# Optimum® AQUAmax® Hybrid Performance with Varying Irrigation and Seeding Rates

CROP BULLETIN


## SUMMARY

- Optimum® AQUAmax® corn hybrids have proven superior in performance in water-limited environments.
- Optimization of hybrid seeding rates and irrigation timing are important keys to maximizing production.
- Field experiments were conducted over three years at drought research centers to evaluate the performance of Optimum AQUAmax hybrids and check hybrids at different seeding rates and irrigation levels.
- Across three years of this study, Optimum AQUAmax hybrids produced more grain yield under limited water and at higher plants/acre relative to comparative hybrids.


## INTRODUCTION

Limited-water irrigation is becoming more common for corn acres in the West due to water restrictions and decreasing well pumping capacity. Thus, growers must manage their water resources carefully to achieve high grain yields with less water. Optimum AQUAmax corn hybrids have proven superior in performance in water-limited environments; however, utilization of best management practices is still necessary to maximize production. Optimization of hybrid seeding rates and irrigation timing are important keys to success in this endeavor. The research presented here focused on the performance of Optimum AQUAmax hybrids under a range of seeding rates and limited irrigation application scenarios.

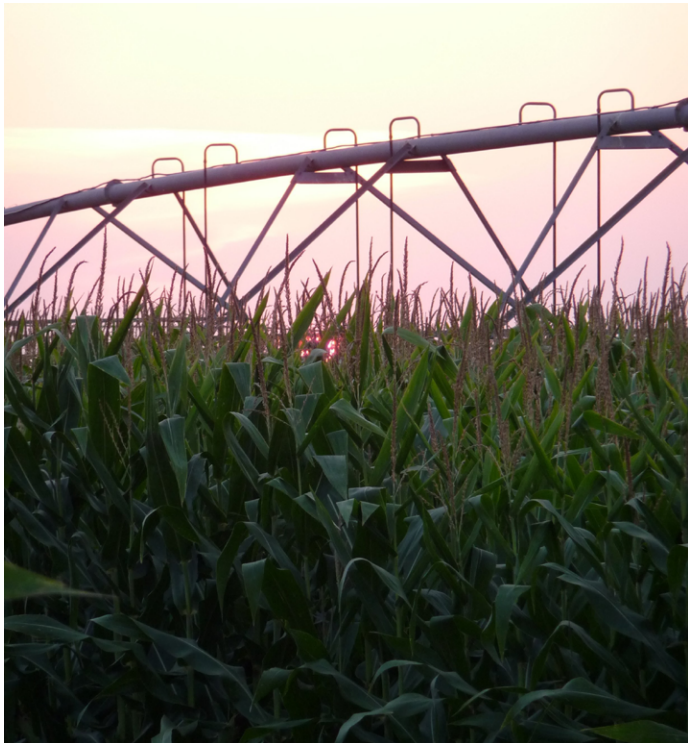
## RESEARCH OBJECTIVES

- Evaluate the performance of Optimum AQUAmax (AQUA) hybrids and check hybrids at different irrigation levels.
- Evaluate the plant population response of Optimum AQUAmax hybrids and check hybrids at each irrigation level.

## STUDY DESCRIPTION

Field experiments were conducted at drought research centers in Garden City, KS, and Plainview, TX, in 2012, 2013, and 2014. The experiment design was a randomized complete block in a split split-plot arrangement with four replicates. Irrigation was the main plot, population was the sub-plot and hybrid was the sub sub-plot. Each plot consisted of four rows, spaced at 30-inches, 15 feet long. Target final stands were 12, 18, 24, 30 and 36,000 plants/acre. Plots were thinned to target population levels.

Data analysis was performed on the center two rows based on the actual plant counts taken during the growing season. Best management practices were incorporated for pest and nutrient management. Nitrogen fertilizer was injected through the drip tape.



Corn hybrids compared in the experiment across 2012 to 2014 included Optimum AQUAmax hybrids and comparative hybrids.

The water regimes used in this study included 45, 55, and 80 percent evapotranspiration (ET) replacement irrigation treatments. These treatments simulate gradual onset but chronic moisture stress throughout the growing season. Reference ET values were determined and used to calculate water use by the corn crop. Crop water use calculation was based upon relative maturity, crop emergence date, soil rooting depth and irrigation efficiency. ET calculations were based upon the Penman-Monteith method. The soil moisture profile combined for 2012, 2013, and 2014 was 80 percent field capacity. Soil cores were taken each year to confirm soil volumetric water content just prior to planting. Irrigation was applied with subsurface drip tape on 30-inch centers, 10 inches below the surface.

