

# Overexpression of the AtDREB1A Gene in Almonds with Respect to Drought Tolerance

Thousand Oaks High School AP Research STEM

# Almonds in Relation to Drought

- One almond requires 1.1 gallons of water
  - 1900 gallons per pound
- Use 9.5% CA agricultural water
  - Drought prone state
- The Central Valley of California produces 80% of the world's almonds
  - Central Valley is in D4 Exceptional Drought

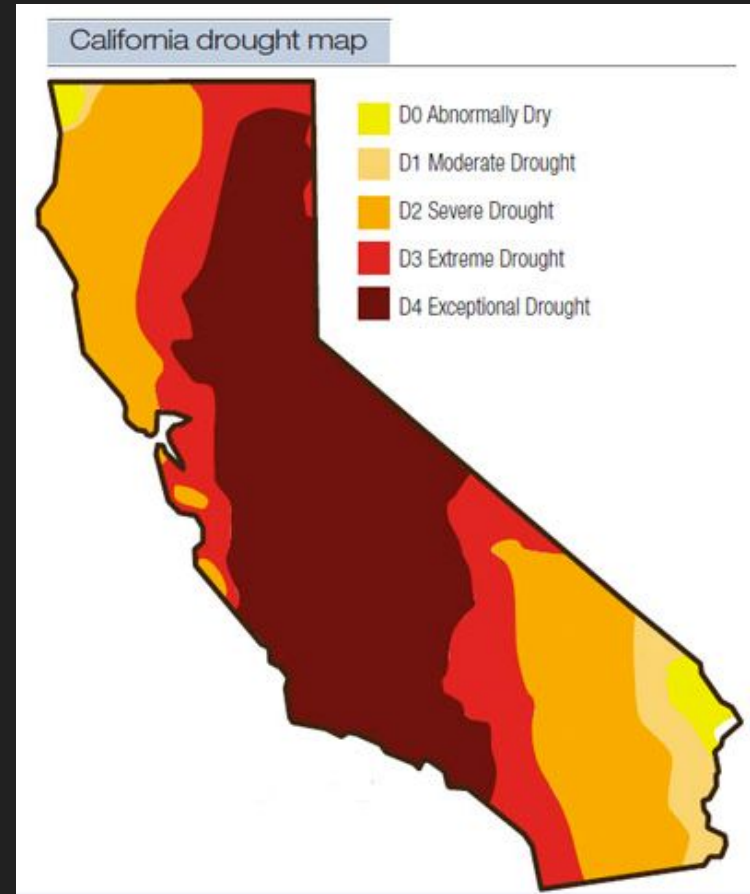


Figure 1. Map of California's drought 2015

# Almonds in an Economic Perspective

- The export of almonds from California has increase **65 times** in volume since 1965
- Increasing trend in Almond consumption due to a rise in demand for products (almond milk, flour, etc).
- Almond sales contribute **\$11 billion** to California's economy every year

