

IPM of Date Palm Insect Pests and Diseases

Training Course

Statistical Designs and Analysis of IPM data of Date Palm Pests
(Dose - Binary Response Relationship for Probit Analysis, LD50)

Name: Khaled Al-Shamaa

Date: 28 February 2017

Venue: Muscat, Oman

Citation: Khaled Al-Shamaa (2017). Statistical Designs and Analysis of IPM data of Date Palm Pests (Dose - Binary Response Relationship for Probit Analysis, LD50). IPM of Date Palm Insect Pests and Diseases Training Course, 28 Feb 2017, Muscat, Oman. BSS/DDG-R, ICARDA, Amman. 15 slides.

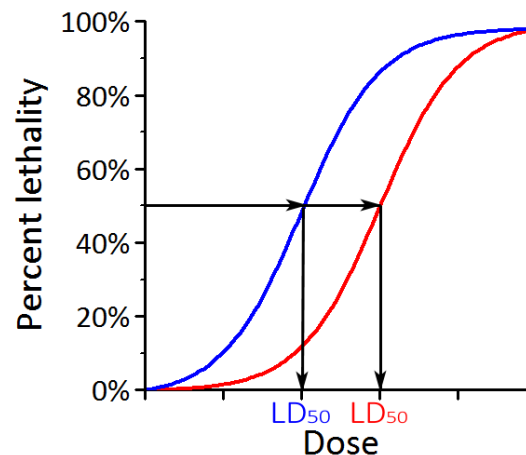
Binomial Response

- Binomial refers to a response variable with only two outcomes.
 - Flipping a coin (heads or tails)
 - The toxicity of pesticides (death or no death)



LD50 and LC50

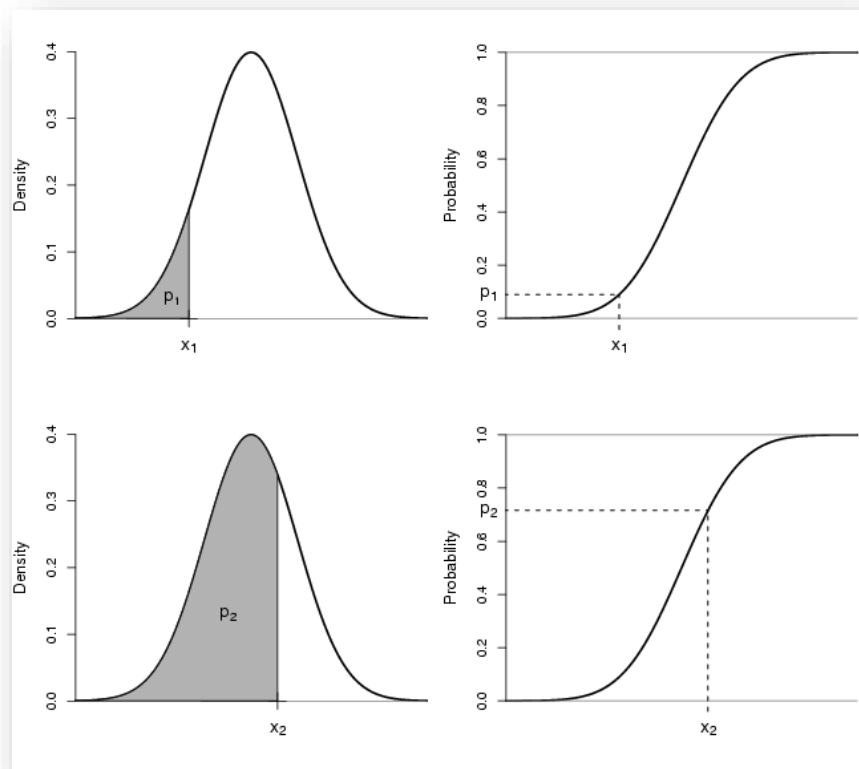
- The LC50 (Lethal Concentration for liquids) or LD50 (Lethal Dose for solids) at which 50% of population responds are the most widely used outcomes of the modern pesticide response experiments to compare the toxicities of chemicals.



Probit Analysis

It transforms the sigmoid dose-response curve to a straight line(i.e. acts as a transformation from sigmoid to linear) and then runs a regression on the relationship.

