6-8-90

256424,256425,256427
RECORD NO.

80803
SHAUGHNESSEY NO

REVIEW NO.

EEB REVIEW

DATE: IN 12/26/89 OUT JUN 8 1990

FILE OR REG. NO. 80803-O

PETITION OR EXP. NO.

DATE OF SUBMISSION 09/05/89

DATE RECEIVED BY EFED 12/18/89

RD REQUESTED COMPLETION DATE 01/18/90

EEB ESTIMATED COMPLETION DATE 01/18/90

RD ACTION CODE/TYPE OF REVIEW 870

TYPE PRODUCT(S) Herbicide

DATA ACCESSION NO(S) 412230-01,-02,-03

PRODUCT MANAGER, NO. Andreasen(76)

PRODUCT NAME(S) Atrazine

COMPANY NAME Ciba-Geigy

SUBMISSION PURPOSE Review Tier II phytotoxicity data

| SHAUGHNESSEY NO. | CHEMICAL | % A.I. |
|---|---|---|
| 80803 | Atrazine | 97.7 |

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 8 1990

MEMORANDUM

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

SUBJECT: Review of Terrestrial Plant Data for Atrazine

FROM: James W. Akerman, Chief
Ecological Effects Branch
Environmental Fate and Effects Division (H7507C)

TO: Jude E. Andreasen, PM 76
Reregistration Branch
Special Review and Reregistration Division (H7508C)

The Ecological Effects Branch (EEB) has completed its review of three atrazine Tier II terrestrial plant growth studies submitted by Ciba-Geigy Corporation. The following is a brief summary of the phytotoxicity data reviewed:

1. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Seed Germination Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07B. Conducted by Pan-Agricultural Laboratories, Inc., Madera, CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. MRID No. 412230-01.

**CONCLUSIONS:** This study is scientifically sound and fulfills the guideline requirement for a Tier II seed germination test. Calculated EC25 values for cucumber and oat were 0.8 and 1.8 lb ai/a, respectively. EC25 values for soybean, lettuce, carrot, tomato, cabbage, ryegrass, corn, and onion were greater than 4.0 lb ai/a. Assuming a maximum application of 4.0 lb ai/a with 2% runoff, 0.08 lb ai could be deposited on an adjoining one acre site. This EEC is below the lowest EC25 calculated and it is assumed that germination of nontarget plants will not be adversely affected from runoff. Aerial application with 5% drift falling on an adjacent 1 acre field would result in an EEC of 0.2 lb ai/a. This value is also below the EC25 for the most sensitive species tested and it is assumed that aerial application will not to be hazardous to the germination of nontarget plants.

2. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Seedling Emergence Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07C. Conducted by Pan-Agricultural Laboratories, Inc., Madera, CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. MRID No. 412230-02.

**CONCLUSIONS:** This study is scientifically sound but does not fulfill the guideline requirement for a Tier II seedling emergence test. Inconsistencies were observed in the data that prevented verification of EC25 values. Submission of satisfactory explanations for the inconsistencies listed in the EEB review may result in upgrading the study to core.

3. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Vegetative Vigor Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07A. Conducted by Pan-Agricultural Laboratories, Inc., Madera, CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. MRID No. 412230-03.

**CONCLUSIONS:** This study is scientifically sound but does not fulfill the guideline requirement for a Tier II vegetative vigor test. Inconsistencies were observed in the data that prevented verification of EC25 values. Submission of satisfactory explanations for the inconsistencies listed in the EEB review may result in upgrading the study to core.

File

MRID No. 412230-01

# DATA EVALUATION RECORD

1. **CHEMICAL:** Atrazine.
Shaughnessey No. 80803.

2. **TEST MATERIAL:** Atrazine technical: 2-chloro-4-ethylamino-6-isopropylamino-s-triazine; Sample No. FL-850612; a white powder; 97.7% active ingredient.

3. **STUDY TYPE:** Non-target plants: Seed Germination Nontarget Phytotoxicity Test. Species tested: Soybean, Lettuce, Carrot, Tomato, Cucumber, Cabbage, Oat, Ryegrass, Corn and Onion.

4. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Seed Germination Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07B. Conducted by Pan-Agricultural Laboratories, Inc., Madera, CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. EPA MRID No. 412230-01.

5. **REVIEWED BY:**

Debra S. Segal, M.S.
Associate Scientist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat for Debra S. Segal
**Date:** 1-25-90

Charles Peace
5/29/90

6. **APPROVED BY:**

Prapimpan Kosalwat, Ph.D.
Staff Toxicologist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat
**Date:** January 25, 1990

Henry T. Craven, M.S.
Supervisor, EEB/HED
USEPA

**Signature:** H. T. Craven
**Date:** 5/31/90

17 hours



4

7. **CONCLUSIONS:** This study is scientifically sound and fulfills the guideline requirements for a Tier-2 seed germination toxicity test using non-target plants. Seed germination of all test species was not affected after being treated with the equivalent of atrazine concentrations up to 4.0 lb ai/A.

   Treatment of seeds with the equivalent of atrazine concentrations up to 4.0 lb ai/A did not result in a detrimental effect on the radicle length of soybean, lettuce, carrot, tomato, cabbage, ryegrass, corn, and onion. Atrazine application rates of $\geq$0.5 and $\geq$1.0 lb ai/A significantly affected the radicle length of cucumber and oat, respectively.

   The NOEC values for cucumber and oat were 0.25 and 0.5 lb ai/A, respectively. The remaining test species had an NOEC of 4.0 lb ai/A, the highest concentration tested. The EC50 values for all plant species tested were greater than 4.0 lb ai/A.

8. **RECOMMENDATIONS:** N/A.

9. **BACKGROUND:**

10. **DISCUSSION OF INDIVIDUAL TESTS:** N/A.

11. **MATERIALS AND METHODS:**

   A. **Test Species:** Dicotyledon plants were represented by six species from six families (i.e., soybean, lettuce, carrot, tomato, cucumber, and cabbage), while monocotyledon plants were represented by four species from two families (i.e. oat, ryegrass, corn, and onion). Cultivars and seed sources were provided in the report.

   B. **Test System:** Two circles of blue blotter filter paper (87.5 mm) were placed in the bottom of a glass petri plate. The test solutions were prepared with water from a well located at the testing facility. Fifteen milliliters of the test solution were pipetted into plates for soybean, cucumber, oat, and corn. Ten milliliters were pipetted into plates for lettuce, carrot, tomato, cabbage, ryegrass, and onion. An Oxford Macro-Set Pipetter was used for distributing the test solution in each plate.

   After the test solution was absorbed into the blue blotter, ten seeds of each crop were added to the petri

plate. Petri plates were placed in plastic boxes (12.25 X 9.0 X 4.1 inches) in which the lids were sealed with parafilm to prevent moisture loss. The petri plates containing lettuce seeds were incubated in the dark at 18 ± 1°C for seven days, while the remaining test species were incubated at 25 ± 1°C.

C. **Dosage:** Treatment concentrations were 0, 0.25, 0.5, 1.0, 2.0, and 4.0 lb ai/A. A 4.0-lb ai/A application rate is equal to a 12.0-ppm solution of atrazine.

D. **Design:** Each treatment/crop combination was replicated three times (ten seeds/plate, three plates/treatment). After seven days of incubation, the seeds were removed from the petri plates and the radicle lengths were measured to the nearest millimeter. The mean radicle length was calculated for all ten seeds placed in each petri plate. Seeds were considered germinated if the radicle was ≥5 mm in length.

E. **Statistics:** All data were entered into a Lotus 1-2-3 spreadsheet. The spreadsheet calculated replicate means, treatment means, standard deviations, and analysis of variance tables. Treatment means were used to calculate the percent detrimental effect resulting from the treatment. The percent effect was calculated using the following equation:

$$\% \text{ effect} = \frac{(\text{treatment mean} - \text{control mean})}{\text{control mean}} \times 100$$

An analysis of variance table was constructed using the Lotus 1-2-3 raw data spreadsheet. A one-way analysis of variance model for data with equal subsamples was used to analyze data from the seed germination (radicle length and percent germination). Treatment mean separation was achieved using the Lotus 1-2-3 spreadsheet. The percent detrimental effect values were input into a SAS probit analysis program.

12. **REPORTED RESULTS:** According to the author, treatment of seeds with atrazine at the equivalent of 4.0 lb ai/A did not result in a significant effect ($p \leq 0.05$) on radicle length in any of the plant species tested (Tables 1-5, attached). All plant species exhibited a no-effect level at 4.0 lb ai/A.

Probit analysis, based on radicle length, was conducted on all species except cabbage and corn but showed no clear

dose-response relationship. Probit analysis of the data showed that lettuce was the least sensitive plant species to atrazine and cucumber was the most sensitive (Table 6, attached).

Treatment of seeds with atrazine at the equivalent of 4.0 lb ai/A did not result in a significant effect ($p \leq 0.05$) on percent germination in any of the plant species tested. All plant species exhibited a percent germination no-effect level at 4.0 lb ai/A (Table 7, attached). Soybean, carrot and oat were the only plant species to exhibit a percent germination dose-response relationship. The remaining plant species did not exhibit a dose-response relationship and therefore a probit analysis could not be conducted.

13. **STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES:** No conclusions were presented by the author. A quality assurance statement was included in the report, indicating that the study was conducted under Good Laboratory Practices (GLP) standards.

14. **REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS:**

A. **Test Procedure:** The test procedures were in accordance with the SEP and Subdivision J guidelines for a Tier-2 seed germination test on non-target plants except for that a germination pretest was not conducted to determine the germination potential of seeds.

B. **Statistical Analysis:** The reviewer conducted statistical analyses on selected data for both germination and radicle length using the analysis of variance with multiple comparison tests (Tukey's and Dunnett's). All printouts are attached. The results obtained were the same as those performed by the author with the exception of radicle length of cucumber and oat.

