

# **STATISTICAL ANALYSIS OF ALLELOPATHY BIOASSAY**

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# INTRODUCTION – THORN FOREST BIOME



- Located on the Gulf coast plain in N.E. Mexico and S.E. Texas.
- Transitional zone between tropical and temperate climates
- Sub-tropical and semiarid
- High biodiversity: Over 1,850 plant species
- Only 5% of the native thorn forest habitat remains

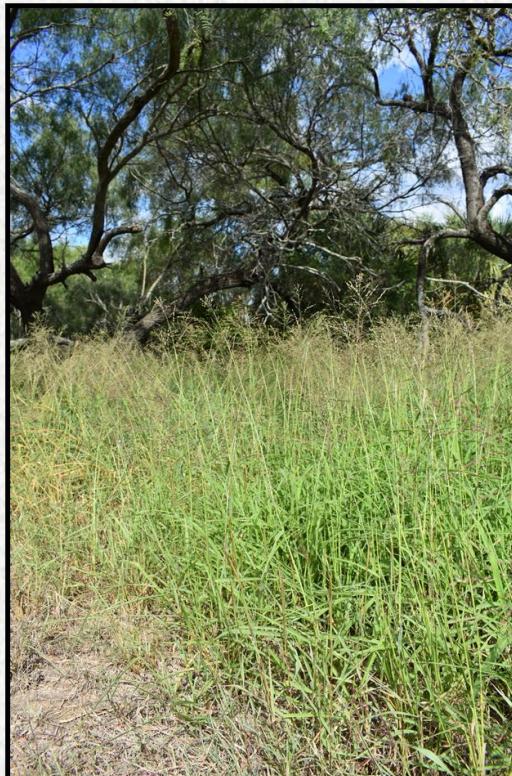


# INTRODUCTION – INVASIVE GRASS AND RESTORATION

## Invasive C4 Grasses

- Guineagrass  
(*Urochloa maxima*)
- Buffel grass  
(*Pennisetum ciliare*)
- Kleberg bluestem  
(*Dichanthium annulatum*)

Invasive grasses are the primary barrier to forest restoration the Rio Grande Valley



# INTRODUCTION – ECOLOGICAL THEORIES

**ALLELOPATHY:** THE CHEMICAL INHIBITION OF ONE PLANT BY ANOTHER, BY THE RELEASE OF SUBSTANCES THAT ACT AS GERMINATION OR GROWTH INHIBITORS.

## Novel Weapons Hypothesis

- Some plants are invasive outside native range
- Allelopathy is the cause
- Plants and soil microbes in invaded ranges are naïve to the allelochemicals
- Invader has a competitive advantage



# INTRODUCTION – ECOLOGICAL THEORIES

**ALLELOPATHY:** THE CHEMICAL INHIBITION OF ONE PLANT BY ANOTHER, BY THE RELEASE OF SUBSTANCES THAT ACT AS GERMINATION OR GROWTH INHIBITORS.

