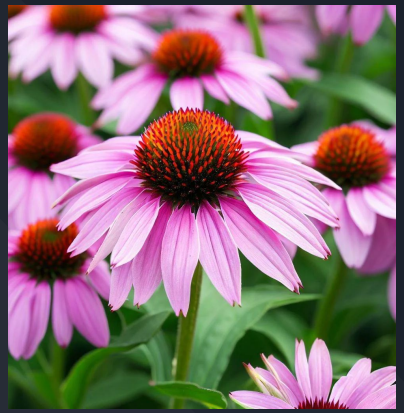
# Echinacea Research Project



Conlan Ramirez

CHICAGO BOTANIC GARDEN

# Research Questions

- Are taller heads more likely to be pollinated?

- Are plants with more heads less likely to be pollinated?

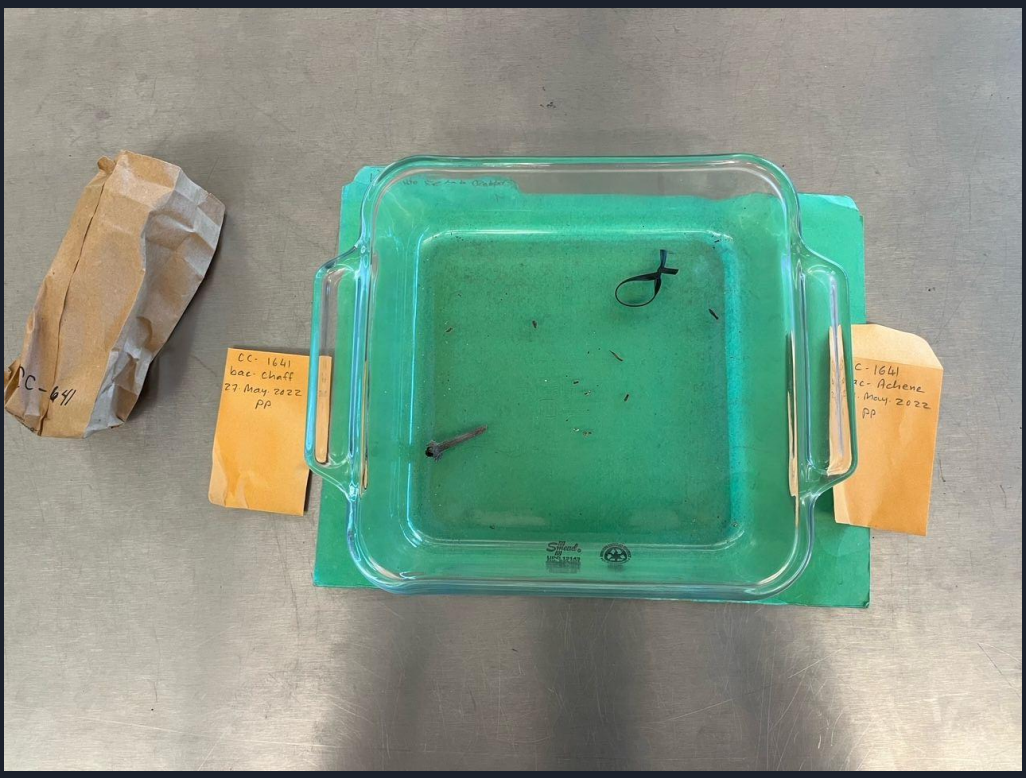
# Background

- Echinacea is mainly pollinated by bees
- Prior studies have shown a positive relationship between pollination rates and head height
- Prior studies have found that plants with more heads are more likely to be pollinated
- Echinacea is self-incompatible

