPONSE MEAN
0.006952	183.2185	130.01267673	70.96044597

SOURCE	DF	TYPE I SS	F VALUE	PR > F
TRT	3	5916.71289576	0.12	0.9499

SOURCE	DF	TYPE III SS	F VALUE	PR > F
TRT	3	5916.71289576	0.12	0.9499

DUNCAN	GROUPING	MEAN	N	TRT
	A	75.406	12	D
	A	71.923	14	A
	A	69.247	14	B
	A	67.900	14	C

1

2

NO significant difference

.. ANALYSIS OF VE/ES DATA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- TRT#A -----						
	14	46.14285714	17.07385380	17.00000000	85.00000000	4.56317937
	14	37.92857143	20.63777077	0.00000000	85.00000000	5.51567625
	14	46.14285714	17.07385380	17.00000000	85.00000000	4.56317937
	14	0.83658527	0.28548761	0.00000000	1.00000000	0.07629977
IS	14	1.25580613	0.44336220	0.00000000	1.57079633	0.11849353
SPONSE	14	71.92344191	25.39256246	0.00000000	89.96378963	6.78644778
----- TRT#B -----						
	14	47.00000000	15.75778196	24.00000000	72.00000000	4.21144438
	14	37.00000000	16.68255653	7.00000000	67.00000000	4.45860078
	14	47.00000000	15.75778196	24.00000000	72.00000000	4.21144438
	14	0.79602522	0.27647078	0.29166667	1.00000000	0.07388992
IS	14	1.20907604	0.37915071	0.57051045	1.57079633	0.10133229
SPONSE	14	69.24708212	21.71499539	32.67468928	89.96378963	5.80357664
----- TRT#C -----						
	14	36.78571429	13.45178611	15.00000000	62.00000000	3.59514106
	14	30.92857143	13.12932294	13.00000000	49.00000000	3.50895915
	14	36.78571429	13.45178611	15.00000000	62.00000000	3.59514106
	14	0.83417086	0.16295665	0.41935484	0.97222222	0.04355200
IS	14	1.18555944	0.20958804	0.70439919	1.40334825	0.05601476
SPONSE	14	67.90022259	12.00367869	40.34286248	80.37358145	3.20811807
----- TRT#D -----						
	14	8.35714286	6.61707747	0	22.00000000	1.76848834
	14	7.00000000	5.85727687	0	15.00000000	1.56542309
	14	8.35714286	6.61707747	0	22.00000000	1.76848834
	12	0.84090909	0.31818182	0	1.00000000	0.09185118
IS	12	1.31661507	0.50367406	0	1.57079633	0.14539818
SPONSE	12	75.40613581	28.84678686	0	89.96378963	8.32735008

3. ANALYSIS OF LE/VE DATA

(Live embryos/viable embryos)

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPONSE
HEIGHT WT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
DEL	3	42215.77674496	14071.92558165	4.74
ROK	48	142567.08314634	2970.14756555	PR > F
ADJUSTED TOTAL	51	184782.85989130		

significant - 0.0057

SUM OF SQUARES	C.V.	ROOT MSE	RESPONSE MEAN Chem
226462	84.8556	54.49906023	54.22566168

SOURCE	DF	TYPE I SS	F VALUE	PR > F
T	3	42215.77674496	4.74	0.0057

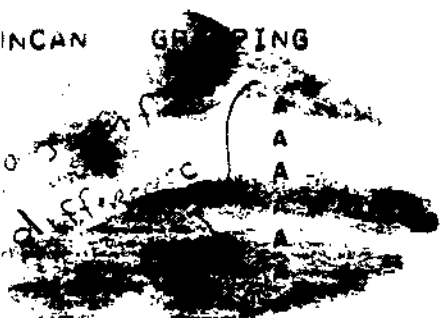
SOURCE	DF	TYPE III SS	F VALUE	PR > F
T	3	42215.77674495	4.74	0.0057