The author's analyses (Tables 3 and 4, attached) showed that none of the radicle length of cucumber and oat exposed to atrazine was significantly different from the control. However, the analyses performed by the reviewer (attached) showed that the radicle lengths of cucumber exposed to $\geq$0.5 lb ai/A atrazine and oat exposed to 1.0 and 4.0 lb ai/A atrazine were significantly lower than those of the control values. Therefore, the NOEC values of atrazine for cucumber and oat, based on radicle length, were determined to be 0.25 and 0.5 lb ai/A, respectively.

The EC25 and EC50 values for cucumber were calculated using a regression analysis (attached). The results were similar to those reported by the author.

C. **Discussion/Results:** Seed germination of all test species treated with atrazine concentration up to 4.0 lb ai/A was comparable to that of the control.

Treatment of seeds with the equivalent of atrazine concentrations up to 4.0 lb ai/A did not result in a significant effect on the radicle length of soybean, lettuce, carrot, tomato, cabbage, ryegrass, corn, and onion. Atrazine concentrations $\geq$0.5 and $\geq$1.0 lb ai/A significantly affected the radicle length of cucumber and oat, respectively. The NOEC values for cucumber and oat were 0.25 and 0.5 lb ai/A, respectively. The remaining test species had an NOEC of 4.0 lb ai/A, the highest dose tested. The EC50 values for all plant species tested were greater than 4.0 lb ai/A.

D. **Adequacy of the Study:**

(1) **Classification:** Core.

(2) **Rationale:** The study followed the approved protocol for a toxicity test on seed germination of non-target plants.

(3) **Repairability:** N/A.

15. **COMPLETION OF ONE-LINER:** N/A.

Atrazine

Page_____ is not included in this copy.

Pages 9 through 15 are not included.

The material not included contains the following type of information:

____ Identity of product inert ingredients.

____ Identity of product impurities.

____ Description of the product manufacturing process.

____ Description of quality control procedures.

____ Identity of the source of product ingredients.

____ Sales or other commercial/financial information.

____ A draft product label.

____ The product confidential statement of formula.

____ Information about a pending registration action.

✓ FIFRA registration data.

____ The document is a duplicate of page(s) _____.

____ The document is not responsive to the request.

The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

Cucumber Radicle Length

Analysis of Variance File: cucrad2 Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: RADICLE

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 180 | 104.9389 | 41.8783 |
| 1 | control | 30 | 124.3000 | 29.9864 |
| 2 | 0.25 lb ai/A | 30 | 135.2667 | 26.5848 |
| 3 | 0.5 | 29 | 100.9310 | 39.3990 |
| 4 | 1.0 | 30 | 73.6000 | 39.8156 |
| 5 | 2.0 | 30 | 118.3667 | 36.3133 |
| 6 | 4.0 | 31 | 77.9355 | 37.8135 |

---

Fmax for testing homogeneity of between subjects variances: 2.24
Number of variances= 6 df per variance= 29.

---

Analysis of Variance Dependent variable: RADICLE

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 179 | 313928.2800 | | | |
| C (CONC) | 5 | 96782.2660 | 19356.4531 | 15.510 | 0.0000 |
| Subj w Groups | 174 | 217146.0160 | 1247.9656 | | |

---

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 124.300 | 6 | 77.935 |
| 2 | 135.267 | | |
| 3 | 100.931 | | |
| 4 | 73.600 | | |
| 5 | 118.367 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 > 3 | | 0.0500 |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | | |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | 0.0100 | N.A. |
| 2 > 4 | 0.0100 | N.A. |
| 2 > 5 | | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | 0.0500 | N.A. |
| 3 < 5 | | N.A. |
| 3 > 6 | | N.A. |
| 4 < 5 | 0.0100 | N.A. |
| 4 < 6 | | N.A. |
| 5 > 6 | 0.0100 | N.A. |

NOEC = 0.25 lb ai/A

* The only possible P-values are .01, .05 or .10 (up to 0.1000).
A blank means the P-value is greater than 0.1000.

For Dunnett's test only the P-values .05 and .01 are possible

Analysis of Variance File: oatrad Date: 01-23-1990

FILTER: None - Oat Radicle Length

N's, means and standard deviations based on dependent variable: RADICLE

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 180 | 104.9944 | 41.8783 |
| 1 | control | 30 | 124.6333 | 29.7617 |
| 2 | 0.25 lb ai/A | 30 | 135.2667 | 26.5848 |
| 3 | 0.5 | 30 | 101.7667 | 38.9834 |
| 4 | 1.0 | 30 | 73.6000 | 39.8156 |
| 5 | 2.0 | 30 | 118.3667 | 36.3133 |
| 6 | 4.0 | 30 | 76.3333 | 37.3745 |

Fmax for testing homogeneity of between subjects variances: 2.24
Number of variances= 6 df per variance= 29.

Analysis of Variance Dependent variable: RADICLE

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 179 | 313928.9700 | | | |
| C (CONC) | 5 | 98951.9770 | 19790.3945 | 16.018 | 0.0000 |
| Subj w Groups | 174 | 214977.0000 | 1235.5000 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 124.633 | 6 | 76.333 |
| 2 | 135.267 | | |
| 3 | 101.767 | | |
| 4 | 73.600 | | |
| 5 | 118.367 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 > 3 | | |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | | |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | 0.0100 | N.A. |
| 2 > 4 | 0.0100 | N.A. |
| 2 > 5 | | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | 0.0500 | N.A. |
| 3 < 5 | | N.A. |
| 3 > 6 | 0.1000 | N.A. |
| 4 < 5 | 0.0100 | N.A. |
| 4 < 6 | | N.A. |
| 5 > 6 | 0.0100 | N.A. |

NOEC = 0.5 lb ai/A

* The only possible P-values are .01, .05 or .10 (up to 0.1000). A blank means the P-value is greater than 0.1000.

For Dunnett's test only the P-values .05 and .01 are possible and only for comparisons with the control mean (level 1).

Atrazine - Carrot germination

Analysis of Variance File: carrot Date: 01-08-1989

FILTER: None

N's, means and standard deviations based on dependent variable: GERM

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| | * | 18 | 74.4444 | 14.2343 |
| | 1 Control | 3 | 73.3333 | 5.7735 |
| | 2 0.25 lb ai/A | 3 | 83.3333 | 11.5470 |
| | 3 0.5 | 3 | 80.0000 | 26.4575 |
| | 4 1.0 | 3 | 66.6667 | 15.2753 |
| | 5 2.0 | 3 | 70.0000 | 10.0000 |
| | 6 4.0 | 3 | 73.3333 | 15.2753 |

Fmax for testing homogeneity of between subjects variances: 21.00
Number of variances= 6 df per variance= 2.

Analysis of Variance Dependent variable: GERM

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 17 | 3444.4443 | | | |
| C (CONC) | 5 | 577.7778 | 115.5556 | 0.484 | 0.7837 |
| Subj w Groups | 12 | 2866.6665 | 238.8889 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 73.333 | 6 | 73.333 |
| 2 | 83.333 | | |
| 3 | 80.000 | | |
| 4 | 66.667 | | |
| 5 | 70.000 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 < 3 | | |
| 1 > 4 | | |
| 1 > 5 | | |
| 1 = 6 | | |
| 2 > 3 | N.A. | |
| 2 > 4 | N.A. | |
| 2 > 5 | N.A. | |
| 2 > 6 | N.A. | |
| 3 > 4 | N.A. | |
| 3 > 5 | N.A. | |
| 3 > 6 | N.A. | |
| 4 < 5 | N.A. | |
| 4 < 6 | N.A. | |
| 5 < 6 | N.A. | |

NOEC = 4.0

* The only possible P-values are .01, .05 or .10 (up to 0.0500).
A blank means the P-value is greater than 0.0500.

For Dunnett's test only the P-values .05 and .01 are possible and only for comparisons with the control mean (level 1).

Radicle length
Cucumber

REGRESSION EQUATION:
Y= 4.408 + .8338872 X

COEFFICIENT OF CORRELATION= .9247767

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -.602 | 4.01 | 3.906 | .1040003 |
| 2 | -.301 | 4.19 | 4.157 | 3.299999E-02 |
| 3 | 0 | 4.12 | 4.408 | -.2880001 |
| 4 | .301 | 4.72 | 4.659 | 6.099987E-02 |
| 5 | .602 | 5 | 4.91 | 9.000015E-02 |

EC 50 = 5.128 lb ai/A

EC 25 = 0.806 lb ai/A

lewis atrazine seed germination carrot

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB.(PERCENT) |
|---|---|---|---|---|
| 4 | 100 | 0 | 0 | 0 |
| 2 | 100 | 8 | 8 | 0 |
| 1 | 100 | 8 | 8 | 0 |
| .5 | 100 | 0 | 0 | 0 |
| .25 | 100 | 0 | 0 | 0 |

BECAUSE THE NUMBER OF ORGANISMS USED WAS SO LARGE, THE 95 PERCENT CONFIDENCE INTERVALS CALCULATED FROM THE BINOMIAL PROBABILITY ARE UNRELIABLE. USE THE INTERVALS CALCULATED BY THE OTHER TESTS.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 0

THE MOVING AVERAGE METHOD CANNOT BE USED WITH THIS DATA SET BECAUSE NO SPAN WHICH PRODUCES MOVING AVERAGE ANGLES THAT BRACKET 45 DEGREES ALSO USES TWO PERCENT DEAD BETWEEN 0 AND 100 PERCENT.

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 5 | 29.27537 | 7.434649 | 0 |

A PROBABILITY OF 0 MEANS THAT IT IS LESS THAN 0.001.