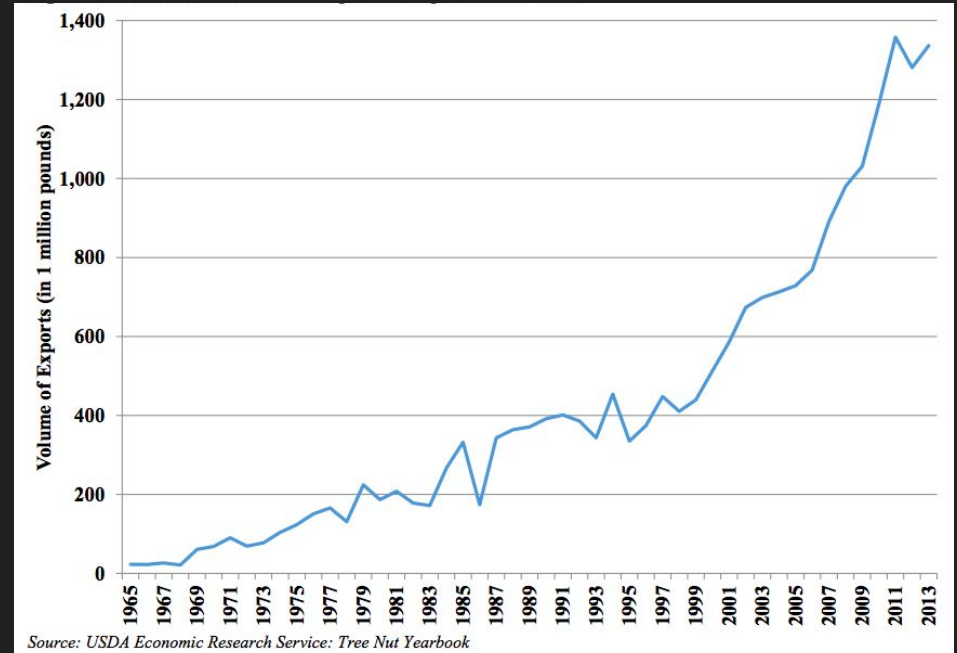


Figure 2. This shows the volume of almond exports (million pounds) from 1965 to 2013 in the state of California (USDA Economic Research Service, 2013).

# Increasing Demand

- Americans consuming more almonds
  - 220% increase from 2005 to 2014

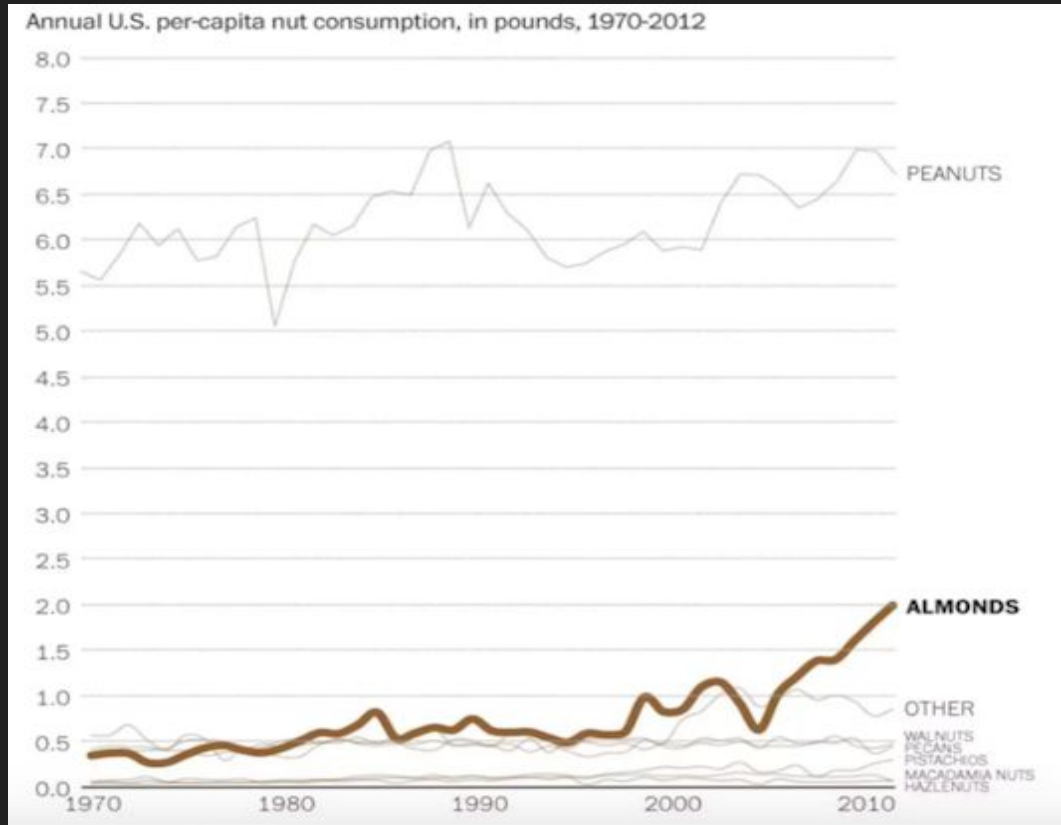


Figure 3. Graph demonstrating annual nut consumption 1970-2012 (Sumner et al., 2013).

