

# Population divergence and plasticity of *Pleuraphis jamesii* across a monsoon gradient

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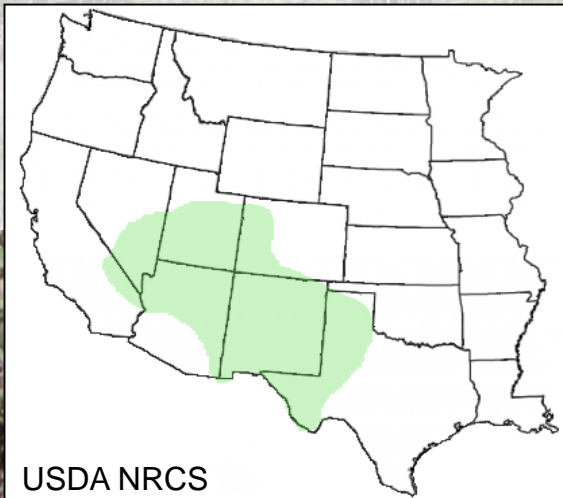


*Pleuraphis jamesii*  
(galleta grass)





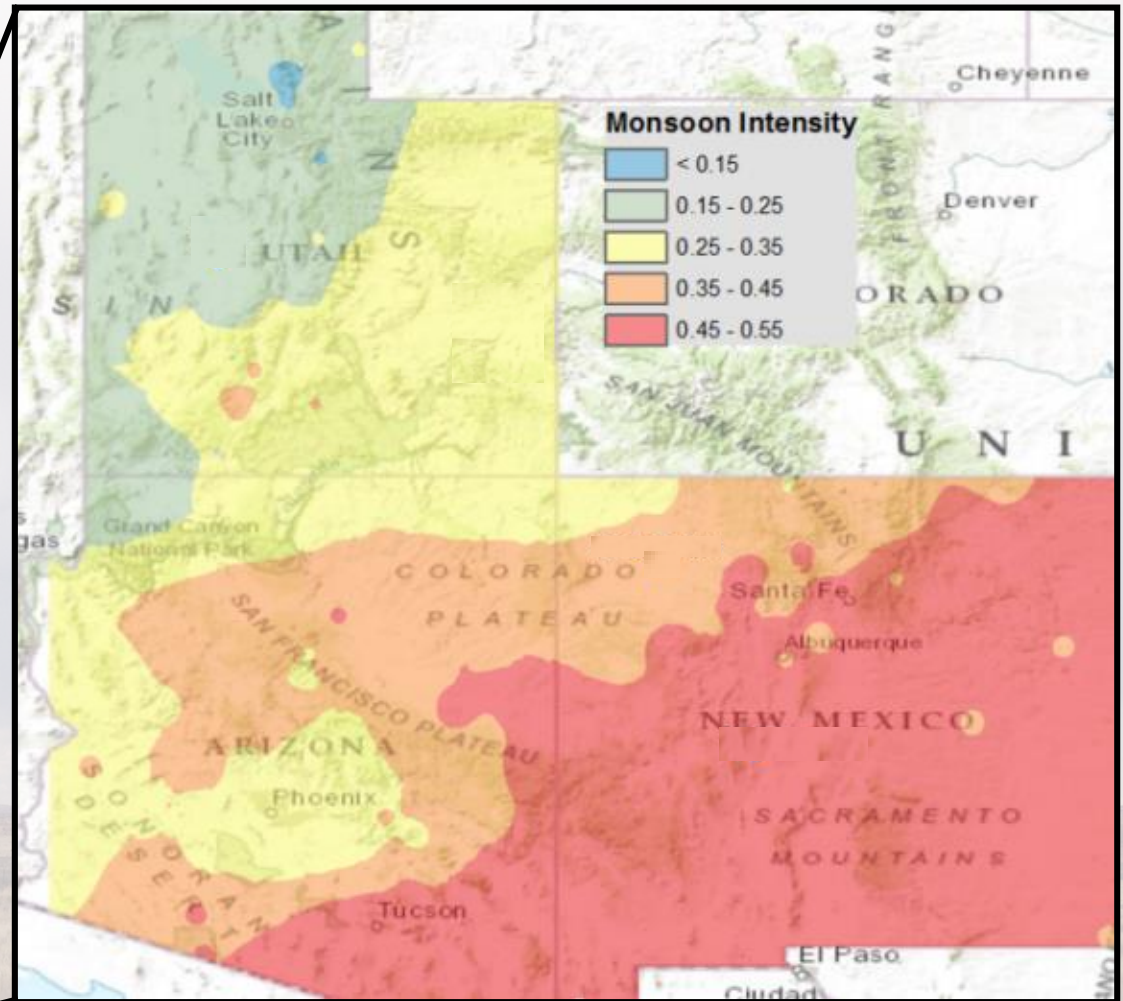
- Dominant, widespread C<sub>4</sub> grass
- Restoration
  - Surface stabilization, erosion control, drought tolerance



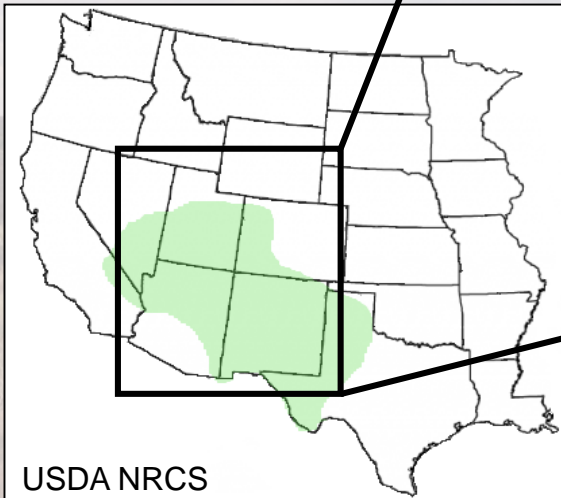
*Pleuraphis jamesii*  
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# Galleta grass spans a sharp monsoon gradient