3. ANALYSIS OF LE/VE DATA

GENERAL LINEAR MODELS PROCEDURE

DISPERSED ANOVAS MULTIPLE RANGE TEST FOR VARIABLE: RESPONSE
THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
NOT THE EXPERIMENTWISE ERROR RATE.
PFA=0.05 DF=48 MSE=2970.15
WARNING: CELL SIZES ARE NOT EQUAL.
HARMONIC MEAN OF CELL SIZES=12.8746
CELLS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

INCAN	GROUPING	MEAN	N	TRT
	A	71.209	13	A
	A	70.296	14	B
	A	66.179	14	C
	A	45.761	11	D



... suggest that the ... embryo development is

J. ANALYSIS OF LEAVE DATA

16148

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- TRT=A -----						
	14	37.92857143	20.63777077	0.00000000	85.00000000	5.51567625
	14	34.00000000	20.21043143	0.00000000	82.00000000	5.40146500
	14	37.92857143	20.63777077	0.00000000	85.00000000	5.51567625
	13	0.87666826	0.10677036	0.58823529	1.00000000	0.02961277
SPONSE	13	1.24333571	0.16911881	0.87409797	1.57079633	0.04690512
	13	71.20922718	9.68589550	50.06197439	89.96378963	2.68638407
----- TRT=B -----						
	14	37.00000000	16.68255653	7.00000000	67.00000000	4.45860078
	14	32.78571429	16.19201404	6.00000000	60.00000000	4.32749778
	14	37.00000000	16.68255653	7.00000000	67.00000000	4.45860078
	14	0.87317117	0.09990184	0.60000000	0.97916667	0.02669989
SPONSE	14	1.22738266	0.14276103	0.88607712	1.42595283	0.03815449
	14	70.29555223	8.17631335	50.74805345	81.66820752	2.18521166
----- TRT=C -----						
	14	30.92857143	13.12932294	13.00000000	49.00000000	3.50895915
	14	25.85714286	12.34040981	8.00000000	48.00000000	3.29811325
	14	30.92857143	13.12932294	13.00000000	49.00000000	3.50895915
	14	0.82054410	0.11639666	0.61538462	0.97959184	0.03110832
SPONSE	14	1.15550601	0.16341601	0.90183225	1.42744876	0.04367477
	14	66.17898083	9.35928082	51.65039264	81.75388341	2.50137302
----- TRT=D -----						
	14	7.00000000	5.85727687	0	15.00000000	1.56542309
	14	4.14285714	4.91241978	0	14.00000000	1.31289941
	14	7.00000000	5.85727687	0	15.00000000	1.56542309
	11	0.52490842	0.37995786	0	1.00000000	0.11335556
SPONSE	11	0.79900157	0.52359082	0	1.57079633	0.15786857
	11	45.76099920	29.98747411	0	89.96378963	9.04156364

ES by my thinking

ANALYSIS OF NH/LE DATA (Normal hatching/Live embryos)
 GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RESPONSE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
HEIGHT				
PRICE	3	754.41922095	251.47307365	0.04
DEL	46	312130.41078660	6785.44371275	PR > F
CORRECTED TOTAL	49	312884.83000755		
SQUARE	C.V.	ROOT MSE	RESPONSE MEAN	
102411	168.6598	82.37380477	48.84022155	
PRICE	DF	TYPE I SS	F VALUE	PR > F
	3	754.41922095	0.04	0.9903
PRICE	DF	TYPE III SS	F VALUE	PR > F
	3	754.41922095	0.04	0.9903

not significant — 0.9903
 Chemical does not effect NH/LE ratio

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: RESPONSE
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.
 ALPHA=0.05 DF=46 MSE=6785.44
 WARNING: CELL SIZES ARE NOT EQUAL.
 HARMONIC MEAN OF CELL SIZES=12.0886
 MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	52.032	14	C
	A	48.314	13	A
	A	47.882	9	D
	A	46.753	14	B