# ABA Acid

- Levels increase under water stress
  - Stimulates closure of stomatal guard cells
    - Interacts with jasmonic acid and nitric oxide oxide
  - Reduces water loss
  - Reduces CO<sub>2</sub>
- Forms reactive oxygen species

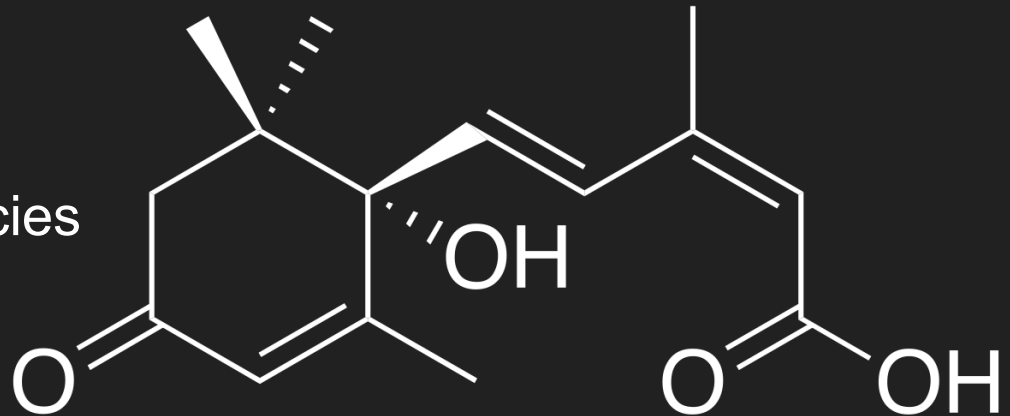
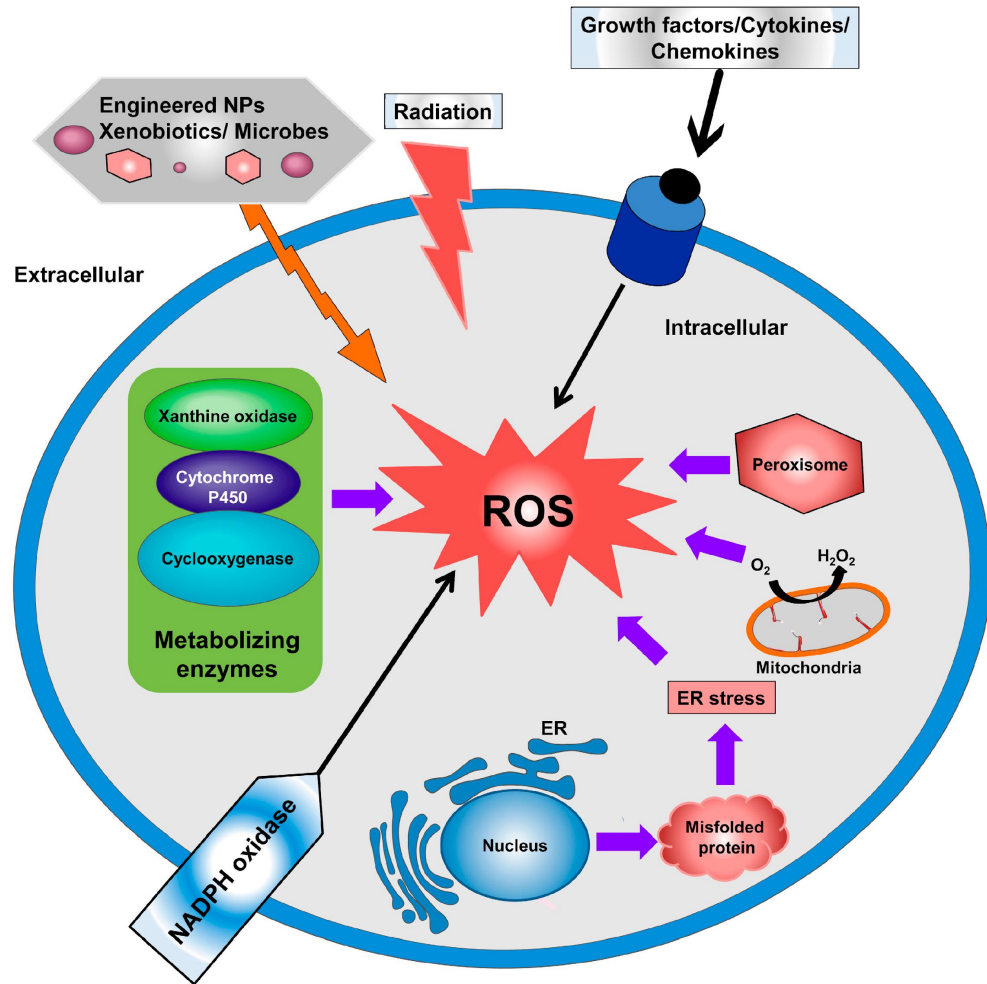