Probability
Density
Function
(PDF)



Cumulative
Distribution
Function
(CDF)

Statistical Details (Skip if you'd like)

$$Pr(x) = \Phi(a + b \cdot x)$$

Normal Cumulative Distribution Function (CDF)

$$\Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{\frac{-t^2}{2}} dt$$

GenStat – Probit Analysis, Menu

Treatment: Phosphine, PH₃ (mg/l)

Subject: Storage Pests (*Rhizopertha dominica*)

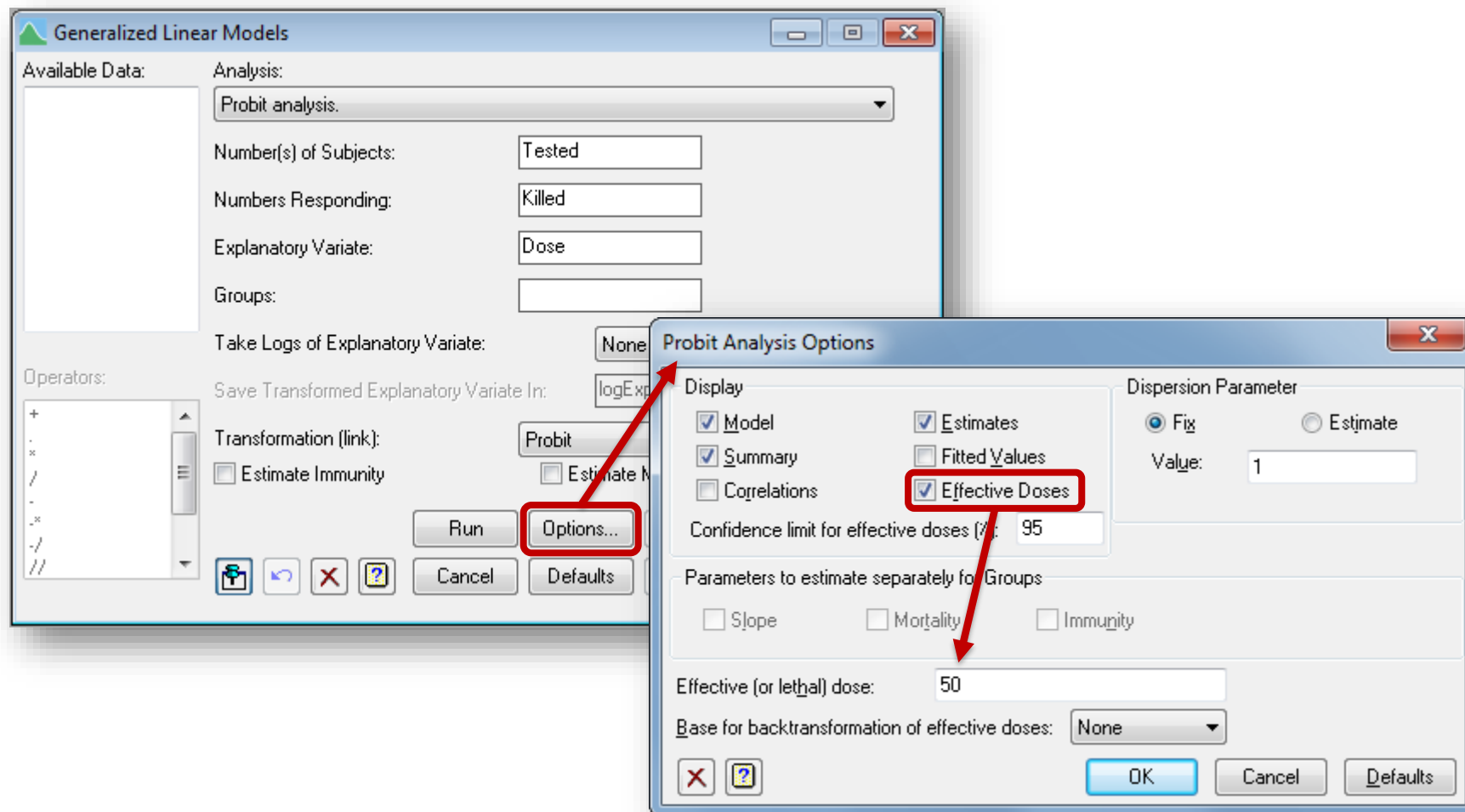
The screenshot displays the GenStat software interface. The 'Stats' menu is open, and the 'Probit Analysis...' option is highlighted. The background shows a spreadsheet with experimental data.

