Original Research Paper

Evaluation of sugar beet genotypes and harvesting schedules on yield and quality parameters

ABSTRACT

Field experiment was undertaken during 2005-06 to 2006-07 to study the various agro-techniques for sugar beet cultivation for Northern Karnataka at Agricultural Research Station, Bailhongal, Belgaum district (Karnataka) under irrigated condition. The experiment consisted of 18 treatment combinations comprising of sugar beet genotypes and harvesting schedules with split plot design comprised of three replications. The significantly higher yield and quality attributes were observed by Cauvery genotypes. With respect to harvesting dates, tuber harvested at 5 and 5 ½ months after sowing recorded significantly higher tuber yield than rest of the harvesting schedule. Therefore, Cauvery genotype harvested 5 ½ months after sowing was found more economical and sustainable production technology.

Keywords: Sugar beet, yield, quality, harvesting date

1. INTRODUCTION

Dominance of sugarcane with respect to the sugar sources is observed in tropical and subtropical regions of the world as well as in India. Statistics on area and production clearly indicates that bulk of the sugar production is from sugarcane as source globally. Among 113 countries in the world which produce sugar, 71 countries produce sugar from sugarcane, 35 only from sugar beets, and 7 from both plants sources accounting 78 per cent of sugar from sugarcane growing countries while, the rest (22%) comes from sugar beet growing countries. Brazil is the largest producer of sugar with 31.35 m t with 20.96 m. t. of exports. India is the second largest producer with 28.80 m t of sugar and the largest consumer of sugar in the world. With sugar exports of 3.30 m t India stands in 4th position after Brazil, Thailand and Australia [1]. On an account of increasing demand and stagnant production of sugarcane India has been shifting from being a net exporter to a net importer time and again.

Presently prices of petroleum products are at the peak and major sugar producing countries such as Brazil and USA are diverting their sugarcane for ethanol production and also as per recent declaration of Government of India regarding admixing of ethanol (anhydrous alcohol) upto 5 and 10 per cent in petrol and diesel, respectively, the requirement of ethanol is going to be almost more than double. Therefore, production of ethanol from beet juice has greater scope. In addition, due to rising trend in the energy prices, plans for production of ethanol from cane may limit the availability of sugarcane for production of sugar. Sugar beet apart from serving as prime source of the sugar production it can also be used directly for ethanol production with output of about 6 to 7 thousand litres per hectare. Further, because of it is high dry matter producing root crop, it can also help for the improvement of soil conditions.

Owing to concerns and problems associated with sugarcane cultivation and potential production feasibilities associated with the sugar beet production indicated greater

perspectives for the sugar beet cultivation as economically viable and potential sugar crop for crop diversification in the sugarcane grown area. Decision making process in crop production like selection of best genotypes, date of sowing, fertilizer application and date of maturity for harvesting which form prime agronomic practices for evaluating the performance of crop and extending hand in improvement of yield as well as the quality parameters needs critical [2]. The scientific information on different agro-techniques to be adopted for cultivation of sugar beet is not available as it is completely new to this region. The technical information regarding the cultivation of sugar beet will be helpful for the cultivators of the region to harvest good yield. Being an introduced crop in the country, there is an urgent need to undertake research on tropical sugar beet in the country in general and north Karnataka in particular. Hence, the research work was conducted with following objectives.

2. MATERIAL AND METHODS

Field experiment was undertaken during 2005-06 to 2006-07 to study the various agro-techniques for sugar beet cultivation for Northern Karnataka at Agricultural Research Station, Bailhongal, Belgaum district (Karnataka) under irrigated condition. The experiment consisted of 18 treatment combinations comprising of sugar beet genotypes and harvesting schedules with split plot design comprised of three replications. The initial soil pH was 7.20, Available N, P_2O_5 and K_2O were 216, 17 and 270 kg ha^{-1}. The organic carbon was 0.48 % and EC 0.23 dSm^{-1}. For analyzing growth and development of the crop, five plants were selected at random from each net plot area in each treatment and were tagged to record various biometric observations. The average values were used for analysis.