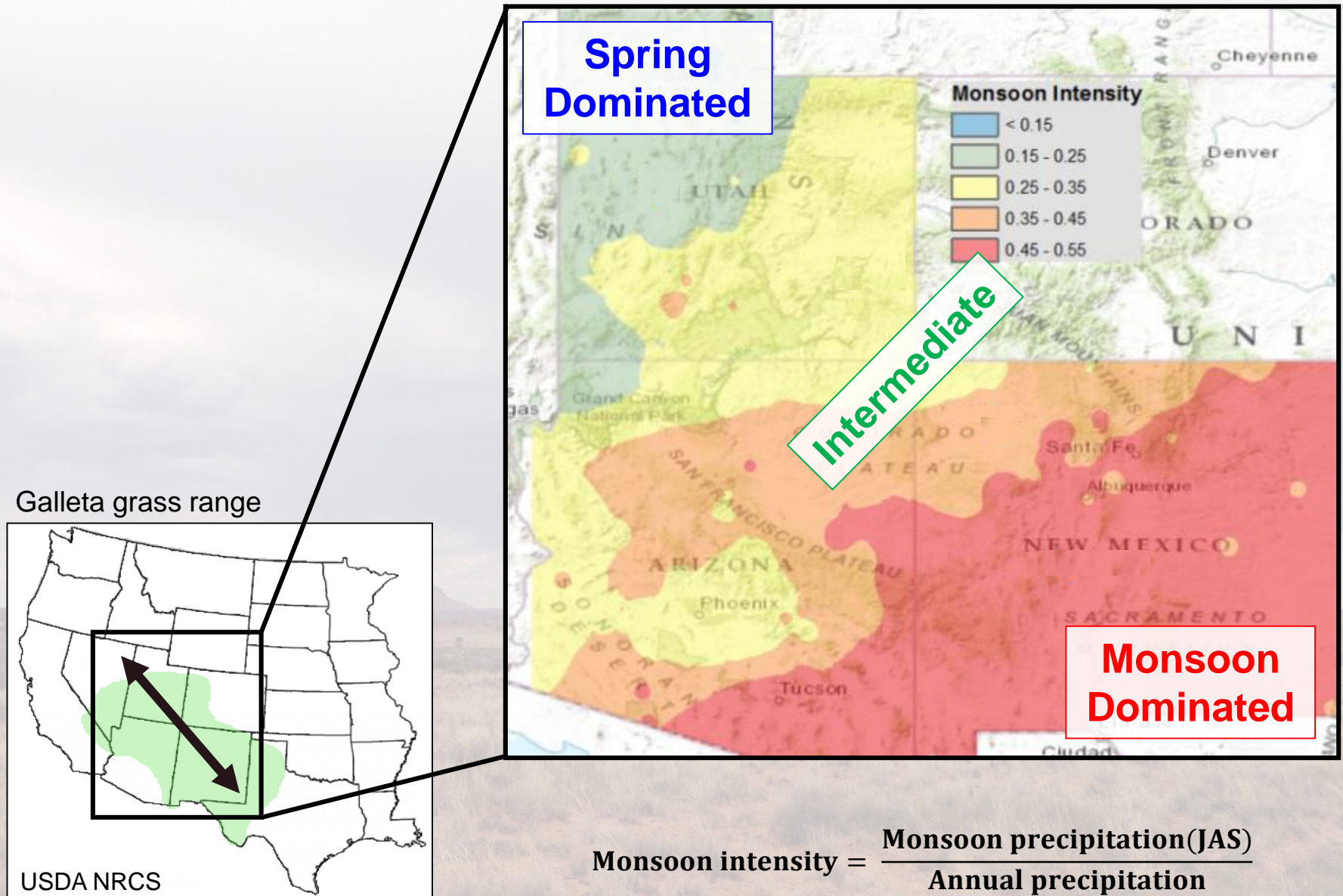


Galleta grass range



$$\text{Monsoon intensity} = \frac{\text{Monsoon precipitation(JAS)}}{\text{Annual precipitation}}$$

# Galleta grass spans a sharp monsoon gradient





**Do galleta grass traits and climatic sensitivity  
vary across the Southwest monsoon  
gradient?**



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***H1:*** Traits will vary among populations.





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***H2:*** Traits will respond to precipitation seasonality.