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

SLOPE = .4318586
95 PERCENT CONFIDENCE LIMITS =-1.904787 AND 2.768504

LC50 = 22883.51
95 PERCENT CONFIDENCE LIMITS = 4.60946 AND +INFINITY

LC10 = 26.22677
95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

lewis atrazine seed germination [redacted]

**********

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 4 | 100 | 50 | 50 | 0 |
| 2 | 100 | 39 | 39 | 0 |
| 1 | 100 | 19 | 19 | 0 |
| .5 | 100 | 21 | 21 | 0 |
| .25 | 100 | 16 | 16 | 0 |

THE BINOMIAL TEST SHOWS THAT 4 AND 4 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 4

RESULTS CALCULATED USING THE MOVING AVERAGE METHOD

| SPAN | G | LC50 | 95 PERCENT CONFIDENCE LIMITS | |
|---|---|---|---|---|
| 1 | 1.585396 | 4 | 2.528628 | +INFINITY |

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 3 | .1110815 | 1 | .1717395 |

[redacted]

95 PERCENT CONFIDENCE LIMITS = .575819 AND 1.151523

[redacted]

95 PERCENT CONFIDENCE LIMITS = 3.063653 AND 10.81023

[redacted]

95 PERCENT CONFIDENCE LIMITS = 5.672428E-02 AND .2869879

**********

lewis atrazine seed germination [redacted]

**********

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 4 | 100 | 39 | 39 | 0 |
| 2 | 100 | 5 | 5 | 0 |
| 1 | 100 | 40 | 40 | 0 |
| .5 | 100 | 18 | 18 | 0 |
| .25 | 100 | 0 | 0 | 0 |

THE BINOMIAL TEST SHOWS THAT 4 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 4

THE MOVING AVERAGE METHOD CANNOT BE USED WITH THIS DATA SET
BECAUSE NO SPAN WHICH PRODUCES MOVING AVERAGE ANGLES THAT
BRACKET 45 DEGREES ALSO USES TWO PERCENT DEAD BETWEEN 0 AND
100 PERCENT.

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 5 | 7.968501 | 21.539 | 0 |

A PROBABILITY OF 0 MEANS THAT IT IS LESS THAN 0.001.

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

[redacted] 95 PERCENT CONFIDENCE LIMITS =-1.520119 AND 3.187964

[redacted] 95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

[redacted] 95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

**********

lewis atrazine seed germination ryegrass

**********

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 4 | 100 | 7 | 7 | 0 |
| 2 | 100 | 7 | 7 | 0 |
| 1 | 100 | 5 | 5 | 0 |
| .5 | 100 | 0 | 0 | 0 |
| .25 | 100 | 0 | 0 | 0 |

THE BINOMIAL TEST SHOWS THAT 4 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 4

THE MOVING AVERAGE METHOD CANNOT BE USED WITH THIS DATA SET BECAUSE NO SPAN WHICH PRODUCES MOVING AVERAGE ANGLES THAT BRACKET 45 DEGREES ALSO USES TWO PERCENT DEAD BETWEEN 0 AND 100 PERCENT.

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 4 | .3271579 | 1 | .1470054 |

SLOPE = 1.051475

95 PERCENT CONFIDENCE LIMITS = .4500551 AND 1.652894

LC50 = 70.27767

95 PERCENT CONFIDENCE LIMITS = 17.70273 AND 9654.451

LC10 = 4.355016

95 PERCENT CONFIDENCE LIMITS = 2.610268 AND 16.82121

22

**********

lewis atrazine seed germination corn

**********

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 4 | 100 | 11 | 11 | 0 |
| 2 | 100 | 0 | 0 | 0 |
| 1 | 100 | 8 | 8 | 0 |
| .5 | 100 | 13 | 13 | 0 |
| .25 | 100 | 19 | 19 | 0 |

THE BINOMIAL TEST SHOWS THAT 4 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 4

THE MOVING AVERAGE METHOD CANNOT BE USED WITH THIS DATA SET BECAUSE NO SPAN WHICH PRODUCES MOVING AVERAGE ANGLES THAT BRACKET 45 DEGREES ALSO USES TWO PERCENT DEAD BETWEEN 0 AND 100 PERCENT.

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 4 | 6.264705 | 5.111174 | 1.552522E-03 |

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

SLOPE = -.5344673

95 PERCENT CONFIDENCE LIMITS =-1.872206 AND .8032718

LC50 = 3.650692E-03

95 PERCENT CONFIDENCE LIMITS = 0 AND .2145117

LC10 = .8681074

95 PERCENT CONFIDENCE LIMITS = 0 AND +INFINITY

**********

F.2

MRID No. 412230-02

# DATA EVALUATION RECORD

1. **CHEMICAL:** Atrazine.
Shaughnessy No. 80803.

2. **TEST MATERIAL:** Atrazine: 2-chloro-4-ethylamino-6-isopropylamino-s-triazine; Sample No. FL-850612; a white powder; 97.7% active ingredient.

3. **STUDY TYPE:** Tier 2 Seedling Emergence Nontarget Test. Species Tested: Soybean, Lettuce, Carrot, Tomato, Cucumber, Cabbage, Oat, Ryegrass, Corn, and Onion.

4. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Seedling Emergence Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07C. Conducted by Pan Agricultural Laboratories, Inc., Madera CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. MRID No. 412230-02.

5. **REVIEWED BY:**

Debra S. Segal, M.S.
Associate Scientist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat for Debra S. Segal
**Date:** 1-25-90

Charles Lim
5/29/90

6. **APPROVED BY:**

Prapimpan Kosalwat, Ph.D.
Staff Toxicologist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat
**Date:** January 25, 1990

Henry T. Craven, M.S.
Supervisor, EEB/HED
USEPA

**Signature:** Henry T. Craven
**Date:** 5/31/90



17 pages

7. **CONCLUSIONS:** The study was conducted in a scientifically sound manner. However, inconsistencies were observed among data obtained from tests conducted at different time for the same species and same parameters. Disagreement exists between the summarized NOEC values and results from statistical analyses for some species. It was unclear as to which set of treatments was used to calculate the EC25 and EC50 values. This study does not fulfill the guideline requirements for a Tier-2 seedling emergence toxicity test using non-target plants.

   The NOEC values of atrazine for all species except corn were ≤0.025 lb ai/A. The EC25 and EC50 values for all species except corn were ≤0.8 lb ai/A. Corn was the least sensitive species to atrazine with an NOEC of 4.0 lb ai/A, the highest concentration tested.

8. **RECOMMENDATIONS:** N/A.

9. **BACKGROUND:**

10. **DISCUSSION OF INDIVIDUAL TESTS:** N/A.

11. **MATERIALS AND METHODS:**

   A. **Test Plants:** Dicotyledon plants are represented by soybean, lettuce, carrot, tomato, cucumber, and cabbage. Monocotyledon plants are represented by corn, oat, ryegrass, and onion. Cultivars, lot number, and germination ratings are provided in the report.

   B. **Test System:** Seeds of each crop were planted in plastic pots (7.5 x 7.5 x 6.0 cm) filled with sterilized soil obtained from the laboratory facility. A plexiglass template was used to create planting holes in the soil, thus allowing for uniform planting depth and seed distribution. An analysis of the soil was provided in the report.

      Soybean and corn were planted at a depth of 2.5 cm, while the remaining eight species were planted at a depth of 1.3 cm. A belt sprayer was used with a nozzle height of 12 inches and a nozzle pressure of 50 psi. The test spray solutions were prepared by dissolving atrazine technical in acetone and water. The plants were sprayed at the equivalent of 468 l/ha (50 gpa) of water.

C. **Dosage:** Atrazine was applied at the rates of 0, 0.25, 0.5, 1.0, 2.0, and 4.0 lb ai/A in Test 1 using all crops. In Test 2, atrazine was applied at rates of 0, 0.025, 0.05, 0.1, 0.2, and 0.4 lb ai/A on all crops except corn. In Test 3, all crops except soybean and corn were treated with 0, 0.0025, 0.005, 0.01, 0.02, and 0.04 lb ai/A. Treatment application rates were adjusted for the percent purity of the test material (97.7%).

D. **Design:** Each crop/treatment combination was replicated three times (10 seeds/pot, 3 pots/treatment level). The percentage of the ten seeds planted in each pot which emerged was calculated for each treatment. After treatment, the pots were randomized within crops and among treatments and placed in an on-site greenhouse.

Seedling height and phytotoxicity ratings were recorded at 7, 14, and 21 days after treatment. Twenty-one days after treatment, the plants within treatment replicates (pots) were cut at the soil level and dried in a pre-weighed paper bag at 70°C for a minimum of 48 hours. After drying, the dry weight of the plant material was recorded.

The phytotoxicity ratings evaluated five observable toxic effects: 0-indicates no effect; 1-indicates slight plant effect; 2-indicates a moderate effect, e.g., mild stunting or chlorosis; 3-indicates a severe effect; and 4-indicates a total effect or plant death.

Temperature, relative humidity, photoperiod, and illuminance during the period of growth are provided in the report. The study was terminated 21 days after treatment for all species except lettuce and carrot, which was terminated after 28 days.

E. **Statistics:** Percent detrimental effect was calculated using the following equation:

$$\% \text{ effect} = \frac{(\text{treatment mean} - \text{control mean})}{\text{control mean}} \times 100$$

A one-way analysis of variance model for data with equal subsamples was used to analyze data from the percent seedling emergence portions of the study. A one-way analysis of variance model for data with unequal subsamples was used to analyze the seedling height data. Treatment mean separation was achieved

using either SAS or the Lotus 1-2-3 spreadsheet. The percent detrimental effect values were input into a SAS probit analysis procedure to calculate EC values.

12. **REPORTED RESULTS:** Table A (attached) lists the NOEC, EC25, and EC50, along with the parameters in which these concentrations were observed. Detailed results for each specific parameter are described below.