### Water Supplied to Plots

Plots received water from rainfall and irrigation. In-season rainfall and irrigation amounts with corresponding ET values are provided in Figure 1. During 2012 to 2014, Garden City consistently maintained a higher crop ET value when compared to Plainview. Irrigation for both locations was based upon crop ET. Irrigation was applied on a weekly basis to maintain actual crop water use. Garden City received 4.53, 8.66 and 11.29 inches of rainfall in 2012 to 2014 respectively. Plainview received 4.23, 6.50 and 10.87 inches of rainfall in 2012 to 2014 respectively.

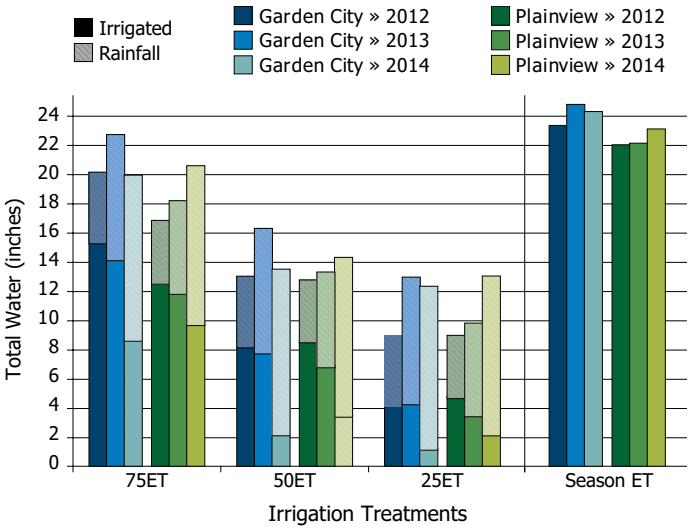



**Figure 1.** In-season rainfall, irrigation amounts and total crop ET for the 45, 55 and 80 percent ET treatments at Garden City, KS, and Plainview, TX; 2012 to 2014.

The critical difference between the two locations was timing of rainfall. In 2012, Garden City received significant rainfall on July 9 (flowering). Plainview received significant rainfall on June 13 (V8 growth stage). In 2013, Garden City received significant rainfall on August 1 (grain fill). Plainview received significant rainfall on July 16 (start grain fill). In 2014, both locations received substantially more rainfall through the season compared to the previous two years. Timing of rain is critical when crop production is managed with limited water.

## RESULTS AND DISCUSSION

Grain yield means averaged over all populations across 2012 to 2014 are presented in Figure 2. Yield means in Plainview across the three years trended lower when compared to Garden City but yield differences between Optimum® AQUAmax® hybrid and comparative hybrid groups were similar at both locations. At the 45 percent ET treatments,

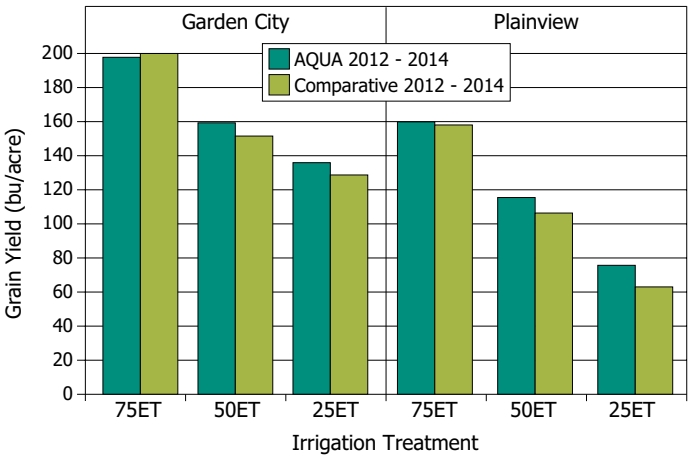



**Figure 2.** Combined grain yield means across all populations of Optimum AQUAmax and comparative hybrid groups for the 45, 55 and 80 percent ET replacement irrigation treatments at Garden City and Plainview in 2012 to 2014.

the Optimum AQUAmax hybrid group was significantly higher yielding compared to the comparative hybrid group at both Garden City and Plainview. At the 55 and 80 percent ET treatments, yields were not statistically different. These results demonstrated that Optimum AQUAmax hybrids yielded significantly more under the highest drought stress level imposed in the study, while maintaining parity at the low and moderate stress levels.

