ENSURING FUTURE ECONOMIC VIABILITY OF US SHORT-DAY ONION PRODUCTION THROUGH MECHANICAL HARVESTING

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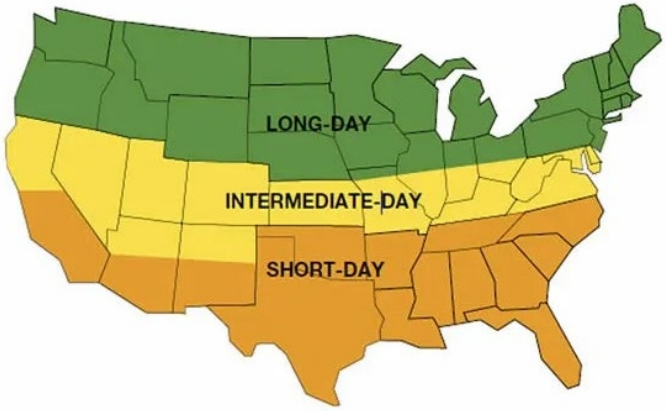
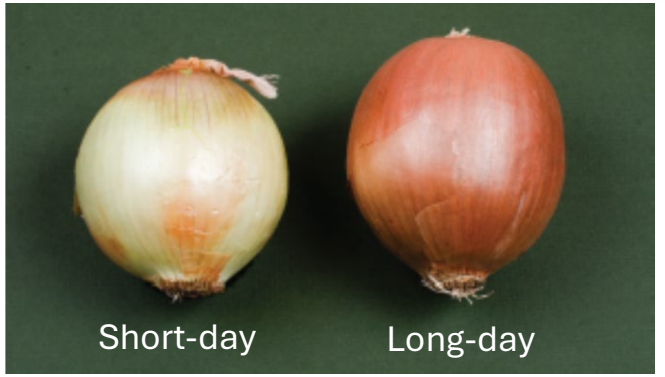
Harvesting challenges in short-day onions

- Short-day onions have lower dry matter, higher moisture, softer texture, green tops and are more prone to mechanical damage.
- As per USDA standards, impact bruising >2 fleshy scales and >1 fleshy scale when bruising includes broken scales can count as damage.
- Mechanical harvest can cause up to 8% losses.
- Manual harvesting of short-day onions increases labor and production costs, and labor shortages make this even more challenging.
- The long-term goal is to mechanize short-day onion harvesting.





Addressing harvesting challenge

- Identify machines and practices for an economically viable mechanical harvesting system for short-day onions.

- Evaluate germplasm and standard management practices affecting mechanical harvest efficiency.

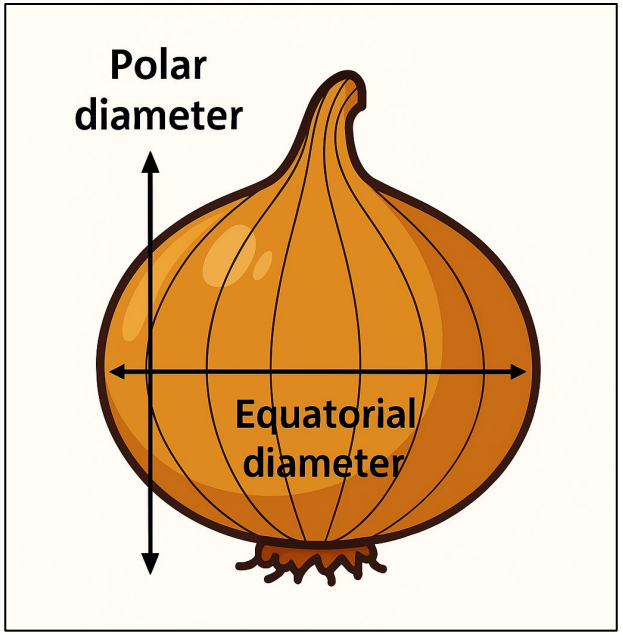
  - **Determine the optimal maturity stages, curing times, and irrigation schedules to minimize bruising and damage**

  - **Assess how bulb traits influence susceptibility to mechanical injury**

How is susceptibility to mechanical harvesting measured?

