2012 Pioneer Optimum® AquaMax™ Drought Tolerant Corn Trial Progress Report

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a. Problem description

Corn is a major irrigated crop in the northern Texas High Plains, with some of the highest average yields in the nation. Corn production in this area is achievable only with irrigation derived from the Ogallala aquifer. However, the declining water table and water conservation awareness of the aquifer has questioned these sustainable high yields with irrigated corn for the future. Limited irrigation, the application of less irrigation water than the plants required for full evapotranspiration (ET), will be the primary practice in the future. Therefore, development of management strategies under limited irrigation is extremely important to reducing production risk and maintaining profitability. Currently, producers in the Texas High Plains are not well prepared to manage corn production under reduced irrigation levels.

b. Background

Managing corn under limited irrigation is risky because water stress cannot be avoided. Toward this end, the newly developed drought tolerant (DT) hybrids may fit well to the corn production system under limited irrigation. However, it is largely unknown that how the new DT hybrids perform under field conditions in the Texas High Plains. The objectives of this study were to (1) investigate water use, yield and water use efficiency (WUE) of Pioneer AquaMax corn hybrids under limited irrigation regimes; (2) determine the appropriate planting densities and hybrids to achieve high yield under limited irrigation.

c. Study description

Field experiment was conducted at the North Plains Research Field, Texas A&M AgriLife Research near Etter, TX under a center pivot irrigation system. Treatments were consisted of 4 Pioneer AquaMax hybrids (P1151HR, P1324HR, P1498HR and P1564HR) and one check hybrid (P33D49), three (3) planting densities (24,000, 30,000 and 34,000 plants/ac), and three (3) irrigation levels (100%, 75% and 50% ET). The experimental design was a split plot design with four (4) replications. The irrigation levels were main plots, and hybrids and planting densities were sub-plots. Each plot was 10 feet wide and 30 feet long with a row spacing of 30 inches. The cropping system is in a corn-wheat rotation with strip tillage, a common practice in the area. The field was fertilized before planting at 250-100-0-30 (N-P-K-S) lb/ac based on soil testing. The experiment was planted on May 10, 2012, using a John Deere Max-Emerge planter. Weeds were controlled by Sharpen and Roundup as pre-emergence and ResolveQ plus Status as post-emergence applications.

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Irrigation scheduling was determined by a water loss equation developed by Thomas Marek, Texas AgriLife Research Irrigation Engineer, which accounts for evapotranspiration (ET or water use), and calculates the amount of plant available water in the profile. The total irrigation amounts for 100%, 75% and 50% ET were 24.1, 18.6 and 13.2 inches, respectively. The total effective rainfall was 5.98 inches during growing season. The irrigation, rainfall and maximum temperature during growing season are shown in figure 1.