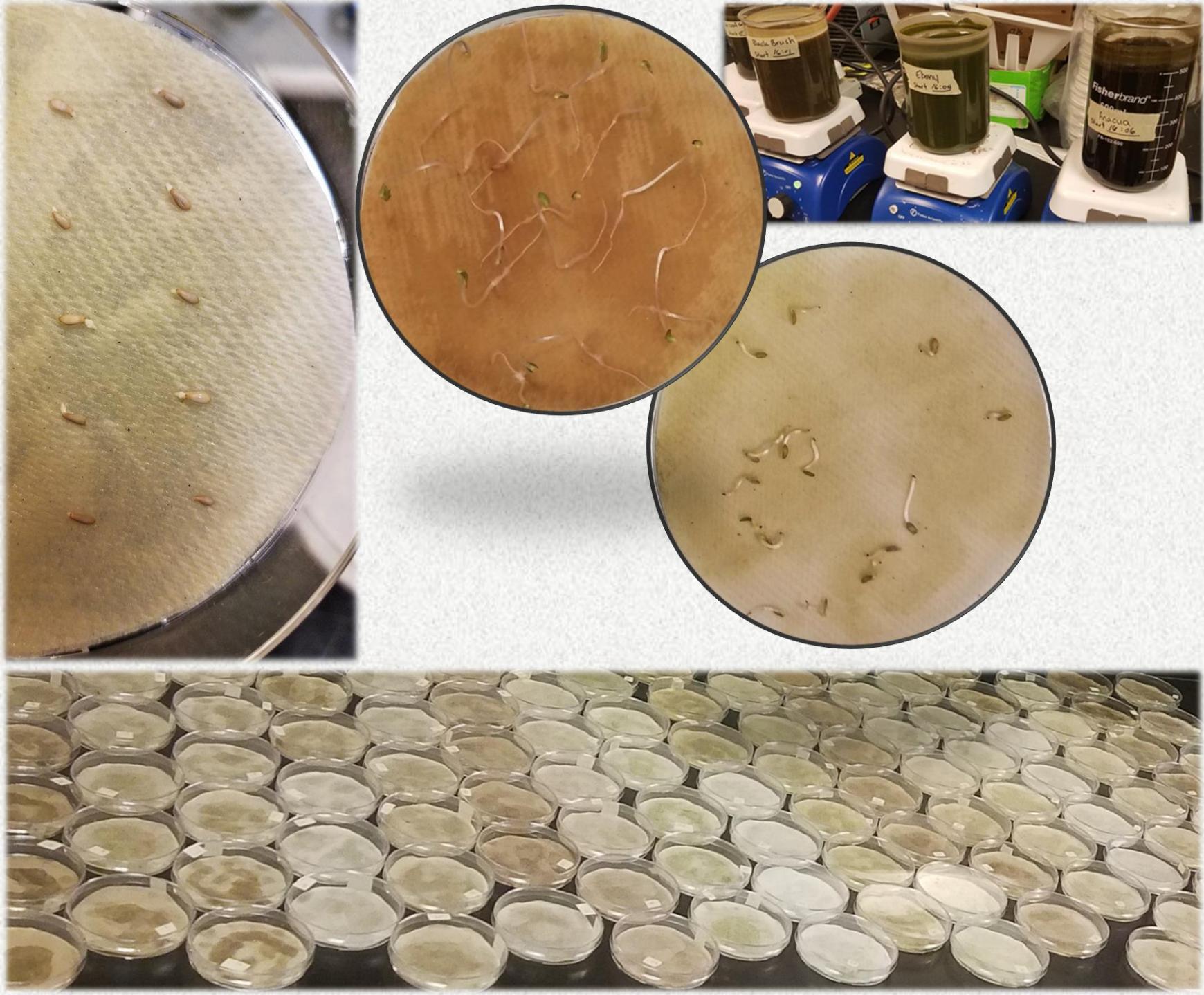
## Homeland Security Hypothesis

- Within intact ecosystems, allelopathy of native species may inhibit invasion
- Novel species will be naïve to the allelochemicals of the native plants.
- Some species in the Fabaceae family inhibit the growth of invasive C4 African grasses
  - ❖ Many of the species in the Tamaulipan Thorn Forest belong to the Fabaceae family



# METHODS – BIOASSAY

- Allelopathic extracts were made from dried leaves
- Extracts applied to lettuce seeds
- Germination measured daily
- Seedling length measured after 5 days
- Germination metrics calculated
  - Seed Germination Index (SGI)
  - Mean Germination Time (MGT)
  - Percent Germination
  - Seedling Length



# METHODS – TESTING FOR NORMALITY

- Made histograms and Q-Q plots
  - Histograms don't look normally distributed
  - Residuals not normal
- Shapiro test to confirm non-normality
  - All variables had p-values < 0.05
- Log transformation of data
- More Q-Q plots
- Run Shapiro test again
- Log transformation made non-normality more extreme

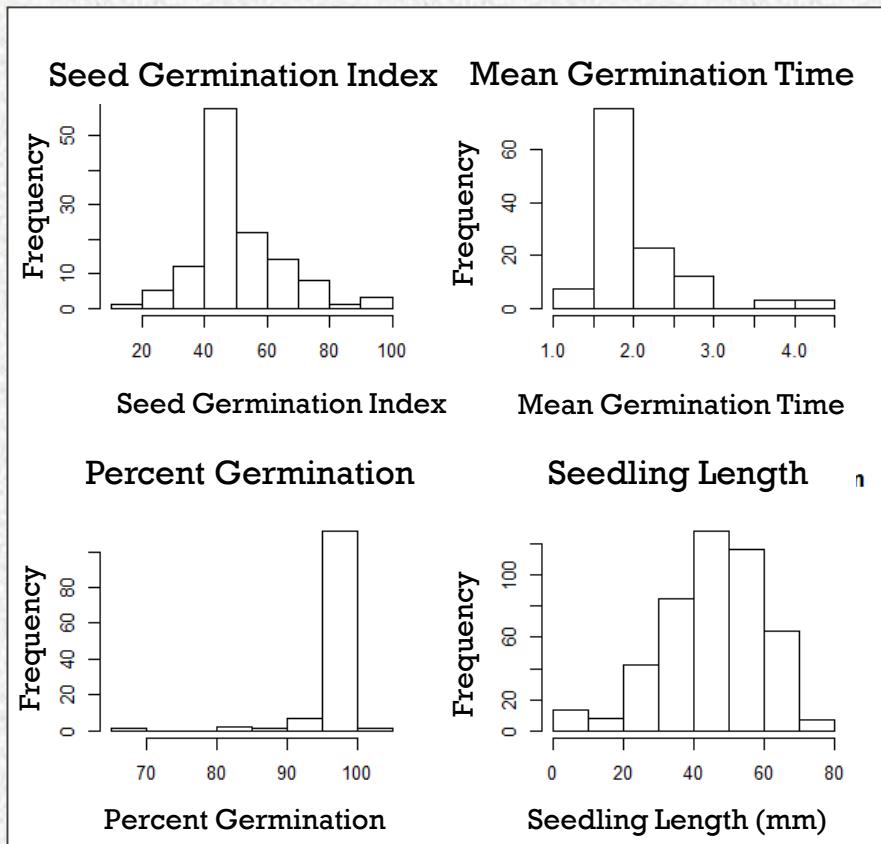


Figure 1: Exploratory histograms of each variable (SGI, MGT, Percent Germination, and Seedling Length)