No significant difference

8

4. ANALYSIS OF NH/LE DATA

VARIABLE N MEAN STANDARD DEVIATION MINIMUM VALUE MAXIMUM VALUE STD ERROR OF MEAN

----- TRT=A -----

E	14	34.00000000	20.21043143	0.00000000	82.00000000	5.40146500
H	14	20.42857143	17.83132199	0.00000000	69.00000000	4.76562126
T	14	34.00000000	20.21043143	0.00000000	82.00000000	5.40146500
RS	13	0.54990637	0.23974972	0.18750000	0.89189189	0.06649461
RESPONSE	13	0.84358524	0.25954831	0.44783240	1.23576583	0.07198575
	13	48.31442743	14.86503940	25.64858273	70.77567915	4.12282014

----- TRT=B -----

E	14	32.78571429	16.19201404	6.00000000	60.00000000	4.32749778
H	14	18.57142857	14.84128486	1.00000000	54.00000000	3.96650022
T	14	32.78571429	16.19201404	6.00000000	60.00000000	4.32749778
RS	14	0.50815185	0.25709981	0.16666667	1.00000000	0.06871282
RESPONSE	14	0.81632447	0.31824026	0.42053434	1.57079633	0.08505329
	14	46.75312890	18.22648742	24.08514829	89.96378963	4.87123366

----- TRT=C -----

E	14	25.85714286	12.34040981	8.00000000	48.00000000	3.29811325
H	14	14.85714286	8.33765456	5.00000000	33.00000000	2.22833191
T	14	25.85714286	12.34040981	8.00000000	48.00000000	3.29811325
RS	14	0.61015646	0.21675811	0.25581395	0.91666667	0.05793104
RESPONSE	14	0.90849267	0.23823208	0.53028653	1.27795356	0.06367020
	14	52.03185293	13.64420114	30.37095570	73.19188543	3.64656614

----- TRT=D -----

E	14	4.14285714	4.91241978	0	14.00000000	1.31289941
H	14	2.42857143	3.77673619	0	12.00000000	1.00937521
T	14	4.14285714	4.91241978	0	14.00000000	1.31289941
RS	9	0.54641655	0.30192257	0	1.00000000	0.10064086
RESPONSE	9	0.83602672	0.43302560	0	1.57079633	0.14434187
	9	47.88153057	24.80055689	0	89.96378963	8.26685230

ANALYSIS OF NH/EL DATA (Normal Hatch/Egg Laid)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VAL
MODEL	3	26137.57263992	8712.52421331	0.
ERROR	51	483700.57462261	9484.32499260	PR >
CORRECTED TOTAL	54	509838.14726253		

not significant difference 0.44

R-SQUARE	C.V.	ROOT MSE	RESPONSE MEAN
0.051266	310.7260	97.38749916	31.34192210

Chemical does not effect NH/EL ratio

SOURCE	DF	TYPE I SS	F VALUE	PR > F
TRT	3	26137.57263992	0.92	0.4404

SOURCE	DF	TYPE III SS	F VALUE	PR > F
TRT	3	26137.57263992	0.92	0.4404

5. ANALYSIS OF NH/EL DATA

GENERAL LINEAR MODELS PROCEDURE

UNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: RESPONSE
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.
 ALPHA=0.05 DF=51 MSE=9484.32
 WARNING: CELL SIZES ARE NOT EQUAL.
 HARMONIC MEAN OF CELL SIZES=13.7359
 MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