Row	Dose	Rep	Tested	Killed
1	0	1	51	0
2	0	2	49	2
3	0	3	49	2
4	0.0024	1	52	2
5	0.0024	2	50	1
6	0.0024	3	50	2
7	0.004	1	51	8
8	0.004	2	51	7
9	0.004	3	52	7
10	0.008	1	50	14
11	0.008	2	50	45
12	0.008	3	49	40
13	0.017	1	50	48
14	0.017	2	52	48
15	0.017	3	53	48
16	0.021	1	50	48
17	0.021	2	49	42
18	0.021	3	50	46
19	0.03	1	51	50

Stats menu options:

- Summary Statistics
- Statistical Tests
- Distributions
- Regression Analysis
 - Linear Models...
 - Generalized Linear Models...
 - Logistic Regression...
 - Log-linear Models...
 - Probit Analysis...**
 - Multinomial Regression...
 - Ordinal Regression...
 - All-subsets Regression
 - Screening Tests
 - Split-line Regression...
 - Parallel Regression...
- Design
- Analysis of Variance
- Mixed Models (REML)
- Multivariate Analysis
- Six Sigma
- Survey Analysis
- Time Series
- Spatial Analysis
- Survival Analysis
- Repeated Measurements
- Meta Analysis
- Microarrays
- Genetic Models
- QTLs (Linkage/Association)
- Data Mining
- Sample Size
- Bootstrap...

GenStat – Probit Analysis, Options



GenStat – Probit Analysis, Outputs

```
61 "Probit analysis."
62 PROBITANALYSIS [PRINT=model,summary,estimates,effectivedose; TRANSFORMATION=probit;\
63 DISP=1; LD=(50); CIPROBABILITY=0.95] Killed; DOSE=Dose; NBINOMIAL=Tested
```

Regression analysis

Response variate: Killed
 Binomial totals: Tested
 Distribution: Binomial
 Link function: Probit
 Fitted terms: Constant, Dose

X 1000 (i.e. mg/l → mcg/l)

Summary of analysis

Source	d.f.	deviance	mean deviance	deviance ratio
Regression	1	752.9	752.879	752.88
Residual	19	166.8	8.781	
Total	20	919.7	45.986	

Dispersion parameter is fixed at 1.00.

Estimates of parameters

Parameter	estimate	s.e.	t(*)
Constant	-1.4575	0.0808	-18.03
Dose	148.62	7.56	19.66

Message: s.e.s are based on dispersion parameter with value 1.