Phytotoxicity rating. With the exception of ryegrass and corn, all plant species tested demonstrated a significant effect on 21-day phytotoxicity ratings following treatment with atrazine technical at 4.0 lb. ai/A. The author stated that ryegrass and corn were the least sensitive to atrazine, while lettuce was the most sensitive plant species.

At the 14-day observation period, there was a significant difference in the mean phytotoxicity rating of oat at a concentration of 0.04 lb ai/A. However, at the 21-day observation period, all plants in one of the three replications produced new growth. Statistical analysis, therefore, showed that phytotoxicity rating of oat at 0.04 lb ai/A at the 21-day observation period was not significant. All plant species except corn required a study continuation to determine a phytotoxicity rating no-effect level. Crops listed in order of increasing sensivity to atrazine, based on 21-day phytotoxicity rating NOEC values, are as follows:

corn < tomato = oat < soybean = carrot < cabbage < cucumber = onion < lettuce = ryegrass.

Percent seedling emergence. Treatment of the test plant species with the initial range (0.25 to 4.0 lb ai/A) resulted in the death and decomposition of many of the emerged seedlings by the 21-day observation period. Lettuce, carrot, tomato, cucumber, cabbage, and onion exhibited the greatest mortality rate. Plant death generally occurred after the seedlings had emerged between the 14- and 21-day observation periods.

Treatment of all plant species with the maximum concentration of 4.0 lb ai/A did not result in a significant difference in percent emergence at the 14- and 21-day observation period. Lettuce emerged slowly due to the warm temperature. Although there was a big difference in percent emergence between the control and the five treatments in lettuce, the results were not significant due to variability between treatments.

Since soybean, tomato, cucumber, cabbage, corn, and onion showed no dose-response relationship, the EC50 values could not be determined for these plant species. Crops listed in order of increasing sensitivity to atrazine, based on EC50 values, are as follows:

ryegrass < oat < carrot < lettuce.

Plant height. Treatment with atrazine at the lowest concentration of 0.25 lb ai/A (Test 1) resulted in a significant effect ($p < 0.05$) on plant height of all species except corn. Lettuce, carrot, tomato, cucumber, cabbage, and onion were decomposed by day 21. Lettuce, oat, and ryegrass were the most sensitive species tested while corn was the least sensitive, based on no-effect concentrations (Table 43, attached). All plants species except corn required a study continuation to determine a plant height no-effect level. Crops listed in order of increasing sensitivity to atrazine, based on plant height NOEC values, are as follows:

corn < tomato < soybean = cucumber < cabbage < carrot = onion < lettuce = oat = ryegrass.

Since corn showed no dose-response relationship, its EC50 value could not be calculated. Crops listed in order of increasing sensitivity to atrazine, based on plant height EC50 values, are as follows:

cabbage < soybean < cucumber < tomato < ryegrass < onion < carrot < cabbage < lettuce.

Plant dry weight. Treatment of the test plant species with the maximum concentration of 4.0 ai/A did not have a significant effect ($p < 0.05$) on dry weight of lettuce, carrot, corn, and onion. Results of dry weight no-effect data showed that lettuce, carrot, corn, and onion were the plant species least sensitive to atrazine while oat was the most sensitive (Table 44, attached).

Although the mean dry weight of carrot, tomato, and onion showed a decrease of more than 25% in dry weight at various concentrations, the results were not significant because of variability in individual plant dry weight between treatments. Crops listed in order of increasing sensitivity to atrazine, based on dry weight NOEC values, are as follows:

lettuce = carrot = corn = onion < tomato < soybean < cabbage < cucumber = ryegrass < oat.

Since lettuce, carrot, oat, ryegrass, corn, and onion showed no dose-response relationship, their EC50 values could not be calculated. Crops listed in order of increasing sensitivity to atrazine, based on dry weight EC50 values, are as follows:

soybean < tomato < cucumber < cabbage.

13. **STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES:** No conclusions were presented by the study author. The study was inspected by the Quality Assurance Unit of Pan-Agricultural Labs, Inc. on several occasions to assure compliance with Good Laboratory Practice (GLP) Standards.

14. **REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS:**

A. **Test Procedure:** The test procedures followed the SEP and Subdivision J guidelines. However, the following discrepancies were found in the report:

o Discrepancies were found between Table 44 and Tables 32, 34, and 40 (all are attached). According to Tables 32, 34, and 40, the NOEC values for lettuce, tomato, and onion based on dry weight, were determined to be 0.005, <0.25, and 0.02 lb ai/A, respectively. However, Table 44 presents 4.0 lb ai/A as the NOEC value for these species.

o The result and summary sections in the report stated that, for phytotoxicity rating, ryegrass was one of the least sensitive species to atrazine, whereas Table 41 (attached) showed that ryegrass is among the most sensitive species with an NOEC of 0.005 lb ai/A.

o Table 44 (attached) states that a dose-response curve did not occur for oat based on dry weight, however, the third set of data in Table 37 (attached) suggests otherwise.

o The NOEC value for tomato was reported as 0.04 lb ai/A in Tables 41 and 43 (attached), based on phytotoxicity rating and height, and as 4.0 lb ai/A in Table 44 (attached), based on dry weight. The NOEC values were <0.025 lb ai/A when determined from Tables 4 and 24 (attached) and <0.25 lb ai/A when determined from Table 34 (attached).

o The NOEC value for oat, based on phytotoxicity rating, was reported as 0.04 lb ai/A in Table 41 (attached). However, the value determined from Table 7 (attached) was <0.025 lb ai/A.

o The NOEC value for carrot, based on phytotoxicity rating, was 0.025 lb ai/A in Table 41 (attached). However, it was shown to be 0.01 lb ai/A in Table 3 (attached), when determined from day-21 data in Test 3.

o The NOEC value for ryegrass, based on height, was reported as 0.005 lb ai/A in Table 43 (attached). However, the value determined from Table 28 (attached) was 0.0025 lb ai/A.

o The NOEC value for cucumber, based on height, was reported as 0.025 lb ai/A in Table 43 (attached). However, the value determined from Table 25 (attached) was 0.02 lb ai/A.

B. **Statistical Analysis:** Statistically analyses were conducted on selected data by the reviewer (attached) using the analysis of variance with multiple comparison tests (Tukey's and Dunnett's). The results were in general agreement with those presented by the author.

The EC25 and EC50 for selected species were calculated by the reviewer using a regression analysis (attached). It was unclear, however, which of the three possible tests the author used to calculate EC25 and EC50, and therefore, these values were difficult for the reviewer to verify.

C. **Discussion/Results:** Inconsistencies were observed among data obtained from tests conducted at different time (i.e., Tests 1-3) for the same species and same parameters. For example, a complete inhibition in growth (measured as dry weight) was observed in lettuce exposed to 0.02 and 0.04 lb ai/A in Test 3, while stimulation in growth was found in lettuce exposed to 4.0 lb ai/A in Test 1 (Table 32, attached). These inconsistencies make all test results doubtful.

Conclusions for NOEC, EC25, and EC50 were often based on results of the first test (which used the highest range of treatment concentrations) even though lower treatment concentrations in subsequent tests produced significant results. A more conservative approach of

data interpretation should have been made by basing the results on the third test rather on the first test.

Table A (attached) summarizes the NOEC, EC25, and EC50 values for all test species. The corrections were made by the reviewer in ink.

D. **Adequacy of the Study:**

(1) **Classification:** Supplemental

(2) **Rationale:** Inconsistencies were observed among tests conducted at different time using the same species and same parameters. Also, the EC values were difficult to verify due to the inconsistencies of which set of treatments the author analyzed.

(3) **Repairability:** Pending satisfactory explanations on the stated inadequacies in Sections 14.A and 14.C.

15. **COMPLETION OF ONE-LINER:** N/A

Atrazine

Page_____ is not included in this copy.

Pages 32 through 46 are not included.

The material not included contains the following type of information:

_____ Identity of product inert ingredients.

_____ Identity of product impurities.

_____ Description of the product manufacturing process.

_____ Description of quality control procedures.

_____ Identity of the source of product ingredients.

_____ Sales or other commercial/financial information.

_____ A draft product label.

_____ The product confidential statement of formula.

_____ Information about a pending registration action.

✓ FIFRA registration data.

_____ The document is a duplicate of page(s) _____.

_____ The document is not responsive to the request.

The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

Soybean Height

Analysis of Variance File: soyht Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| | * | 160 | 129.0188 | 57.4060 |
| | 1 Control | 29 | 189.2414 | 40.4569 |
| | 2 0.025 lb a/A | 24 | 194.4583 | 23.1028 |
| | 3 0.05 | 28 | 131.0357 | 48.3402 |
| | 4 0.1 | 26 | 103.1538 | 29.5590 |
| | 5 0.2 | 28 | 80.0714 | 20.9336 |
| | 6 0.4 | 25 | 75.8000 | 15.4839 |

Fmax for testing homogeneity of between subjects variances: 9.75
Number of variances= 6 df per variance= 26.

