Impact of deficit irrigation on the productivity and nutritive quality of forage corn and sorghum.

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Introduction

Given the unpredictability of climatic patterns with the onset of climate change it is of paramount importance to develop systems that are more resilient to drought stress. Corn silage is a major component of the forage system in western dairies, but the water use for corn silage is substantial. Additionally, if submitted to drought stress, it is very likely that corn yields will decrease notably (Payero et al, 2006). Crops that can adjust to lower seasonal supplies whilst maintaining biomass yields and nutritive quality will gain importance as water shortages begin to arise (Howitt, 2014). One of such crops is sorghum. Novel sorghum brown midrib (BMR) varieties have been shown to improve the digestibility of sorghum to the extent where it is comparable to corn (Marsalis et al, 2010). Conventional sorghum has been proven to yield considerably more than corn underwater deficit circumstances (McCuistion et al, 2010). Sorghum, however, lacks the energy component that the corn grain provides.

Objective

To examine the yield and nutritive quality of annual forage crop production under various water deficits.

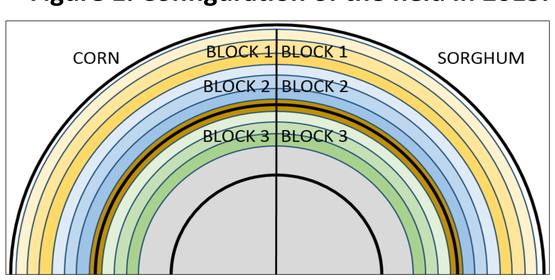
Methods

- University of California, Westside Research and Experimental Station (WSERC). The replications of each cultivar within a block x irrigation were treated as subsamples.
- Forage types tested were corn (CORN), conventional sorghum (CONV) and BMR sorghum (BMR)
- Regression analysis was used to determine response to irrigation treatments, and ANOVAs were used to determine differences between treatments.
- Quality analysis were done at the Dairylands Laboratory in Arcadia, WI by NRI.

Table 1. Seasonal environmental conditions.

2015	
Season length (days)	100
ETo (mm)	731
100% Water (mm)	581
81% Water (mm)	469
63% Water (mm)	369

Figure 1. Configuration of the field in 2015.



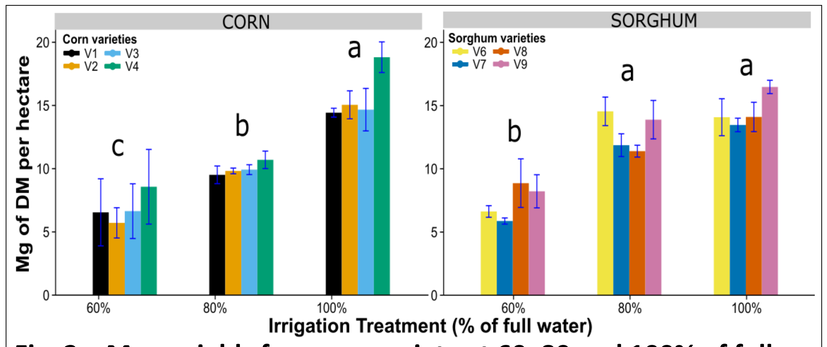


Fig. 2 – Mean yields for every variety at 60, 80 and 100% of full irrigation. Error bars are the standard error of the mean. Different letter are significantly different at Tukey *P≤0.05.*