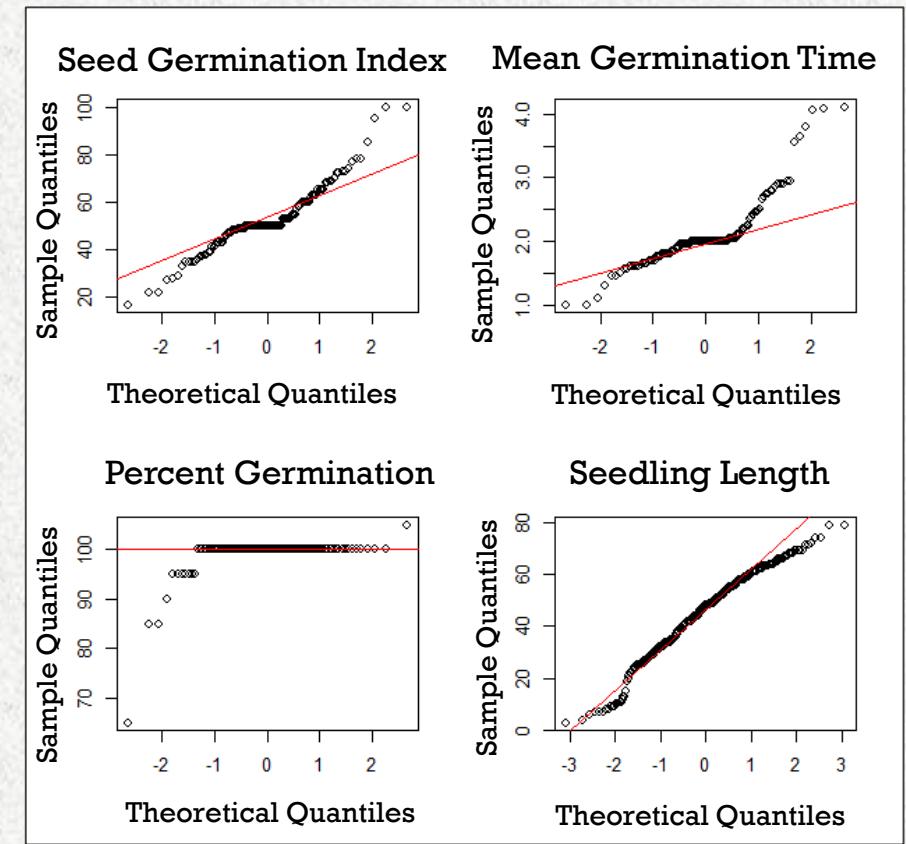
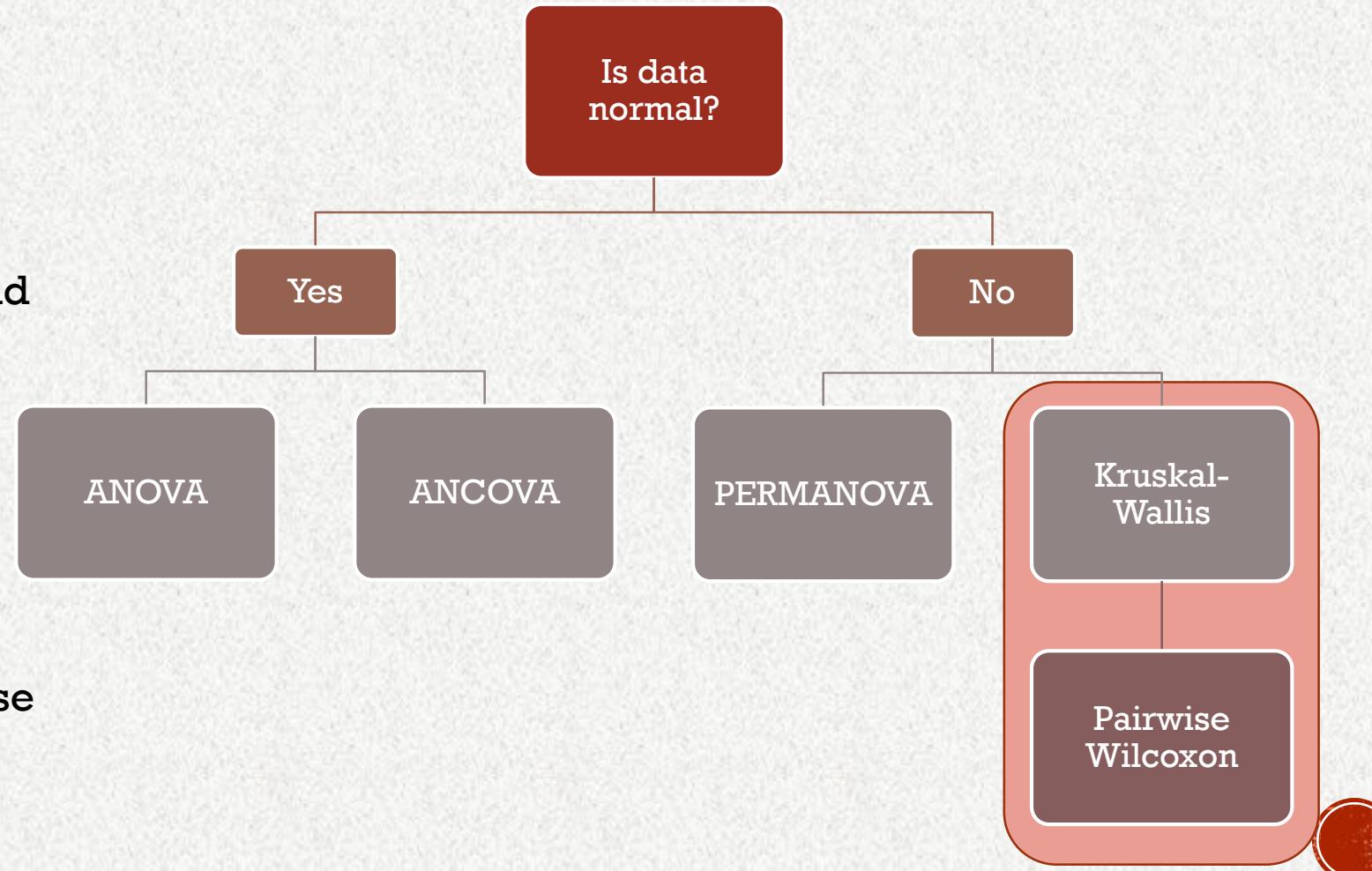