Fischer's method of analysis of variance was used for analysis and interpretation of the data as outlined by [3]. The level of significance used in 'F' and 'T' tests was p=0.05. Critical differences were calculated wherever 'F' test was significant.

2.1.1 Yield attributes

2.1.1.1Tuber yield

Tuber yield per hectare was calculated based on the net plot yield and expressed in t ha^{-1}.

2.1.1.2 Top yield

Top yield per hectare was calculated based on the net plot yield and expressed in t ha^{-1}.

2.1.1.3 Harvest index (HI)

The harvest index is defined as the ratio of economic yield to biological yield [4] and expressed in percentage. The harvest index of sugar beet was worked out as indicated below.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q ha}^{-1}\text{)}}{\text{Biological yield (q ha}^{-1}\text{)}}$$

2.1.2 Quality attributes

2.1.2.1 **Sucrose content**

Sugar beet content was done by determination, cold extraction procedure, as described by [5]. Root material of 26 g was ground in an electric mixer (warming blender) for two minutes with 177 ml of dilute lead acetate solution. The mixture was then filtered and the filtrate was polarized using a 400 mm tube. The readings were then converted at 20^0C b using Clerget formula.

$$[P]^{20} = P^t + [1 - 0.003\ (t-20)]$$

Where,

P^t - Polarized reading

t = temperature at which polarized is read 3.7.4.2 α-amino nitrogen content

Thin juice was utilized for amino-nitrogen was estimation by colorimetry as described by [6] and expressed in milligrams per kg.

2.1.2.2 Impurity index

The impurity index was calculated from the values of amino nitrogen, sodium, potassium and sugar (Pol) by adopting the following formula and expressed in absolute values.

$$\text{Impurity index} = \frac{10 \times \text{amino N} + 3.5 \times \text{Na} + 2.5 \times \text{K}}{\%\ \text{sugar (Pol)}}$$

Note: Amino N, Na and K values were expressed in terms of ppm in thin juice and impurity index as absolute value.

3. RESULTS AND DISCUSSION

3.1 Effect of Different Sowing Date and Variety on Growth Attributes

3.1.1. Sugar beet tuber yield (t ha^{-1})

The tuber yield of sugar beet differ significantly by genotypes and harvesting dates during both the years and in pooled data (Table 1).

Among the genotypes tested significantly higher root yield was recorded by the genotype Cauvery (108.10 t ha^{-1}) as compared to Indus (83.90 t ha^{-1}) and IPB (98.40 t ha^{-1}). Among the harvesting dates, tuber harvested at 5 and 5 ½ months after sowing recorded significantly higher tuber yield (105.30 – 106.10 t ha^{-1}) as compared to harvesting at 6 months, while the lowest root yield was observed in root harvesting at 7 months after sowing (80.50 t ha^{-1}).

The interaction combined effect of genotypes and harvesting date failed to influence the sugar tuber yield significantly at all the other growth stages. The ability of Cauvery genotype to withstand the changes in weather by producing more yield than Indus. However, the favorable condition during 5 ½ months after sowing was congenial to get more yield. Similar results were obtained by [7, 8]

3.1.2 Beet top yield (t ha^{-1})

The sugar beet genotypes and harvesting date had significant influence on the beet top yield during both the years of experimentation and in their pooled analysis (Table 1).

The beet top yield also differed significantly with sugar beet genotypes and the highest beet top yield was recorded in Cauvery (20.75 t ha^{-1}) as compared to IPB (18.79 tha^{-1}).

On the contrary to the beet root yield, beet top yield increased as the harvesting delayed. Among the harvesting date beet harvested 7 months after sowing recorded significantly higher beet top yield (24.69 t ha^{-1}), At 6 ½ months after sowing as compared to earlier harvesting dates, while the lowest beet top yield was recorded in early harvesting of sugar beet *i.e.*, 4 ½ months after sowing (12.12 t ha^{-1}).

