Performance of sugar beet genotypes and date of sowing 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 24 treatment combinations comprising of sugar beet dates of sowing and cultivars. Design of the experiment was split plot having date of sowing as main plot and genotypes as subplots. Among the 12 different dates of sowing, higher yield and yield attributes were observed in sowing at October I fortnight compared to the rest of the treatments and between the two sugar beet genotypes, Cauvery recorded significantly higher yield and yield attributes than Indus. Similar trend was followed for quality parameters also.

Keywords: Sugar beet, yield, quality, date of sowing

1. INTRODUCTION

Sugar is the most important food commodity meeting the energy requirement of world population. Sugar beet along with sugarcane is prime plant sources used for the sugar production across the global. 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 24 treatment combinations comprising of sugar beet dates of sowing and cultivars. 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.

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 (Donald, 1962) 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 Brown and Zerban (1941). 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 Stout (1961) and expressed in milligrams per kg.

2.1.2.2 Potassium and sodium content

A part of juice extracted for sucrose analysis was also utilized for estimating the potassium and sodium content by the procedure given by Jackson (1967) and expressed in mg per kg.

2.1.2.3 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 differed significantly due to sowing dates and genotypes during both the years of experimentation and in their pooled analysis (Table 1). Similar trend was observed between individual years and pooled analysis, the results of pooled data is presented.

Among sowing dates, October I FN sown crop recorded significantly higher tuber yield (105.77 t ha^{-1}) over other sowing dates, but was on par with September I FN (102.47 t ha^{-1}). The lowest tuber yield was recorded with April I FN sowing (45.51 t ha^{-1}) and was at par with March and May I FN (52.67 and 50.15 t ha^{-1}, respectively).

Among the genotypes, tuber yield of sugar beet was significantly higher in Cauvery (79.14 t ha^{-1}) than Indus genotype (73.42 t ha^{-1}). This was due to the higher potential ability of genotype to adjust and produce similar performance under given condition [3]

The interaction effect of sowing dates and genotypes did not affect the sugar beet tuber yield significantly.

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

Beet top yield of sugar beet was significantly influenced by sowing dates and genotypes during both I and II year and in their pooled analysis (Table 2).

Beet top yield was significantly higher in October sown crop (21.7 t ha^{-1}) as compared to rest of the sowing dates. However, it was on par with September I FN sown crop (19.15 t ha^{-1}). April sown crop recorded significantly lower top yield (10.06 t ha^{-1}) which was on par with May (11.02 t ha^{-1}), June (28.9 t ha^{-1}) and March (14.02 t ha^{-1}) sown crop.

Among the genotypes, Cauvery recorded significantly higher top yield (15.99 t ha^{-1}) compared to Indus (15.01 t ha^{-1}).

Top yield was did differ significantly due to interaction effects between sowing dates and genotypes. Similar trend was followed for sowing dates, genotypes and their interactions in both the years. Higher yield might be due to higher translocation of assimilates from source to sink [4]. Similar results were observed by [5].

3.2 Effect of Different Sowing Date and Variety on Quality

3.2.1. Sucrose content (%)

Sucrose content of beet was significantly influenced both by sowing dates and genotypes on pooled and individual year basis.

October I FN sown crop recorded significantly higher sucrose content (18.75%) compared to all other sowings and was on par with September I FN (18.25%) and November I FN (18.09%). Whereas, April I FN sown crop recorded significantly lower sucrose content (14.71%) which was on par with May I FN (15.14%) sown crop. Among the genotypes, Cauvery recorded higher sucrose content (17.03%) than Indus (16.19%).

The sucrose content of sugar beet was not influenced significantly due to either genotypes or interaction effect of sowing dates and genotypes. Similar results were observed by [5].

3.2.2. Sodium content

Sodium content of beet was significantly influenced by sowing dates only. October I FN sown crop recorded significantly lower sodium content (339.0 mg kg^{-1}) which was on par with September I FN (353.60 mg kg^{-1}) sown crop. April I FN sown crop recorded higher sodium significantly content (706.01 mg kg^{-1}) and it was on par with March I FN (601.70 mg kg^{-1}) sown crop. Similar results were obtained by 6 and 7.

3.2.3 Sucrose content (%)

Sucrose content of beet was significantly influenced both by sowing dates and genotypes on pooled and individual year basis.

October I FN sown crop recorded significantly higher sucrose content (18.75%) compared to all other sowings and was on par with September I FN (18.25%) and November I FN (18.09%). Whereas, April I FN sown crop recorded significantly lower sucrose content (14.71%) which was on par with May I FN (15.14%) sown crop. Among the genotypes, Cauvery recorded higher sucrose content (17.03%) than Indus (16.19%).

The sucrose content of sugar beet was not influenced significantly due to either genotypes or interaction effect of sowing dates and genotypes. Similar findings were observed by [8-12].

CONCLUSION

The suitability of genotype for particular environment is important for obtaining higher yield. The performance of the sugar beet Cauvery genotype is much better than Indus, which was depicted in higher yield and quality attributes. The sowing date for any genotype plays a key role in harnessing more solar energy. Sowing during I fortnight was found more yield and quality parameter compared to other dates of sowing. By and large, the present investigation conclude that sowing of sugar beet genotype Cauvery in I fortnight of October registered higher tuber yield, top yield and quality parameters *viz.,* sucrose content.