Figure 4. Molecular structure of ABA Acid

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# Reactive Oxygen Species

- Signals for activation of stress response
- Problem: Decreased availability of  $\text{CO}_2$  leads to overproduction of ROS
- Causes oxidative damage to chlorophylls, proteins and nucleic acids

Figure 5. Diagram explaining different sources of ROS, in this case the ROS comes from the presence of ABA Acid.

# Proline

- Provides protection to plants
  - ROS detoxification
  - Protection of membrane integrity
- Overproduced in a stressful environment

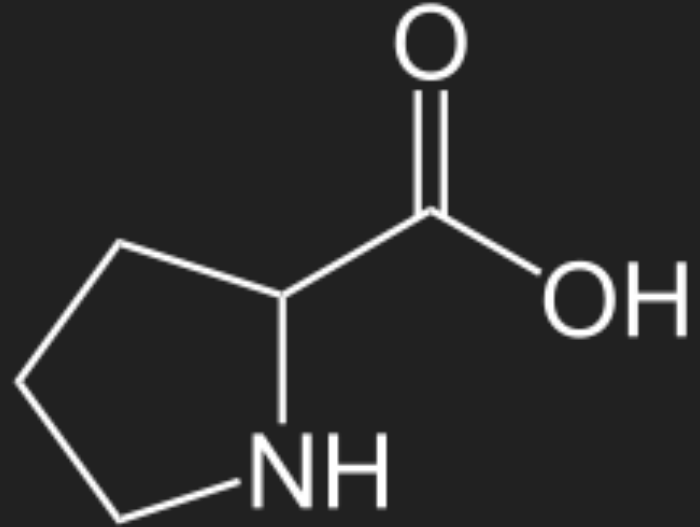


Figure 6. Molecular structure of Proline

# AtDREB1A Gene

- Provides protection to plants
  - ROS detoxification
  - Protection of membrane integrity
- Overproduced in a stressful environment





## Purpose

- Analyze effects of AtDREB1A in other crops
- Determine if similar results would occur in almonds



# Research Question

Will the overexpression of the *ATDREB1A* gene in other plants show a significant change in drought tolerance to offer viable reasoning for further studies in Almonds?



