Variation in the quality parameters of sweet sorghum across different dates of sowing

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Citation : Reddy BVS, Sanjana Reddy P, Ashok Kumar A and Ramaiah B, (2007) Variation in the quality parameters of sweet sorghum across different dates of sowing. Journal of SAT Agricultural Research 5(1).

Introduction

Sweet sorghum (*Sorghum bicolor*) is a multipurpose crop (food, feed, fodder and fuel) that has potential as an alternative raw material for ethanol production owing to its high biomass production, high Brix (%), short duration and low water requirement (4,000 cubic m ha^{-1}) and wider adaptability (Reddy et al. 2005). In addition, sweet sorghum is a seed propagated species and better suited for mechanized crop production. The other significant advantage is that the sweet sorghum ethanol blended gasohol is environment friendly. It does not have sulfur and aldehydes making it a green fuel.

The environment and cost considerations and the need for alternative raw material for production of ethanol to meet increased demand has triggered interest in the utilization of sweet sorghum for ethanol production in India and several other countries like the Philippines, Thailand and China. The cost of cultivation of sweet sorghum is about one-third that of sugarcane (*Saccharum officinarum*) (Dayakar Rao et al. 2004). Further, sweet sorghum is best suited for ethanol production because of its higher reducing sugar content compared to sugarcane (Huilgol et al. 2004). Policies to blend petrol with up to 10% ethanol has been widely adopted globally, leading to additional ethanol requirement.

Continuous supply of feed stock to the industries is one major constraint in sweet sorghum ethanol production. To encourage the distilleries to make sweet sorghum a major raw material in addition to sugarcane molasses in ethanol production, there is an urgent need to arrange for the supply of sweet sorghum stalks to the distilleries all-round the year. The current study was undertaken in order to study the feasibility of growing sweet sorghum throughout the year.

Materials and methods

The material for the present study consisted of 7 hybrids (ICSA 264 × SSV 74, ICSA 293 × SSV 74, ICSA 293 × SSV 84, ICSA 293 × SPV 1411, ICSA 474 × SPV 1411, ICSA 474 × ICSV 700, ICSA 529 × SPV 1411) and 3 varieties (SPV 1411, SSV 74 and SSV 84) of sweet sorghum. Each entry was planted six times at monthly intervals during July to December 2005 in two rows of 4 m length with a spacing of 75 cm between rows and 10 cm between plants within a row in Vertisols of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. The experiment was laid out in a randomized complete block design with three replications. All the recommended agronomic practices were followed to raise a healthy crop. Observations were recorded on eight randomly selected plants in each entry and in each replication for time to 50% flowering, plant height, fresh stalk yield, cane yield, juice yield, juice volume, Brix, stillage yield and grain yield.

Results and discussion

Highly significant differences (P <0.01) were observed among the genotypes and the sowing time for all the traits (Table 1). The interaction effects of sowing time with genotypes were also highly significant.

For sugar yield (calculated as a product of Brix (%) and juice yield) that correlates with the ethanol yield, July and August sowings (which were similar though the August sowing was numerically superior) were significantly superior to the subsequent sowings in September to December. However for Brix, July, August, September and November sowings were similar, while October sowing had significantly lower and December sowing had significantly higher Brix (Table 2). When hybrids and varieties were observed as two separate groups, varieties performed better than hybrids for sugar yield (this may not be the case always as the hybrids used in the study were in the preliminary stages of testing). However, variability across different dates was greater in varieties (GCV = 62.92) compared to hybrids (GCV = 28.13) (Table 3). This indicates that hybrids have better buffering capacity to environmental fluctuations compared to varieties.

This study gives an indication that hybrids are more suitable for fuel alcohol production compared to varieties owing to their stability in expression over different

Table 1. Analysis of variance of quality parameters of sweet sorghum genotypes at different sowing dates[1].

Source of variation	df	Time to 50% flowering (days)	Plant height (m)	Stalk weight ($t\ ha^{-1}$)	Cane weight ($t\ ha^{-1}$)	Juice weight ($t\ ha^{-1}$)	Juice volume ($kl\ ha^{-1}$)	Brix (%)	Stillage ($t\ ha^{-1}$)	Grain yield ($t\ ha^{-1}$)	Sugar yield ($t\ ha^{-1}$)
Sowing time . Replication stratum											
Sowing time	5	1481.87**	7.97**	5687.52**	3163.41**	609.48**	577.40**	265.95**	6216865**	73.57**	10.41**
Residual	12	8.71	0.02	53.72	32.78	7.51	7.17	20.18	39650	0.75	0.27
Sowing time . Replication Units stratum											
Genotype	9	176.75**	0.46**	241.85**	145.67**	34.86**	32.44**	73.41**	293649**	6.36**	1.82**
Sowing time × Genotype	45	41.32**	0.05**	82.41**	36.96**	9.27**	8.35**	21.33**	59034**	1.97**	0.60**
Residual	108	2.25	0.02	15.19	7.95	2.28	2.05	3.83	27630	0.49	0.07

1. ** = Significant at 1% level.

Table 2. Mean performance of sweet sorghum varieties and hybrids across different dates of sowing during the 2005 rainy and postrainy seasons at ICRISAT, Patancheru, India.

Trait	July	August	September	October	November	December	LSD (5%)
Time to 50% flowering (days)	81	74	69	68	79	86	1.7
Plant height (m)	2.8	2.9	2.6	2.2	2.0	1.6	0.1
Stalk weight ($t\ ha^{-1}$)	41.2	39.5	28.9	20.5	11.7	8.7	4.1
Cane weight ($t\ ha^{-1}$)	30.9	28.5	21.4	14.5	8.9	6.0	3.2
Juice weight ($t\ ha^{-1}$)	14.3	15.0	10.4	9.1	5.9	3.5	1.5
Juice volume ($kl\ ha^{-1}$)	12.4	13.1	8.7	7.5	4.3	1.9	1.5
Brix (%)	12.3	13.4	12.2	9.3	11.1	18.1	2.5
Stillage ($t\ ha^{-1}$)	13.8	12.1	11.4	5.9	3.8	3.5	1.1
Grain yield ($t\ ha^{-1}$)	3.3	1.4	1.2	4.9	2.5	0.7	0.5
Sugar yield ($t\ ha^{-1}$)	1.8	2.0	1.2	0.9	0.7	0.7	0.3

Table 3. Performance of sweet sorghum varieties and hybrids for sugar yield (t ha^{-1}) across different dates of sowing in 2005 at ICRISAT, Patancheru, India.

Cultivar	July	August	September	October	November	December	Mean	GCV[1]
Hybrids	1.38	1.80	1.18	0.82	0.60	0.65	1.07	28.13
Varieties	2.83	2.52	1.41	1.04	0.79	0.70	1.55	62.92

1. GCV = Genetic coefficient variation.

sowing periods. There is a need to repeat the study with high sugar yielding hybrids along with varieties to confirm the results and for identification of stable hybrids.

References

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