Ethical Approval: NA

Consent: NA

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Table 1. Tuber and top yield of sugar beet as influenced by sowing dates and genotypes (Pooled data of 2005-06 and 2006-07)

Sowing date	Tuber yield (t/ha)			Top yield (t/ha)			Root: Shoot ratio			Harvest index		
	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean
August I FN	98.97	90.08	94.52	18.24	16.80	17.52	5.23	5.09	5.16	0.843	0.831	0.837
September I FN	105.79	99.15	102.47	19.38	18.93	19.15	5.52	5.24	5.38	0.843	0.838	0.840
October I FN	111.77	99.78	105.77	22.06	21.36	21.71	5.12	4.78	4.95	0.825	0.806	0.815
November I FN	96.36	86.89	91.63	17.58	17.82	17.70	5.48	4.90	5.19	0.846	0.830	0.838
December I FN	88.37	81.38	84.88	16.97	16.59	16.78	5.23	4.91	5.07	0.839	0.832	0.835
JanuaryI FN	79.02	75.61	77.31	14.98	14.33	14.66	5.48	5.39	5.44	0.854	0.847	0.850
FebruaryI FN	66.16	63.30	64.73	13.27	12.24	12.75	5.09	5.41	5.25	0.853	0.860	0.856
March I FN	54.02	51.33	52.67	15.23	12.81	14.02	3.56	4.07	3.82	0.774	0.798	0.786
April I FN	45.44	45.57	45.51	10.71	9.41	10.06	4.96	4.76	4.86	0.845	0.846	0.846
May I FN	53.35	46.94	50.15	11.40	10.64	11.02	4.57	5.45	5.01	0.850	0.869	0.860
June I FN	67.34	66.30	66.82	14.67	12.65	13.66	4.63	5.30	4.96	0.828	0.851	0.839
July I FN	83.12	74.77	78.94	17.40	16.49	16.94	4.78	4.58	4.68	0.825	0.815	0.820
Mean	79.14	73.42		15.99	15.01		4.97	4.99		0.835	0.835	
For comparison of means	S.Em.±	CD @ 5%		S.Em.±	CD @ 5%		S.Em.±	CD @ 5%		S.Em.±	CD @ 5%	
Month (M)	3.35	9.82		0.49	1.43		0.17	0.49		0.01	0.03	
Genotypes (G)	0.78	2.28		0.13	0.39		0.06	NS		0.01	NS	
M x G	2.71	NS		0.59	NS		0.22	0.65		0.01	NS	

G_1: Cauvery **G_2: Indus** **NS: Non significant** **FN: Fortnight**

Table 2. Quality parameters of sugar beet as influenced by sowing dates and genotypes (Pooled data of 2005-06 and 2006-07)

Sowing date	Alfa amino N (mg/kg)			Sodium (mg/kg)			Potassium (mg/kg)			Sucrose (%)			Impurity index		
	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean
August I FN	145.4	156.2	150.8	423.4	432.3	427.8	1276.6	1372.0	1324.3	16.56	15.61	16.09	370.9	424.1	397.5
September I FN	132.1	135.9	134.0	356.9	350.2	353.6	989.4	1092.3	1040.9	18.74	17.76	18.25	271.1	301.0	286.0
October I FN	132.7	146.7	139.7	340.1	337.9	339.0	1008.7	1140.5	1074.6	19.16	18.33	18.75	263.4	301.2	282.3
November I FN	106.8	123.7	115.2	406.3	425.6	415.9	1283.6	1378.0	1330.8	18.34	17.83	18.09	311.4	346.5	329.0
December I FN	151.7	138.4	145.1	480.4	500.0	490.2	1446.7	1503.4	1475.0	18.38	17.59	17.98	371.4	392.9	382.1
January I FN	129.2	137.2	133.2	544.7	538.3	541.5	1478.7	1513.5	1496.1	17.75	16.13	16.94	388.0	437.6	412.8
February I FN	146.0	156.5	151.2	593.8	701.1	647.4	1540.1	1617.4	1578.7	16.61	16.26	16.43	445.4	500.1	472.8
March I FN	158.1	154.3	156.2	617.5	671.3	644.4	1682.0	1847.0	1764.5	16.23	15.20	15.72	489.5	561.5	525.5
April I FN	170.1	161.9	166.0	692.6	719.5	706.0	1602.8	1694.6	1648.7	14.76	14.66	14.71	554.7	573.1	563.9
May I FN	182.1	160.0	171.0	604.8	598.5	601.7	1459.7	1555.3	1507.5	15.20	15.07	15.14	501.0	504.4	502.7
June I FN	112.1	113.1	112.6	463.6	475.0	469.3	1457.5	1478.7	1468.1	16.37	14.76	15.56	391.0	444.3	417.7
July I FN	109.3	109.6	109.4	412.3	393.0	402.6	1303.9	1257.0	1280.4	16.21	15.07	15.64	357.7	374.4	366.0
Mean	139.6	141.1		494.7	511.9		1377.5	1454.1		17.03	16.19		393.0	430.1	

For comparison of means	Alfa amino N S.Em.±	Alfa amino N CD @ 5%	Sodium S.Em.±	Sodium CD @ 5%	Potassium S.Em.±	Potassium CD @ 5%	Sucrose S.Em.±	Sucrose CD @ 5%	Impurity index S.Em.±	Impurity index CD @ 5%
Month (M)	10.18	29.85	30.1	88.2	42.8	125.7	0.36	1.04	16.1	47.1
Genotypes (G)	2.75	NS	8.4	NS	19.6	57.2	0.15	0.43	6.2	18.0
M x G	12.21	NS	36.4	NS	64.3	NS	0.51	NS	22.1	NS

G_1: Cauvery **G_2: Indus** **NS: Non significant** **FN: Fortnight**