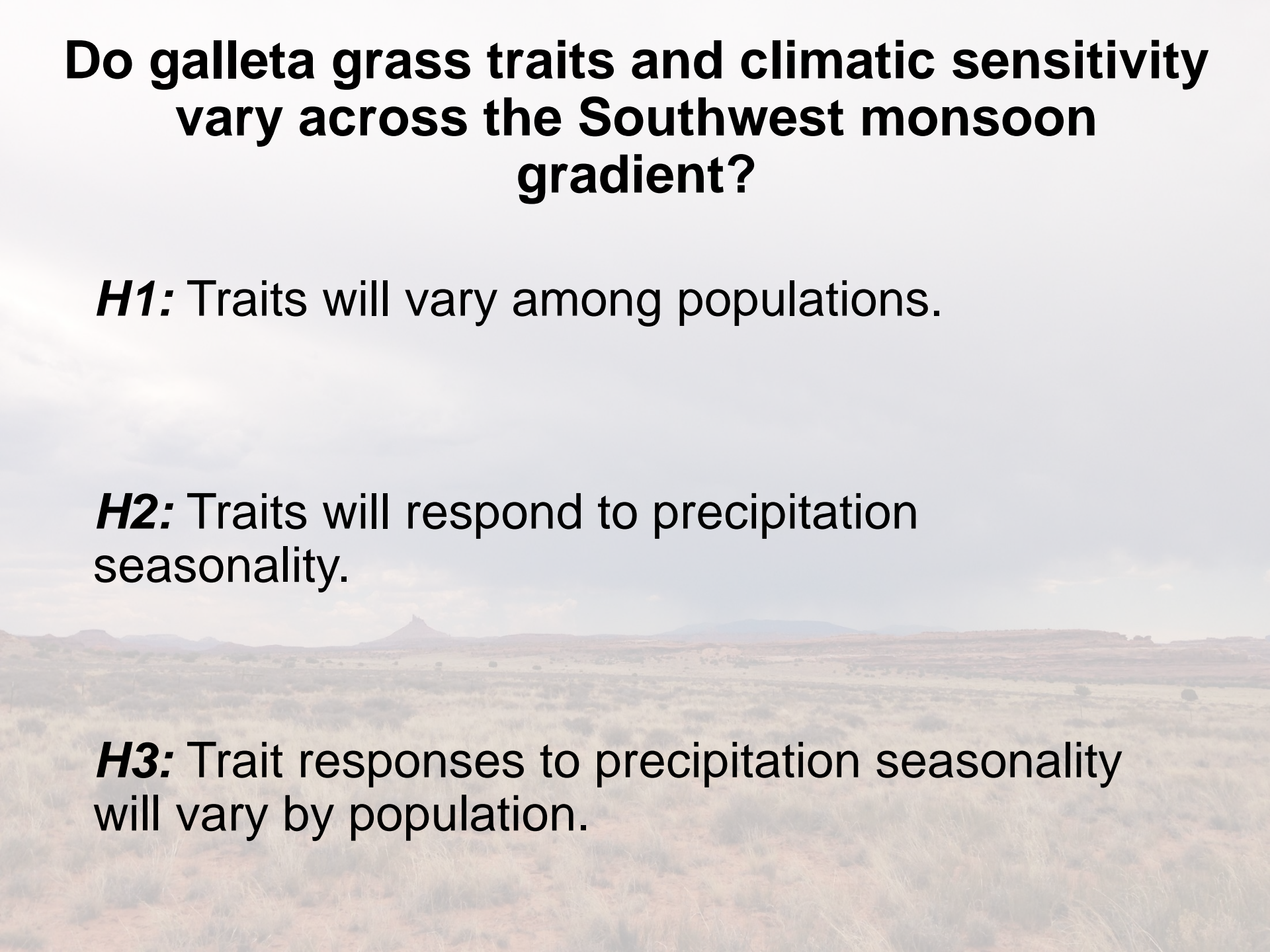


# Do galleta grass traits and climatic sensitivity vary across the Southwest monsoon gradient?

***H1:*** Traits will vary among populations.

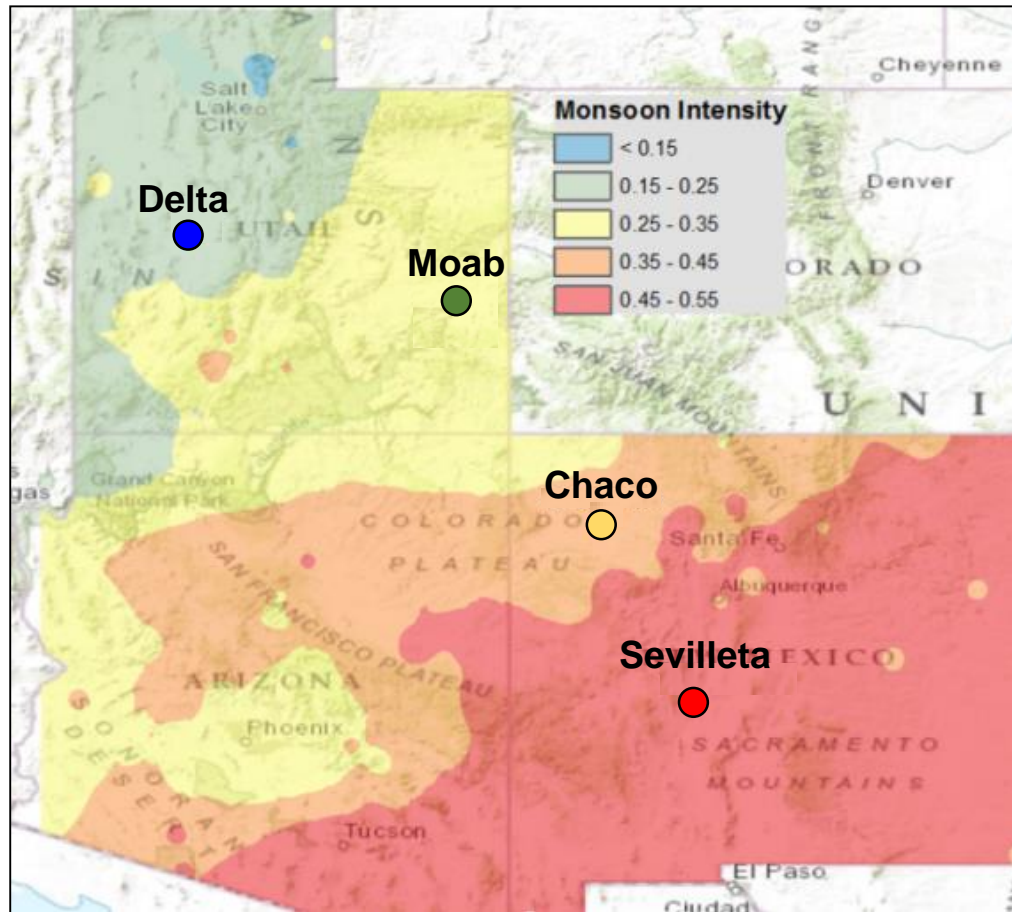
***H2:*** Traits will respond to precipitation seasonality.

***H3:*** Trait responses to precipitation seasonality will vary by population.





# Field collections: populations sourced across the monsoon gradient



Same annual precipitation (~230 mm/yr),  
different monsoon intensity





# Common garden experiment

**2015:** field collections,  
garden establishment  
**2016:** treatment year 1  
**2017:** treatment year 2

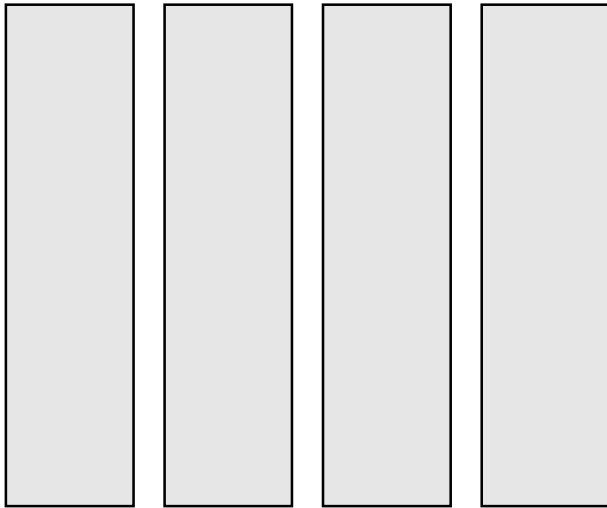


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RESEARCH CENTER



# Common garden experiment

4 greenhouse  
blocks



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garden establishment  
**2016:** treatment year 1  
**2017:** treatment year 2