UNCAN	GROUPING	MEAN	N	TRT
	A	36.294	14	C
	A	35.196	14	A
	A	34.963	14	B
	A	17.959	13	D

no significant difference

lower average suggest 16 ppm and embeo

5. ANALYSIS OF NH/EL DATA

16148 THURSDAY, MARCH 10, 198

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERRO OF MEAN
----- TRT=A -----						
L	14	52.14285714	18.36324566	19.00000000	91.00000000	4.9077838
H	14	20.42857143	17.83132199	0.00000000	69.00000000	4.7656212
T	14	52.14285714	18.36324566	19.00000000	91.00000000	4.9077838
	14	0.35810841	0.21957357	0.00000000	0.75824176	0.0586835
RS	14	0.61452605	0.27392066	0.00000000	1.05676778	0.07320831
ESPONSE	14	35.19558295	15.68818344	0.00000000	60.52397261	4.19284331

----- TRT=B -----						
L	14	53.57142857	16.81443650	25.00000000	81.00000000	4.49384718
H	14	18.57142857	14.64128486	1.00000000	54.00000000	3.96650022
T	14	53.57142857	16.81443650	25.00000000	81.00000000	4.49384718
	14	0.35105996	0.25683642	0.04000000	0.77142857	0.06864242
RS	14	0.61046736	0.29311907	0.20135792	1.07231589	0.07833937
ESPONSE	14	34.96313085	16.78772833	11.53231728	61.41445550	4.48670912

----- TRT=C -----						
L	14	42.21428571	14.45512191	18.00000000	71.00000000	3.86329383
H	14	14.85714286	8.33765456	5.00000000	33.00000000	2.22833191
T	14	42.21428571	14.45512191	18.00000000	71.00000000	3.86329383
	14	0.35710866	0.15780100	0.15909091	0.67346939	0.04217409
RS	14	0.63370485	0.16858477	0.41027554	0.96255075	0.04505618
ESPONSE	14	36.29400515	9.65530983	23.49759919	55.12790647	2.58049010

----- TRT=D -----						
L	14	11.35714286	7.78170579	0	27.00000000	2.07974835
H	14	2.42857143	3.77673619	0	12.00000000	1.00937521
T	14	11.35714286	7.78170579	0	27.00000000	2.07974835
	13	0.15768056	0.19404142	0	0.63157895	0.05381741
RS	13	0.31357071	0.30772669	0	0.91854517	0.08534803
ESPONSE	13	17.95905002	17.62434692	0	52.60758712	4.88811435

MALLARD Duck Reproduction Study (8-67)

OBS	TRT	EL	EC	ES	VE	LE	NH
1	A	19	1	17	16	16	3
2	A	46	1	41	23	18	5
3	A	56	3	49	48	46	31
4	A	47	4	38	35	29	23
5	A	20	0	17	17	10	5
6	A	52	5	43	43	36	12
7	A	46	1	42	42	37	33
8	A	52	2	45	45	39	17
9	A	54	0	49	49	47	20
10	A	52	0	47	40	36	12
11	A	91	1	85	85	82	69
12	A	59	1	54	0	0	0
13	A	74	8	63	57	51	32
14	A	62	1	56	31	29	24
15	B	70	1	64	25	15	4
16	B	52	2	45	43	41	19
17	B	70	1	64	62	60	54
18	B	25	0	24	7	6	1
19	B	60	3	52	17	16	5
20	B	57	3	49	48	47	37
21	B	50	4	42	34	26	8
22	B	76	4	67	67	57	17
23	B	36	5	27	27	22	14
24	B	33	2	27	24	22	10
25	B	49	1	44	43	38	16
26	B	53	0	49	49	46	33
27	B	81	4	72	40	34	13
28	B	38	1	32	32	29	29
29	C	42	1	36	35	33	13
30	C	34	2	29	26	23	14
31	C	29	1	25	24	23	18
32	C	40	1	35	34	25	17
33	C	62	0	57	49	43	11
34	C	58	2	52	49	35	18
35	C	18	1	15	14	10	5
36	C	71	4	62	49	48	31
37	C	37	2	31	13	8	6
38	C	43	3	35	22	15	13
39	C	24	1	20	13	12	11
40	C	44	0	39	33	27	7
41	C	49	0	45	43	38	33
42	C	40	2	34	29	22	11
43	O	19	1	15	15	14	12
44	O	17	1	13	13	12	7
45	O	14	0	10	5	0	0
46	O	2	2	0	0	0	0
47	O	0	0	0	0	0	0
48	O	6	1	2	2	2	1
49	O	16	0	14	14	7	0
50	O	2	0	1	1	0	0
51	O	11	0	7	7	4	1
52	O	10	1	7	7	2	2
53	O	10	0	7	7	4	2
54	O	19	2	14	14	2	1
55	O	27	1	22	13	11	8
56	O	6	0	5	0	0	0