Figure 2: Exploratory Q-Q plots of each variable (SGI, MGT, Percent Germination, and Seedling Length)



# METHODS – CHOOSING A STATISTICAL TEST

- None of the data was normally distributed, this violates the assumptions of ANOVA and ANCOVA
- PERMANOVA's multivariate spread assumption was violated by the data
- Kruskal-Wallis was used
  - Also known as one-way ANOVA on ranks
- Post-hoc test used was the Pairwise Wilcoxon test



# RESULTS – STATISTICAL ANALYSIS

- Kruskal – Wallis test was significant for SGI, MGT, and seedling length
- Post-hoc testing: Wilcoxon Rank Sum
  - SGI: all treatments varied significantly from the control
  - MGT: All treatments EXCEPT Huisache 66% varied significantly from the control
  - Seedling Length: Anacua, Indian Mallow, Ebony, Elbowbush, Huisachillo, Colima 99%, Turk's Cap 99% varied significantly from the control
    - ❖ This does not mean they reduced seedling length



Treatment	Mean	SD
Control	1.1	0.14
Huisache 66%	2.1	0.10



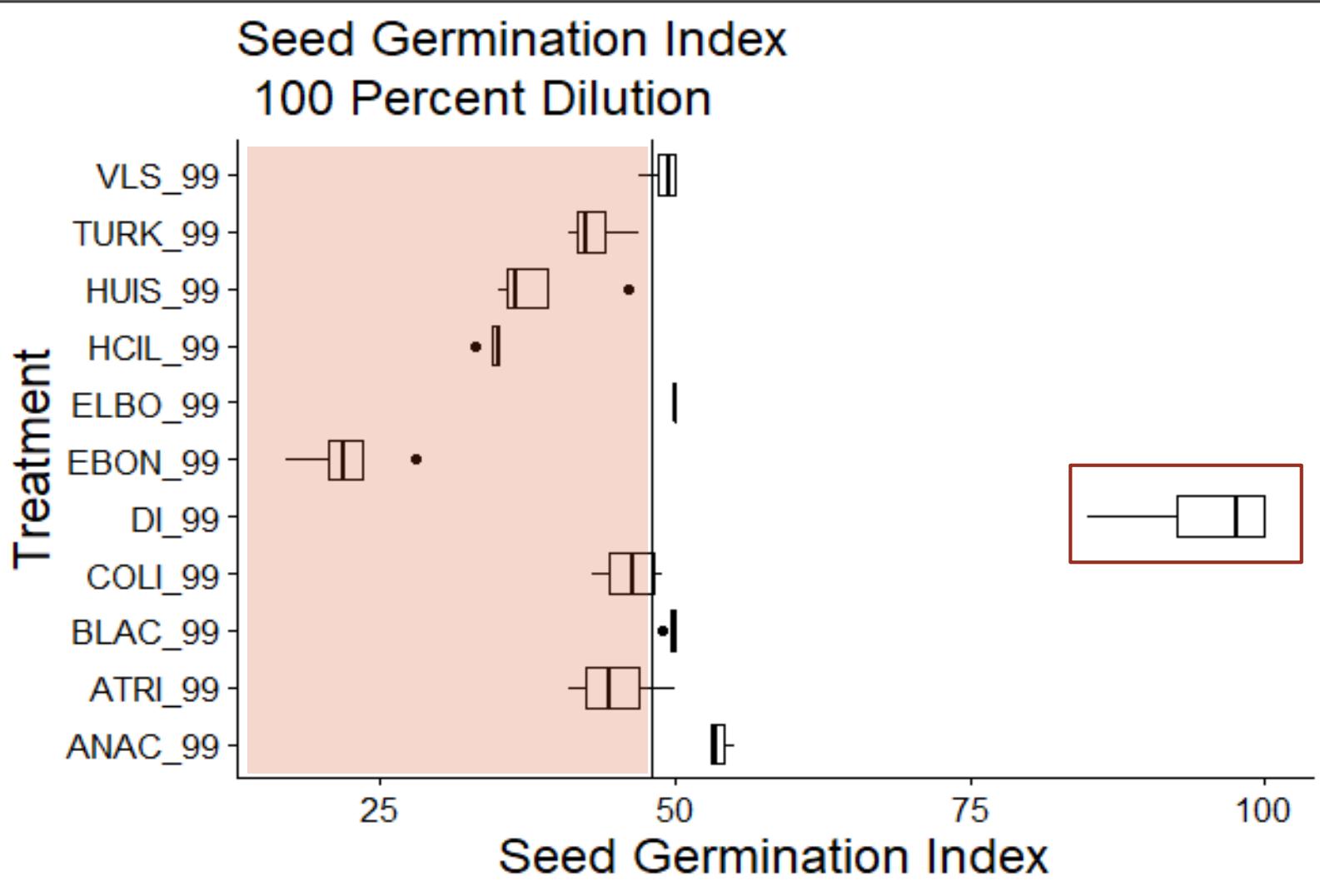


Figure 3: Boxplot of Seed Germination Index for all treatments at the 100% dilution. Horizontal line indicates the mean SGI.

## RESULTS – SEED GERMINATION INDEX

Treatments that reduce Seed Germination Index to below the mean

- Turks's Cap
- Huisache
- Huisachillo
- Ebony
- Colima
- Three Furrowed Indian Mallow