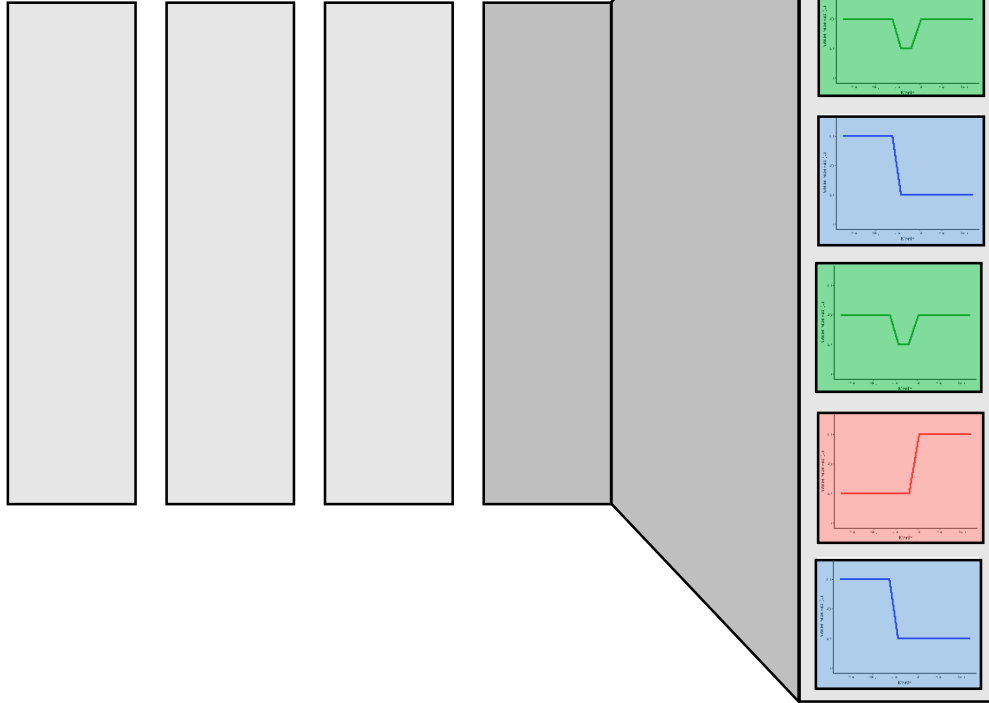


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RESEARCH CENTER



# Common garden experiment

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blocks

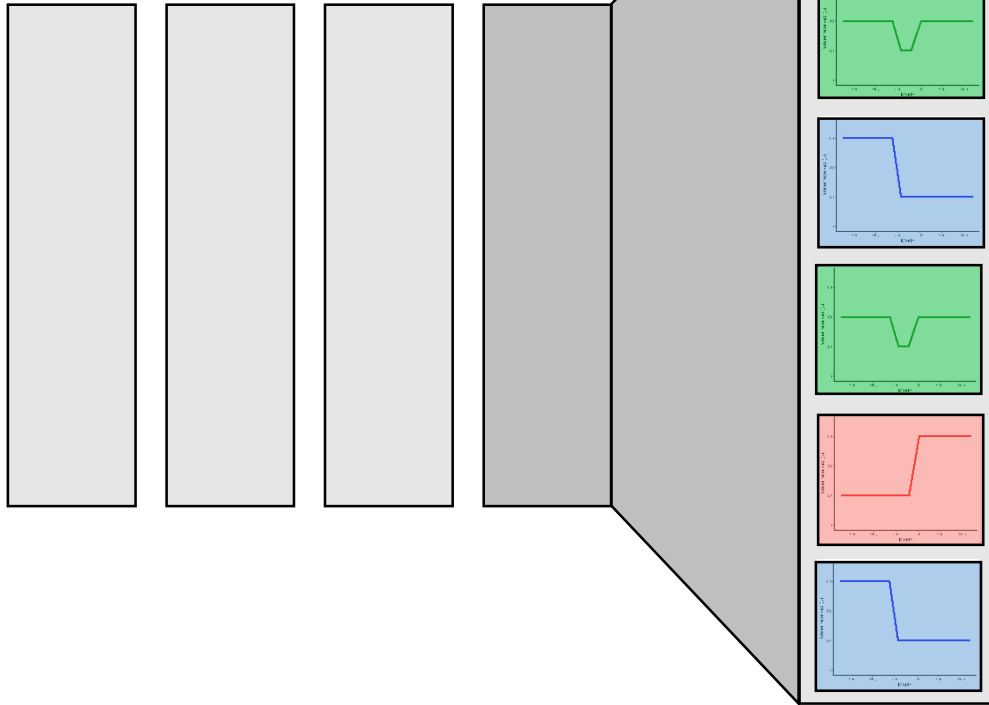


3 precip. treatments/block  
2 reps/treatment



# Common garden experiment

4 greenhouse  
blocks



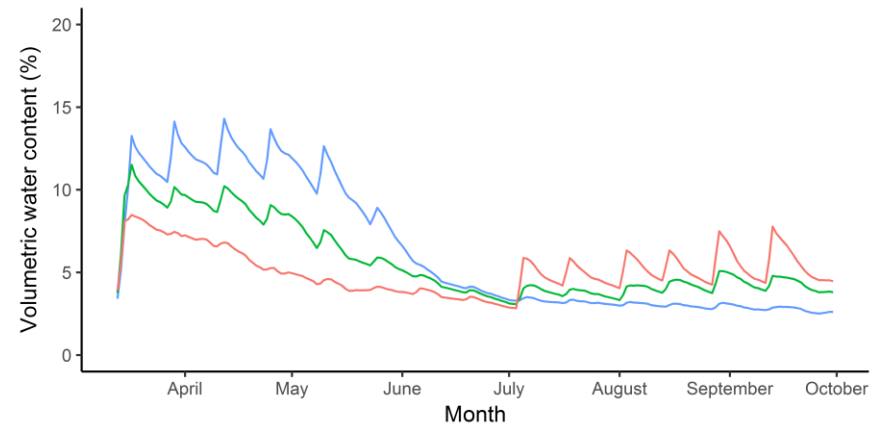
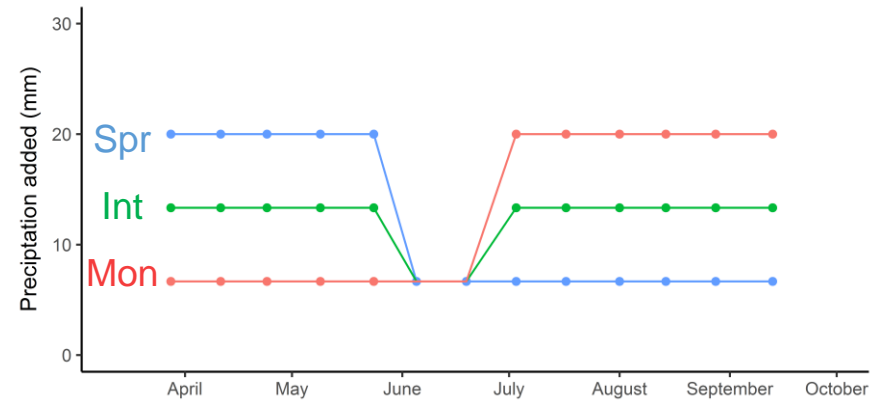
3 precip. treatments/block

