Improving Corn Water Use With Hybrid Selection: Trait evaluation for both dryland and limited irrigated systems

2018 TAWC Water College, Lubbock Texas

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Crop Water Use

Water use is driven by environmental demands
1. Maintain turgor
2. Transport nutrients
3. Transpiration and Photosynthesis

WATER USE = YIELD
Crop Yield vs. ET Relationships

From: Stone et al., 2006; Crop Yield as Related to ET
Irrigated or Dryland

Maximum corn water use ~ 0.35 in./day at tassel

Water use ≥ 0.3 in./day from 12-leaf through blister ~ 2 months

How does this impact your water plan and hybrid selection?
Enhancing Crop Water Use With Hybrid Selection

Knowledge of hybrid characteristics are key to properly positioning hybrids under different irrigation regimes and dryland.
Corn Hybrid Traits that Enhance Water Use

- **Maturity** – Total water use changes with maturity class NOT daily water use
- **Drought Tolerance** – does not always mean plants use less water
- **Ear Flex**
- **Leaf Orientation**
- **Aggressive Silking**
- **Staygreen**
Corn Maturity Classes

• Longer season hybrids do not always out yield earlier maturing hybrids
  • Longer season may have a greater yield potential, but final yield a function of specific agronomic traits and management

• Corn Belt: Greater concern about RM as related to GDDs

• Texas High Plains not a GDD limited region for corn
  • Corn heat units calculated on a 50°F base not 60°F like cotton

• Texas High Plains challenges: water and heat
  • greater RM class = greater seasonal crop water demand
  • early maturing hybrids often have kernel integrity issues
# GDD and Maturity Classification

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Days</th>
<th>GDD</th>
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<tbody>
<tr>
<td>Early</td>
<td>85-100</td>
<td>2100-2400</td>
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<tr>
<td>Mid</td>
<td>101-130</td>
<td>2400-2800</td>
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<tr>
<td>Full</td>
<td>131-145</td>
<td>2900-3200</td>
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Average hybrid requirement is 2700 GDDs

- 1400 GDD planting to mid-silk
- 1925 GDD planting to soft-dough
- 2450 GDD planting to dent
- 2700 GDD planting to physiological maturity
Drought Tolerance ≠ Heat Tolerance

- At increased temperatures less assimilate is produced per growth stage
- High temperatures damage pollen
  - Pollen shed occurs early to mid-morning
  - As we move east across the Panhandle we often see a yield reduction due to increased night-time temperatures
- In susceptible hybrids, high temperatures during grain-fill can result in poor kernel integrity
- Manage maturity class and/or planting date to offset heat stress
Kernel Integrity

- Early planted, early maturing hybrids planted early can be prone to kernel splitting/silk cut
  1. Rapid drying of kernel surface
     • Premature hardening of the kernel surface
  2. Followed by rehydration at nights results in splitting
- This often not considered a problem but...
  • 2018 increased fumonisin levels correlated to poor kernel integrity
Drought Tolerant Hybrids

• AQUAmx (Pioneer)
• Droughtgard (Monsanto)
• Artesian (Syngenta)
Drought Tolerant Hybrids and WUE

• Traditional Hybrids: As water use decreases, yield decreases and WUE decreases

• Drought tolerant hybrids maintain WUE because they seem to partition water into biomass more efficiently (Tolk, 2016)
Drought Tolerant Hybrids

AQUAmax (Pioneer)

- Native Traits
- Enhanced stay green for deeper kernel set
- Aggressive silking
- Stomatal regulation
Drought Tolerant Hybrids

Droughtgard (Monsanto)

- Combination of native traits and transgenic
- Cold shock protein – “RNA chaperone”
- Temporal pattern of water use varies not necessarily seasonal water use – ensures plant reaches flowering under favorable soil moisture
Drought Tolerant Hybrids

Artesian (Syngenta)

• Native Traits
• Enhanced stay green for deeper kernel set
• Aggressive silking
• Robust root system
Ear Flex: Provides flexibility to match the population to the available water

1. **Fixed Ear (Determinate)**
   - Ear size not easily changed
   - Plant at higher populations to optimize yield

2. **Semi-flex Ear**
   - Less flex than true flex
   - Maintain size at higher population
   - Flexes to preserve yield at lower populations

3. **Flex Ear**
   - Ear size increases with optimum inputs
   - Maximizes yields at LOWER populations
   - Hybrids flex down under high populations and poor fertility
Leaf Orientation

1. Upright Leaf Hybrids
   - Ideal for high populations, narrower rows
   - Leaves grows straight up
   - Allows light to penetrate canopy to maximize photosynthesis

2. Pendulum Leaf Hybrids
   - Ideal for low populations or in a situation with low crop residue
   - Leaves “flop-out” to enhance canopy closure
   - Minimize soil evaporation
   - Intercept light

