IRRIGATION AND SUGAR IN SWEET CORN

T.E. Dickert and W.F. Tracy[1/]

Abstract

Sweet corn (*Zea mays* L.) producers desire high yields and high sugar content in the endosperm. High irrigation levels result in high yield, but their effect on sugar content is unclear. The effects of two irrigation levels, standard and stressed on endosperm sugar content were evaluated using three *sugary1* hybrids over 2 years. No significant differences were found among the treatments when averaged over hybrids and years. In 1996, reduced irrigation resulted in higher sugar levels. As expected, there were significant differences in sucrose and total sugar levels among hybrids. The ranking among hybrids differed over years.

Introduction

One of the goals of sweet corn producers is to produce sweet corn with high sugar concentration in the endosperm. In sweet corn, sweetness is the major component of flavor and is affected by the amounts of sugar and starch in the endosperm. Other characteristics of high quality sweet corn are tenderness, creamy texture, and low starch content.

On sandy soils in central Wisconsin, supplemental irrigation is necessary for dependable sweet corn production. Soil moisture stress, especially during the silking stage, is deleterious to sweet corn yields. When moisture is adequate, sandy soils have a high production potential.

There has been little information on the effects of irrigation on sugar concentration in sweet corn, but there is some information on irrigation and early sugar beet production. Water stress can temporarily increase sugar concentration in sugar beets. However water stress treatments reduced total yield and yielded less sugar per acre.

Standard irrigation levels result in high yield, but its effect on sugar levels in sweet corn is unclear. The objective of this study was to evaluate the effects two rates of irrigation on sugar levels of sweet corn.

Materials and Methods

Three *su1* hybrids, ‘Jubilee’, ‘GH 1703’ and ‘Empire’ were machine planted on 13 May 1996 and 8 May 1997 at Hancock Wisconsin (Plainfield loamy sand; mixed, mesic Typic

[1/] Research Assistant and Professor, Department of Agronomy, UW-Madison.

Udipsamments). In both years, four row plots were planted and all the data were taken from the center two rows. The rows were 3.5 m long and 0.76 m apart. The plots were over-planted with 30 kernels per row and thinned to a final density of 44,500 plants ha^{-1}. Both years, 252 kg N ha^{-1} of 33.5-0-0 were applied and an additional 84 kg N ha^{-1} of 34-0-0 were applied at 50% pollen shed.

Each year a completely randomized design with split-plot restrictions for irrigation, six replications, and two harvests for each plot were conducted. The design had split-plot restrictions because of the irrigation system used. This design is less than ideal, but the soil types at the Hancock Agricultural Research Station are very uniform. Standard irrigated plots were on one side of the irrigation alley and low irrigation on the opposite side. Mid-silk and mid-pollen dates were recorded. Growing degree days were calculated (GDDs) using the following formula:

$$GDU = [\text{Max temp} + \text{Min temp}]/2 - 10^{o}C$$

All of the plots were irrigated on the regular station schedule up to and including 19 July in 1996 and 2 August in 1997. Then, the next two to three scheduled irrigations were withheld from the low irrigation plots. Afterwards all plots received standard irrigation throughout the harvest dates.

Plots were harvested after approximately 250 heat units (^{o}C) had accumulated from the date of pollination. Five ears from the center two rows of each plot were harvested twice. Approximately 113 grams of kernels were cut and collected from the center of each ear, and the wet weights were recorded. The samples were first frozen with dry ice and then freeze-dried. Dry weights were recorded and percent moisture at harvest was calculated. The mg sugar mg/dry weight were calculated. To reduce the number of plots for analysis we selected three replications such that moisture levels for all replications and treatments were similar. The freeze-dried kernel samples were ground by a cyclone grinder with a 20-mesh screen.

Sugars were extracted in the laboratory and sucrose, fructose, glucose and total sugars were determined using an HPLC. Only sucrose and total sugars was used in the analysis.
Analysis of variance was used to analyze the data from the completely randomized design with split plot restrictions within and combined over years. All effects were considered fixed.

Results and Discussion

Year effects were highly significant as well as year x hybrid effects (Table 1). The data are presented for each year separately because there was significant year x hybrid interaction due to a change in rank among the three hybrids. In the 1996 growing season the low irriga-ion treatments could be described as stressed because during the treatment period only 8.0 mm of precipitation was reported and the irrigated plots received 38.1 mm of irrigation water. In 1997, there was 56.0 mm in reported precipitation during the treatment period and the normal irrigation treatment received an additional 25.4 mm of irrigation water.

Table 1. Analysis of variance for sucrose and total sugars over years 1996 and 1997, and two irrigation (Irr) treatments.

Source	df	Sucrose MS	Total MS
Year	1	0.0120**	0.1087**
Hybrid	2	0.0015	0.0067
Irr	1	0.0018	0.0039
Year x Hybrid	2	0.0112**	0.0220**
Year x Irr	1	0.0008	0.0009

Hybrid x Irr	2	0.0013	0.0026
Year x Hybrid x Irr	2	0.0014	0.0032
Error	60	0.0009	0.0018

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.

Hybrids differed for sucrose and total sugar levels in 1996 and for sucrose levels in 1997 (Tables 2 and 3). Irrigation treatments did not affect total sugar levels in either year but did affect sucrose in 1996 (Tables 2 and 3). In 1996 the low irrigation treatment resulted in significantly more sucrose than the standard irrigation treatment (Table 4).

Table 2. Analysis of variance for sucrose and total sugars in the endosperm of three hybrids with two irrigation (Irr) treatments in 1996.

Source	df	Sucrose MS	Total MS
Hybrid	2	0.0080**	0.0249**
Irr	1	0.0025*	0.0042
Hybrid x Irr	2	0.0012	0.0027
Error	30	0.0006	0.0010

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.

Table 3. Analysis of variance for sucrose and total sugars in the endosperm of three hybrids with two irrigation (Irr) treatments in 1997.

Source	df	Sucrose MS	Total MS
Hybrid	2	0.0047*	0.0037
Irr	1	0.0001	0.0005
Hybrid x Irr	2	0.0016	0.0030
Error	30	0.0012	0.0026

* Significant at the 0.05 probability level.

Table 4 Means for sucrose and total sugars under standard and low irrigation treatments in 1996 and 1997, averaged over three hybrids.

	1996		1997	
Irrigation treatment	Sucrose	Total	Sucrose	Total
	--------------------- mg sugar/mg dry wt. ----------------			
Standard †	0.1951 b‡	0.2474 NS§	0.2275 NS	0.3320 NS
Low	0.2116 a	0.2690	0.2309	0.3398

† See text for treatments.

‡ a, b = significant differences among means within the columns.
§ NS = no significant differences among means within the columns.

In this experiment we were unable to detect any consistent affects of irrigation treatments on sugar content in sweet corn. However, due to irrigation constraints at our experimental plots we did not have a higher than normal irrigation treatment. It is possible that very high levels of irrigation could affect sugar content of irrigated sweet corn. We would like to examine the relationship of high irrigation levels, nitrogen, and sugar levels. However, we must develop a system were we can exclude rain during the critical test periods.