Contact

9 ppm

8 ppm

16 ppm

2.

Bird ANOVA - one way ANOVA

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: EL (Eggs Laid)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
DEL	3	16195.50000000	5398.50000000	24.28
ERROR	52	11562.71428571	222.35989011	PR > F
ADJUSTED TOTAL	55	27758.21428571		

Significant effect on egg production → 0.0001

SUM OF SQUARE	C.V.	ROOT MSE	EL MEAN
583449	37.4465	14.91173666	39.82142857

SOURCE	DF	TYPE I SS	F VALUE	PR > F
T	3	16195.50000000	24.28	0.0001

SOURCE	DF	TYPE III SS	F VALUE	PR > F
T	3	16195.50000000	24.28	0.0001

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: EL
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=222.36

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	53.571	14	B
	A	52.143	14	A
	A	42.214	14	C
	B	11.357	14	D

DUNCAN'S indicate that Nemacur 3 (16 ppm) significant effects the number 22

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: EC (Eggs Cracked)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	20.71428571	6.90476190	2.83
ERROR	52	127.00000000	2.44230769	PR > F
CORRECTED TOTAL	55	147.71428571		

Significant effect on egg cracking **0.0468**

MEAN SQUARE	C.V.	ROOT MSE	EC MEAN
1.140232	99.4502	1.56278843	1.57142857

SOURCE	DF	TYPE I SS	F VALUE	PR > F
MODEL	3	20.71428571	2.83	0.0468

SOURCE	DF	TYPE III SS	F VALUE	PR > F
MODEL	3	20.71428571	2.83	0.0468

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: EC
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=2.44231

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	2.2143	14	B
	A	2.0000	14	A
B	A	1.4286	14	C
B		0.6429	14	D
B				

Duncan's indicates significant effect of 16 ppm on increased cracking of eggs

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: ES (Eggs Set)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	13726.42857143	4575.47619048	23.9
ERROR	52	9939.28571429	191.14010989	PR >
CORRECTED TOTAL	55	23665.71428571		0.000

Significant
 ES MEAN Chemical effect
 Number of egg set

MEAN SQUARE	C.V.	ROOT MSE
1.580013	39.9907	13.82534303

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RT	3	13726.42857143	23.94	0.0001

SOURCE	DF	TYPE III SS	F VALUE	PR > F
RT	3	13726.42857143	23.94	0.0001

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: ES
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=191.14

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	47.000	14	B
	A	46.143	14	A
	A	36.786	14	C
	B	8.357	14	D

Duncan 16 ppm in diet significantly effects the number of eggs set

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: VE (Viable embryos)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	8805.57142857	2935.19047619	12.89
ERROR	52	11841.85714286	227.72802198	PR > F
CORRECTED TOTAL	55	20647.42857143		

significant 0.0001
 Chemical effect
 VE MEAN Number of
Viable Embryo

MEAN SQUARE	C.V.	ROOT MSE
2935.19047619	53.4859	15.09066009

SOURCE	DF	TYPE I SS	F VALUE	PR > F
MODEL	3	8805.57142857	12.89	0.0001

SOURCE	DF	TYPE III SS	F VALUE	PR > F
MODEL	3	8805.57142857	12.89	0.0001

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: VE
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=227.728

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	37.929	14	A
	A	37.000	14	B
	A	30.929	14	C
	B	7.000	14	D

