Plant growth and pollution

- **Glyphosate is a powerful weed-killer, its presence in the water-supply is potentially harmful to irrigated crops.**
- **The following data show the empirical relationship between glyphosate concentration and total root-length for batches of 15 safflower plants**
- **The experiment used both distilled and tap-water.**

Glyphosate data

x (ppm)	0.000	0.000	0.053	0.106	0.211
y (dist.)	107.0	110.9	106.2	97.3	105.9
y (tap)	111.0	168.3	105.7	116.7	143.7
x (ppm)	0.423	0.845	1.609	3.380	
y (dist)	88.5	74.4	46.2	30.0	
y (tap)	84.7	59.3	36.7	38.0	

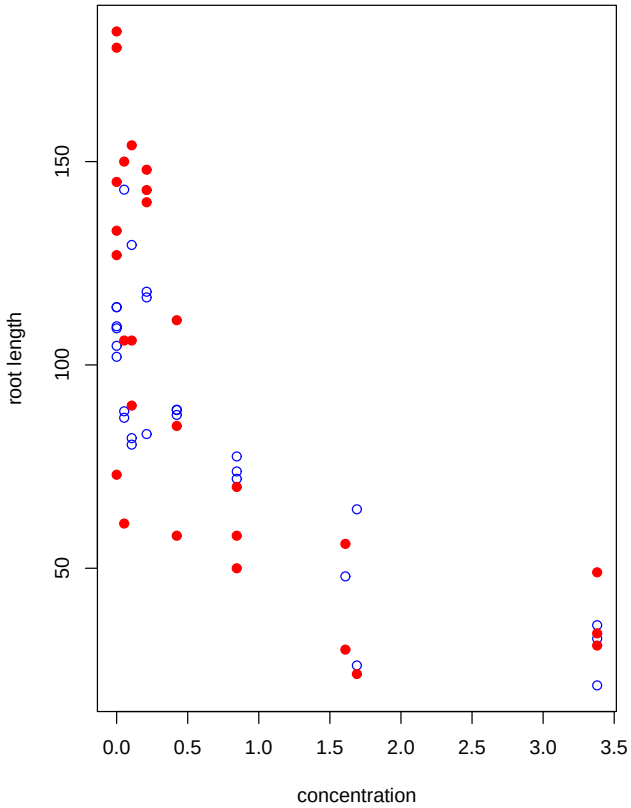
Scientific and statistical objectives

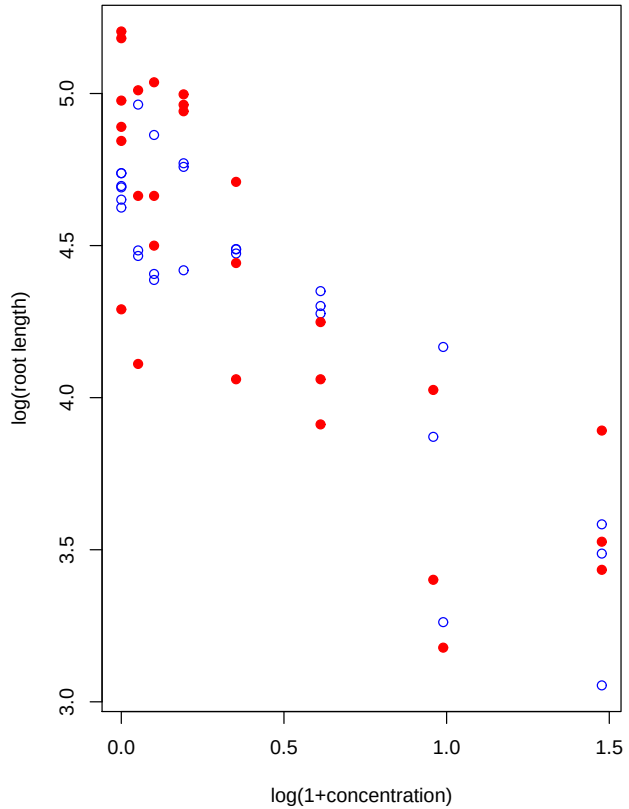
- what can these data tell us about the effect of small concentrations of glyphosate on plant growth?
- how could we build a statistical model to describe the relationship between glyphosate concentration and root-length?

Where do models come from?

- in the gravity experiment, the linear regression model had a mechanistic justification (physics plus physiology)
- In the glyphosate experiment, there is no scientific law to guide us.
- but we may still be able to use the linear regression model to describe the empirical relationship between glyphosate concentration and root-length.

Plotting the glyphosate data





Notes on data-transformations

- other transformations of the data could have been used
- choice could be determined by empirical and/or scientific considerations

Example.
Suppose x and y follow a power law model,

$$y = ax^b$$

Then, log-log transformation produces a linear model,

$$Y = \alpha + \beta X$$

where $Y = \log y$, $X = \log x$, $\alpha = \log a$ and $\beta = b$.

A linear model for the glyphosate data

$y = \log(\text{root length})$ (response)

$x = \log(1 + \text{glyphosate})$ (explanatory variable)

$w = 0/1 = \text{distilled/tap water}$ (factor)

$$y = \{\alpha_0 + \alpha_1 w\} + \beta x + z$$

- parallel straight-line relationships for distilled and for tap-water
- $\alpha_1 = 0$ if source of water does not affect average root-length
- β measures effect of glyphosate on plant-growth (on transformed scale)

Residuals vs fitted values plot