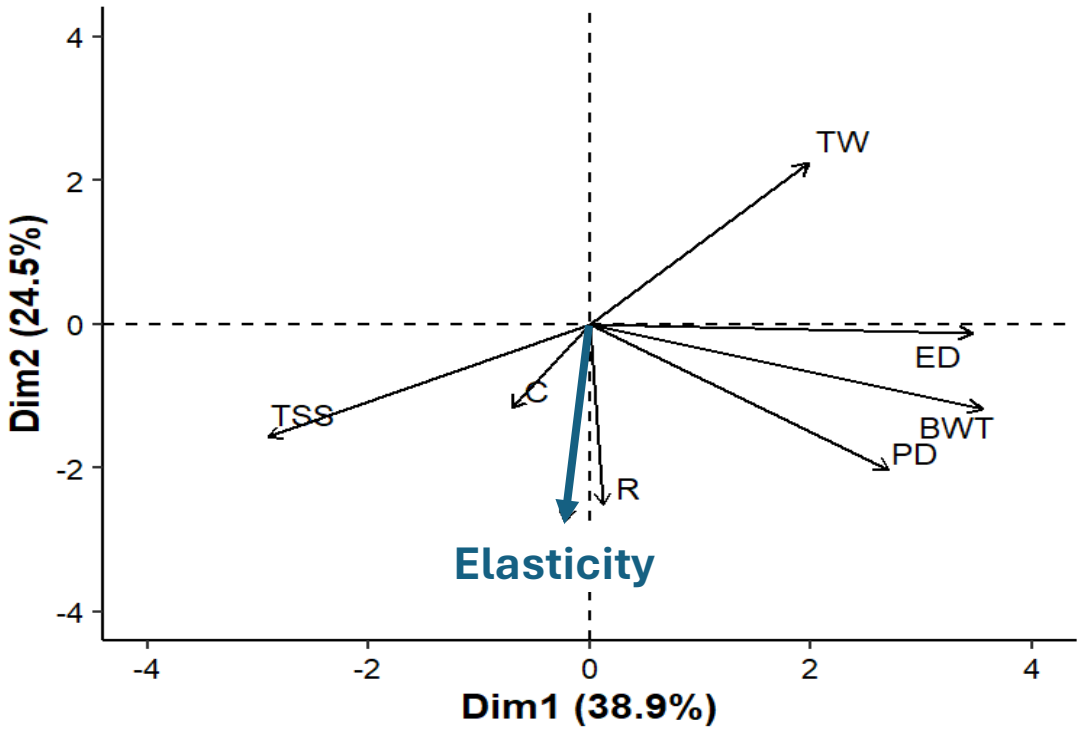
- Firmness could be an indicator of onion sensitivity to mechanical damage.
- It was measured by texture analyzer (TA) that uses a probe to apply force and measure the resistance.
- Onion shape affects TA readings: Flat bulb, for instance, have a broader contact area that spreads the force and shows lower firmness compared to the round bulb.
- To correct for bulb's geometry, polar and equatorial diameters are used to calculate modulus of elasticity from TA readings.
- Modulus of Elasticity tells how much force per area is needed to deform the onion.

Texture analyzer testing onion firmness.



How firmness relate to bulb traits?

- **48 onion varieties** (early, main, and late season) were evaluated in **Texas**.
- **Eight bulb traits** (Elasticity, PD, BWT, ED, R, C, TW, and TSS) were analyzed using PCA biplot in RStudio.



PCA biplot showing correlation of elasticity with key bulb traits.