16 ppm significantly effects the
 Viability of mallard duck eggs.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LE

[Live Embryos]

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	8047.05357143	2682.35119048	12.67
ERROR	52	11011.78571429	211.76510989	PR > F
CORRECTED TOTAL	55	19058.83928571		

significant → 0.0001

SUM OF SQUARES	C.V.	ROOT MSE	LE MEAN
122222	60.1417	14.55215138	24.19642857

SOURCE	DF	TYPE I SS	F VALUE	PR > F
MODEL	3	8047.05357143	12.67	0.0001

SOURCE	DF	TYPE III SS	F VALUE	PR > F
MODEL	3	8047.05357143	12.67	0.0001

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: LE
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=211.765

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	34.000	14	A
	A	32.786	14	B
	A	25.857	14	C
	B	4.143	14	D

16 ppm significant effects the development of mallard embryos

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: NH

(Sexual Hatching)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	2755.71428571	918.57142857	5.91
ERROR	52	8086.00000000	155.50000000	PR > F
CORRECTED TOTAL	55	10841.71428571		

Significant → 0.0016

Chemical Effect
Embryo development

SUM OF SQUARES	C.V.	ROOT MSE	NH MEAN
154177	88.6190	12.46996391	14.07142857

SOURCE	DF	TYPE I SS	F VALUE	PR > F
	3	2755.71428571	5.91	0.0016

SOURCE	DF	TYPE III SS	F VALUE	PR > F
	3	2755.71428571	5.91	0.0016

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: NH
 NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
 NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=52 MSE=155.5

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN	GROUPING	MEAN	N	TRT
	A	20.429	14	A
	A	18.571	14	B
	A	14.857	14	C
	B	2.429	14	D

16 ppm significant effects the number of 14 in summary

SAS

21
15157 WEDNESDAY, MARCH 16, 1983

TABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- TRT#A -----						
	14	52.14285714	18.36324566	19.00000000	91.00000000	4.90778384
	14	2.00000000	2.28708750	0.00000000	8.00000000	0.61124985
	14	46.14285714	17.07385380	17.00000000	85.00000000	4.56317937
	14	37.92857143	20.63777077	0.00000000	85.00000000	5.51567625
	14	34.00000000	20.21043143	0.00000000	82.00000000	5.40146500
	14	20.42857143	17.83132199	0.00000000	69.00000000	4.76562126
----- TRT#B -----						
	14	53.57142857	16.81443650	25.00000000	81.00000000	4.49384718
	14	2.21428571	1.62568667	0.00000000	5.00000000	0.43448304
	14	47.00000000	15.75778196	24.00000000	72.00000000	4.21144438
	14	37.00000000	16.68255653	7.00000000	67.00000000	4.45860078
	14	32.78571429	16.19201404	6.00000000	60.00000000	4.32749778
	14	18.57142857	14.84128486	1.00000000	54.00000000	3.96650022
----- TRT#C -----						
	14	42.21428571	14.45512191	18.00000000	71.00000000	3.86329383
	14	1.42857143	1.15786845	0.00000000	4.00000000	0.30945336
	14	36.78571429	13.45178611	15.00000000	62.00000000	3.59514106
	14	30.92857143	13.12932294	13.00000000	49.00000000	3.50895915
	14	25.85714286	12.34040981	8.00000000	48.00000000	3.29811325
	14	14.85714286	8.33765456	5.00000000	33.00000000	2.22833191
----- TRT#D -----						
	14	11.35714286	7.78170579	0	27.00000000	2.07974835
	14	0.64285714	0.74494634	0	2.00000000	0.19909528
	14	8.35714286	6.61707747	0	22.00000000	1.76848834
	14	7.00000000	5.85727687	0	15.00000000	1.56542309
	14	4.14285714	4.91241978	0	14.00000000	1.31289941
	14	2.42857143	3.77673619	0	12.00000000	1.00937521