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 159 | 523976.8800 | | | |
| C (CONC) | 5 | 363349.4700 | 72669.8910 | 69.672 | 0.0000 |
| Subj w Groups | 154 | 160627.4060 | 1043.0352 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 189.241 | 6 | 75.800 |
| 2 | 194.458 | | |
| 3 | 131.036 | | |
| 4 | 103.154 | | |
| 5 | 80.071 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 > 3 | 0.0100 | 0.0100 |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | 0.0100 | 0.0100 |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | 0.0100 | N.A. |
| 2 > 4 | 0.0100 | N.A. |
| 2 > 5 | 0.0100 | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | 0.0500 | N.A. |
| 3 > 5 | 0.0100 | N.A. |
| 3 > 6 | 0.0100 | N.A. |
| 4 > 5 | | N.A. |
| 4 > 6 | 0.0500 | N.A. |

NOEL = 0.025

Lettuce Height

Analysis of Variance File: letht Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | N | Mean | S.D. |
|---|---|---|---|
| * | 155 | 36.3935 | 29.2021 |
| 1 | 28 | 60.3929 | 15.5190 |
| 2 | 29 | 60.7931 | 8.9856 |
| 3 | 26 | 59.0385 | 14.4457 |
| 4 | 24 | 22.6667 | 17.2164 |
| 5 | 25 | 4.3200 | 11.3641 |
| 6 | 23 | 0.0000 | 0.0000 |

Fmax for testing homogeneity of between subjects variances: Not defined

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 154 | 131325.0000 | | | |
| C (CONC) | 5 | 107427.8280 | 21485.5664 | 133.964 | 0.0000 |
| Subj w Groups | 149 | 23897.1719 | 160.3837 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 60.393 | 6 | 0.000 |
| 2 | 60.793 | | |
| 3 | 59.038 | | |
| 4 | 22.667 | | |
| 5 | 4.320 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 > 3 | | |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | 0.0100 | 0.0100 |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | | N.A. |
| 2 > 4 | 0.0100 | N.A. |
| 2 > 5 | 0.0100 | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | 0.0100 | N.A. |
| 3 > 5 | 0.0100 | N.A. |
| 3 > 6 | 0.0100 | N.A. |
| 4 > 5 | 0.0100 | N.A. |
| 4 > 6 | 0.0100 | N.A. |
| 5 > 6 | | N.A. |

Tomatoe - Height

Analysis of Variance File: TOMHT Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | N | Mean | S.D. |
|---|---|---|---|
| * | 160 | 27.7375 | 40.1882 |
| 1 control | 24 | 105.1250 | 10.3685 |
| 2 0.025 lb ai/A | 27 | 53.2963 | 29.8532 |
| 3 0.05 | 26 | 4.6538 | 10.5145 |
| 4 0.1 | 30 | 6.8333 | 12.6275 |
| 5 0.2 | 23 | 1.3913 | 4.7648 |
| 6 0.4 | 30 | 3.9333 | 8.2417 |

Fmax for testing homogeneity of between subjects variances: 39.25
Number of variances= 6 df per variance= 25.

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 159 | 256798.9840 | | | |
| C (CONC) | 5 | 221297.3280 | 44259.4650 | 191.990 | 0.0000 |
| Subj w Groups | 154 | 35501.6560 | 230.5302 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 105.125 | 6 | 3.933 |
| 2 | 53.296 | | |
| 3 | 4.654 | | |
| 4 | 6.833 | | |
| 5 | 1.391 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 > 2 | 0.0100 | 0.0100 |
| 1 > 3 | 0.0100 | 0.0100 |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | 0.0100 | 0.0100 |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | 0.0100 | N.A. |
| 2 > 4 | 0.0100 | N.A. |
| 2 > 5 | 0.0100 | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 < 4 | | N.A. |
| 3 > 5 | | N.A. |
| 3 > 6 | | N.A. |
| 4 > 5 | | N.A. |
| 4 > 6 | | N.A. |

NOEC < 0.025

## Soybean height - Test 2

REGRESSION EQUATION:
Y= 9.140018 + 5.794018 X

COEFFICIENT OF CORRELATION= .7602876

ACTUAL VERSUS ESTIMATED VALUES
X=LOGCONC Y=PROBIT

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -1.602 | -3.12 | -.1419992 | -2.978001 |
| 2 | -1.301 | 4.5 | 1.602 | 2.898 |
| 3 | -1 | 4.9 | 3.346 | 1.554 |
| 4 | -.699 | 5.2 | 5.089999 | .1100006 |
| 5 | -.398 | 5.25 | 6.833999 | -1.583999 |

EC 50 = 0.193 lb ai/A
EC 25 = 0.143 lb ai/A

---

## Oat height - Test3

REGRESSION EQUATION:
Y= 7.334891 + 1.664446 X

COEFFICIENT OF CORRELATION= .9967216

ACTUAL VERSUS ESTIMATED VALUES
X=LOGCONC Y=PROBIT

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.602 | 2.95 | 3.004003 | -.054003 |
| 2 | -2.301 | 3.59 | 3.505001 | 8.499885E-02 |
| 3 | -2 | 3.96 | 4.006 | -4.599953E-02 |
| 4 | -1.699 | 4.56 | 4.506998 | 5.300236E-02 |
| 5 | -1.398 | 4.97 | 5.007996 | -3.799582E-02 |

EC50 = 0.04 lb ai/A
EC25 = 0.016 lb ai/A

## Ryegrass Height

Test3

REGRESSION EQUATION:
Y= 11.10134 + 3.996669 X

COEFFICIENT OF CORRELATION= .5045455

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.602 | 4.01 | .7020063 | 3.307994 |
| 2 | -2.301 | -3.52 | 1.905003 | -5.425003 |
| 3 | -2 | 4.16 | 3.108001 | 1.051999 |
| 4 | -1.699 | 5.25 | 4.310998 | .939002 |
| 5 | -1.398 | 5.64 | 5.513995 | .1260047 |

$EC_{50}$ = 0.03 lb ai/A

$EC_{25}$ = 0.02 lb ai/A

---

## Soybean dry weight

Test2

REGRESSION EQUATION:
Y= 6.779509 + 1.747509 X

COEFFICIENT OF CORRELATION= .8814684

ACTUAL VERSUS ESTIMATED VALUES
X=LOGCONC Y=PROBIT

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -1.602 | 3.45 | 3.979999 | -.5299988 |
| 2 | -1.301 | 4.87 | 4.506 | .3640003 |
| 3 | -1 | 5.52 | 5.032 | .4880004 |
| 4 | -.699 | 5.61 | 5.558 | 5.200005E-02 |
| 5 | -.398 | 5.71 | 6.084 | -.3740001 |

$EC_{50}$ = 0.096 lb ai/A

$EC_{25}$ = 0.04 lb ai/A

## Tomato dry weight

REGRESSION EQUATION:
Y= 6.77475 + 1.385374 X

COEFFICIENT OF CORRELATION= .932774

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.301 | 3.66 | 3.587004 | 7.299662E-02 |
| 2 | -2 | 3.77 | 4.004002 | -.2340016 |
| 3 | -1.699 | 4.67 | 4.420999 | .249001 |
| 4 | -1.398 | 4.75 | 4.837997 | -8.799648E-02 |

$EC_{50}$ = 0.052 lb ai/A
$EC_{25}$ = 0.017 lb ai/A

---

## Oat dry weight

REGRESSION EQUATION:
Y= 9.585419 + 2.285709 X

COEFFICIENT OF CORRELATION= .9781082

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.602 | 3.36 | 3.638003 | -.278003 |
| 2 | -2.301 | 4.53 | 4.326001 | .203999 |
| 3 | -2 | 5.23 | 5.014 | .2160001 |
| 4 | -1.699 | 5.77 | 5.701999 | 6.800127E-02 |
| 5 | -1.398 | 6.18 | 6.389997 | -.2099972 |

$EC_{50}$ = 0.01 lb ai/A
$EC_{25}$ = 0.005 lb ai/A

File

MRID No. 412230-03

# DATA EVALUATION RECORD

1. **CHEMICAL:** Atrazine.
Shaughnessy No. 80803.

2. **TEST MATERIAL:** Atrazine: 2-chloro-4-ethylamino-6-isopropylamino-s-triazine; Sample No. FL-850612; a white powder; 97.7% active ingredient.

3. **STUDY TYPE:** Vegetative Vigor Nontarget Phytotoxicity Test - Tier 2. Species Tested: Soybean, Lettuce, Carrot, Tomato, Cucumber, Cabbage, Oat, Ryegrass, Corn, and Onion.

4. **CITATION:** Chetram, R.S. 1989. Atrazine: Tier 2 Vegetative Vigor Nontarget Phytotoxicity Test. Laboratory Study No. LR 89-07A. Conducted by Pan-Agricultural Laboratories, Inc., Madera, CA. Submitted by Ciba-Geigy Corporation, Greensboro, NC. MRID No. 412230-03.

5. **REVIEWED By:**

Debra S. Segal, M.S.
Associate Scientist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat for Debra S. Segal
**Date:** 1-25-90

Charles Lewis
5/29/90

6. **APPROVED BY:**

Prapimpan Kosalwat, Ph.D.
Staff Toxicologist
KBN Engineering and
Applied Sciences, Inc.

**Signature:** P. Kosalwat
**Date:** January 25, 1990

Henry T. Craven, M.S.
Supervisor, EEB/HED
USEPA

**Signature:** Henry T. Craven
**Date:** 5/31/90

17 hours



53

7. **CONCLUSIONS:** The study was conducted in a scientifically sound manner. However, inconsistencies were observed among tests conducted at different time using the same species and same parameters. Disagreement exists between the summarized NOEC values and results from statistical analyses for some species. It was unclear as to which set of treatments was used to calculate the EC25 and EC50 values. This study does not fulfill the guideline requirements for a Tier-2 vegetative vigor phytotoxicity test using non-target plants.

   The NOEC values for soybean, lettuce, carrot, tomato, cucumber, cabbage, and onion were ≤0.5 lb ai/A atrazine. The NOEC for Oat and ryegrass was 2.0 lb ai/A, while the value for corn was 4.0 lb ai/A, the highest concentration tested. The EC25 and EC50 values for soybean, lettuce, tomato, cucumber, cabbage, and onion were ≤1.4 lb ai/A, while the value for oat was 3.8 lb ai/A. The EC25 and EC50 for carrot, ryegrass, and corn were >4.0 lb ai/A, the highest concentration tested.