The interaction effect of genotype and harvesting date also had significant influence on the beet top yield. Among the treatment combinations significantly higher beet top yield was registered in genotype Cauvery harvested under delayed condition *i.e.*, 26.44 t ha^{-1} as compared to other treatment combinations. However, it was on par with genotype IPB and Indus harvested at 7 months after sowing and genotype Cauvery harvested at 6 ½ months after sowing. While, the lowest beet top yield was observed in genotype Indus harvested at 4 months after sowing (11.43 t ha^{-1}) and on par with genotype Cauvery and IPB harvested during the same month. Combination of suitable genotype and favorable condition could be ascribed to improvement in top yield of sugar beet. Similar observation were noticed by [9, 10]

3.1.3 Harvest index (HI)

The harvest index did not differ significantly by genotypes and harvesting dates during both the years and in pooled data (Table 1).

3.2 Effect of Different Sowing Date and Variety on Quality

3.2.1. Impurity index

Impurity index of tuber differed significantly among tested genotype at harvest of observations during both the years of experimentation and in their pooled analysis (Fig.1).

The data on two years pooled basis indicated that significantly lower were recorded in genotypes Cauvery (355.60) as compared to genotype Indus (403.60) but were on par with IPB (367.50).

The harvesting date of sugar beet had significant influence on the Impurity index percentage content during the years (2005-06 and 2006-07) and in their pooled analysis. Among the harvesting time, significantly higher Impurity index was recorded in beet harvest at 7 month as compared to all other dates of harvest, but were on par with beet harvest at 6 ½ month. The significantly lower Impurity index content in beet harvest at 4 ½ month compared to all other dates of harvest.

The interaction effect of genotypes and harvesting date had not influenced the Impurity index percentage content significantly during the years of experimentation and in their pooled data. Similar results were obtained by [11, 12]

3.2.2. Sucrose content

Sucrose per cent of tuber differed significantly among tested genotype at harvest of observations during both the years of experimentation and in their pooled analysis (Fig. 1).

The data on two years pooled basis indicated that significantly higher were recorded in genotypes Cauvery (18.65%) as compared to genotype Indus (17.79) but were on par with IPB (18.53%).

The harvesting date of sugar beet had significant influence on the sucrose percentage content during the years (2005-06 and 2006-07) and in their pooled analysis. Among the harvesting time, significantly higher sucrose content was recorded in beet harvested at 7 month as compared to all other dates of harvest, but were on par with beet harvest at 6 ½ month. The significantly lower sucrose content in beet harvest at 4 ½ month compared to all other dates of harvest.

The interaction effect of genotypes and harvesting date had not influenced the sucrose percentage content significantly during the years of experimentation and in their pooled data. Results of the study are in line with the findings of [13, 14]

CONCLUSION

The present study inferred that cauvery sugar beet genotype harvested at 5 and 5 ½ months after sowing was found economical viable and sustainable for producing higher yield across the changing weather condition.

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Table 1. Tuber and top yield (t/ha) of sugar beet as influenced by harvesting date and genotypes (Pooled data of 2005-06 and 2006-07)

Treatment	Tuber yield (t/ha)				Top yield (t/ha)				Root-shoot ratio				Harvest index			
	Genotype				Genotype				Genotype				Genotype			
Time of harvesting	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
4 ½ month	106.4	78.5	95.8	93.6	12.82	11.43	12.12	12.12	8.35	6.91	7.97	7.74	0.892	0.872	0.888	0.884
5 month	118.4	91.1	108.8	106.1	19.11	12.09	14.74	15.32	6.23	7.55	7.43	7.07	0.861	0.883	0.881	0.875
5 ½ month	119.2	90.6	106.1	105.3	21.23	13.46	16.96	17.22	5.66	6.77	6.27	6.23	0.848	0.871	0.862	0.860
6 month	112.0	86.7	102.4	100.4	21.99	18.18	22.15	20.77	5.19	4.91	4.72	4.94	0.836	0.826	0.823	0.829
6 ½ month	105.3	83.3	96.3	95.0	22.93	21.58	22.69	22.40	4.62	3.88	4.29	4.26	0.820	0.795	0.810	0.808
7 month	87.6	73.3	80.8	80.5	26.44	23.53	24.10	24.69	3.37	3.13	3.39	3.30	0.769	0.757	0.769	0.765
Mean	108.1	83.9	98.4		20.75	16.71	18.79		5.57	5.53	5.68		0.838	0.834	0.839	
For comparison of means	S.Em.±		CD (P=0.05)		S.Em.±		CD (P=0.05)		S.Em.±		CD (P=0.05)		S.Em.±		CD (P=0.05)	
Genotype (G)	1.98		7.77		0.44		1.72		0.11		NS		0.003		NS	
Month (M)	1.74		5.03		0.63		1.83		0.15		0.44		0.004		0.013	
G x M	3.39		NS		1.10		3.16		0.26		0.76		0.008		0.022	

