The Effects of Sunlight and Water on Geranium Growth

Ruth Frahm, Minh Tran, and Addison Andrix




Intro

- Whether sunlight and/or water affect the growth of geraniums
- 16 identical pots were obtained and filled with soil
- Each pot had the same number of seeds planted
- Plants were grown in the same greenhouse
- Each pot was assigned one of four treatment levels
- All treatment groups have four pots
- After 12 weeks the plants' heights were measured in centimeters

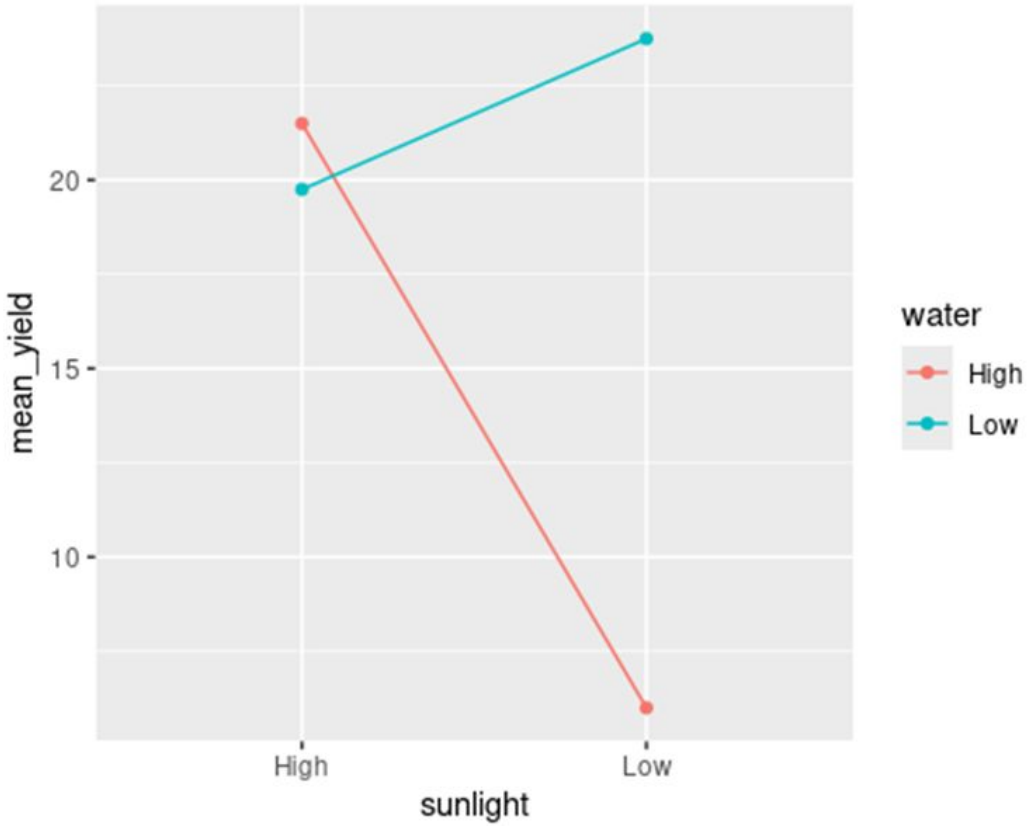
Data description

Interaction

- two lines cross
- opposite slopes

→ interaction between sunlight and water

Thus, we focus on the combined effect



Notations

Sunlight.Water

→ High.High = High sunlight . High water

Low.High = …

High.Low = …

Low.Low = …

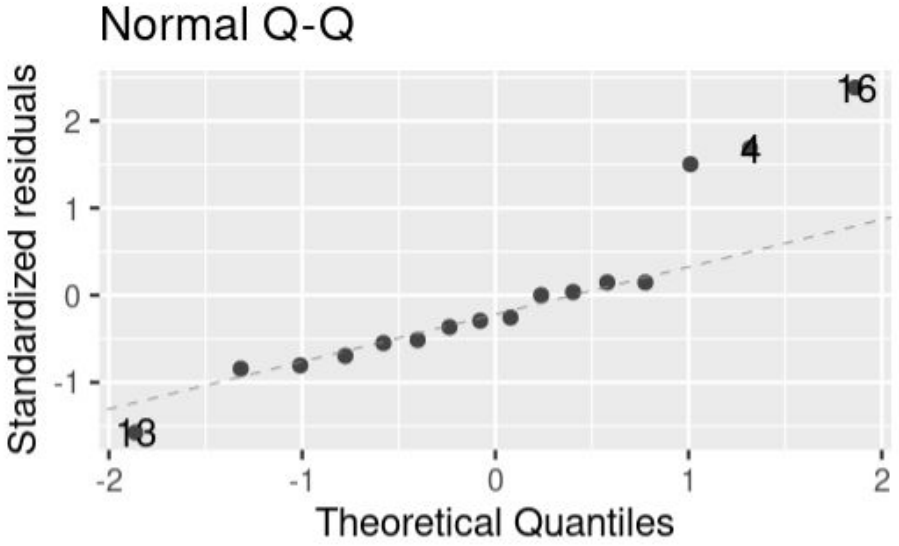
Summary Statistics (before)

sunlight.water	min	Q1	median	Q3	max	mean	sd	n
High.High	16	17.50	18.5	22.5	33	21.5	7.77	4
Low.High	4	5.50	6.5	7.0	7	6.0	1.41	4
High.Low	14	14.75	17.5	22.5	30	19.75	7.32	4
Low.Low	13	18.25	21.0	26.5	40	23.75	11.50	4