# Methods

- Collected data from a batch of about 229 echinacea heads

- Cleaned, Rechecked, Scanned, Counted, Randomized, Xrayed, and Classified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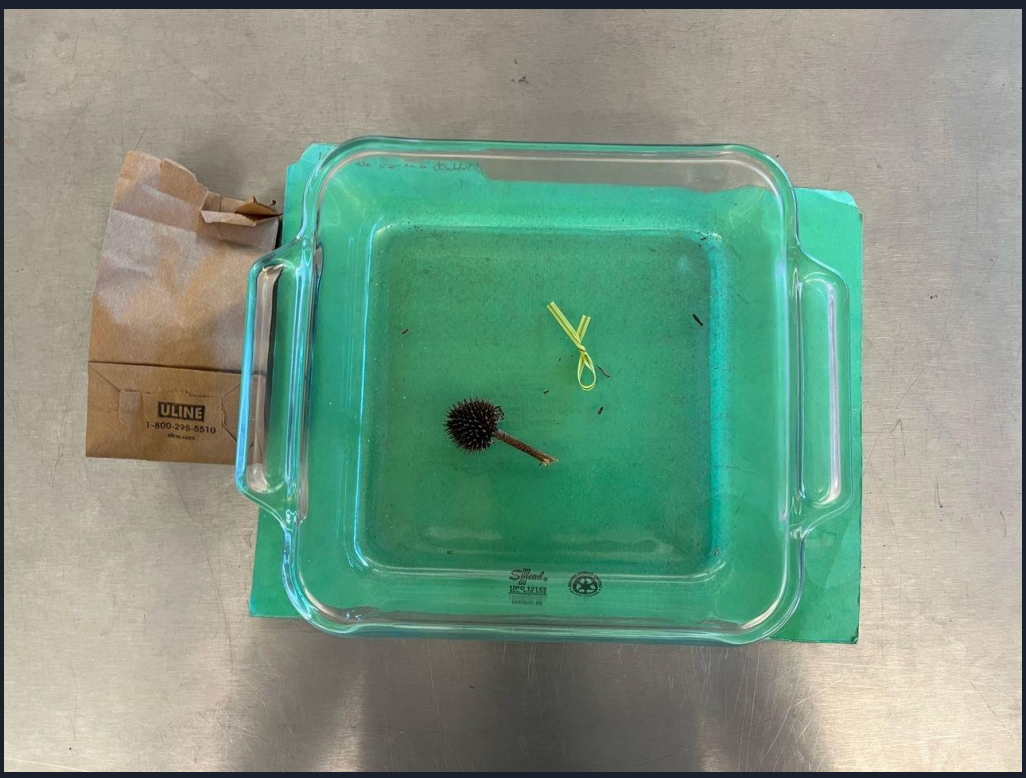