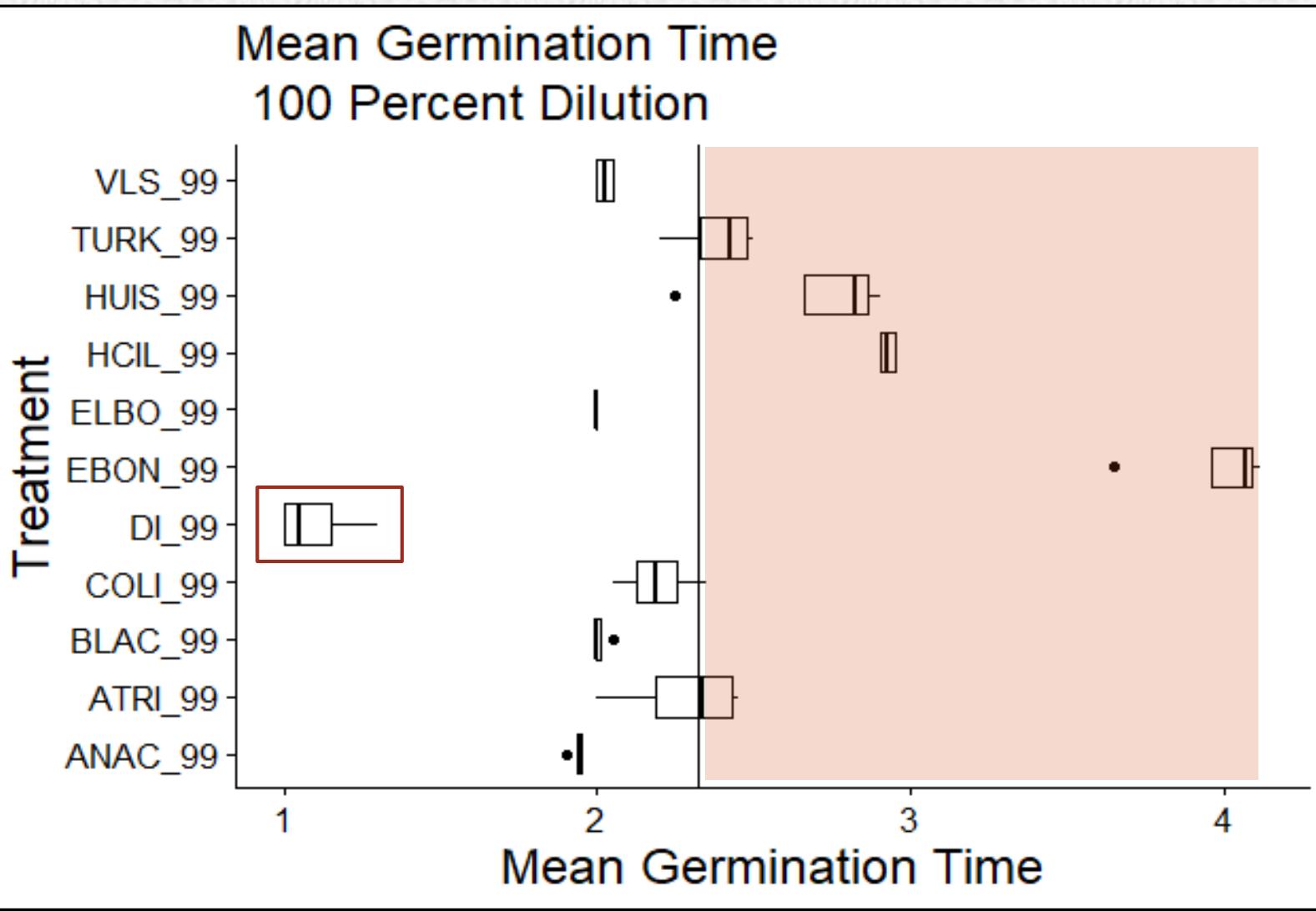


Figure 4: Boxplots of mean germination time by treatment at 100% dilution. Horizontal line indicates the mean MGT across all treatments.

## RESULTS – MEAN GERMINATION TIME

Treatments that reduce Seed Germination Index to above the mean