G_1: Cauvery G_2: Indus G_3: Interprice Brucille (IPB) **NS: Non significant**

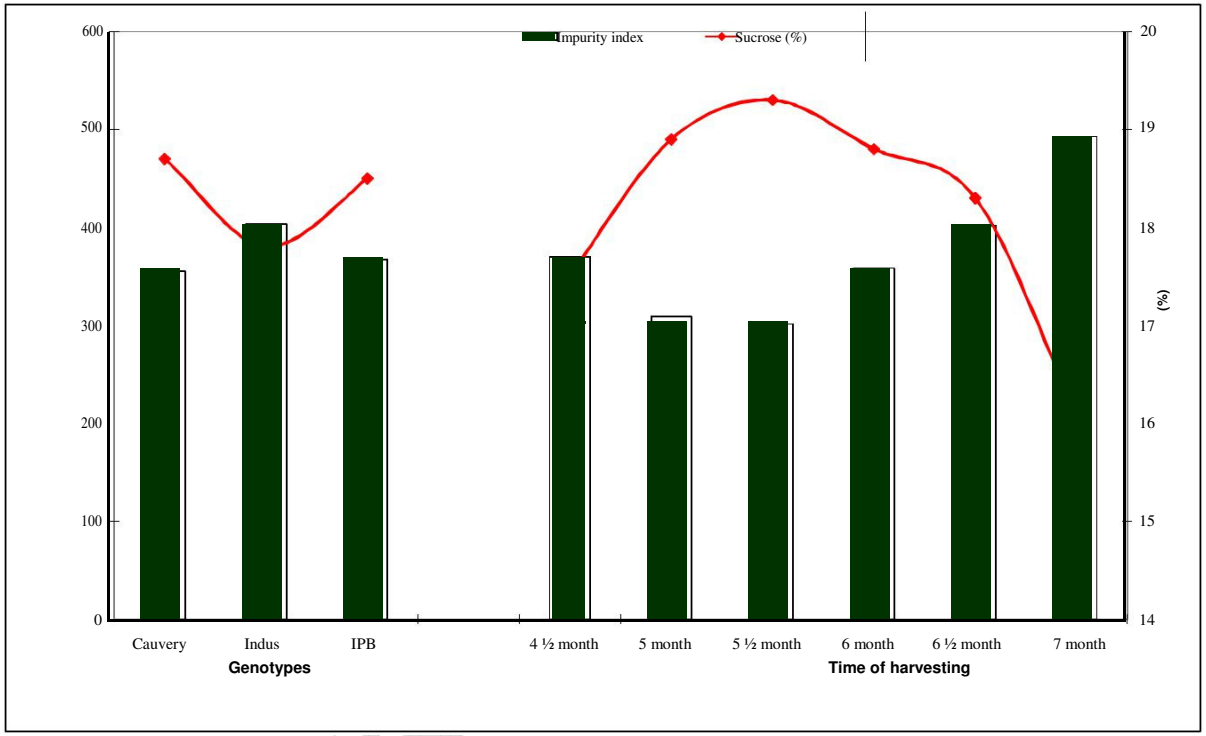

Fig. 1: Impurity index (%) and sucrose content (%) of sugar beet as influenced by harvesting dates and genotypes