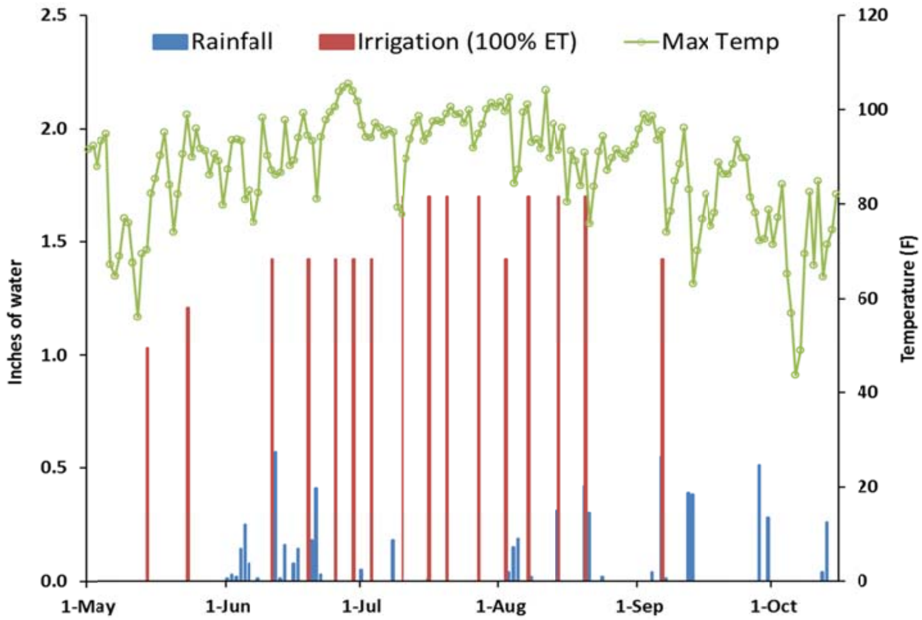

Fig 1. Climate data of Etter, TX (2012).

Water content of soil profile at planting and after harvesting was measured gravimetrically. Total water use (ET) was calculated using a water balance model. Yield was determined by combine harvest and adjusted to 15.5% grain moisture. WUE was calculated as the ratio of yield and ET. The collected data was analyzed using appropriate analysis of variance (ANOVA) and mean separation procedures.

d. <u>Results and discussion</u>

1. Yield responses to irrigation

Irrigation has the dominant effect on corn yield, ET and WUE. However, irrigation is also interacted with planting density (PD) and hybrid as the 3-way interaction is significant (Table 1). For all hybrids, yield, ET and WUE decreased as irrigation levels decreased from 100% ET to 50% ET. For 75% ET level, yield in some treatments only reduced about 10% as compared to 100% ET level. For example, yields of P1151HR, P1398HR and P1564HR were close to 200 bu/ac at PDs of 30,000 and 34,000 plants/ac. The ability to maintain 200 bu/ac yield level for 75% ET is attractive for irrigation water savings because it saved over 20% or 5 inches irrigation. When the irrigation level dropped to 50% ET, yield reduced to 100-130 bu/ac levels. It will be up to producers to determine if they can afford a 100 bu/ac corn yield level or not.

2. *Planting density effect on yield, ET and WUE*

The PD effect on yield, ET and WUE is related to irrigation level and hybrid (Table 1). For 100% ET, 30,000 plants/ac resulted in the highest yields in P33D49, and P1498HR and P1564HR, and 34,000 plants/ac had the highest yield in P1151HR and P1324HR. At 75% ET level, yield was either stable or still increased as PD increased. Apparently, at least the planting density of 30,000 plants/ac is required to achieve high yields for 100% and 75% ET levels. At 50% ET level, yield in the check hybrid (P33D49) linearly decreased as PD increased from 24,000 to 34,000 plant/ac. However, yield was the highest at PD of 30,000 plants /ac for all 4 AquaMax hybrids, indicating that new AquaMax hybrids require higher PD even under drought conditions (Table 2). The PD effect on ET and WUE was similar to the effect on yield.

3. *Hybrid differences in yield, ET and WUE*

There were significant differences in yield, ET and WUE among hybrids. However, the magnitude of the differences was related to irrigation and planting density. In general, all AquaMax hybrids yielded more than the check hybrid except for P1324HR at 100% ET. The yield difference between AquaMax hybrid and check increased as irrigation level decreased. For example, the yield difference between AquaMax hybrid and check was generally less than 10 bu/ac at 100% ET. However, the yield difference was as high as 39 bu/ac between P33D49 (88.5 bu/ac) and P1151HR (127.8 bu/ac) at 34,000 PD for 50% ET level. Among the hybrids, P1564HR had the highest yield and WUE at 100% ET but P1151HR had the highest yield and WUE at 50% ET (Table 2). Clearly, AquaMax hybrids, particularly P1151HR, P1498HR and P1564HR showed significant yield benefits over check hybrid (P33D49) under reduced irrigation levels in this year's study.

Table 1. Analysis of variance (ANOVA) and LSD for yield, evapotranspiration (ET), and water use efficiency (WUE) in 2012 season at Etter, TX.