# Hypothesis

- Alternate Hypothesis
  - It is worth the investment to overexpress AtDREB1A in almonds because of reported success in other species



# Null Hypothesis

- Null Hypothesis
  - The effects of overexpressing *AtDREB1A* in model species indicate little support of applying the treatment to almonds

# Methods

- Systematic literature review
- Many databases used at (UCSB, CSUCI, etc.)
  - PLOS, PubMed, EbscoHost, etc.
- Plants used for data: Tomatoes, peanuts, rice, and potatoes
- Limited papers with data

# Selection Criteria

- **Peer reviewed** papers regarding the experimentation of AtDREB1A
- **Peer reviewed** papers comparing wild type plants (Controls) to transgenic plants
- Studies showing relative gene expression were preferred
- Over expression in common species: tomato, peanuts

# Data

P value=.000465

Hydrogen Peroxide Concentration in Tomatoes

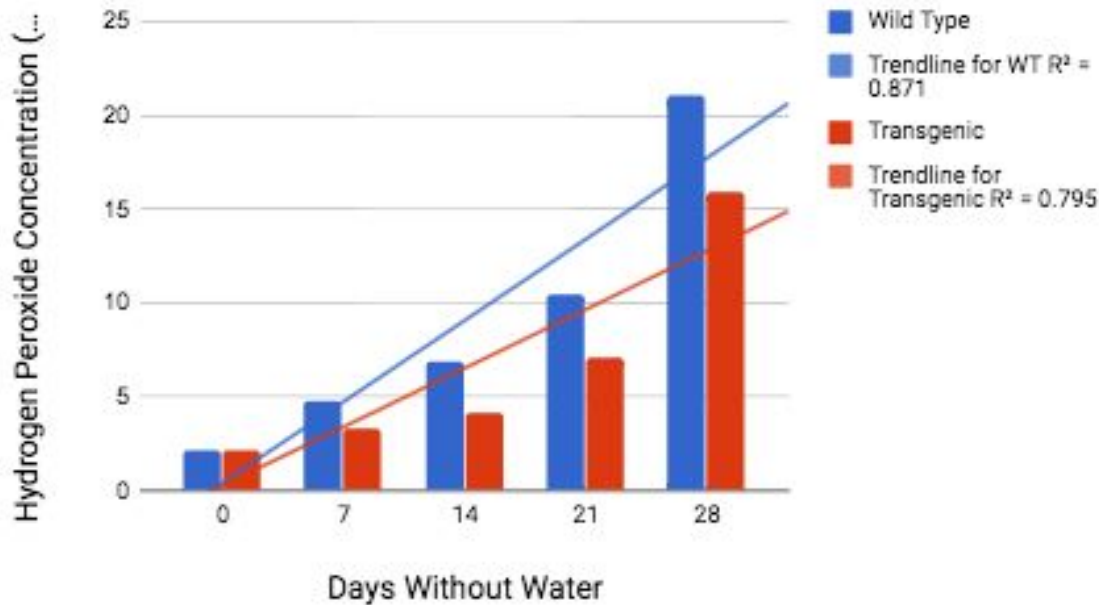


Figure 7. Displays the Hydrogen Peroxide Concentration (m mol/g) 0 days (well watered-control), 7 days, 14 days, 21 days, and 28 days after being restricted of water. WT are non-transformed plants while transgenic plants are overexpressing AtDREB1A.