PD - Polar Diameter (cm)

BWT - Bulb Weight (gm)

ED - Equatorial Diameter (cm)

R - Number of Rings

C – Single centeredness (%)

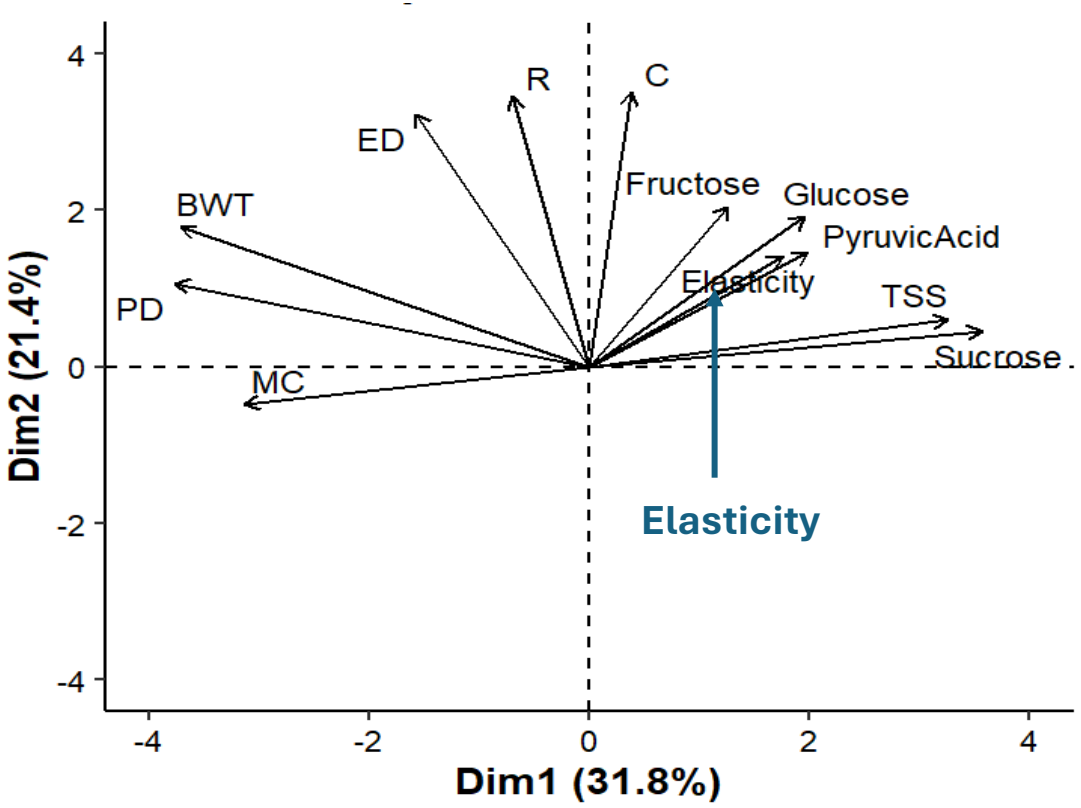
TSS - Total Soluble Solids

TW – Thickest Wet Layer (mm)

Elasticity (firmness) shows a similar trend to number of centers, number of rings, and TSS.

Quality Traits of Onions: Sugar, Pyruvic acid, and Firmness

- **Sugars (glucose, sucrose, and fructose):** quantified via HPLC
- **Pyruvic acid:** measured using EasyChem Plus assay (405 nm absorbance)
- **Samples analyzed:** 104 onion bulbs



PCA biplot showing association between firmness and quality traits.