2 reps/treatment

Spring

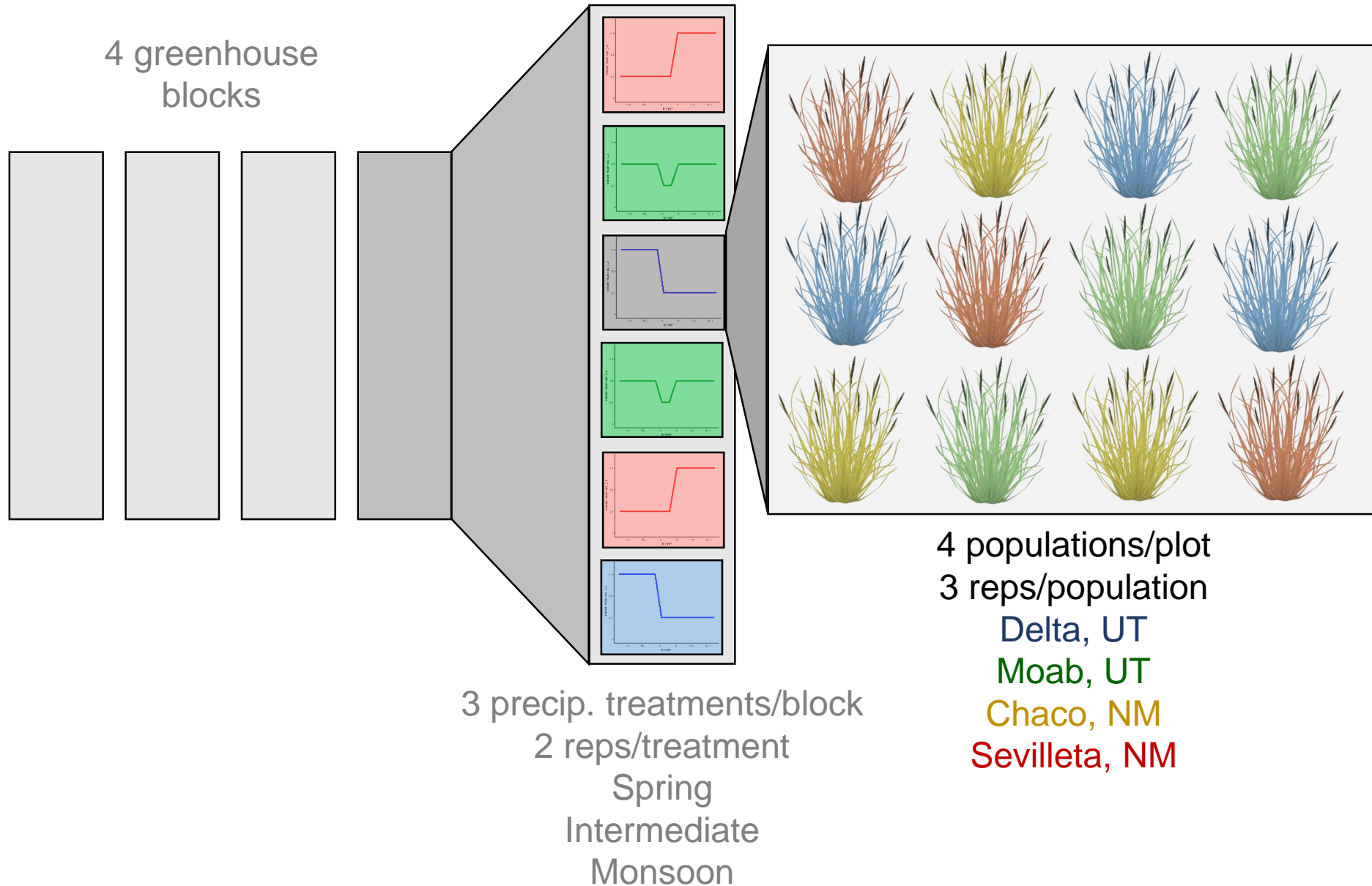
Intermediate

Monsoon





# Common garden experiment









# Today, focus on four traits:



**Aboveground  
biomass**



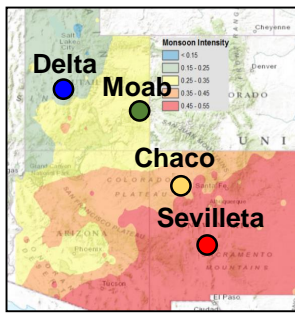
**Number of  
inflorescences**



**Belowground  
biomass**

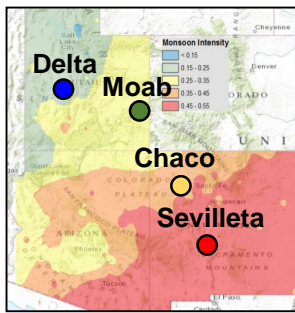


**Date of first  
flower**

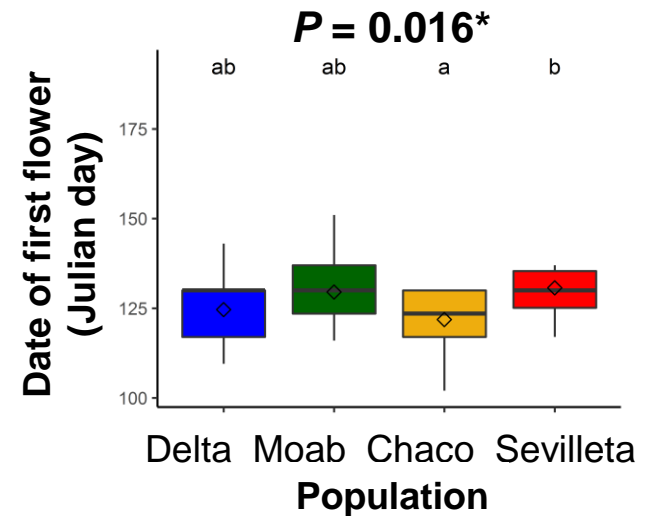
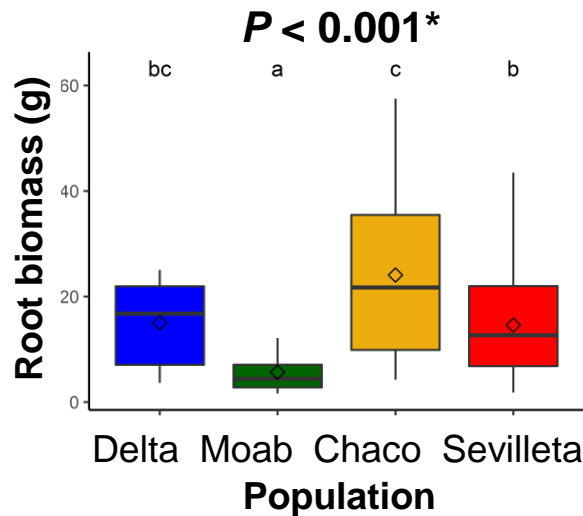
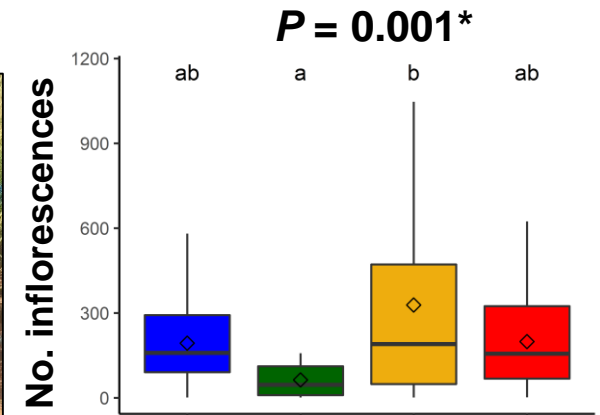
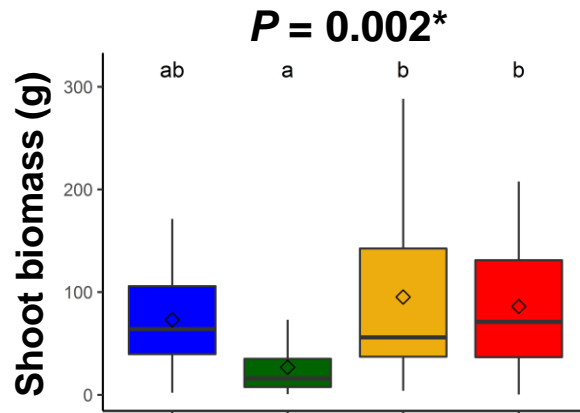
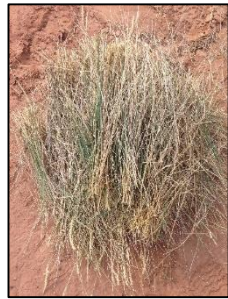


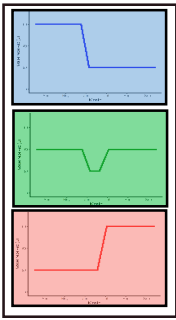
***H1:*** Traits will vary among populations.





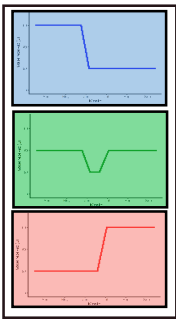
# *H1*: Strong trait differentiation among populations.



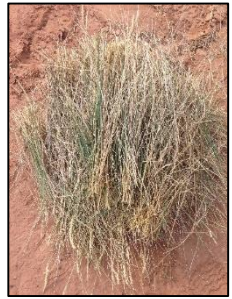


***H2:*** Traits will respond to precipitation seasonality.

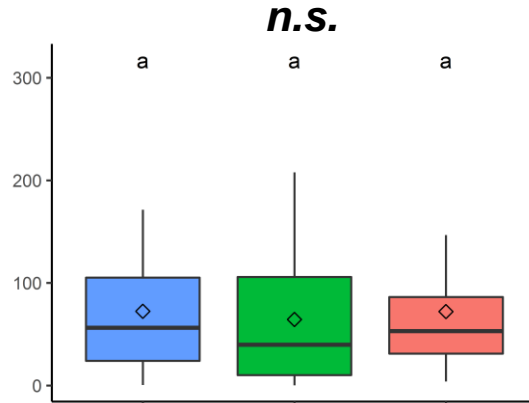




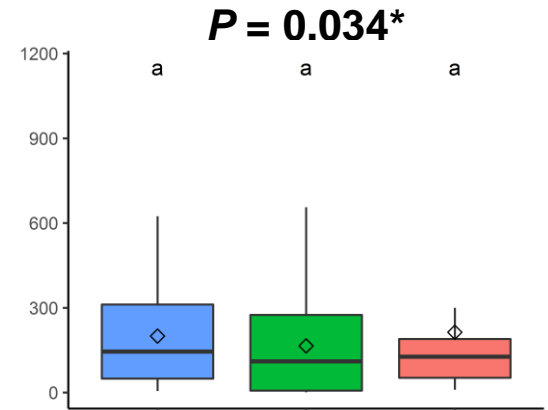
## ***H2:*** Traits respond to precipitation seasonality, but responses are weak or non-significant.



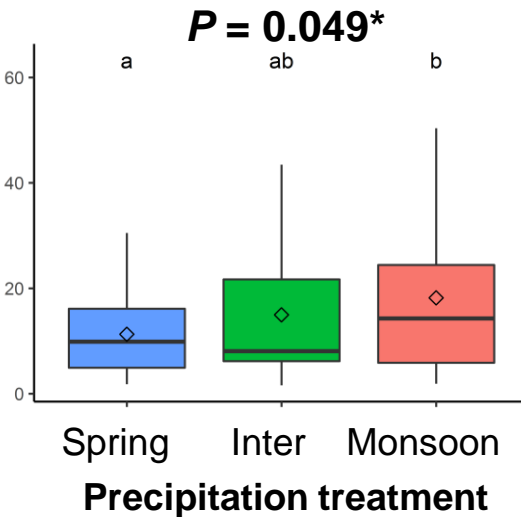
Shoot biomass (g)