- Turks's Cap
- Huisache
- Huisachillo
- Ebony
- Three Furrowed Indian Mallow



# RESULTS – PERCENT GERMINATION

Only Ebony reduced percent germination

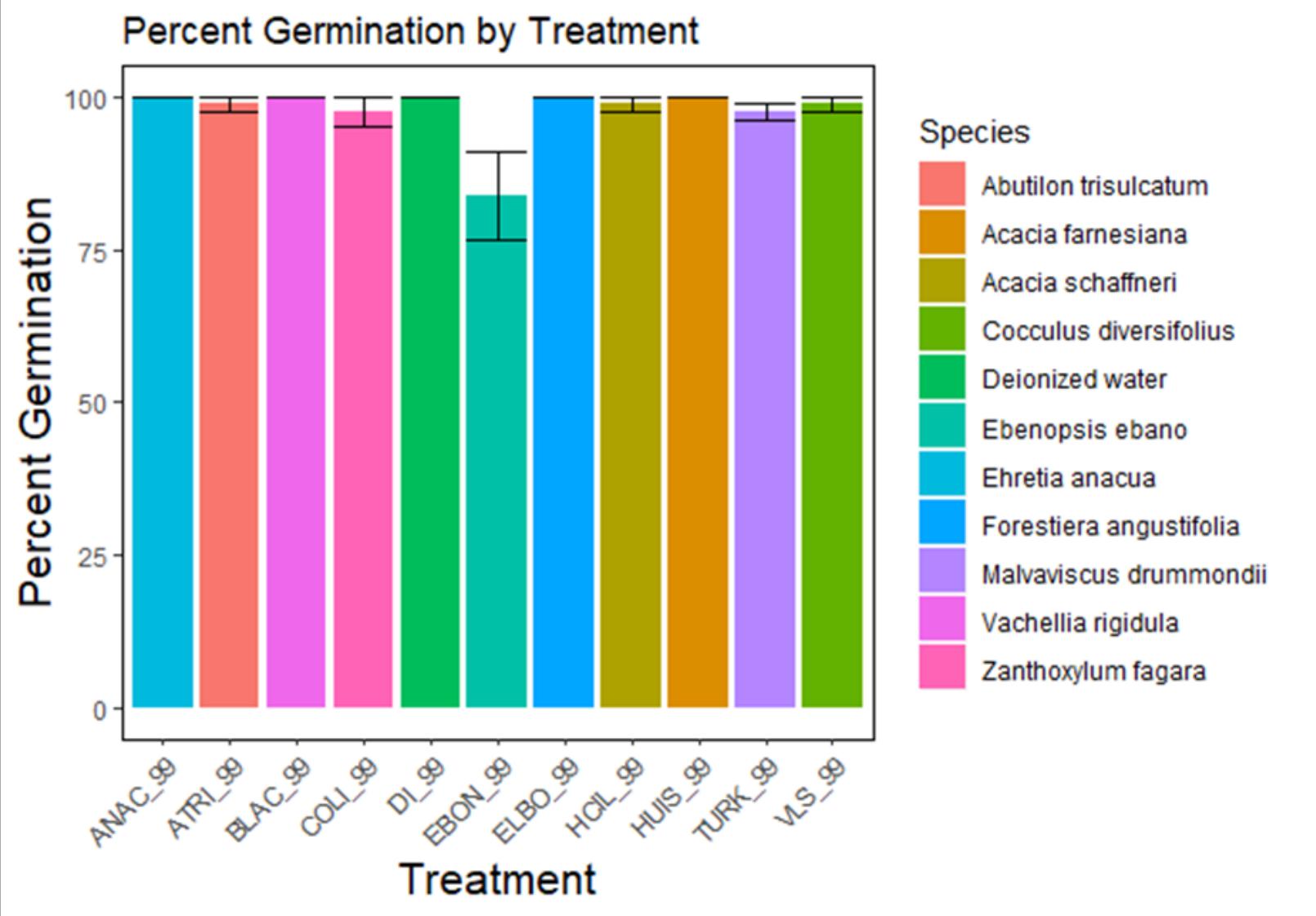


Figure 5: Bar graph depicting the percent germination for each treatment at the 100% dilution.



