# Effect of Different Harvest Time on Sugar and Juice Yield of Sweet Sorghum

Satheesh K. Subramanian[1],* P.V. Vara Prasad[1], Scott A. Staggenborg[1], Jianming Yu[1] and Praveen V. Vadlani[2]

[1]Agronomy Department; and [2]Department of Grain Science and Industry, Kansas State University, Manhattan, KS 66506

## Rationale and Objective

Sweet sorghum (*Sorghum bicolor* L. Moench) is an important bioenergy crop, and has potential to be grown for ethanol production. In sweet sorghum, sugar content changes with development, so time of harvesting is an important factor determining quality and yield sugar. It is important to determine and optimize of stage of development that provides maximum yield potential for sugar and bioenergy production.

The objective of this research was to determine the optimum harvesting time for obtaining highest brix, sugar and juice yield of sweet sorghum. The hypothesis of this study was sugar yield increases between milk and dough stages in sweet sorghum.

## Materials and Methods

This experiment was conducted during 2009 in Manhattan, KS. Sweet sorghum variety M81E was harvested at ten growth stages: flag leaf tip appearance (H1), start of panicle emergence (H2), complete panicle emergence (H3), anthesis (H4), post-anthesis (7 d after anthesis, H5), milk stage (H6), soft dough (H7), hard dough (H8), physiological maturity (H9) and post-physiological maturity (H10; 30 d after physiological maturity). Plot size of 9 m x 3 m with 0.5 m space between plots and 1.0 m between blocks (replicates) were used. The variety had four rows with row length of 9 m and row spacing of 0.75 m. The experimental design was a randomized complete block with four replications.

All plants from center 1.5-m long row were harvested at each growth stage, and the stalks were stripped of leaves and juice was extracted using motor operated three roller sugarcane crusher. After juice extraction, the juice volume of the sample was used to calculate juice yield. Data on plant height, stem girth, brix value (Digital refractometer, Atago, Bellevue, WA), and dry weights of stem, leaves and seed were determined. Juice yield and brix values were used to calculate sugar yield. The total sugars and reducing sugars were estimated by Robertson et al. (1996) method in the juice samples and expressed as percentage. Non-reducing sugar was obtained from the differences of total and reducing sugars and expressed as percentage.

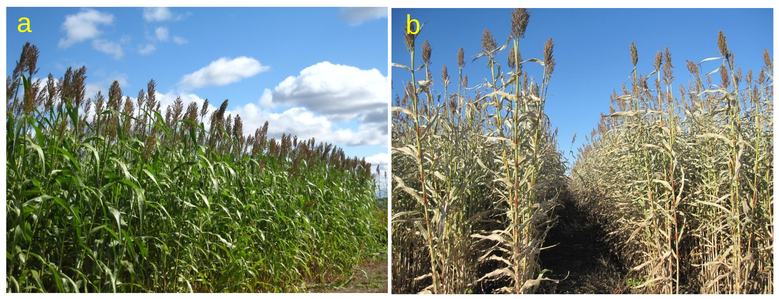
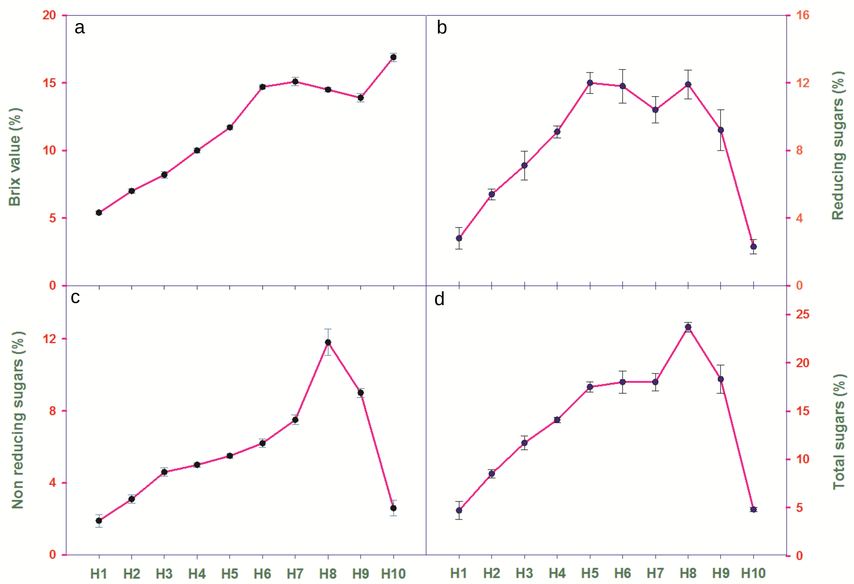



Figure 1. Photographs showing plants at (a) milky stage; and (b) hard dough stage of sweet sorghum M81E under field conditions during 2009 in Manhattan, Kansas.

