Agronomic Responses of Corn Hybrids to Drought Stress and Nitrogen Supply

Samadangla Ao[1*], Jeffrey A. Coulter[1], Michael P. Russelle[1], Tamás Varga[1], and Gary W. Feyereisen[2]

[1]Univ. of Minnesota; [2]USDA-ARS, St. Paul, MN

E-mail: aoxxx011@umn.edu

INTRODUCTION

- A significant portion of corn (*Zea mays* L.) production in the U.S. regularly experiences drought. This is especially important if drought occurs during tasselling and ear formation[2].
- Drought-tolerant corn hybrids could reduce yield losses associated with increasingly variable rainfall[7] by maintaining kernel number through reduction in kernel abortion[4].
- However, recently released drought-tolerant hybrids showed similar yield as non-drought-tolerant ('standard') hybrids under severe drought stress or in the absence of drought stress[5].
- Higher N supply has improved yield during short-term drought[3] but can increase vegetative growth and transpiration[6]. This may increase the risk of drought stress at anthesis.

OBJECTIVES

- Evaluate yield and N uptake of drought-tolerant and standard corn hybrids as affected by the duration of moderate drought stress (mid-day leaf rolling) and N supply.

MATERIALS AND METHODS

- Three field experiments were conducted in 2013 at the Sand Plain Research Farm, Becker, MN.
- Soil - Hubbard-Mosford loamy sand complex.
- Experimental design - split-plot arrangement in a randomized complete block with four replications.
- Main plots - three durations of moderate sustained drought stress: i) no drought stress (None); ii) drought stress from the 14-leaf collar stage (V14) until physiological maturity (R6); and iii) drought stress from the blister stage (R2) until R6.
- Subplots - a factorial arrangement of two hybrids, a drought-tolerant and standard hybrid; and three fertilizer N rates, sub-optimal (0.5X), optimal (1.0X), and supra-optimal (1.5X).

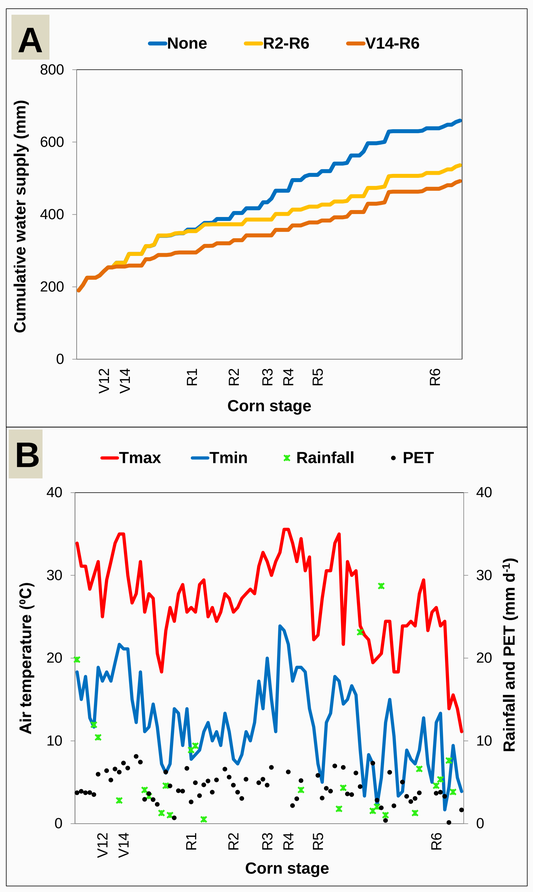
Moderate sustained drought stress was maintained using drip irrigation.

RESULTS AND DISCUSSION

Corn response to drought duration and fertilizer N rate, averaged across experiments and hybrids.