## Cumulative Germination by Day 100 percent concentration

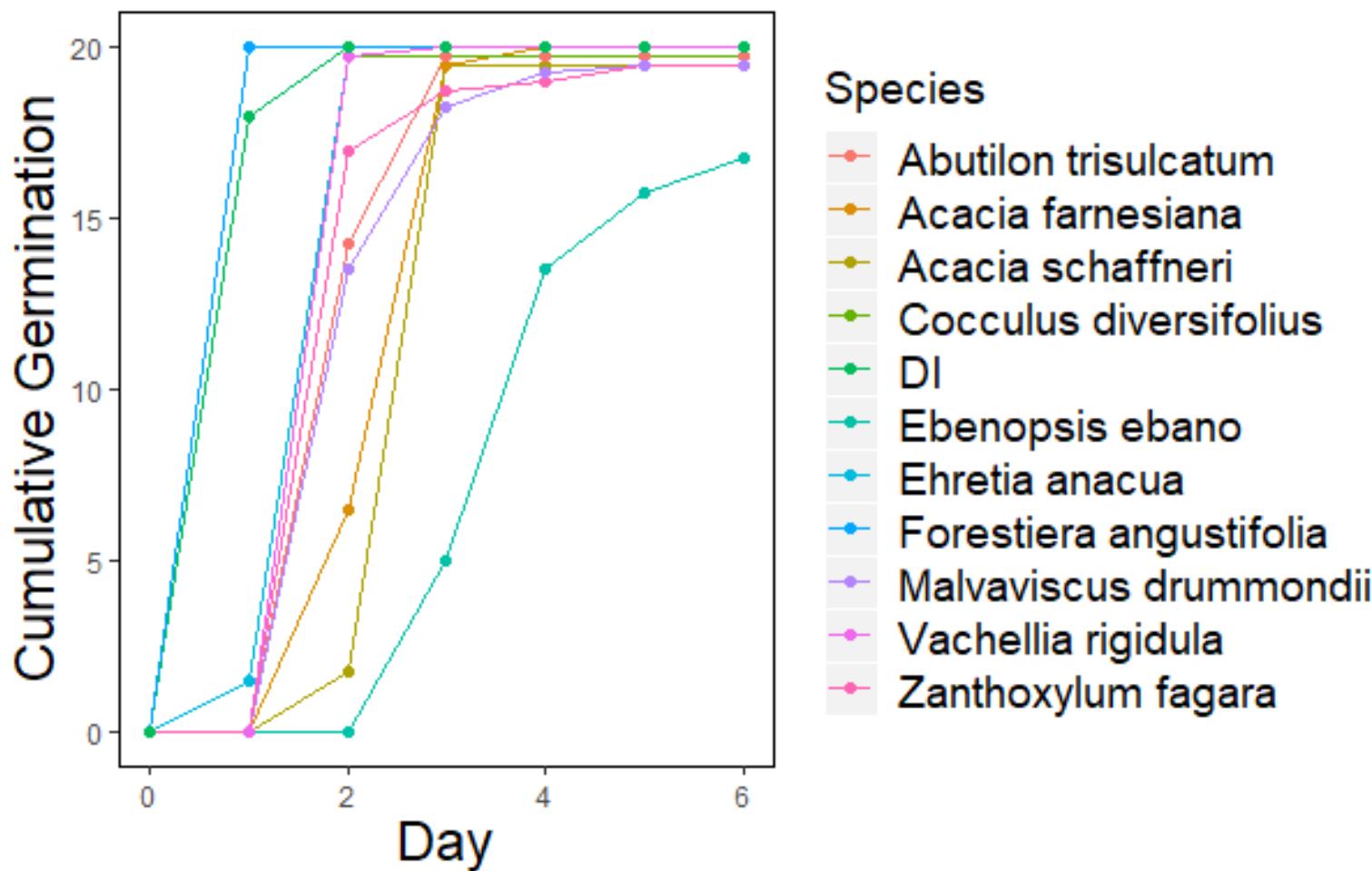


Figure 6: Bar graph depicting the percent germination for each treatment at the 100% concentration.

## RESULTS – CUMULATIVE GERMINATION

The rate at which different treatments reached their final percent germination varied.