# Data

P value=.002

Fold Increase in Expression of AtDREB1A in Peanuts

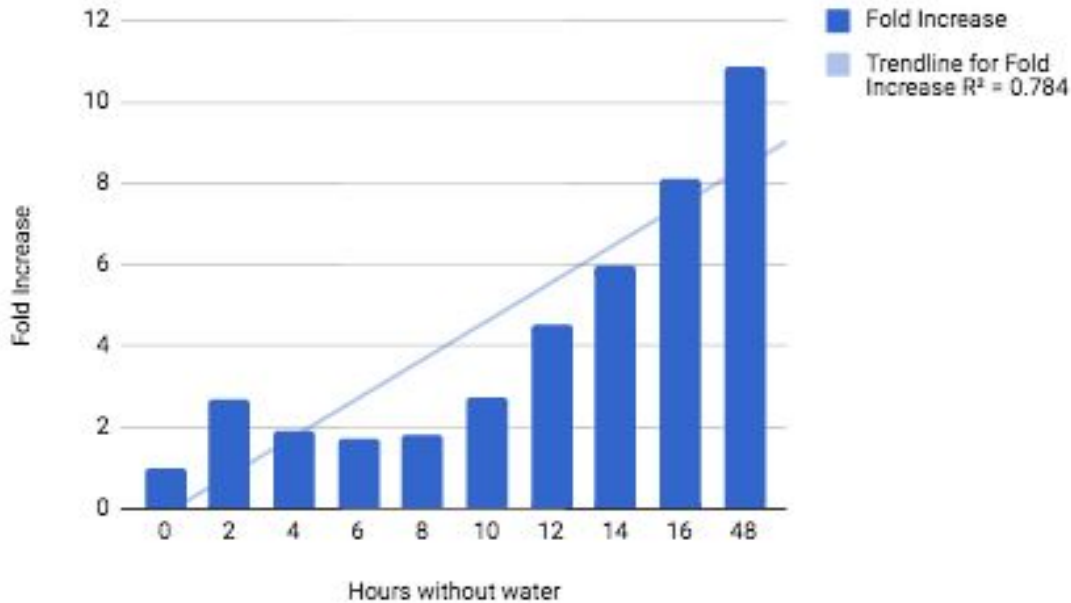


Figure 8. Displays fold increase of the overexpression of AtDREB1A in peanuts after 0 (well watered-control), 2, 4, 6, 8, 10, 12, 14, 16, and 48 hours of being deprived of water.



# Data

P value=.201

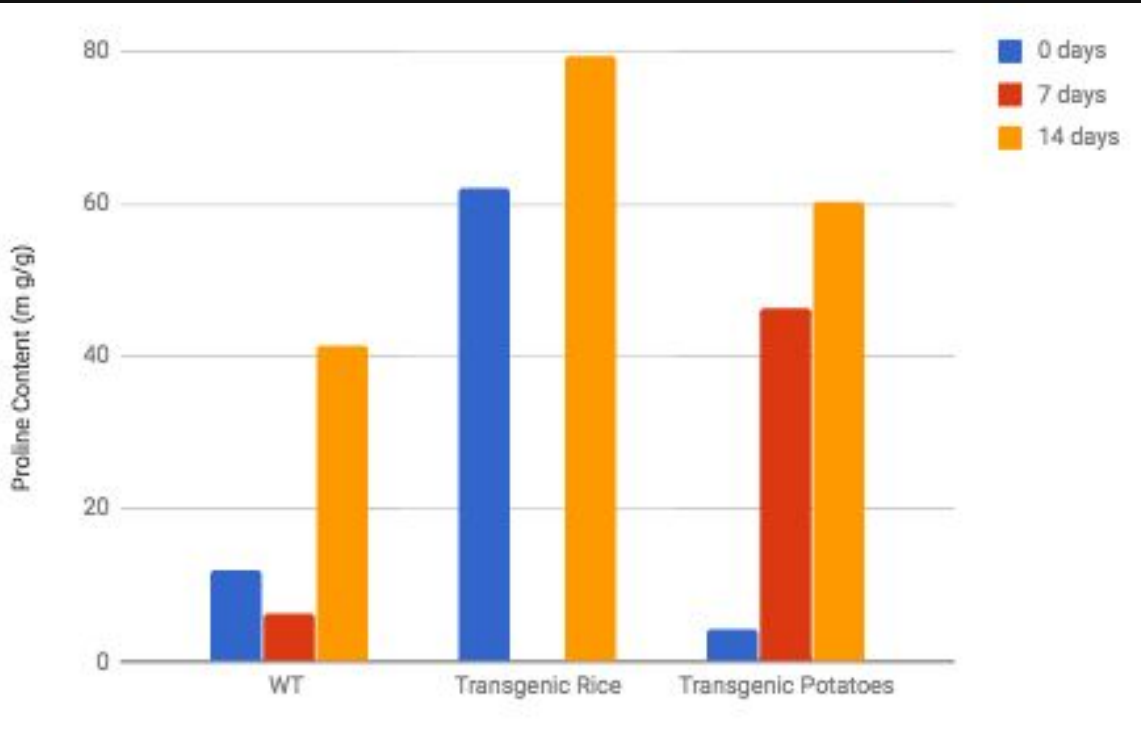


Figure 9. Displays the proline content (mg/g) in wild type plants, transgenic rice, and transgenic potatoes. Values were taken after 0 (well watered), 7, and 14 days of being deprived of water. No value was available for transgenic rice at 7 days.