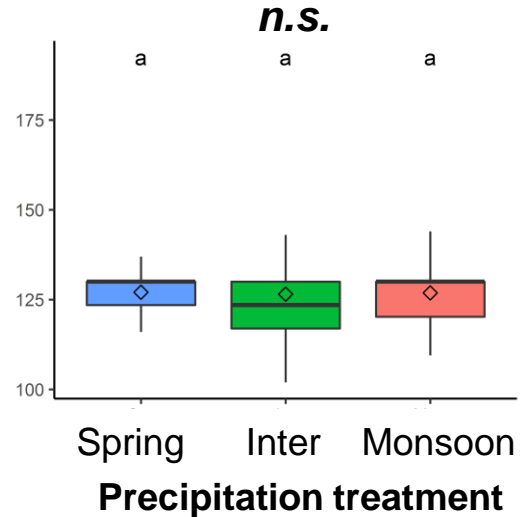
No. inflorescences

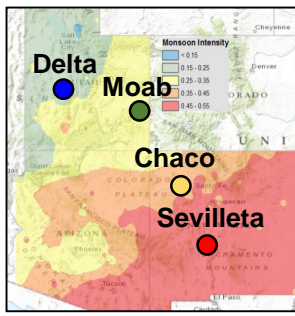


Root biomass (g)

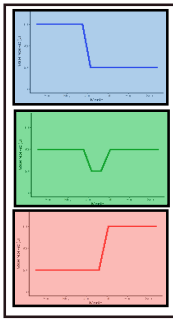


Date of first flower (Julian day)



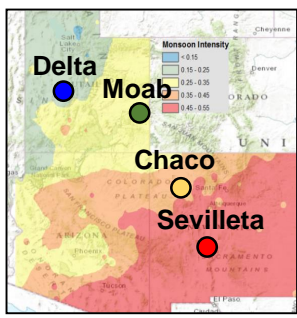


X

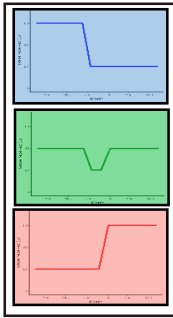


***H3:*** Trait responses to precipitation seasonality will vary by population.





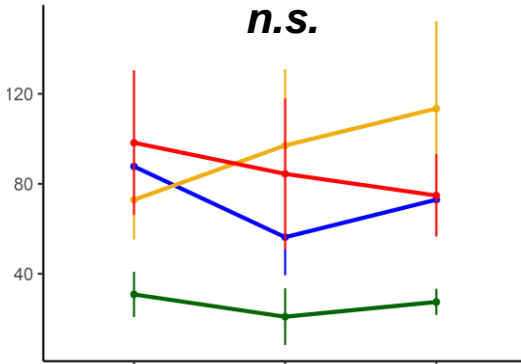
**X**



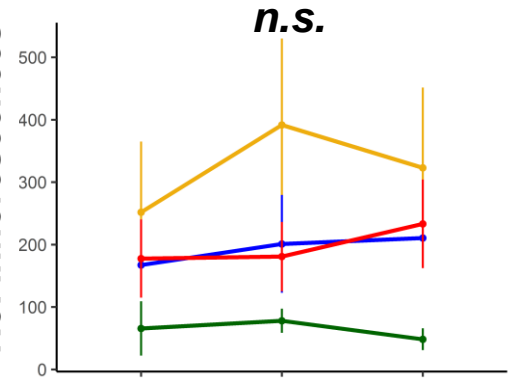
***H3:*** No population-specific responses to precipitation seasonality.



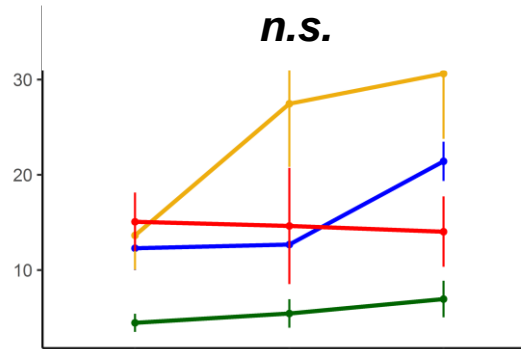
Shoot biomass (g)



No. inflorescences



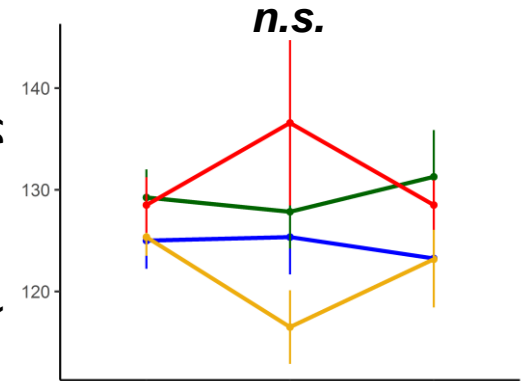
Root biomass (g)



Spring Inter Monsoon  
Precipitation treatment



Date of first flower  
(Julian day)



Spring Inter Monsoon  
Precipitation treatment

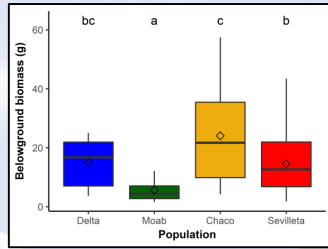
# Conclusions and Implications





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## 1. Galleta grass populations are different

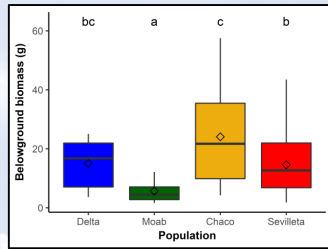


- Population source will determine traits (and suitability?) introduced via restoration.
- Mixed-source plantings would increase trait diversity, adaptive capacity.

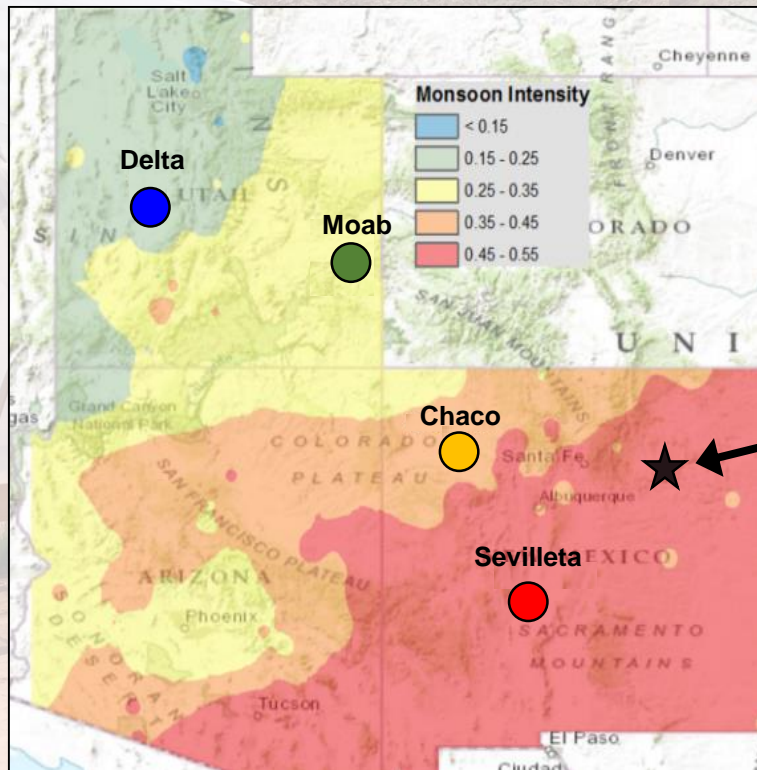


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**USDA**  
United States Department of Agriculture

A Conservation Plant Released by the Natural Resources Conservation Service  
Los Lunas Plant Materials Center, Los Lunas, NM

### 'Viva' James' galleta

*Pleuraphis jamesii* Torr.