## Experimental Results

There were significant effects of harvesting time on plant height, stem girth, brix, juice yield, sugar yield, total sugars, reducing sugars, non-reducing sugars, stem fresh weight, stem dry weight, total biomass production and seed yield

Figure 2. Effect of different harvest times on (a) brix; (b) reducing sugars; (c) non-reducing sugars; and (d) total sugar content of sweet sorghum var. M81E.




Legend (Figure 2):

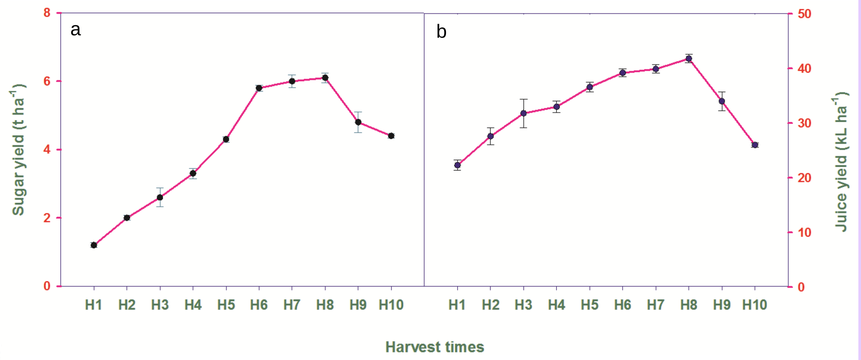
| | |
|---|---|
| H1 - Flag leaf tip appearance | H6 - Milk |
| H2 - Start of panicle emergence | H7 - Soft dough |
| H3 - Complete panicle emergence | H8 - Hard dough |
| H4 - Anthesis | H9 - Physiological maturity |
| H5 - Post-anthesis | H10 - Post-physiological maturity |

The data on brix (%) revealed increasing trend from flag leaf tip appearance (5.4%) up to hard dough stage (14.5%), decreased slightly at physiological maturity (13.9%), then increased at about 30 d after physiological maturity ( 6.9%) (Figure 2a).

The amount of reducing sugars (glucose and fructose) increased from early (flag leaf stage) from 2.8% until 7 d after anthesis stage where the highest amount of reducing sugars (12%) (Figure 2b), which remained similar until hard dough stage. Harvesting beyond physiological maturity resulted in significantly lower (2.26%) reducing sugars.

The data show that the amount of non-reducing sugar (e.g. sucrose) steadily increased from appearance of flag leaf and peaked at hard dough stage and steadily decreased thereafter until post physiological maturity. The highest amount of non-reducing sugar (11.8%) was obtained when plants were harvested at hard dough stage (Figure 2c).

Figure 3. Effect of different harvest times on (a) sugar; and (b) juice yield of sweet sorghum var. M81E. See Fig. 2 for legends.




The total sugars continuously increased as plants matured with lowest value of 4.66 % noted among plants harvested at flag leaf stage and the highest, (23.7%) at hard dough. A decline in the % total sugars was observed when harvesting at physiological and post physiological maturity stage of the plant (Figure 2d).

For the sugar yield (Figure 3a), the best stage to harvest in order to get the maximum yield is hard dough stage. Sugar yield at this stage was 6.1 t ha$^{-1}$ which was similar to those at milk or soft dough. Harvesting sweet sorghum after hard dough stages decreased sugar yield by 21.8% at physiological maturity.

The juice yield was significantly highest (41.8 kL ha$^{-1}$) when plants were harvested at hard dough stage. A further delay in harvesting beyond hard dough stage resulted in a lower (18.6%) juice yield (Figure 3b).

## Conclusions

Our results suggest that the optimum time for harvesting of sweet sorghum cultivar M81E is at hard dough stage when highest brix, total sugars, reducing sugars and non-reducing sugars were observed. The highest level of sugar and juice yield were also obtained when harvested at hard dough stage.

## Reference

Robertson, M.J., Muchow, R.C., Wood, A.W., Campbell J.A., 1996. Accumulation of reducing sugars by sugarcane: Effects of crop age, nitrogen and cultivar. Field Crops Res. 49, 39–50.

## Acknowledgments

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