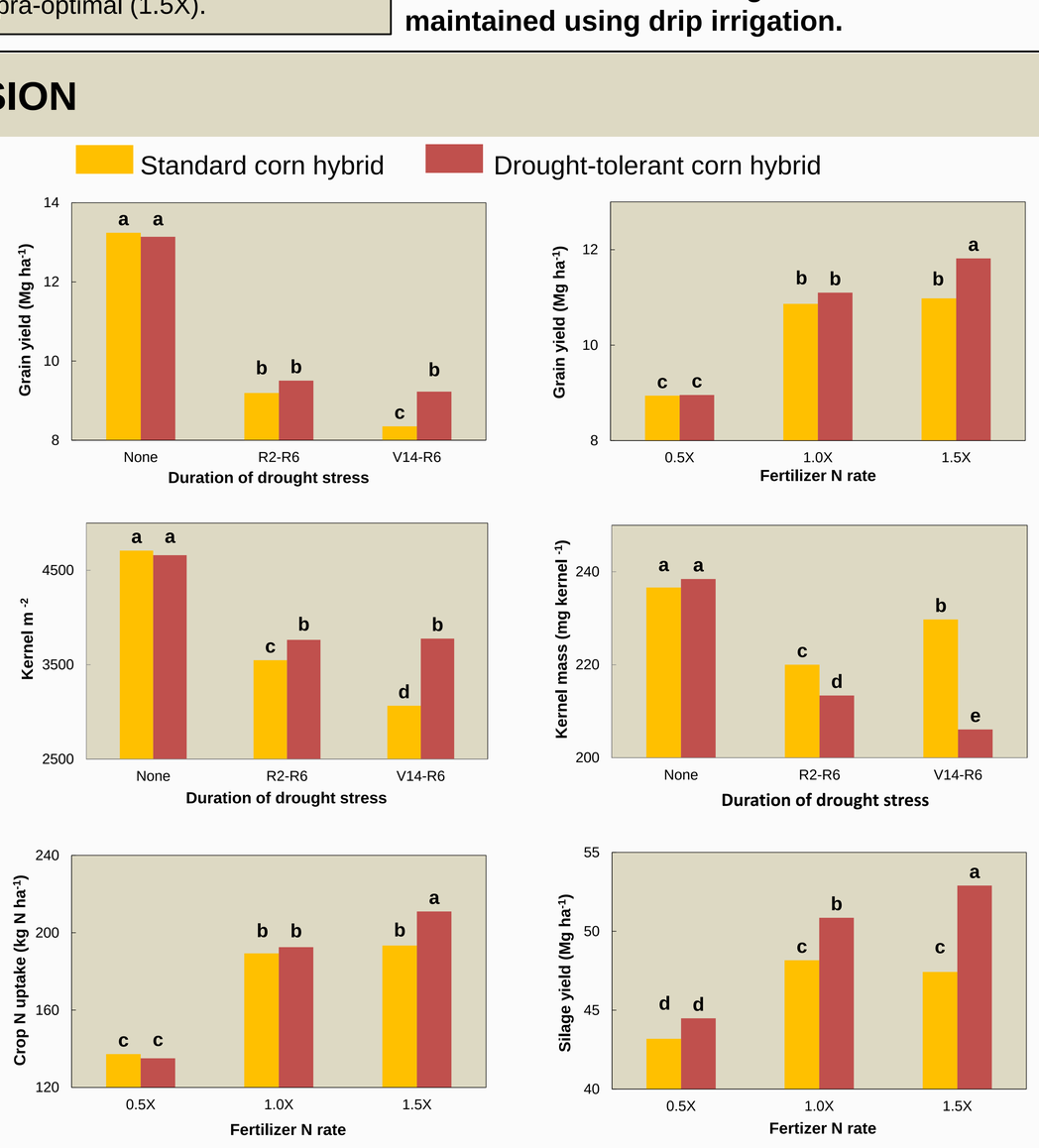
Dependent variable	N rate	Duration of drought stress: None	R2-R6	V14-R6
Grain yield, Mg ha^{-1}†	0.5X	10.6 cA¶	8.4 bB	7.8 bC
	1.0X	14.1 bA	9.6 aB	9.2 aB
	1.5X	14.8 aA	10.0 aB	9.4 aC
Silage yield, Mg ha^{-1}‡	0.5X	50.9 bA	42.2 bB	38.5 bC
	1.0X	61.8 aA	45.2 aB	41.5 aC
	1.5X	62.3 aA	46.3 aB	41.9 aC
Grain N uptake, kg N ha^{-1}	0.5X	103 cA	92 bB	85 bB
	1.0X	158 bA	120 aB	113 aB
	1.5X	166 aA	128 aB	118 aC
Crop N uptake, kg N ha^{-1}	0.5X	146 cA	134 cB	128 cB
	1.0X	225 bA	180 bB	168 bB
	1.5X	235 aA	192 aB	179 aC

† Grain yield at 155 g kg^{-1} moisture, ‡silage yield at 650 g kg^{-1} moisture, ¶ for a given dependent variable, treatment means followed by the same lowercase letter within a column and means followed by an uppercase letter in a row are not significantly different at $P \leq 0.05$.



Cumulative water supply [A], and daily air temperature, rainfall, and potential evapotranspiration (PET) [B] during the growing season, 2013.

- PET = Pan evaporation x K_c [1]



Corn hybrid effects by duration of drought stress and fertilizer N rates.

- Within each figure, treatment means followed by same letter are not significantly different at $P \leq 0.05$.

CONCLUSIONS

- Grain yield was greater with the drought-tolerant hybrid only when drought stress encompassed silking; that difference was 10%.
- Kernel number of the drought-tolerant hybrid was 21% greater than the standard hybrid when drought stress encompassed silking.
- With the supra-optimal N rate, the drought-tolerant hybrid had 7% greater grain yield than the standard hybrid.
- Corn N uptake was less with drought stress than in the absence of drought stress, and was further reduced with less N.
- Greater kernel number, N uptake, and aboveground biomass were associated with greater grain yield of the drought-tolerant hybrid.

REFERENCES

1. Al-Kaisi, M. 2000. Crop water use or evapotranspiration. Iowa State Univ. Ext., Ames, IA.
2. Çakir, R. 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field Crops Res. 89:1–16.
3. Markels, R.J.C., R.S. Strellner, and A.D.B. Leakey. 2011. Impairment of C4 photosynthesis by drought is exacerbated by limiting nitrogen and ameliorated by elevated [CO2] in maize. J. Exp. Bot. 62:3235–3246.
4. Monneveux, P., C. Sánchez, D. Beck, and G.O. Edmeades. 2006. Drought tolerance improvement in tropical maize source populations. Crop Sci. 46:180–191.
5. Roth, J.A., I.A. Ciampitti, T.J. Vyn. 2013. Physiological evaluations of recent drought-tolerant maize hybrids at varying stress levels. Agron. J. 105:1129–1141.
6. Sinclair, T.R., and R.C. Muchow. 2001. Systems analysis of plant traits to increase grain yield on limited water supplies. Agron. J. 93:263–270.
7. Wesley, J.D. 2012. Impact of drought stress on transgenic corn seed technologies in the United States: A comparative analysis. M.S. Thesis, Auburn Univ., Auburn, AL.