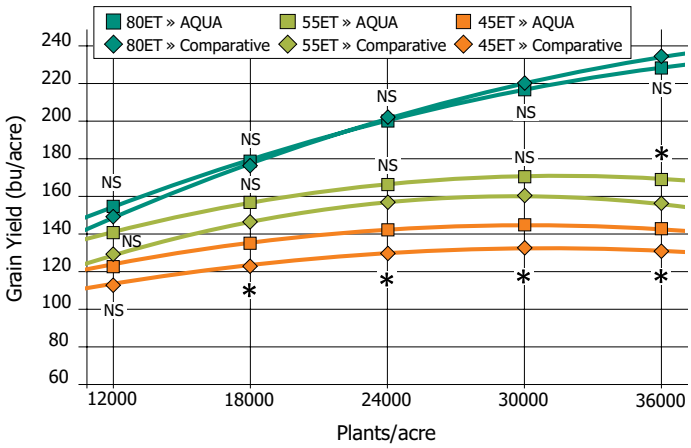



**Figure 3.** Grain yield means of Optimum AQUAmax hybrid and comparative hybrid groups for the various ET replacement irrigation treatments at Garden City in 2012 to 2014 (data averaged across years). *NS = not significant. * = significant at P = 0.05.*

Grain yield means by population averaged across 2012 to 2014 are presented in Figure 3 for Garden City and Figure 4 for Plainview.

**80 Percent ET Treatment** - Corn hybrid grain yields increased with increasing population up to 36,000 plants/ acre, the highest population tested. There were no significant yield differences between the two hybrid groups at Garden City during 2012 to 2014. A significant yield difference at 36,000 plants per acre at Plainview was observed in 2012 to 2014 between the Optimum AQUAmax and comparative hybrid groups. Thus, Optimum AQUAmax hybrids maintained parity under low water stress conditions.

**55 Percent ET Treatment** - At Garden City, a significant yield difference between the Optimum AQUAmax and comparative hybrid groups was observed at 36,000 plants per acre. At Plainview, Optimum AQUAmax hybrids out-yielded comparative hybrids at 24,000, 30,000 and 36,000 plants/ acre, demonstrating the superiority of Optimum AQUAmax hybrids at that level of drought stress.

**45 Percent ET Treatment** - In both locations, all populations except 12,000 plants/acre showed a significant grain yield advantage for the Optimum® AQUAmax® hybrid group over the comparative hybrid group. At this high level of drought stress, Optimum AQUAmax hybrids not only yielded more than comparative hybrids but the benefit increased with increasing population. Higher populations could take advantage of rainfall events throughout the season.

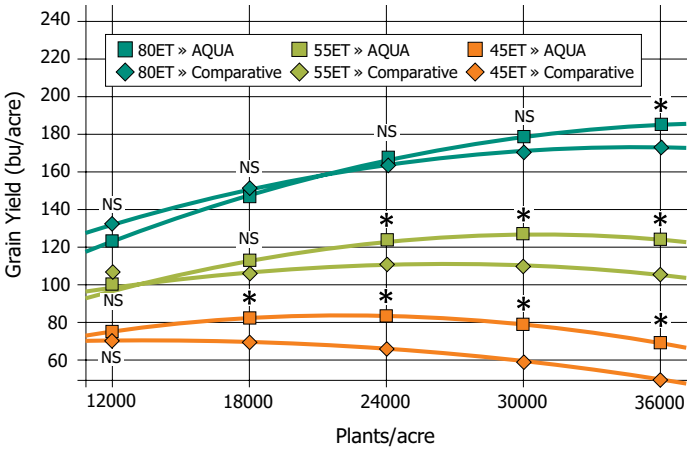



**Figure 4.** Grain yield means of Optimum AQUAmax hybrid and comparative hybrid groups for the various ET replacement irrigation treatments at Plainview in 2012 to 2014 (data averaged across years). *NS = not significant. * = significant at P = 0.05.*

## AGRONOMIC WATER-USE EFFICIENCY

Agronomic water-use efficiency is calculated by taking total yield divided by inches of water applied. Bushels produced per inch of water applied were calculated based on total in-season water for each irrigation treatment.

A significant difference in bushels produced per inch of water was observed in the 80 percent ET treatment across the three years of testing at Plainview at 36,000 plants per acre (Table 1). Data showed a general trend of increased bushels produced per inch of water as plants/acre increased. The 36,000 plants/acre treatment resulted in the greatest bushels produced per inch of water.