MC - Moisture Content

PD - Polar Diameter

BWT - Bulb Weight

ED - Equatorial Diameter

R - Number of Rings

C - Number of Centers

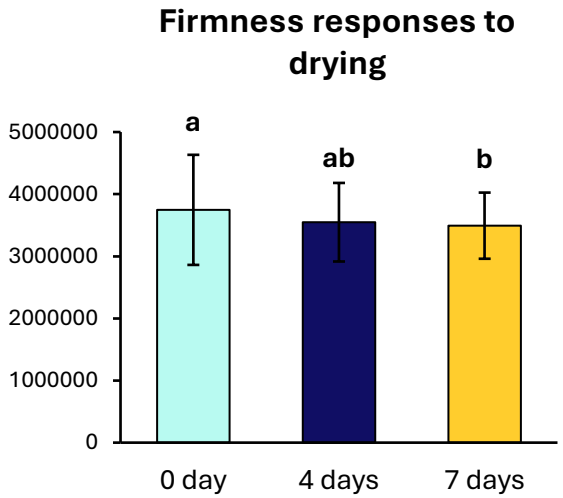
TSS - Total Soluble Solids

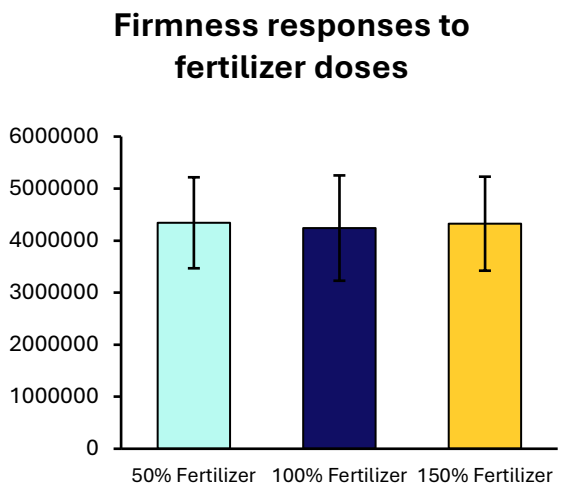
TW – Thickest Wet Layer (mm)

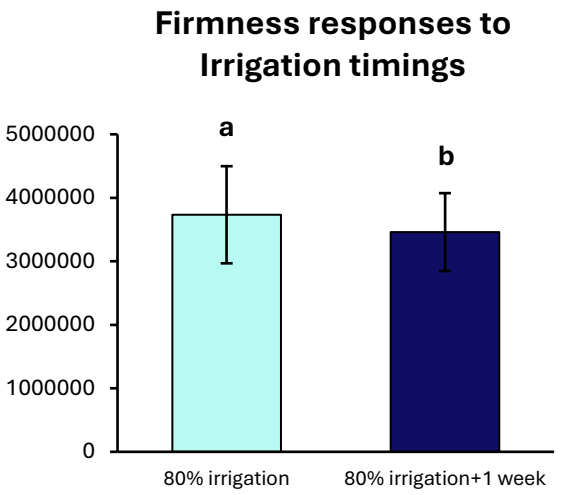
Elasticity (firmness) shares trend with the sugar and pyruvic acid content.

Do cultural practices influence onion firmness?

- **Field drying:** For 0, 4, and 7 days
- **Fertilizer application:** 50%, 100%, and 150%
- **Irrigation:** irrigation was stopped at 80% maturity and 1 week after 80% maturity



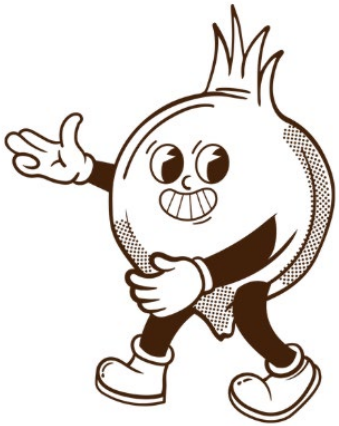




More drying = softer onions.

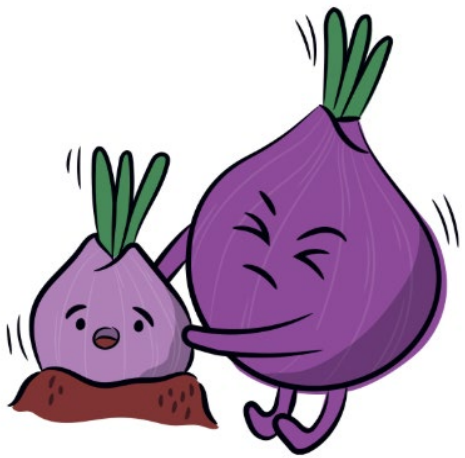
Fertilizer dose = no clear effect on firmness.

Extending irrigation by 1 week = weakened firmness.