# RESULTS – SEEDLING LENGTH

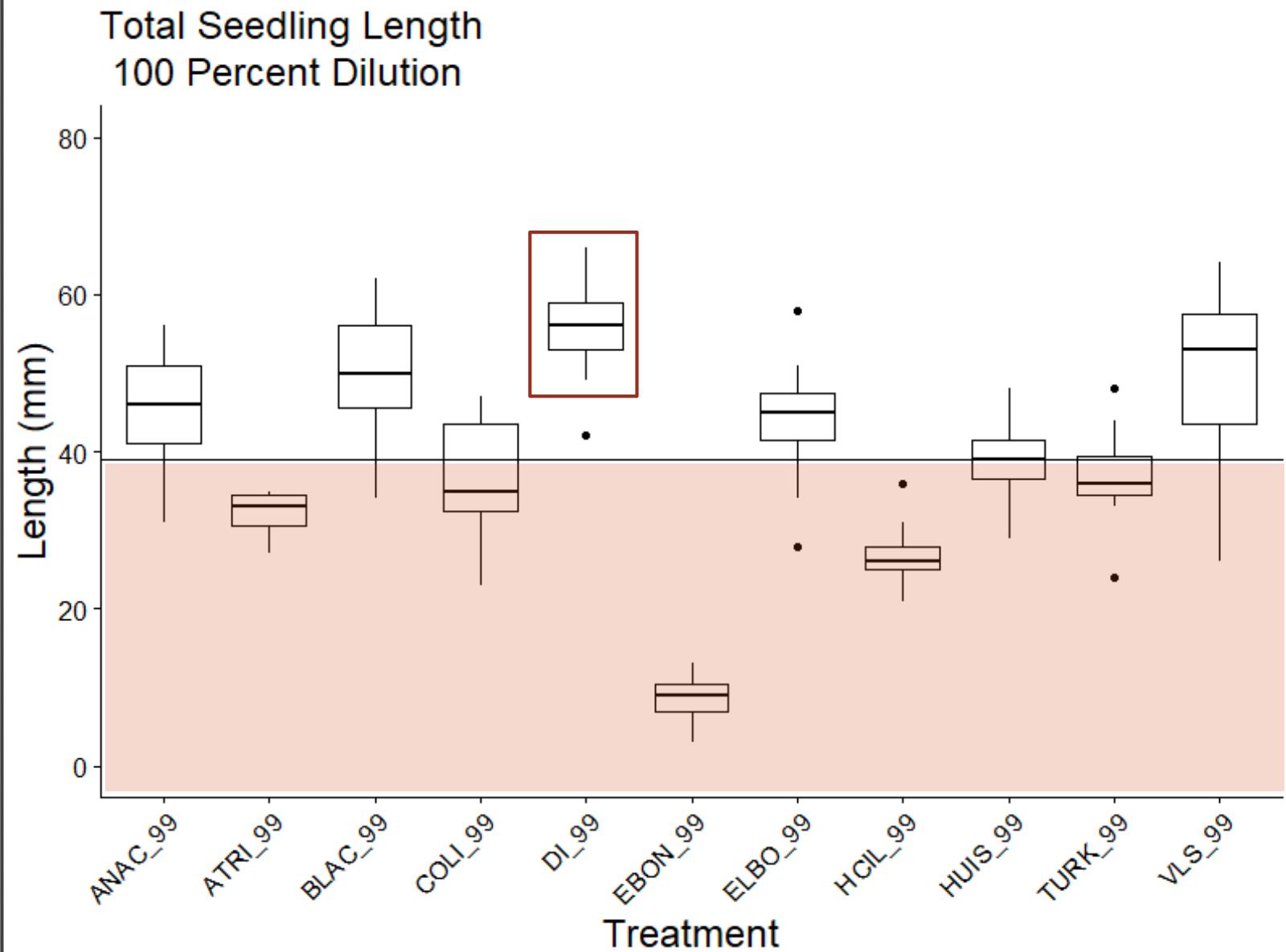


Figure 7: Boxplots of measured lengths of all treatments. Horizontal line indicates the mean length of all seedlings in that dilution.



# DISCUSSION – WHICH SPECIES ARE LIKELY ALLELOPATHIC

SGI	MGT	% Germ.	Length
Turk's Cap	Turk's Cap	Ebony	Turk's Cap
Huisache	Huisache		Huisache
Huisachillo	Huisachillo		Ebony
Ebony	Ebony		Colima
Colima	Mallow		Mallow
Mallow			



# CONCLUSIONS

- Species plays important role in the inhibition of germination and early growth
- Thorn scrub species that exhibit allelopathic potential

## Woody Plants:

- *E. ebano* (Texas Ebony)
- *A. schaffneri* (Huisachillo)
- *Z. fagara* (Colima)
- *A. farnesiana* (Huisache)

## Herbaceous Plants:

- *A. trisulcatum* (Three Furrowed Indian Mallow)
- *M. drommondii* (Turk's Cap)

- Field experiments are vital in confirming allelopathic interactions between plants
- Surveying species before use in restoration is vital: in this experiment *E. anacua* increased the early growth of lettuce seedlings



# IMPLICATIONS AND FURTHER RESEARCH

These species may be able to aid future forest restoration efforts by inhibiting the growth of invasive grasses

Research is ongoing to explore the use of:

- Allelopathic mulch
- Seeding allelopathic forbs

Avenues for further research

- High density plantings with allelopathic species



# QUESTIONS?