8. **RECOMMENDATIONS:** N/A.

9. **BACKGROUND:**

10. **DISCUSSION OF INDIVIDUAL TESTS:** N/A.

11. **MATERIALS AND METHODS:**

   A. **Test Plants:** Dicotyledon plants are represented by soybean, lettuce, carrot, tomato, cucumber, and cabbage. Monocotyledon plants are represented by corn, oats, ryegrass, and onion. Cultivars, lot number, source, and germination ratings were provided in the report.

   B. **Test System:** Seeds of each crop were planted in plastic pots (7.5 x 7.5 x 6.0 cm) filled with Supersoil, a pasteurized potting soil comprised of fir bark, redwood, Canadian peat, and sand. An analysis of the soil was provided in the report. A plexiglass template was used to create planting holes in the soil, thus allowing for uniform planting depth and seed distribution.

      Soybean and corn were planted at a depth of 2.5 cm, while the remaining eight species were planted at a depth of 1.3 cm. After planting, the pots were placed in an on-site greenhouse and allowed to grow to the appropriate stage of growth (1-3 true leaves). Prior

to treatment, each pot was thinned to five plants of uniform height and stage of growth. Throughout the study, the plants were fertilized weekly with a fertilizer (20-20-20, N-P-K) at a rate of 1.0 tsp/gal.

A belt sprayer was used to apply the treatment with a nozzle height of 12 inches and a nozzle pressure of 50 psi. The test spray solutions were prepared by dissolving atrazine technical in acetone and water. The photoperiod, temperature, and relative humidity monitored during the tests were included in the report.

C. **Dosage:** Atrazine was applied at the rates of 0, 0.25, 0.5, 1.0, 2.0, and 4.0 lb ai/A in Test 1, using all crops. Two months later, atrazine was applied at rates of 0, 0.025, 0.05, 0.1, 0.2, and 0.4 lb ai/A to soybean, cucumber and cabbage (Test 2). In Test 3 (five weeks later), cucumber and cabbage were treated with 0, 0.0025, 0.005, 0.01, 0.02, and 0.04 lb ai/A. Treatment application rates were adjusted for the percent purity of the test material (97.7%).

D. **Design:** Each crop/treatment combination was replicated three times (10 seeds/pot, 3 pots/treatment level). After treatment, the pots were randomized within crops and among treatments and placed in the greenhouse. Seedling height was recorded prior to treatment and 21 days after treatment. Phytotoxicity ratings were recorded at 7, 14, and 21 days after treatment. Twenty-one days after treatment, the plants within treatment replicates (pots) were cut at the soil level and dried in a pre-weighed paper bag at 70°C for a minimum of 48 hours. After drying, the dry weight of the plant material was recorded.

Plant height was measured by extending the seedling to its maximum height and recording the height to the nearest millimeter. The mean plant height was calculated for each treatment. The phytotoxicity ratings evaluated five observable toxic effects: 0-indicates no effect; 1-indicates slight plant effect; 2-indicates a moderate effect, e.g., mild stunting or chlorosis; 3-indicates a severe effect; and 4-indicates a total effect or plant death.

E. **Statistics:** Percent detrimental effect was calculated using the following equation:

$$\% \text{ effect} = \frac{\text{treatment mean - control mean}}{\text{control mean}} \times 100$$

The percent increase in height from day-0 reading was calculated using the following equation:

$$\% \text{ increase} = \frac{(\text{day-21 mean}) - (\text{day-0 mean})}{\text{day-0 mean}} \times 100$$

The percent effect on growth was calculated for each treatment using the following equation:

$$\% \text{ effect} = \frac{(\text{treatment \% increase} - \text{control \% increase})}{\text{control \% increase}} \times 100$$

A one-way analysis of variance model for data with equal subsamples was used to analyze the data. The percent detrimental effect on each replicate mean was input into a SAS probit analysis procedure to calculate EC values.

12. **REPORTED RESULTS:** Table A (attached) lists the NOEC, EC25, and EC50 values, along with the parameters in which these concentrations were observed. Detailed results for each specific parameter are described below.

Phytotoxicity rating. Table 31 (attached) summarizes the NOEC values of atrazine for mean phytotoxicity rating. Treatment of all plant species with atrazine at concentrations ≥1.0 lb ai/A resulted in a significant increase ($p < 0.05$) in the day-21 mean phytotoxicity rating of soybean, lettuce, carrot, tomato, cucumber and cabbage. At 4.0 lb ai/A, all plant species except corn exhibited a significant increase in phytotoxicity rating ($p < 0.05$) at test termination (day 21). Plant species listed (with NOEC, lb ai/A) in order of increasing sensitivity to atrazine, based on phytotoxicity rating NOEC values, are as follows:

corn (4.0) < oat = ryegrass = onion (2.0) < soybean = tomato (1.0) < lettuce = carrot = cabbage (0.5) < cucumber (0.025).

Plant height. Table 32 (attached) summarizes the NOEC, EC25 and EC50 of atrazine for plant height. Treatment with atrazine at rates ≥0.5 lb ai/A resulted in a significant effect ($p < 0.05$) on plant height of soybean, lettuce, tomato, cucumber, and cabbage at test termination (day 21). At 4.0 lb ai/A, plant height of all crops except ryegrass and corn was significantly affected ($p < 0.05$) by day 21. Plant species listed (with NOEC, lb ai/A) in order of increasing sensitivity to atrazine, based on plant height NOEC values, are as follows:

ryegrass = corn (4.0) < carrot = oat (2.0) < onion (1.0) < soybean = lettuce = tomato = cabbage (0.5) < cucumber (0.25).

All plant species except corn exhibited a dose-response relationship. Crops listed (with EC50, lb ai/A) in order of increasing sensitivity to atrazine, based on plant height EC50 values, are as follows:

oat (17.773) < ryegrass (11.512) < soybean (9.88) < carrot (4.788) < tomato (2.474) < onion (2.132) < cabbage (1.534) < lettuce (0.82) < cucumber (0.137).

Plant dry weight. The NOEC, EC25, and EC50 of atrazine for plant dry weight are summarized in Table 33 (attached). Although carrot exhibited an NOEC of 4.0 lb ai/A with a 39% detrimental effect, this was not statistically significant because of the variability between two replications at this concentration. Soybean, cucumber, and cabbage required two additional study continuations to achieve NOEC values. Plant species listed (with NOEC, lb ai/A) in order of sensitivity to atrazine, based on dry weight NOEC values, are as follows:

carrot = ryegrass = corn (4.0) < oat (2.0) < tomato = onion (0.5) < lettuce (0.25) < soybean (0.02) < cucumber (0.005) < cabbage (0.0025).

All plant species except corn exhibited a dose-response relationship. Plants listed (with EC50, lb ai/A) in order of increasing sensitivity to atrazine, based on dry weight EC50 values, are as follows:

ryegrass (20.613) < carrot (12.885) < oat (3.791) < tomato (1.408) < onion (1.113) < lettuce (0.555) < soybean (0.285) < cabbage (0.104) < cucumber (0.019).

13. **STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES:** No conclusions were stated by the author. The study was inspected by the Quality Assurance Unit of Pan-Agricultural Labs, Inc. on several occasions to assure compliance with Good Laboratory Practice (GLP) Standards.

14. **REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS:**

A. **Test Procedure:** The test procedures followed the SEP and Subdivision J guidelines. The following discrepancies were observed in the report:

o A discrepancy was found in the data between Table A (attached) in the summary section and Table 13 (attached) in the result section. Table A states that the NOEC for carrot based on plant height is 0.5 lb ai/A, while the NOEC determined for this species in Table 13 is 2.0 lb ai/A.

o Discrepancies were found between Table 31 and Tables 1, 5, and 6 (all are attached). According to Tables 1, 5, and 6, the NOEC values for soybean, cucumber, and cabbage based on phytotoxicity rating were determined to be 0.1, 0.02, and 0.02 lb ai/A, respectively. However, Table 31 presents 1.0, 0.25, and 0.5 lb ai/A, respectively, as the NOEC values for these species.

o Discrepancies were also found between Table 32 and Tables 11, 15, and 16 (all are attached). According to Tables 11, 15, and 16, the NOEC values for soybean, cucumber and cabbage based on height were determined to be 0.1, 0.02 and 0.01 lb ai/A, respectively. However, Table 32 presents 0.5, 0.25, and 0.5 lb ai/A, respectively, as the NOEC values for these species.

B. **Statistical Analysis:** Statistically analyses were conducted by the reviewer for selected species and parameters using the analysis of variance with Tukey's and Dunnett's tests (attached). The results were in general agreement with those presented by the author.

EC25 and EC50 values for selected species were calculated by the reviewer using a regression analysis. It was unclear which of the three possible tests the author used to calculate the EC values, and therefore, these values were difficult for the reviewer to verify. It appears, however, that the author used the first test (the highest range of treatment concentrations) to calculate the EC values rather than taking a more conservative approach by using data from the test with lower treatment concentrations.

C. **Discussion/Results:** Inconsistencies were observed among tests conducted at different time using the same species and same parameter. For example, 72% effect on cucumber growth (measured as plant height) was observed at 0.04 lb ai/A in Test 3, while approximately the same percentage (71%) was observed at 0.5 lb ai/A in Test 1 (Table 15, attached).

Furthermore, conclusions were often based on results of the first test (which used the highest range of

treatment concentrations) even though lower treatment concentrations in subsequent tests produced significant results. A more conservative approach of data interpretation should have been made by basing the results on the third test rather than on the first test.