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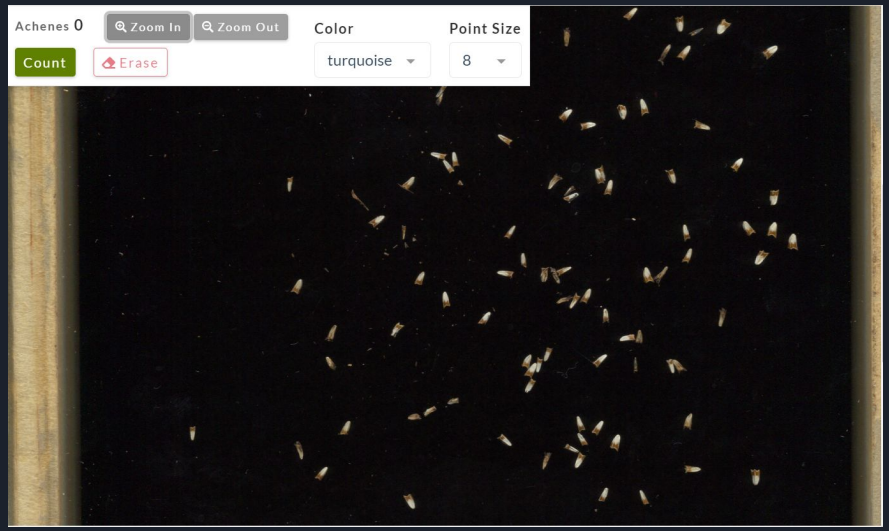
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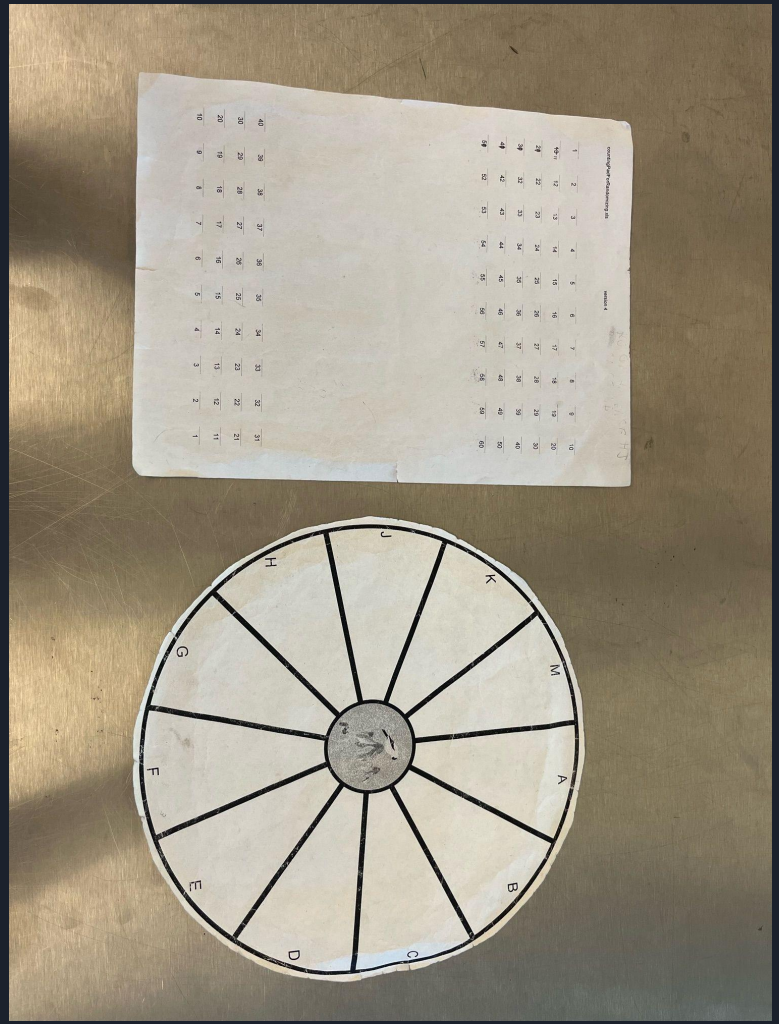
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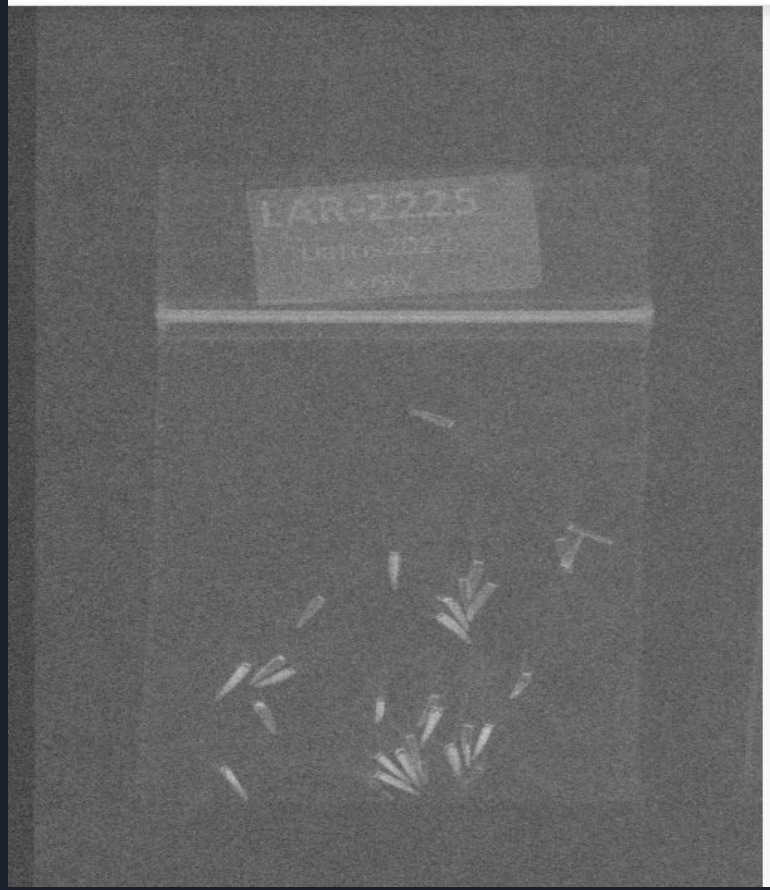


