Physiological Basis for Improving Yield and WUE of Wheat in the Southern High Plains

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INTRODUCTION

Soil water deficit is a primary factor limiting wheat yields in the US Southern High Plains. Selection of cultivars with more drought resistance is an important management strategy for improving yield and water use efficiency (WUE) under water-limited conditions. Two newly released Texas AgriLife Research cultivars, TAM 111 and TAM 112, are widely grown in the High Plains and are among the highest yielding across the region. However, the underlying physiological mechanisms for improved yield and WUE in these cultivars are not well understood. The objective of this study is to investigate the physiological determinations of yield and WUE in these two widely grown wheat cultivars as compared to cultivars (TAM 105 and TAM 110) released earlier.

MATERIALS AND METHODS

- Field location: Bushland, TX (35° 11' N and 102° 06' W).
- Cultivars: TAM 105 (1979), TAM 110 (1996), TAM 111 (2003), TAM 112 (2005).
- Water regimes: Dryland and irrigated.
- Measurements: Soil water content of profile (0-120 cm); Biomass at anthesis and maturity; Yield components; Grain yield (combine).

RESULTS

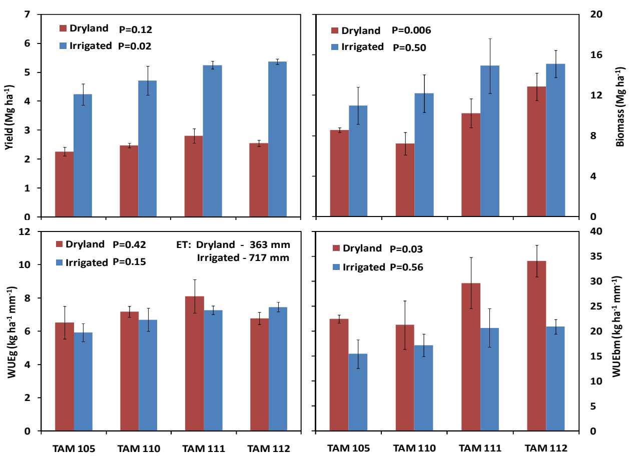

Fig. 1. Yield, biomass at maturity, WUEg and WUEbm in 4 cultivars under dryland and irrigated regimes in 2010 season.

Table 1. Yield components of 4 cultivars under dryland and irrigated regimes in 2010 season.

Cultivar	Spikes	Seeds	TKW	HI
	m⁻²	Spike⁻¹	g	
Dryland				
TAM 105	703	16.8	23.7	0.26
TAM 110	610	19.1	30.1	0.34
TAM 111	577	25.8	26.9	0.33
TAM 112	773	18.5	26.5	0.26
LSD (0.05)	NS	5.2	2.0	0.09
Irrigated				
TAM 105	813	21.1	27.9	0.36
TAM 110	773	21.5	34.3	0.40
TAM 111	823	25.2	31.6	0.38
TAM 112	973	22.0	32.6	0.40
LSD (0.05)	NS	NS	4.4	NS

TKW: 1000 kernel weight; HI: harvest index; NS: not significant P>0.05.

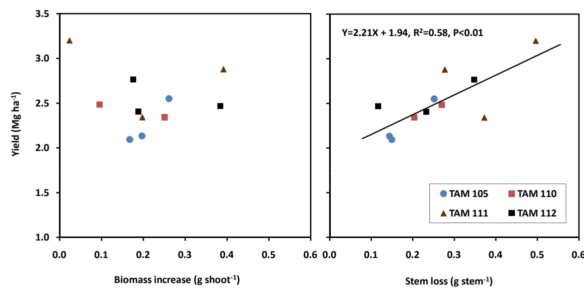

Fig. 2. The relationships between yield, biomass increase and stem loss during grain filling under dryland conditions.

Table 3. Leaf CO_2 assimilation rate (A), stomatal conductance (Gs), intercellular CO_2 concentration (Ci), transpiration rate (Tr) and WUE (A/Tr) in TAM 111 and TAM 112 under dryland condition[†].

Cultivar	A	Gs	Ci	Tr	A/Tr
	μmol m⁻² s⁻¹	mol m⁻² s⁻¹	μL L⁻¹	mmol m⁻² s⁻¹	mmol mol⁻¹
TAM 111	6.18	0.083	201	4.32	1.41
TAM 112	4.45	0.088	235	4.50	1.01
LSD (0.05)	1.70	NS	22	NS	0.25

NS: not significant P>0.05.

([†]The measurements were taken in dryland plots under very dry conditions, RH=11%, VPD=4.6).

Table 2. Spike and stem dry weight of 4 cultivars under dryland and irrigated regimes in 2010 season.

Cultivar	Spike dry weight				Stem dry weight			
	g m⁻²		g spike⁻¹		g m⁻²		g stem⁻¹	
	AN	MA	AN	MA	AN	MA	AN	MA
Dryland								
TAM 105	115	416	0.20	0.59	524	513	0.91	0.73
TAM 110	166	463	0.26	0.74	630	456	0.97	0.73
TAM 111	180	495	0.29	0.88	817	530	1.32	0.94
TAM 112	213	607	0.31	0.79	765	678	1.10	0.87
LSD (0.05)	60	NS	0.02	0.10	NS	NS	0.11	0.13
Irrigated								
TAM 105	201	531	0.23	0.68	783	569	0.88	0.70
TAM 110	193	675	0.29	0.89	586	544	0.89	0.70
TAM 111	242	805	0.31	0.97	898	686	1.17	0.84
TAM 112	261	812	0.31	0.84	794	700	0.93	0.72
LSD (0.05)	NS	NS	0.04	0.10	NS	NS	0.15	0.06

AN: anthesis; MA: maturity; NS: not significant P>0.05.

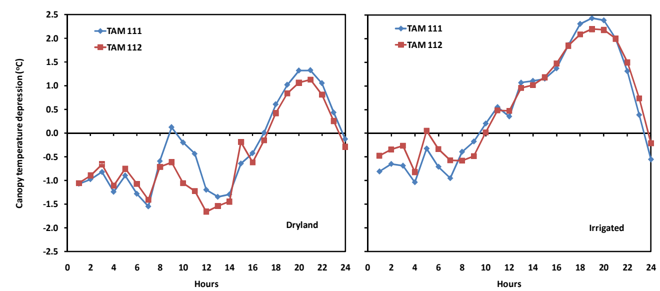

Fig. 3. Canopy temperature depression in 2 cultivars at heading in a dry and hot day (May 11, 2010, RH=25%).

SUMMARY

- Higher yield in new cultivars is contributed by more seeds per spike and heavier seeds as a result of higher biomass (spike+stem).
- Remobilization of carbon reserves is important to dryland yield.
- TAM 111 and TAM 112 may have different mechanisms to respond drought stress.

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