**Source**  
The 'Viva' James' galleta seed was collected by the Soil Conservation Service in 1944 from a native stand near Newkirk, New Mexico.

**Conservation Uses**  
The abundance of galleta and its ability to produce considerable forage make it a very important species on many southwestern ranges. 'Viva' James' galleta is useful for critical area soil stabilization and range revegetation in its natural range of adaptation.

'Viva' galleta is very drought-resistant and maintains itself very well on arid ranges, where average annual precipitation may be as low as seven inches.

**Area of Adaptation and Use**  
'Viva' galleta grows well on medium to heavy, moderately saline soils. It grows from rhizomes and seed mainly in the summer after sufficient rainfall. Its drought resistance allows it to do well even in areas with only 8 inches of annual precipitation. While it is green, its forage value is good for all classes of livestock and wildlife.

Galleta is widely distributed in Colorado (except in the central and north-central parts) from elevations of 3,500 to 7,500 feet (1,070 to 2,290 m). It is most commonly found in the northern two-thirds of New Mexico at elevations of 3,500 to 7,500 feet (1,070 to 2,290 m). It is also found in western Texas, Wyoming, Utah, Nevada, California, and Arizona.

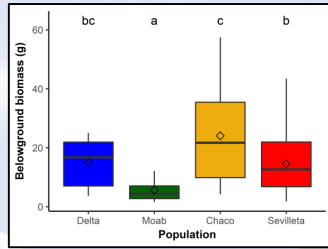
**Description**  
'Viva' James' galleta, a native, warm-season, perennial

**Ecological Considerations**  
'Viva' James' galleta, when placed in mixes with other



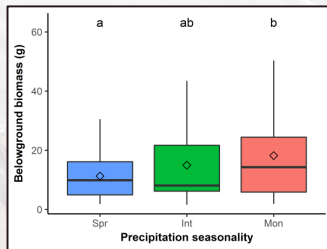
# Conclusions and Implications

## 1. Galleta grass populations are different



- Population source will determine traits (and suitability?) introduced via restoration.
- Mixed-source plantings would increase trait diversity, adaptive capacity.

## 2. Galleta grass is resistant to changes in precipitation timing

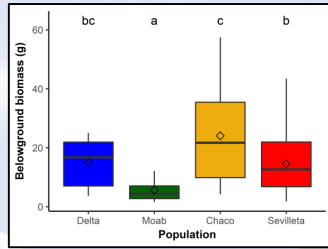


- Long history of frequent shifts in precipitation timing on CO Plateau (Schwinning et al. 2008)
- 'Adaption' to unreliable precipitation rather than any one regime?



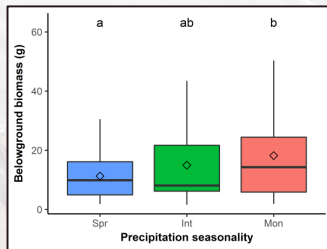
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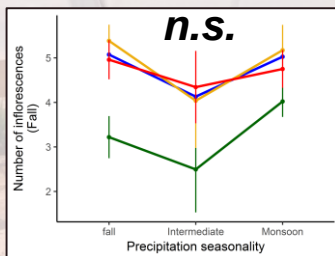
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## 3. Populations respond similarly to precipitation changes

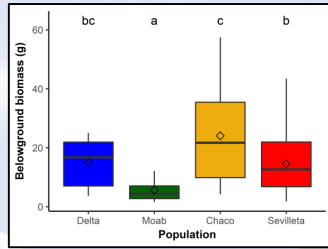


- Not locally adapted to monsoon gradient?



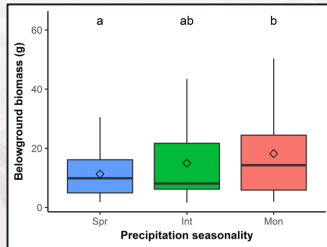
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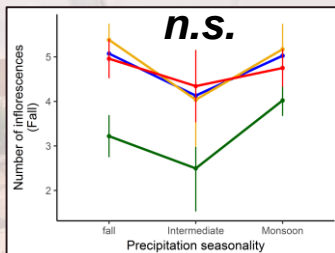
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- Not locally adapted to monsoon gradient?

## 4. Future direction: genetic sequencing: genetic basis, selection



# Applications to BLM Priorities and the National Seed Strategy

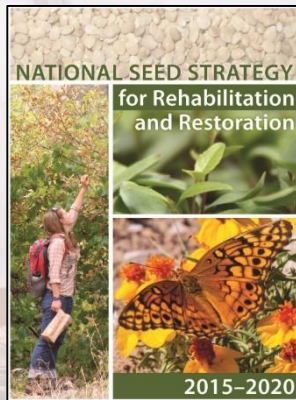


## Priority 1 (Energy Independence)

- Assessing a species used in mine/well pad restoration

## Priority 2 (Shared Stewardship)

- Working with partners at CRC to conduct research



## NSS Objective 2.1 (Genetic Characterization of Restoration Species)

- Informing climate- and genetic-based seed selection



# Thank you!



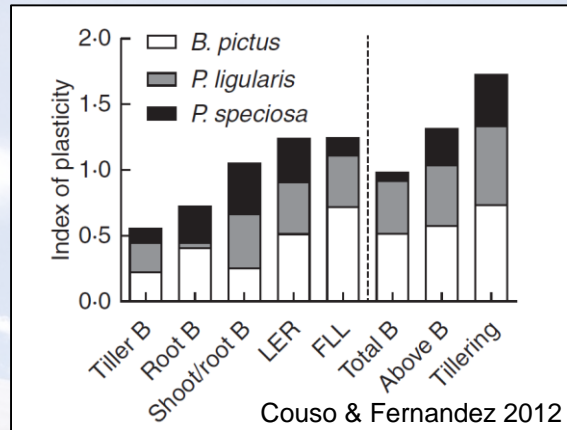
Henry Grover  
Kelly Fruth  
Adeline Murthy  
Brooke Stamper  
Pete Chuckren  
Maddie Logowitz  
Adam Kind  
Hilda Smith  
Matt Ribirich

Rose Egelhoff  
Jessica Mikenas  
Anna Knight  
Megan Starbuck  
Nick Melone  
Sean Hoy-Skubik  
Greg Kosa  
Phil Adams  
Kristen Redd





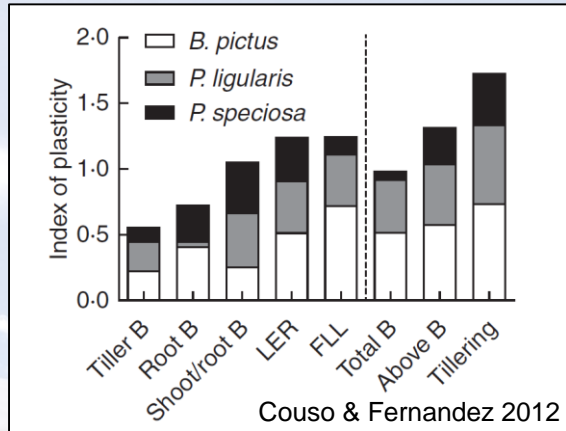
# Future Directions



Indices of plasticity:  
population-level responses  
to precipitation treatments