# Data

P value=.221

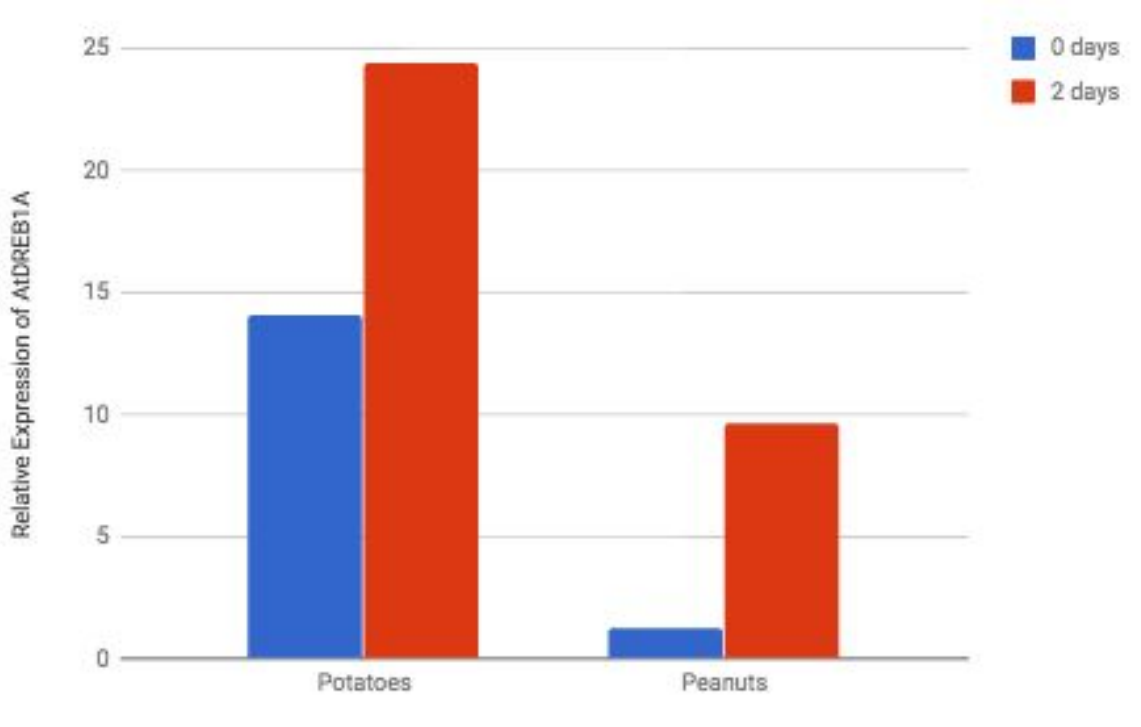


Figure 10. Displays the Relative Expression (Fold Increase) of AtDREB1A in peanuts and potatoes after 0 days (well watered-control) and 2 days of being deprived of water.

# Discussion

- $\text{H}_2\text{O}_2$  concentration decreased
- Proline concentration increased
  - Reduce ROS production
- Cause increased yields

# Discussion

- Expressed in different families
  - Peanuts; *Legumes*
  - Tomatoes and Potatoes; *Nightshade*
  - Rice; *Gramineae*

# Conclusion

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- Most almonds grown in CA, prone to drought
- Becoming more popular worldwide
- Successful overexpression means:
  - Decrease use of water
  - Increased crop yield

# Further Work

- More research must be done
  - Not enough data collected
- Collect data on more crops
- Field tests, not just lab tests


# Acknowledgements

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