# Question 1

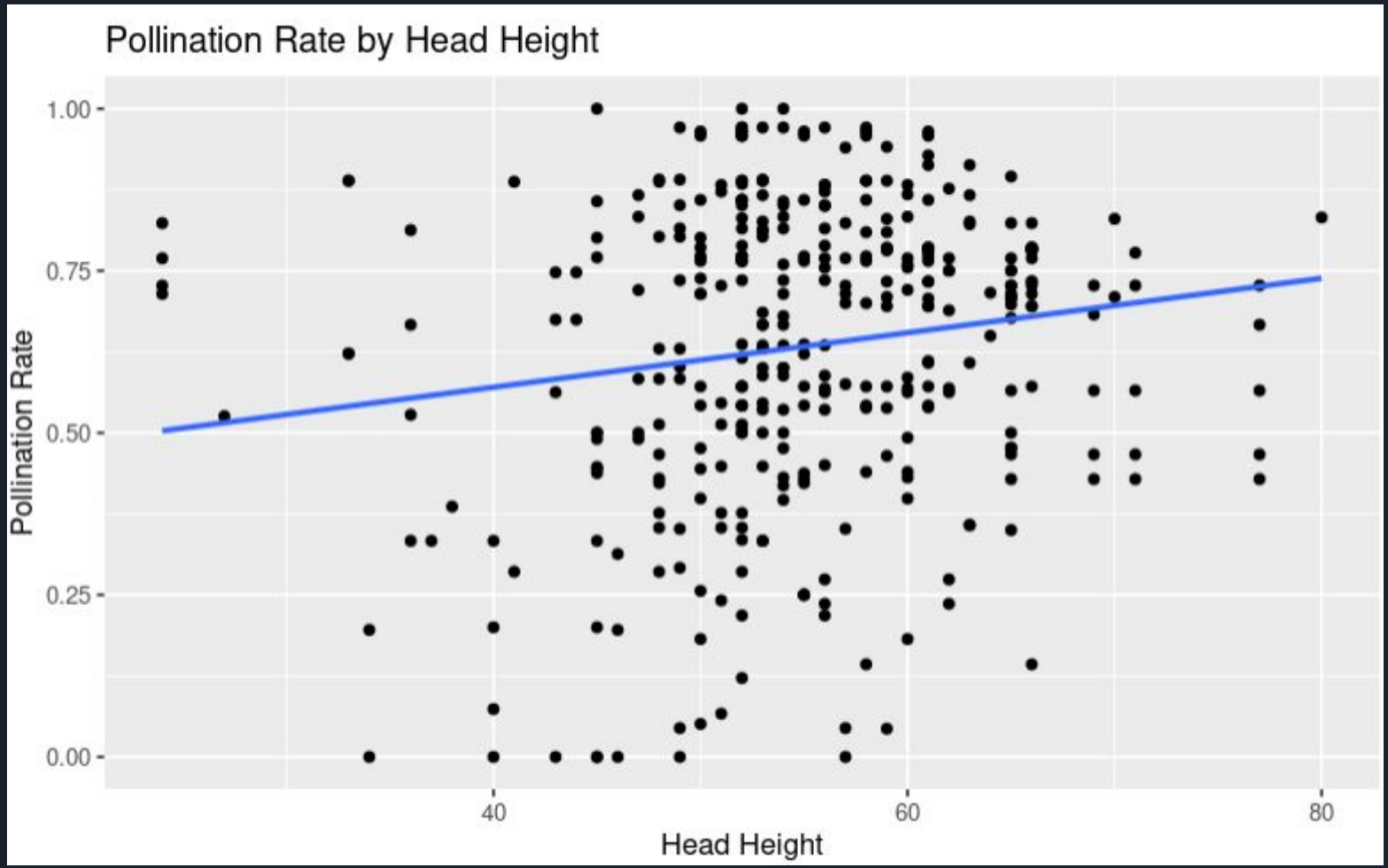
Are taller heads more likely to be pollinated?