3. Semi-upright hybrids
   - Best of both worlds
   - Lower leaves are pendulum to shade soil and capture sunlight
   - Upper leaves are very upright to allow sunlight to penetrate the canopy
Aggressive Silking

• Water stress delays silking
• Hybrids marketed to ensure that pollination and silking coincide
• Objective to increases kernel number

Images from Pioneer.com
Do not confuse aggressive silks with unusually Long Silks

- Cool temperatures
- Cloudy weather
- Sufficient soil moisture
- Silking prior to pollen shed-asynchrony in pollination
Increased Staygreen Expression in Corn

- Plant continues photosynthesis under drought - leaves stay green rather than senesce
- Increased dry matter production during grain development
- Increases duration of grain filling -- deeper kernel set, greater test weight
- Assimilate stored in the stem enhances filling rate after assimilate used from leaves... but you need to keep the plant standing
In order to get the most out of your staygreen trait...you have to **manage** in-season Nitrogen

- Green leaves need N
- N deficient plants have reduced hydraulic conductivity through root cells
- Optimum fertility improves production per unit of water
- Nitrogen management is a seasonal program
- How will you split your fertilizer applications? **2, 3 or even 4 splits?**
Position Corn Hybrids and Population to Available Water:

• Racehorse hybrid environment
  • Highly productive environment (fertility and water)
  • Upright leaves and determinate ear to push population

• Drought environment
  • Pendulum leaf
  • Lower populations and a flex ear to maximize yield

• Variable soils
  • Semi-upright leaf and semi-flex ear
Management must Match Hybrid

26,000 plants/ac

36,000 plants/ac

6.29 gal \, min^{-1} \, acre^{-1}

3.14 gal \, min^{-1} \, acre^{-1}
2017 Bushland Dryland Corn Trial

Calvin Trostle, Jourdan Bell, Qingwu Xue, Ronnie Schnell and Diana Jones
Bushland Dryland Corn
Planted May 5
Photo Taken August 17
Bushland Dryland Corn
Planted June 20
Photo Taken August 17
Figure 1. Dryland Corn Yields and Returns at Various Plant Dates, Populations, and Locations

Economic Analyses Completed by D. Jones
Table 1. Projected 2018 Dryland Corn Profitability at Various Seeding Rates, Locations and Planting Dates - Small Plot Results

<table>
<thead>
<tr>
<th>Bushland Farm</th>
<th>Average Yield/Ac</th>
<th>Projected Price/Bu</th>
<th>Total Revenue Per Acre</th>
<th>Total Variable Costs Per Acre</th>
<th>Return Over Variable Costs</th>
<th>Total Costs Per Acre</th>
<th>Return Over Total Costs</th>
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<td>20.60</td>
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<td>$236.71</td>
<td>$6.42</td>
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| Lubbock Farm |
|---------------|------------------|-------------------|------------------------|------------------------------|----------------------------|----------------------|------------------------|
| Planting Rate 6,000: Early | 19.47 | $3.85 | $74.96 | $117.17 | ($42.21) | $167.58 | ($92.62) |
| Planting Rate 9,000: Early | 24.30 | $3.85 | $93.56 | $129.76 | ($36.20) | $180.17 | ($86.61) |
| Planting Rate 12,000: Early | 26.10 | $3.85 | $100.49 | $141.10 | ($40.62) | $191.51 | ($91.03) |
| Planting Rate 15,000: Early | 25.87 | $3.85 | $99.60 | $151.62 | ($52.02) | $202.03 | ($102.43) |
| Planting Rate 6,000: Late | 35.80 | $3.85 | $137.83 | $123.86 | $13.97 | $174.27 | ($36.44) |
| Planting Rate 9,000: Late | 46.23 | $3.85 | $177.99 | $138.75 | $39.24 | $189.16 | ($11.17) |
| Planting Rate 12,000: Late | 48.73 | $3.85 | $187.61 | $150.38 | $37.23 | $200.79 | ($13.18) |
| Planting Rate 15,000: Late | 50.93 | $3.85 | $196.08 | $161.89 | $34.19 | $212.30 | ($16.22) |

| Small Plot Averages | 41.00 | $3.85 | $157.84 | $152.04 | $5.80 | $202.45 | $(44.61) |

Bushland plots were planted 5-5-2017 and 6-28-17; Lubbock plots were planted 5-2-17 and 6-30-17
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Dryland Data Summary

• No Significant yield difference between hybrids
• Significant difference between planting dates
• Greatest economic return for second planting date at 12,000 seed/acre population
• One year data set -- multiple years needed to evaluate production stability
Last thought.....

• Does the last inch of water matter...depends on the hybrid
• ROT...shut off irrigation at milk line...depends on the hybrid
• We can control irrigation, agronomics, but we cannot control the environment
Conclusions

• Don’t expect irrigation to compensate for poor agronomics
• Don’t expect agronomics to compensate for poor irrigation
• Agronomic plan must complement available water
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