Summary Statistics of Sunlight by Water

Appendix (before)

- ✓ Independence:
  - Ou=eu=geraniums plants
  - No obvious clusters
  - Measured once after 12 weeks
- ❑ Equal variance: 11.5/1.4 = 8.2
- ❑ Normality: Sample size=16



After Natural Log Transformation

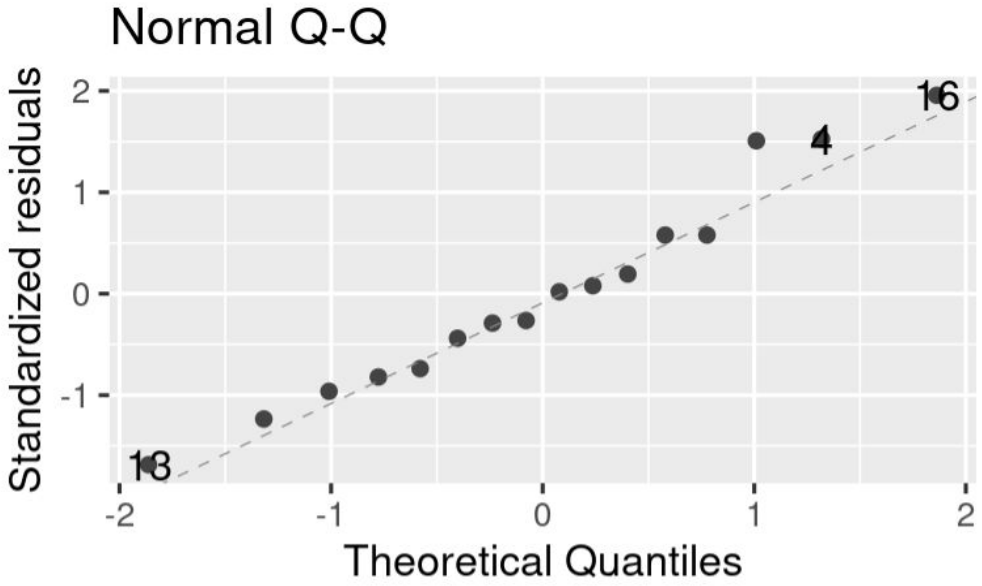
sunlight.water	min	Q1	median	Q3	max	mean	sd	n
High.High	2.773	2.861	2.917	3.082	3.497	3.026	0.322	4
Low.High	1.386	1.690	1.869	1.946	1.946	1.767	0.264	4
High.Low	2.639	2.691	2.852	3.097	3.097	2.936	0.346	4
Low.Low	2.565	2.888	3.043	3.241	3.241	3.085	0.463	4

Summary Statistics of Sunlight by Water after Natural Log Transformation

Appendix (after)

- ✓ Independence:
  - ou=eu=geraniums plants
  - no obvious clusters
  - measured once after 12 weeks
- ✓ Equal variance:

  0.46/0.26 = 1.769
- ✓ Normality: Nice!



Data Analysis

Model and tools

$$\ln(\text{Yield}_{ijk}) = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ij}$$

- μ: natural log average plant height (cm) of plants
- α_i: effect of sunlight where i is the level of sunlight
- βj: effect of water where j is the level of water
- $(\alpha\beta)_{ij}$: interaction between sunlight level i and water level j
- ε_{ij}: random error
- k^{th}: kth pot with combination i and j

ANOVA Results

Variable	**F-statistic**	**df**	**p-value**
sunlight	9.694	1 and 12	0.0089
water	11.873	1 and 12	0.0048
sunlight:water	15.608	1 and 12	0.0019*

Parameter Estimates

Term	**Estimate**	**SE**	**95% CI**
High.High (Intercept)	3.026	0.178	2.638, 3.414
Low.High	-1.259	0.252	-1.807, -0.710*
High.Low	-0.090	0.252	-0.639, 0.459
Low.Low	1.408	0.356	0.631, 2.184*

Pairwise Point Estimates and Confidence Intervals

	Estimate	SE	95% CI
For High sunlight on water			
High - Low	0.09	0.252	-0.459, 0.639
For Low sunlight on water			
High - Low	-1.32	0.252	-1.867, -0.769*
For High water on sunlight			
High - Low	1.259	0.252	0.710, 1.810*
For Low water on sunlight			
High - Low	-0.149	0.252	-0.698, 0.400

Note: A Bonferroni adjustment was used.

Results and Conclusion

Results/Conclusion

$$\text{Low.Low} > \text{High.High} > \text{Low.High}$$

$$\text{Low.Low} \approx \text{High.Low} \approx \text{High.High}$$

Future Studies

- Add more levels for sunlight and water
- Soil type
- Type of light
- Temperature
- Fertilizer
- Nutrients