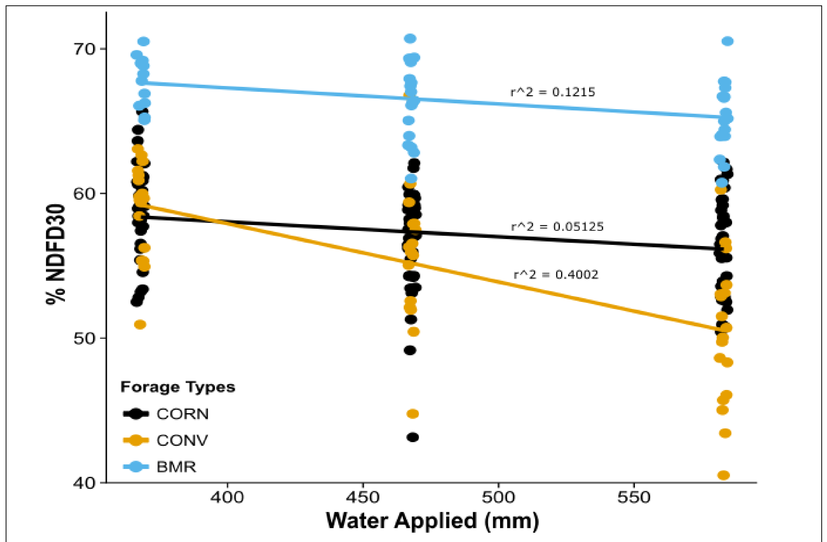


Fig. 3 - % of neutral detergent fiber digested in 30 hours for corn (CORN), conventional sorghum (CONV) and BMR sorghum (BMR) vs seasonal irrigation amount.

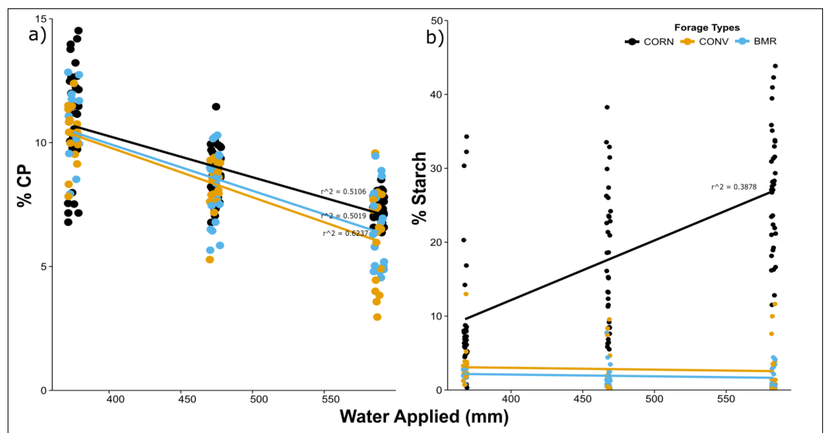


Fig. 4 – a) % crude protein (CP) and b) % starch for corn (CORN), conventional sorghum (CONV) and BMR sorghum (BMR) vs seasonal irrigation amount.

Table 2. Varieties used in the experiment, ID and relative maturity (RM). PPS stands for photoperiod sensitive.

ID	CORN	RM	ID	SORGHUM	RM
V1	TMF2H919 (Mycogen)	123	V6	SPX 903 (Sorghum Partners)	PPS
V2	DKC66-42RIB (Dekalb)	116	V7	AF 7401 (BMR Alta Seeds)	110-115
V3	N75H-GTA (Syngenta)	114	V8	AF 7301 (BMR Alta Seeds)	95-105
V4	6400DG/VT2P/RIB (Croplan)	112	V9	NK 300C (Sorghum Partners)	100-110

Discussion

Fig. 2 - Yields in CORN decreased significantly at 80% of full irrigation while sorghum yields they did not decrease significantly until the 60% treatment. CONV had significantly higher yields at 80% than BMR. The lower yields of V1-V3 is due to early harvesting and plants not having reached their harvest prime.

Fig. 3 – CONV decreased in %NDFD30 significantly faster than CORN and BMR. CORN and BMR were not significantly different. BMR data points (blue) suggest that BMR is more digestible than CORN. BMR had significantly more %NDFD30 than CONV at all levels of irrigation. The rapid decrease of CONV is due to the decrease in the leaf:stem ratio. The stem has more lignin.

Fig. 4 – a) All forage types decreased in % CP uniformly. % CP decreases with added water because of the dilution by other components. High % CP of water stressed plants might be due to the breakdown of mechanisms that convert NO_3^- into amino acids.

Fig. 4 – b) % starch increased at a significantly higher rate in CORN than in any of the sorghum. This is due to the high % starch contained in the corn grain. Sorghum did not have a significant slope due to the lack of grain.

Conclusion

- Under circumstances of uncertain water availability sorghum might be a better option than corn.
- The ideal type of sorghum to be grown is BMR as the digestibility can compete with that of well watered corn and yields at lower irrigation levels can match that of corn..
- Sorghum requires less water, less fertilizer, seed costs less and the degree of crop management is lower than that of corn.
- Sorghum can be of adequate use by dairies as a substitute for corn silage if a supplement of grains is added to the ration.

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