Source	DF	F	P>F	LSD (0.05)
		Yield (bu/ac)		
Rep	3	0.10	0.9601	6.3
Irrigation (I)	2	2845.71	0.0001	3.4
Planting density (PD)	2	4.07	0.0348	5.5
Hybrid (HB)	4	52.62	0.0001	4.0
I×PD	4	5.04	0.0066	9.5
I×HB	8	5.75	0.0001	6.9
PD×HB	8	2.63	0.0114	6.9
I×PD×HB	16	3.04	0.0003	12.0
		ET (in)		
Rep	3	1.75	0.1928	0.24
Irrigation (I)	2	1607.81	0.0001	0.30
Planting density (PD)	2	1.14	0.3419	0.21
Hybrid (HB)	4	31.99	0.0001	0.22
I×PD	4	0.39	0.816	0.36
I×HB	8	7.41	0.0001	0.38
PD×HB	8	1.43	0.1922	0.38
I×PD×HB	16	3.32	0.0001	0.66
		WUE (bu/ac/in)		
Rep	3	0.18	0.9069	0.26
Irrigation (I)	2	951.64	0.0001	0.13
Planting density (PD)	2	8.48	0.0025	0.23
Hybrid (HB)	4	72.39	0.0001	0.17
I×PD	4	9.22	0.0003	0.39
I×HB	8	6.11	0.0001	0.30
PD×HB	8	2.98	0.0046	0.30
I×PD×HB	16	3.93	0.0001	0.51

Table 2. Yield, evapotranspiration (ET) and water use efficiency (WUE) in 5 hybrids at 3 irrigation levels and 3 planting densities in 2012 season at Etter, TX.

Hybrid	Irrigation	Yield (bu/ac)				ET (in)				WUE (bu/ac/in)			
		24,000	30,000	34,000	**Mean**	24,000	30,000	34,000	**Mean**	24,000	30,000	34,000	**Mean**
	% ET	Plants/ac				Plants/ac				Plants/ac			
P33D49	100	216.0	221.6	219.2	**218.9**	27.35	26.39	26.26	**26.67**	7.93	8.48	8.50	**8.30**
	75	171.4	168.3	172.3	**170.7**	22.85	23.00	22.62	**22.82**	7.64	7.36	7.73	**7.57**
	50	119.7	112.6	88.5	**106.9**	18.91	19.47	19.83	**19.40**	6.26	5.79	4.53	**5.53**
P1151HR	100	212.9	219.3	233.1	**221.8**	24.95	25.16	24.98	**25.03**	8.66	8.80	9.27	**8.91**
	75	200.7	195.0	195.4	**197.0**	22.41	22.11	22.05	**22.19**	8.65	8.85	9.05	**8.85**
	50	129.1	149.9	127.8	**135.6**	18.95	18.55	18.53	**18.68**	6.81	8.30	6.79	**7.30**
P1324HR	100	200.5	220.1	222.9	**214.5**	25.82	26.46	26.53	**26.27**	7.87	8.22	8.46	**8.18**
	75	173.6	171.8	185.6	**177.0**	23.40	22.54	23.24	**23.06**	7.38	7.73	8.18	**7.76**
	50	101.0	116.6	100.0	**105.9**	19.16	17.90	18.61	**18.56**	5.55	6.72	5.65	**5.97**
P1498HR	100	205.0	230.5	225.1	**220.2**	26.20	26.18	26.19	**26.19**	7.87	8.79	8.46	**8.37**
	75	178.8	188.8	197.9	**188.5**	22.58	22.75	23.10	**22.81**	7.84	8.37	8.62	**8.28**
	50	126.7	127.6	105.3	**119.8**	19.58	20.02	19.40	**19.67**	6.38	6.30	5.28	**5.98**
P1564HR	100	239.9	240.4	235.7	**238.7**	25.85	26.07	26.55	**26.16**	9.26	9.21	8.87	**9.11**
	75	188.6	205.4	195.3	**196.4**	23.63	23.44	23.27	**23.45**	7.78	8.61	8.57	**8.32**
	50	126.4	132.9	125.8	**128.4**	19.76	19.21	19.73	**19.57**	6.57	7.41	6.49	**6.82**