Effective doses

LD	estimate	s.e.	lower 95%	upper 95%
50.00	0.009807	0.0003636	0.009114	0.01053

Estimates of parameters

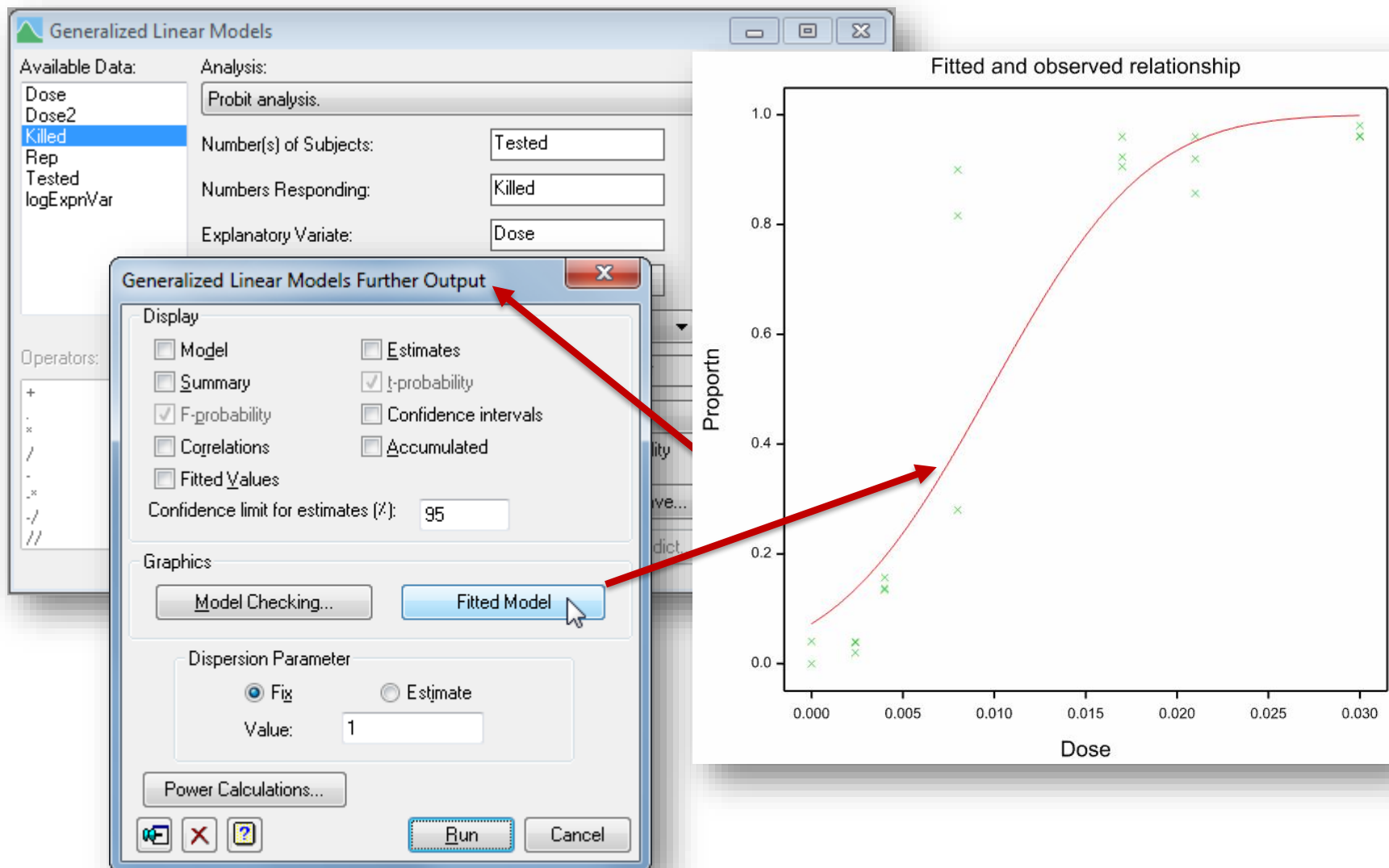
Parameter	estimate	s.e.	t(*)
Constant	-1.4575	0.0808	-18.03
Dose	0.14862	0.00756	19.66

Message: s.e.s are based on dispersion parameter with value 1.