Hypotheses-

Ho: There is no correlation between head height and pollination rates in echinacea.

Ha: There is a correlation between head height and pollination rates in echinacea.

| | cgPlaId | hdHeight | pollination | seedset |
|---|---|---|---|---|
| 1 | 4624 | 52 | 1.0000000 | 0.93333333 |
| 2 | 4627 | 57 | 0.0000000 | 0.00000000 |
| 3 | 4628 | 59 | 0.9411765 | 0.88235294 |
| 4 | 4699 | 50 | 0.7380952 | 0.72294372 |
| 5 | 4720 | 52 | 0.8311688 | 0.78354978 |
| 6 | 4721 | 55 | 0.6216667 | 0.28444444 |
| 7 | 4765 | 62 | 0.2738095 | 0.27380952 |
| 8 | 4765 | 62 | 0.2361884 | 0.10122358 |
| 9 | 4765 | 56 | 0.2738095 | 0.27380952 |
| 10 | 4765 | 56 | 0.2361884 | 0.10122358 |
| 11 | 4768 | 49 | 0.0000000 | 0.00000000 |
| 12 | 4772 | 45 | 0.0000000 | 0.00000000 |
| 13 | 4792 | 53 | 0.5458090 | 0.54580897 |
| 14 | 4792 | 53 | 0.4481481 | 0.44814815 |
| 15 | 4792 | 51 | 0.5458090 | 0.54580897 |
| 16 | 4792 | 51 | 0.4481481 | 0.44814815 |
| 17 | 4885 | 58 | 0.8095238 | 0.76190476 |
| 18 | 4885 | 58 | 0.5384615 | 0.46153846 |


Pollination Rate by Head Height
Pollination Rate
1.00
0.75
0.50
0.25
0.00
40
60
80
Head Height

# Statistical Test

- Performed a linear regression analysis

- With a p-value of .0025 < .05 we reject the null hypothesis and there is enough evidence to conclude there is a positive correlation between pollination rate and head height

```
Call:
lm(formula = hdHeight ~ pollination, data = fulldata)

Residuals:
    Min      1Q  Median      3Q     Max
-31.880  -4.542  -0.518   5.436  24.070

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   51.134      1.277  40.051   <2e-16 ***
pollination    5.764      1.894   3.043   0.0025 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.567 on 373 degrees of freedom
Multiple R-squared:  0.02423,   Adjusted R-squared:  0.02161
F-statistic: 9.262 on 1 and 373 DF,  p-value: 0.002505
```