**Table 1.** Bushels produced per inch of water for Optimum AQUAmax hybrids and comparative hybrids at 45, 55 and 80 percent ET replacement at Plainview, TX, in 2012 to 2014.

| | 45% ET | | | 55% ET | | | 80% ET | | |
|---|---|---|---|---|---|---|---|---|---|
| | AQUA | Comp | | AQUA | Comp | | AQUA | Comp | |
| *Pop* | *bu/in water* | | *LSD* | *bu/in water* | | *LSD* | *bu/in water* | | *LSD* |
| **12** | **6.8** | **6.4** | **0.5** | **6.9** | **7.1** | **0.6** | **6.3** | **6.8** | **0.5** |
| **18** | 7.5 | 6.4 | 0.5 | 8.0 | 7.7 | 0.5 | 7.6 | 7.7 | 0.4 |
| **24** | 7.7 | 6.1 | 0.6 | 8.8 | 8.0 | 0.5 | 8.5 | 8.4 | 0.4 |
| **30** | 7.3 | 5.6 | 0.6 | 9.1 | 8.0 | 0.5 | 9.2 | 8.8 | 0.3 |
| **36** | 6.4 | 4.8 | 0.8 | 9.0 | 7.7 | 0.5 | 9.5 | 8.9 | 0.4 |

**Comp** = Traditional, **Pop** = Plant Population (1,000 plants/acre),
**LSD** = Least Significant Difference (P = 0.05)

**Table 2.** Bushels produced per inch of water for Optimum AQUAmax hybrid and comparative hybrids at 45, 55 and 80 percent ET replacement at Garden City, KS, in 2012 to 2014.

| | 45% ET | | | 55% ET | | | 80% ET | | |
|---|---|---|---|---|---|---|---|---|---|
| | AQUA | Comp | | AQUA | Comp | | AQUA | Comp | |
| *Pop* | *bu/in water* | | *LSD* | *bu/in water* | | *LSD* | *bu/in water* | | *LSD* |
| **12** | **12.1** | **11.0** | **1.1** | **10.5** | **9.6** | **0.9** | **7.7** | **7.4** | **0.9** |
| **18** | 13.2 | 11.9 | 0.8 | 11.7 | 10.9 | 0.7 | 8.9 | 8.9 | 0.8 |
| **24** | 13.7 | 12.3 | 0.8 | 12.4 | 11.7 | 0.7 | 9.9 | 10.0 | 0.7 |
| **30** | 13.9 | 12.5 | 0.8 | 12.7 | 12.0 | 0.7 | 10.7 | 11.0 | 0.6 |
| **36** | 13.5 | 12.3 | 1.0 | 12.6 | 11.7 | 0.8 | 11.3 | 11.7 | 0.5 |

**Comp** = Traditional, **Pop** = Plant Population (1,000 plants/acre),
**LSD** = Least Significant Difference (P = 0.05)

In Plainview, the 55 percent ET treatment resulted in significant differences in bushels per inch at 24,000, 30,000 and 36,000 plants per acre (Table 1). In Garden City, the 55 percent ET treatment did not have any significant results (Table 2).

In the 45 percent ET treatment for both Garden City and Plainview across years, significant differences in bushels per inch of water were observed at all population levels except 12,000 plants/acre (Table 1 and 2).

## CONCLUSIONS

In this and other extensive field trials conducted across multiple locations and years, Optimum AQUAmax hybrids have proven to perform better than comparative hybrids in water-limited environments. These hybrids were developed using native genetics, which has expedited their availability to growers compared to transgenic options that require demanding regulatory approvals. Mechanisms of drought tolerance in these products include stomatal control to conserve water, maintenance of photosynthesis under water-limited conditions, preservation of leaf area under heat and drought stress (staygreen), a more fibrous root system and vigorous silking.

Across three years of this study, Optimum AQUAmax hybrids produced more grain yield under limited water and at higher plants/acre when compared with comparative hybrids. Optimum AQUAmax hybrids also demonstrated their ability to produce more bushels of grain per inch of water in many treatments (both ET and population treatments). These combined results demonstrate how Optimum AQUAmax hybrids can help growers produce more grain with less water as water-pumping capacity declines. Growers could also use this information to relate ET treatments to the water availability of their own fields and adjust their seeding rates to more closely match the optimum seeding rate at that ET level in the study.

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