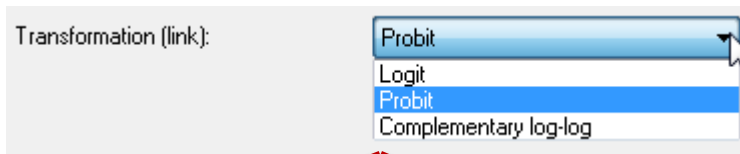
Effective doses

LD	estimate	s.e.	lower 95%	upper 95%
50.00	9.807	0.3636	9.114	10.53

GenStat – Probit Analysis, Further Output



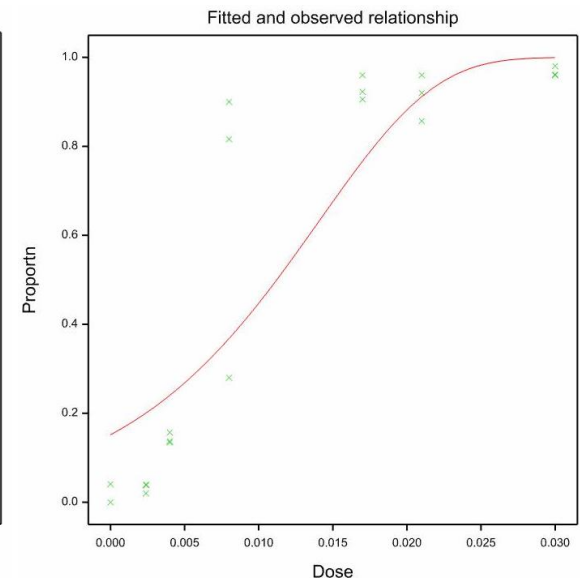
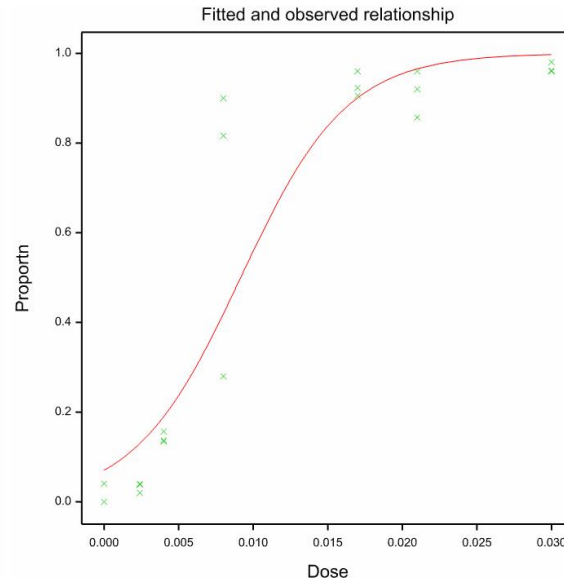
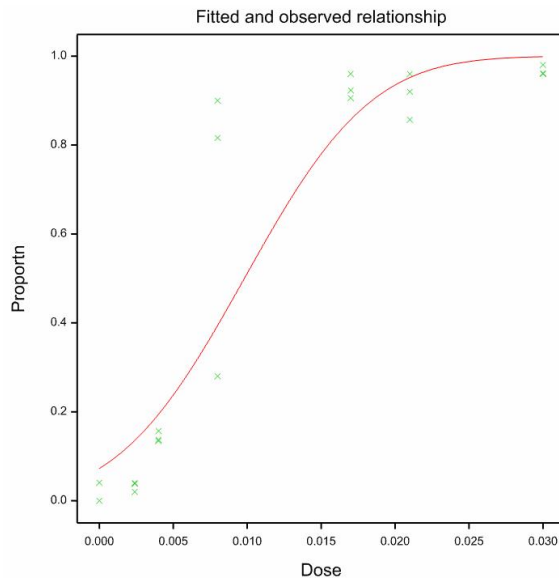
GenStat – Transformation Link



Probit
CDF(P%)