Based on the author's and the reviewer's statistical analyses, the NOEC values for soybean, lettuce, carrot, tomato, cucumber, cabbage, and onion were $\leq$0.5 lb ai/A atrazine. The NOEC for Oat and ryegrass was 2.0 lb ai/A, while the value for corn was 4.0 lb ai/A, the highest concentration tested. The EC25 and EC50 values for soybean, lettuce, tomato, cucumber, cabbage, and onion were $\leq$1.4 lb ai/A, while the value for oat was 3.8 lb ai/A. The EC25 and EC50 for carrot, ryegrass, and corn were >4.0 lb ai/A, the highest concentration tested.

D. **Adequacy of the Study:**

(1) **Classification:** Supplemental.

(2) **Rationale:** Inconsistencies were observed among tests conducted at different time using the same species and same parameters. Also, the EC values were difficult to verify due to the inconsistencies of which set of treatments the author analyzed.

(3) **Repairability:** Pending satisfactory explanations on the stated inadequacies in Sections 14.A and 14.C.

15. **COMPLETION OF ONE-LINER:** N/A.

Atrazine

---

Page_____ is not included in this copy.

Pages 60 through 70 are not included.

---

The material not included contains the following type of information:

____ Identity of product inert ingredients.

____ Identity of product impurities.

____ Description of the product manufacturing process.

____ Description of quality control procedures.

____ Identity of the source of product ingredients.

____ Sales or other commercial/financial information.

____ A draft product label.

____ The product confidential statement of formula.

____ Information about a pending registration action.

__✓__ FIFRA registration data.

____ The document is a duplicate of page(s) _____.

____ The document is not responsive to the request.

---

The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

---

## Soybean height

Test 2

REGRESSION EQUATION:
Y= 6.306564 + 1.830565 X

COEFFICIENT OF CORRELATION= .9749039

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -1.602 | 3.59 | 3.374 | .2159998 |
| 2 | -1.301 | 3.82 | 3.925 | -.105 |
| 3 | -1 | 4.23 | 4.476 | -.2459998 |
| 4 | -.699 | 4.97 | 5.027 | -5.699968E-02 |
| 5 | -.398 | 5.77 | 5.578 | .1920004 |

$EC_{50}$ = 0.193 lb ai/A

$EC_{25}$ = 0.083 lb ai/A

---

## Cabbage height

Test 3

REGRESSION EQUATION:
Y= 5.738655 + .9003274 X

COEFFICIENT OF CORRELATION= .7462761

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.602 | 3.87 | 3.396003 | .4739966 |
| 2 | -2.301 | 3.12 | 3.667002 | -.5470018 |
| 3 | -2 | 3.77 | 3.938 | -.1680002 |
| 4 | -1.699 | 4.29 | 4.208999 | 8.100128E-02 |
| 5 | -1.398 | 4.64 | 4.479998 | .1600022 |

$EC_{50}$ = 0.151 lb ai/A

$EC_{25}$ = 0.027 lb ai/A

Onion height

Test 1

REGRESSION EQUATION:
Y= 5.02 + 3.159469 X

COEFFICIENT OF CORRELATION= .8521079

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -.602 | 3.72 | 3.118 | .6020005 |
| 2 | -.301 | 4.05 | 4.069 | -1.899958E-02 |
| 3 | 0 | 4.42 | 5.02 | -.5999999 |
| 4 | .301 | 4.82 | 5.971 | -1.151 |
| 5 | .602 | 8.09 | 6.922 | 1.168 |

EC50 = 0.986 lb ai/A

EC25 = 0.605 lb ai/A

---

Lettuce weight

Test 1

REGRESSION EQUATION:
Y= 5.634 + 2.757475 X

COEFFICIENT OF CORRELATION= .9877205

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -.602 | 3.77 | 3.974 | -.2039995 |
| 2 | -.301 | 4.9 | 4.804 | .0960002 |
| 3 | 0 | 5.81 | 5.634 | .1760001 |
| 4 | .301 | 6.64 | 6.464 | .1760001 |
| 5 | .602 | 7.05 | 7.294 | -.244 |

EC50 = 0.589 lb ai/A

EC25 = 0.337 lb ai/A

Onion dry weight

Test 1

REGRESSION EQUATION:
Y= 5.044 + 3.813954 X

COEFFICIENT OF CORRELATION= .9469153

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -.602 | 2.95 | 2.748 | .2020001 |
| 2 | -.301 | 4.08 | 3.896 | .184 |
| 3 | 0 | 4.82 | 5.044 | -.224 |
| 4 | .301 | 5.28 | 6.192 | -.9120002 |
| 5 | .602 | 8.09 | 7.34 | .75 |

$EC_{50}$ = 0.974 lb ai/A

$EC_{25}$ = 0.597 lb ai/A

---

Cucumber dry weight

Test 3

REGRESSION EQUATION:
Y= 8.940511 + 2.219255 X

COEFFICIENT OF CORRELATION= .9958481

ACTUAL VERSUS ESTIMATED VALUES
X=logconc Y=probit

| DATA POINT | X | Y | ESTIMATED Y | ERROR |
|---|---|---|---|---|
| 1 | -2.602 | 3.25 | 3.166008 | .083992 |
| 2 | -2.301 | 3.82 | 3.834004 | -1.400399E-02 |
| 3 | -2 | 4.39 | 4.502 | -.112 |
| 4 | -1.699 | 5.1 | 5.169996 | -6.999588E-02 |
| 5 | -1.398 | 5.95 | 5.837992 | .1120081 |

$EC_{50}$ = 0.377 lb ai/A

$EC_{25}$ = 0.008 lb ai/A

Soybean Phytotoxicity - Test 2

Analysis of Variance File: soyphy Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: PHYTO

* Indicates statistics are collapsed over this factor

| Factors: C | N | Mean | S.D. |
|---|---|---|---|
| * | 90 | 0.9444 | 1.3270 |
| 1 Control | 15 | 0.0000 | 0.0000 |
| 2 0.025 | 15 | 0.1333 | 0.5164 |
| 3 0.05 | 15 | 0.0000 | 0.0000 |
| 4 0.1 | 15 | 0.6667 | 0.9759 |
| 5 0.2 | 15 | 1.6667 | 0.8997 |
| 6 0.4 | 15 | 3.2000 | 0.6761 |

Fmax for testing homogeneity of between subjects variances: Not defined

Analysis of Variance Dependent variable: PHYTO

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 156.7222 | | | |
| C (CONC) | 5 | 121.9222 | 24.3844 | 58.859 | 0.0000 |
| Subj w Groups | 84 | 34.8000 | 0.4143 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 0.000 | 6 | 3.200 |
| 2 | 0.133 | | |
| 3 | 0.000 | | |
| 4 | 0.667 | | |
| 5 | 1.667 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 = 3 | | |
| 1 < 4 | 0.1000 | 0.0500 |
| 1 < 5 | 0.0100 | 0.0100 |
| 1 < 6 | 0.0100 | 0.0100 |
| 2 > 3 | | N.A. |
| 2 < 4 | | N.A. |
| 2 < 5 | 0.0100 | N.A. |
| 2 < 6 | 0.0100 | N.A. |
| 3 < 4 | 0.1000 | N.A. |
| 3 < 5 | 0.0100 | N.A. |
| 3 < 6 | 0.0100 | N.A. |
| 4 < 5 | 0.0100 | N.A. |
| 4 < 6 | 0.0100 | N.A. |
| 5 < 6 | 0.0100 | N.A. |

LOEC = 0.05

Cucumber Phytotoxicity - Test 2

Analysis of Variance File: cucphy Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: PHYTO

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 2.3222 | 1.9535 |
| 1 | control | 15 | 0.0000 | 0.0000 |
| 2 | 0.025 lb ai/A | 15 | 0.0000 | 0.0000 |
| 3 | 0.05 | 15 | 1.9333 | 1.8696 |
| 4 | 0.1 | 15 | 4.0000 | 0.0000 |
| 5 | 0.2 | 15 | 4.0000 | 0.0000 |
| 6 | 0.4 | 15 | 4.0000 | 0.0000 |

Fmax for testing homogeneity of between subjects variances: Not defined

Analysis of Variance Dependent variable: PHYTO

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 339.6556 | | | |
| C (CONC) | 5 | 290.7222 | 58.1444 | 99.812 | 0.0000 |
| Subj w Groups | 84 | 48.9334 | 0.5825 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 0.000 | 6 | 4.000 |
| 2 | 0.000 | | |
| 3 | 1.933 | | |
| 4 | 4.000 | | |
| 5 | 4.000 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 = 2 | | |
| 1 < 3 | 0.0100 | 0.0100 |
| 1 < 4 | 0.0100 | 0.0100 |
| 1 < 5 | 0.0100 | 0.0100 |
| 1 < 6 | 0.0100 | 0.0100 |
| 2 < 3 | 0.0100 | N.A. |
| 2 < 4 | 0.0100 | N.A. |
| 2 < 5 | 0.0100 | N.A. |
| 2 < 6 | 0.0100 | N.A. |
| 3 < 4 | 0.0100 | N.A. |
| 3 < 5 | 0.0100 | N.A. |
| 3 < 6 | 0.0100 | N.A. |
| 4 = 5 | | N.A. |
| 4 = 6 | | N.A. |
| 5 = 6 | | N.A. |

NOEC = 0.025

# Cabbage Phytotoxicity Test 3

Analysis of Variance  File: cabphy  Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: PHYTO

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 0.2000 | 0.5236 |
| 1 | Control | 15 | 0.0000 | 0.0000 |
| 2 | 0.0025 lb ai/A | 15 | 0.0000 | 0.0000 |
| 3 | 0.005 | 15 | 0.0000 | 0.0000 |
| 4 | 0.01 | 15 | 0.0000 | 0.0000 |
| 5 | 0.02 | 15 | 0.0667 | 0.2582 |
| 6 | 0.04 | 15 | 1.1333 | 0.7432 |