# Question 2

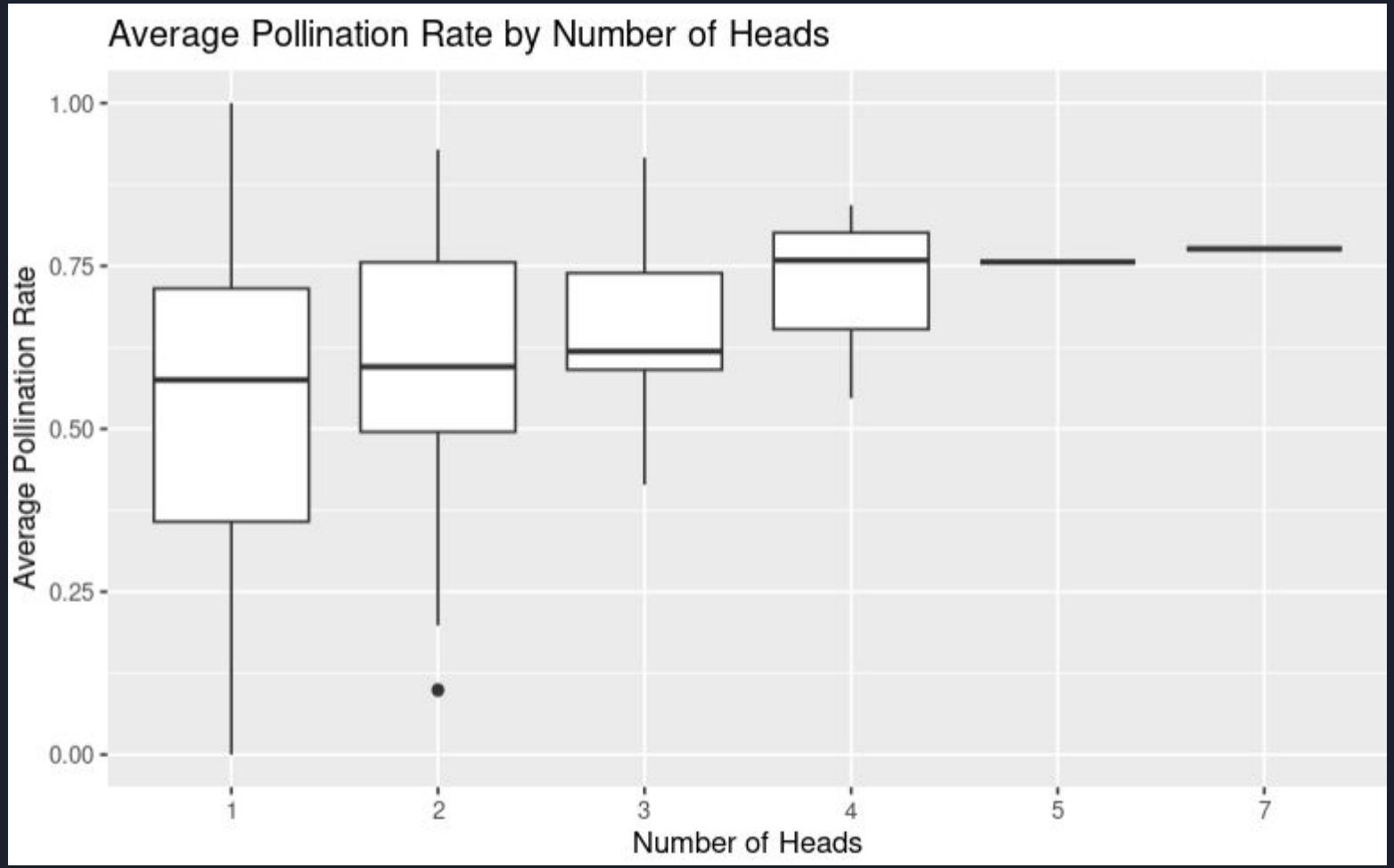
Are plants with more heads less likely to be pollinated?

Hypotheses:

Ho: There is no correlation between the number of heads and pollination rate in echinacea.

Ha: There is a correlation between the number of heads and pollination rate in echinacea.

| | cgPlaId | n | avg |
|---|---|---|---|
| 1 | 4624 | 1 | 1.00000000 |
| 2 | 4627 | 1 | 0.00000000 |
| 3 | 4628 | 1 | 0.94117647 |
| 4 | 4699 | 1 | 0.73809524 |
| 5 | 4720 | 1 | 0.83116883 |
| 6 | 4721 | 1 | 0.62166667 |
| 7 | 4765 | 2 | 0.25499894 |
| 8 | 4768 | 1 | 0.00000000 |
| 9 | 4772 | 1 | 0.00000000 |
| 10 | 4792 | 2 | 0.49697856 |
| 11 | 4885 | 2 | 0.67399267 |
| 12 | 4892 | 1 | 0.43795094 |
| 13 | 4900 | 2 | 0.29023859 |
| 14 | 4929 | 2 | 0.55000000 |
| 15 | 4950 | 3 | 0.60421206 |
| 16 | 4959 | 1 | 0.52777778 |
| 17 | 4965 | 1 | 0.50000000 |
| 18 | 5014 | 1 | 0.33333333 |


Average Pollination Rate by Number of Heads
Average Pollination Rate
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
7
Number of Heads

# Statistical Test

- Performed an ANOVA Test

- With a p-value of .506 > .05 we fail to reject the null hypothesis and there is not enough evidence to conclude there is a correlation between pollination rate and number of heads

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| n | 5 | 0.261 | 0.05223 | 0.866 | 0.506 |
| Residuals | 129 | 7.781 | 0.06032 | | |

# Conclusion

- Taller echinacea heads are correlated with higher pollination rates
- Number of heads is not correlated with pollination rates

- One limitation of the study was limited sample size
- These results only show evidence of a correlation and prove nothing definitively so future research conducting an actual experiment would be useful

# References

Bibliography-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