Logit
 $\log(P\% / (100 - P\%))$

C Log-Log
 $\log(-\log(100-P\%))$



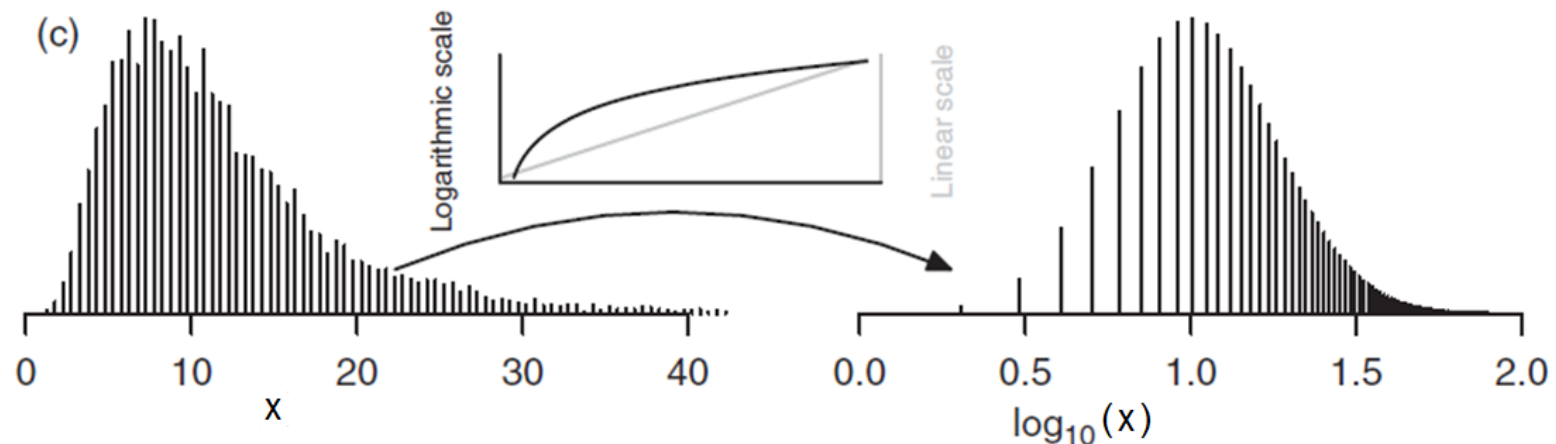
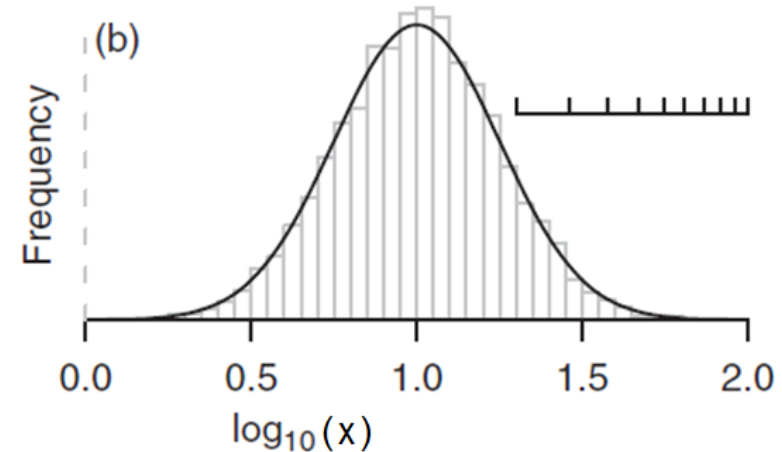
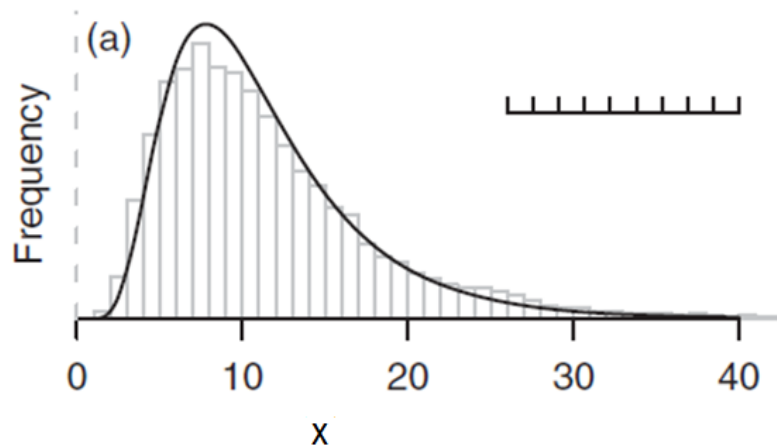
GenStat - Take Logs of Explanatory Variate

Take Logs of Explanatory Variate:

None


Save Transformed Explanatory Variate In:

None
base 10
base e



BioComputing Online – LD50, Input Data

<http://geoagro.icarda.org/bss/shinyapps/ld50>



Science for Better Livelihoods in Dry Areas

Upload Your Data:

Effective (or Lethal) Dose/Concentration:

Level of Confidence Interval:

Link Function:

Take logs of Explanatory:

Numbers of Subjects (e.g. Total):*

Numbers Responding (e.g. Dead):*

Explanatory Variate (e.g. Dose):*

Input Data Analysis Output Graphics Output Help


Input Data

Show entries Search:

Dose	Rep	Tested	Killed
0	1	51	0
0	2	49	2
0	3	49	2
2.4	1	52	2
2.4	2	50	1
2.4	3	50	2
4	1	51	8
4	2	51	7
4	3	52	7
8	1	50	14
8	2	50	45
8	3	49	40
17	1	50	48
17	2	52	48
17	3	53	48
21	1	50	48
21	2	49	42

BioComputing Online – LD50, Analysis Output

ICARDA BioComputing Online (Phase II): Lethal Dose/Concentration Calculator



Science for Better Livelihoods in Dry Areas

Upload Your Data:

Browse...

IPM Examples.xlsx

Upload complete

Effective (or Lethal) Dose/Concentration:

0

50

100

0102030405060708090100

Level of Confidence Interval:

0

80

100

0102030405060708090100

Link Function:

Probit

Take logs of Explanatory:

None

Numbers of Subjects (e.g. Total):*

Tested

Numbers Responding (e.g. Dead):*

Killed

Explanatory Variate (e.g. Dose):*

Dose

[Input Data](#)[Analysis Output](#)[Graphics Output](#)[Help](#)

Model Parameters

Link Function: Probit

Explanatory Transformation: none

Analysis Output

Treat	LD/LC	Dose	SE	Intercept (a)	a SE	Coefficient (b)	b SE
All	50	9.81	0.36	-1.46	0.08	0.15	0.01