Conclusion

- Onions with more rings and higher TSS content are firmer.
- Higher sugar and pyruvic acid content also contribute to greater firmness.
- Field drying for seven days makes onions softer.
- Extending Irrigation by 1 week also reduces firmness.
- Nitrogen dose variations do not significantly affect firmness.
- Future work: Relationship of onion firmness with cell wall properties will be explored.



Role of Cell Wall Composition in Onion Firmness

Cell Wall & Firmness

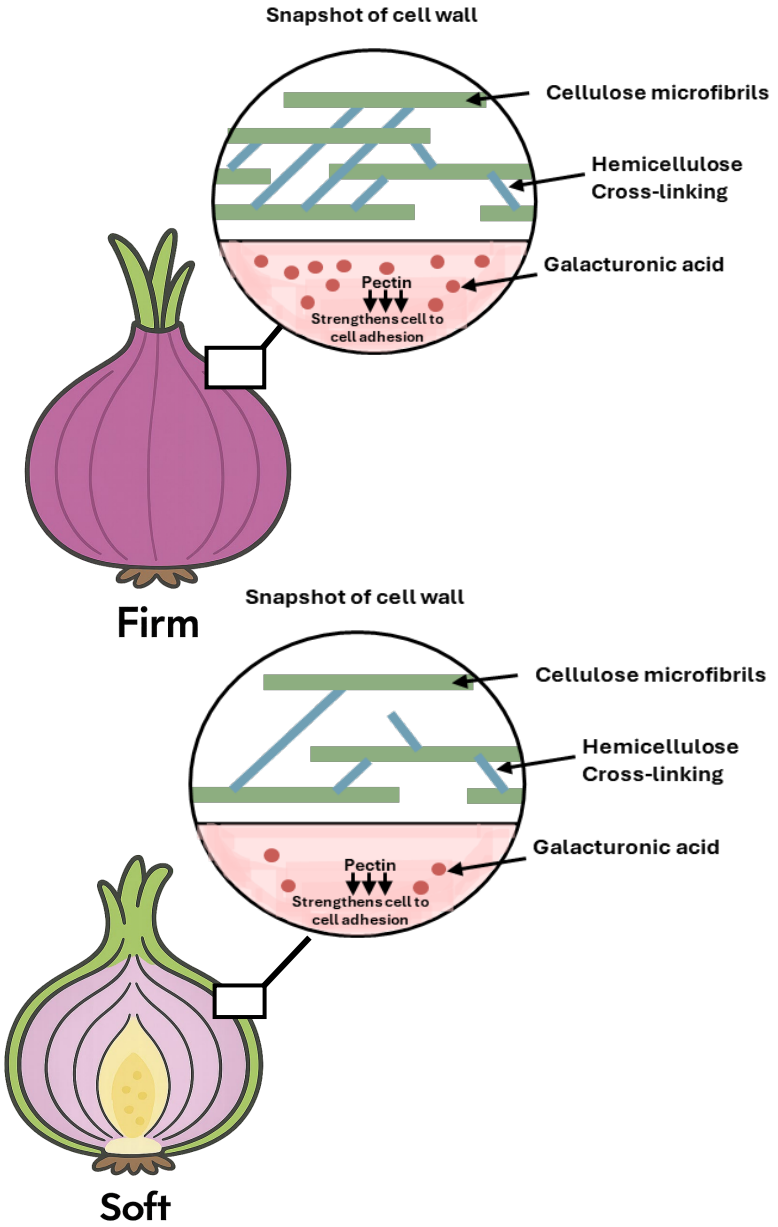
- Onion firmness also depends on cell wall mechanical strength (Coolong et al., 2008).
- Strength is governed by cellulose, hemicellulose and pectin.
- Pectin is present in cell wall as well as middle lamella and is mostly composed of galacturonic acid.

What Are We Investigating?

- Electron microscopy to examine structural differences.
- Role of Galacturonic acid, cellulose, and hemicellulose in firmness using GC-MS.
- Role of fructans (fructose polymer) in onion firmness using HPLC

Current Status

- Data collection is completed
- Data analysis is ongoing to investigate the role of biochemical compounds in firmness



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