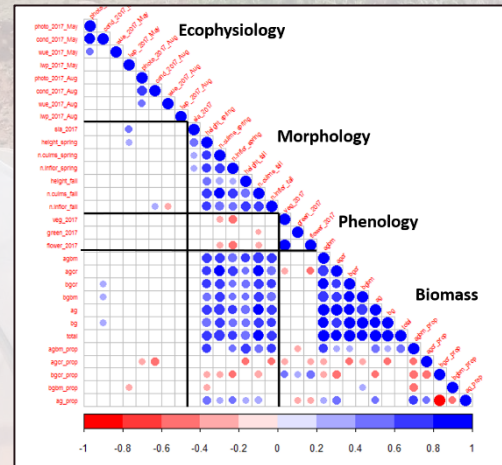


# Future Directions



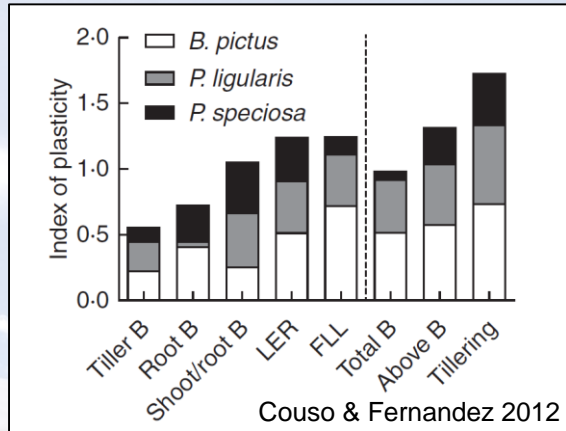
# Indices of plasticity: population-level responses to precipitation treatments

# Correlation analysis: underlying trait-based mechanisms



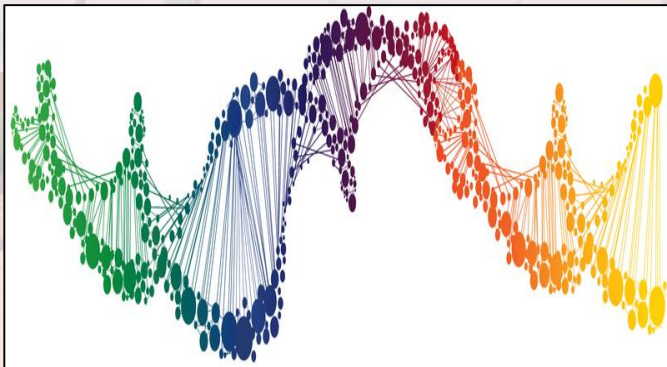
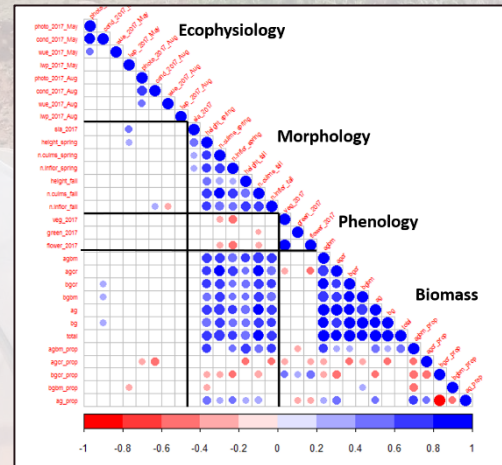


# Future Directions



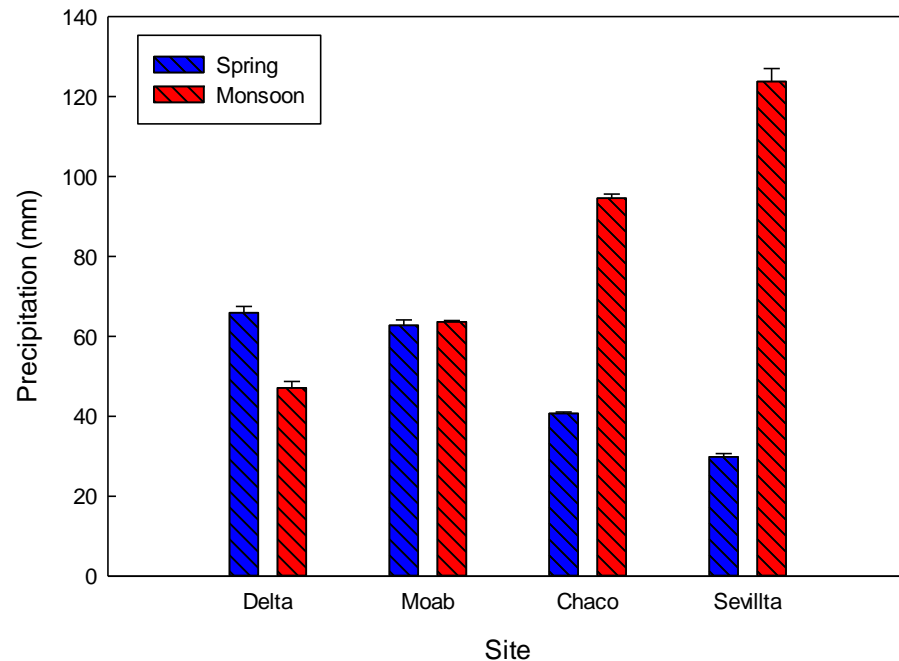
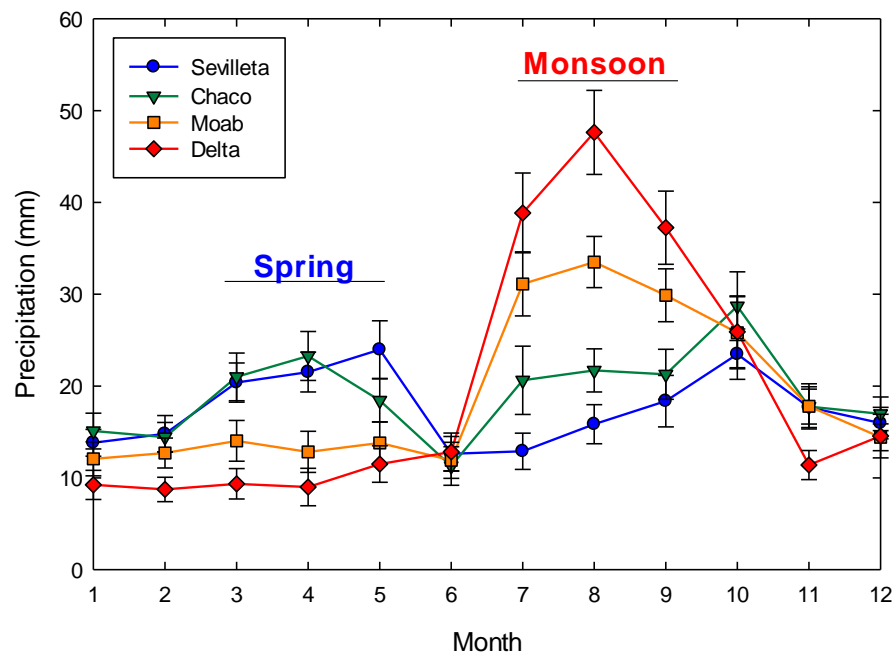
# Indices of plasticity: population-level responses to precipitation treatments

Correlation analysis:  
underlying trait-based  
mechanisms



# RADseq sequencing: genetic differentiation and adaptation among populations





Name	ELEVATION (m)	MAT (°C)	MAP (mm)	Spring PPT (mm)	Monsoon PPT (mm)	Annual Monsoon Intensity (monsoon/MAP)	Spring + Monsoon	Seasonal Monsoon Intensity (monsoon/spr + mon)
Sevilleta (NM)	1409.1	13.9	236.3	29.9	123.7	0.52	153.6	0.81
Chaco (NM)	1869.9	9.7	229.9	40.7	94.5	0.41	135.2	0.70
Moab (UT)	1208.5	14	230.7	62.7	63.6	0.28	126.3	0.50
Delta (UT)	1384.1	9.8	211.4	65.9	47.1	0.22	113	0.42
Average	1467.9	11.9	227.1	49.8	82.2	0.36	132.0	0.61