[Download](#)

Summary Statistics

Dose	Responding	Subjects
Min. : 0.00	Min. : 0.00	Min. :49.00
1st Qu.: 2.40	1st Qu.: 2.00	1st Qu.:50.00
Median : 8.00	Median :40.00	Median :50.00
Mean :11.77	Mean :26.57	Mean :50.52
3rd Qu.:21.00	3rd Qu.:48.00	3rd Qu.:51.00
Max. :30.00	Max. :50.00	Max. :53.00

BioComputing Online – LD50, Graphics Output

ICARDA BioComputing Online (Phase II): Lethal Dose/Concentration Calculator

ICARDA
Science for Better Livelihoods in Dry Areas

Upload Your Data:

Browse... IPM Examples.xlsx

Upload complete

Effective (or Lethal) Dose/Concentration:

0 50 100

0 10 20 30 40 50 60 70 80 90 100

Level of Confidence Interval:

0 80 100

0 10 20 30 40 50 60 70 80 90 100

Link Function:

Probit

Take logs of Explanatory:

None

Numbers of Subjects (e.g. Total):*

Tested

Numbers Responding (e.g. Dead):*

Killed

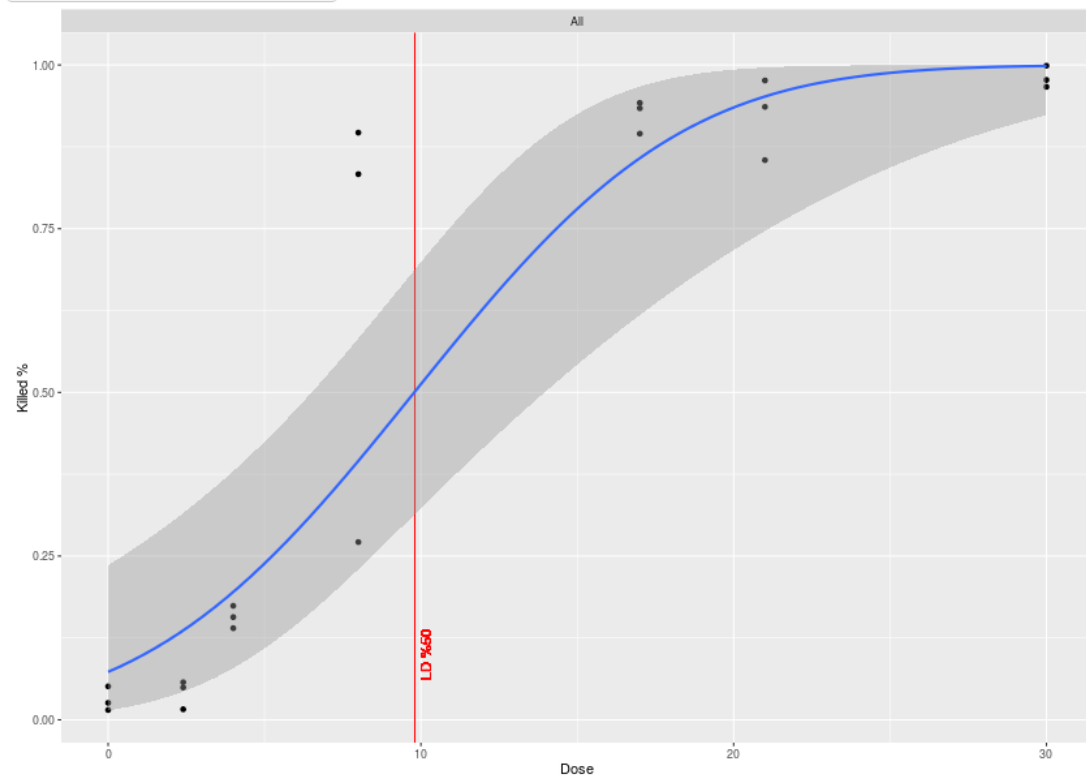
Explanatory Variate (e.g. Dose):*

Dose

[Input Data](#) [Analysis Output](#) [Graphics Output](#) [Help](#)

Graphics Output

Download High Resolution Graph



Thank You

Questions?



Japanese attitude for work:

If one can do it, I can do it. If no one can do it, I must do it.

Middle Eastern attitude for work:

Wallahi... if one can do it, let him do it.

If no one can do it, ya-habibi how can I do it?