Fmax for testing homogeneity of between subjects variances: Not defined

Analysis of Variance  Dependent variable: PHYTO

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 24.4000 | | | |
| C (CONC) | 5 | 15.7333 | 3.1467 | 30.498 | 0.0000 |
| Subj w Groups | 84 | 8.6667 | 0.1032 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 0.000 | 6 | 1.133 |
| 2 | 0.000 | | |
| 3 | 0.000 | | |
| 4 | 0.000 | | |
| 5 | 0.067 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 = 2 | | |
| 1 = 3 | | |
| 1 = 4 | | |
| 1 < 5 | | |
| 1 < 6 | 0.0100 | 0.0100 |
| 2 = 3 | | N.A. |
| 2 = 4 | | N.A. |
| 2 < 5 | | N.A. |
| 2 < 6 | 0.0100 | N.A. |
| 3 = 4 | | N.A. |
| 3 < 5 | | N.A. |
| 3 < 6 | 0.0100 | N.A. |
| 4 < 5 | | N.A. |
| 4 < 6 | 0.0100 | N.A. |
| 5 < 6 | 0.0100 | N.A. |

NOEC = 0.02

Soybean Height - Test 2

Analysis of Variance File: soyht Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 247.1333 | 69.8319 |
| 1 | control | 15 | 309.4667 | 15.4174 |
| 2 | 0.025 lb ai/A | 15 | 291.1333 | 27.0261 |
| 3 | 0.05 | 15 | 287.2000 | 28.4258 |
| 4 | 0.1 | 15 | 262.0000 | 45.9891 |
| 5 | 0.2 | 15 | 199.2000 | 31.8998 |
| 6 | 0.4 | 15 | 133.8000 | 40.9166 |

Fmax for testing homogeneity of between subjects variances: 8.90
Number of variances= 6 df per variance= 14.

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 434008.3800 | | | |
| C (CONC) | 5 | 341847.7200 | 68369.5470 | 62.316 | 0.0000 |
| Subj w Groups | 84 | 92160.6560 | 1097.1506 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 309.467 | 6 | 133.800 |
| 2 | 291.133 | | |
| 3 | 287.200 | | |
| 4 | 262.000 | | |
| 5 | 199.200 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 > 2 | | |
| 1 > 3 | | |
| 1 > 4 | 0.0100 | 0.0100 |
| 1 > 5 | 0.0100 | 0.0100 |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | | N.A. |
| 2 > 4 | | N.A. |
| 2 > 5 | 0.0100 | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | | N.A. |
| 3 > 5 | 0.0100 | N.A. |
| 3 > 6 | 0.0100 | N.A. |
| 4 > 5 | 0.0100 | N.A. |
| 4 > 6 | 0.0100 | N.A. |

NOEC = 0.05

Carrot Height - Test 1

Analysis of Variance File: carht Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 94.0000 | 33.5703 |
| 1 | Control | 15 | 110.8000 | 23.0099 |
| 2 | 0.25 lbs ai/A | 15 | 109.2667 | 20.7759 |
| 3 | 0.5 | 15 | 100.5333 | 17.6549 |
| 4 | 1.0 | 15 | 101.9333 | 15.6363 |
| 5 | 2.0 | 15 | 97.4667 | 18.0945 |
| 6 | 4.0 | 15 | 44.0000 | 44.3041 |

A total of 1 observations had missing data on a dependent variable or covariate or inappropriate factor level codes.

---

Fmax for testing homogeneity of between subjects variances: 8.03
Number of variances= 6 df per variance= 14.

---

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 100300.0000 | | | |
| C (CONC) | 5 | 46994.2660 | 9398.8535 | 14.811 | 0.0000 |
| Subj w Groups | 84 | 53305.7340 | 634.5921 | | |

---

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 110.800 | 6 | 44.000 |
| 2 | 109.267 | | |
| 3 | 100.533 | | |
| 4 | 101.933 | | |
| 5 | 97.467 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 > 2 | | |
| 1 > 3 | | |
| 1 > 4 | | |
| 1 > 5 | | |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 > 3 | | N.A. |
| 2 > 4 | | N.A. |
| 2 > 5 | | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 < 4 | | N.A. |
| 3 > 5 | | N.A. |

NOEC = 2.0

Tomatoe Height - Test 1

Analysis of Variance File: tomht Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: HEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| | * | 90 | 126.8444 | 49.9350 |
| | 1 Control | 15 | 164.6667 | 14.2662 |
| | 2 0.25 lb ai/A | 15 | 149.4667 | 12.0171 |
| | 3 0.5 | 15 | 155.8667 | 15.3710 |
| | 4 1.0 | 15 | 138.8000 | 16.3629 |
| | 5 2.0 | 15 | 120.1333 | 44.8678 |
| | 6 4.0 | 15 | 32.1333 | 13.8092 |

Fmax for testing homogeneity of between subjects variances: 13.94
Number of variances= 6 df per variance= 14.

Analysis of Variance Dependent variable: HEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 221921.8120 | | | |
| C (CONC) | 5 | 179141.1720 | 35828.2340 | 70.349 | 0.0000 |
| Subj w Groups | 84 | 42780.6410 | 509.2933 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 164.667 | 6 | 32.133 |
| 2 | 149.467 | | |
| 3 | 155.867 | | |
| 4 | 138.800 | | |
| 5 | 120.133 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 > 2 | | |
| 1 > 3 | | |
| 1 > 4 | 0.0500 | 0.0500 |
| 1 > 5 | 0.0100 | 0.0100 |
| 1 > 6 | 0.0100 | 0.0100 |
| 2 < 3 | | N.A. |
| 2 > 4 | | N.A. |
| 2 > 5 | 0.0100 | N.A. |
| 2 > 6 | 0.0100 | N.A. |
| 3 > 4 | | N.A. |
| 3 > 5 | 0.0100 | N.A. |
| 3 > 6 | 0.0100 | N.A. |
| 4 > 5 | | N.A. |
| 4 > 6 | 0.0100 | N.A. |

NOEC = 0.5

. Oat Dry Wt. - Test 1

Analysis of Variance File: oatwt Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: WEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 336.1444 | 67.6685 |
| 1 | control | 15 | 339.6667 | 27.1653 |
| 2 | 0.25 lb ai/A | 15 | 353.3333 | 29.9563 |
| 3 | 0.5 | 15 | 341.4667 | 30.5611 |
| 4 | 1.0 | 15 | 342.4000 | 31.6855 |
| 5 | 2.0 | 15 | 357.1333 | 23.7633 |
| 6 | 4.0 | 15 | 282.8667 | 145.1073 |

---

Fmax for testing homogeneity of between subjects variances: 37.29
Number of variances= 6 df per variance= 14.

---

Analysis of Variance Dependent variable: WEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 407533.1600 | | | |
| C (CONC) | 5 | 54815.6560 | 10963.1309 | 2.611 | 0.0301 |
| Subj w Groups | 84 | 352717.5000 | 4199.0181 | | |

---

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 339.667 | 6 | 282.867 |
| 2 | 353.333 | | |
| 3 | 341.467 | | |
| 4 | 342.400 | | |
| 5 | 357.133 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 < 3 | | |
| 1 < 4 | | |
| 1 < 5 | | |
| 1 > 6 | | |
| 2 > 3 | | N.A. |
| 2 > 4 | | N.A. |
| 2 < 5 | | N.A. |
| 2 > 6 | 0.0500 | N.A. |
| 3 < 4 | | N.A. |
| 3 < 5 | | N.A. |
| 3 > 6 | | N.A. |
| 4 < 5 | | N.A. |
| 4 > 6 | | N.A. |

NOEC = 4.0

Ryegrass Dry Weight - Set 1

Analysis of Variance

File: ryewt

Date: 01-23-1990

FILTER: None

N's, means and standard deviations based on dependent variable: WEIGHT

* Indicates statistics are collapsed over this factor

| Factors: C | | N | Mean | S.D. |
|---|---|---|---|---|
| * | | 90 | 221.2333 | 72.0822 |
| 1 | Control | 15 | 221.9333 | 48.3639 |
| 2 | 0.25 lb ai/A | 15 | 229.6000 | 43.2184 |
| 3 | 0.5 | 15 | 230.2000 | 34.3079 |
| 4 | 1.0 | 15 | 233.0667 | 42.0501 |
| 5 | 2.0 | 15 | 239.1333 | 75.6608 |
| 6 | 4.0 | 15 | 173.4667 | 130.5925 |

Fmax for testing homogeneity of between subjects variances: 14.49
Number of variances= 6 df per variance= 14.

Analysis of Variance Dependent variable: WEIGHT

| Source | df | SS (H) | MSS | F | P |
|---|---|---|---|---|---|
| Between Subjects | 89 | 462430.1200 | | | |
| C (CONC) | 5 | 43394.7730 | 8678.9551 | 1.740 | 0.1333 |
| Subj w Groups | 84 | 419035.3400 | 4988.5161 | | |

Post-hoc tests for factor C (CONC)

| Level | Mean | Level | Mean |
|---|---|---|---|
| 1 | 221.933 | 6 | 173.467 |
| 2 | 229.600 | | |
| 3 | 230.200 | | |
| 4 | 233.067 | | |
| 5 | 239.133 | | |

| Comparison | Tukey-A* | Dunnett |
|---|---|---|
| 1 < 2 | | |
| 1 < 3 | | |
| 1 < 4 | | |
| 1 < 5 | | |
| 1 > 6 | | |
| 2 < 3 | N.A. | |
| 2 < 4 | N.A. | |
| 2 < 5 | N.A. | |
| 2 > 6 | N.A. | |
| 3 < 4 | N.A. | |
| 3 < 5 | N.A. | |
| 3 > 6 | N.A. | |
| 4 < 5 | N.A. | |
| 4 > 6 | N.A. | |

NOEC = 4.0