Performance of Sugar Beet (*Beeta vulgaris*) to Different Dates of Sowing under Temperature Regime

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Authors' contributions

This work was carried out in collaboration between both authors. Author KDL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SIH managed the analyses of the study. Both authors read and approved the final manuscript.

Original Research Article

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. Sowing of sugar beet crop either in winter season or monsoon gave higher yield and sowing in April month was not suitable as it gave very low yields.

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1. INTRODUCTION

Sugar beet is a long day plant, which requires adequate moisture and bright sunshine for good growth. Seeds germinate between soil temperature range of 12-15° and high sugar accumulation is observed in temperature of 20-22°C whereas, temperature exceeding 300C adversely affect sugar accumulation. However, recently developed tropical sugar beet varieties require an optimum temperature range of 20-25°C for germination, 30-350C for growth and development and 25-35°C for sugar accumulation, wherein the night 15-200C is suitable. The crop does not prefer high rainfall or continuous heavy rain which may affect development of tuber and sugar synthesis [1]. 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 [2]. 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 [3]. 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 to assess the production potentiality of sugar beet genotypes under various dates of sowing.

2. MATERIAL AND METHODOLOGY

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. Fischer's method of analysis of variance was used for analysis and interpretation of the data as outlined by [4]. 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 Yield Attributes

2.1.1 Tuber yield

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

2.1.2 Top yield

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

2.1.3 Harvest index (HI)

The harvest index is defined as the ratio of economic yield to biological yield [5] and expressed in percentage. The harvest index of sugar beet was worked out as indicated below.

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

2.2 Quality Attributes

2.2.1 Sucrose content

Sugar beet content was done by determination, cold extraction procedure, as described by [6]. 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°C 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 [7] and expressed in milligrams per kg.

2.2.2 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 [8] and expressed in mg per kg.

2.2.3 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 Yield Attibutes

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 2). 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 [9]. The interaction effect of sowing dates and genotypes did not affect the sugar beet tuber yield significantly.

These increased yield attributes might be due to increased yield attributes, due to higher leaf area index as the crop had favorable temperature (Fig. 1) during its entire growing period. These results are in line with the findings of [10,11,12]. A temperature effect on tuber yield is more prominent compared to any other weather parameter (Table 1 and Fig. 1). Higher mean maximum temperature of the month in April (36.7°C) registered very low tuber yield of 45.51 t ha^{-1} and the extent of reduction is 56.9 per cent compared to October I FN sowing. Monthly mean

maximum temperature is more negatively correlated (r = -0.85) with tuber yield. Coincidence of the tuber grand growth stage and maturity stage with the hot months decreased the tuber yield through reduced leaf area, leaf area index and temperature. On the contrary, monthly mean minimum temperature appears to be less effective on the tuber yield with a very low non-significant negative correlation (r = - 0.17). The minimum temperature being within the range of optimum temperature for growth sugar beet did not adversely affect the growth and yield of sugar beet. Since, the experiment is under irrigated condition, rainfall has no effect. Monthly relative humidity is less correlated with the tuber yield (r = 0.57) compared to maximum temperature during its growing period. The October I FN sowing resulted in high tuber yield probably because of lower mean maximum monthly temperature.

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 (2005-06 and 2006-07) 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}). However, 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 [13]. Similar results were observed by [14].

Among the sowing dates, October and September I FN sown crop recorded maximum yield attributes, while, the least yield attributes of sugar beet was noticed in summer sown sugar beet due to prevalence of high temperature and low relative humidity during April and May months and also due to heavy rainfall during July, August and September during southwest monsoon period (Fig. 1). This decreased yield

attributes was mainly attributed to reduction in leaf area and LAI due to prevalence of hot weather during April and May months which is not congenial for growth and development of sugar beet. The maximum temperature ranged between 35.1-37.1°C and that of minimum temperature from 20.3-21.5°C during both the years. Similarly, [15] has reported that when the climatic conditions during later parts of the season was very hot (temperature ranging from 30 – 33°C), the rate of dry matter accumulation was much lesser than under mild temperature conditions (temperature ranging from 25 – 30°C).

3.1.3 Root to shoot ratio and harvest index

Root to Shoot ratio and harvest index of sugar beet was not significantly influenced by sowing dates and genotypes during both I and II year and in their pooled analysis (Table 2).

3.2 Effect of Different Sowing Date and Variety on Quality

3.2.1 Alfa amino N (mg/kg)

The alfa amino-N content of sugar beet differed significantly during both the years of experimentation and in pooled analysis (Table 3) with respect to sowing dates.

Among the various sowing dates, September I FN recorded significantly lower alfa amino-N (134.0 mg kg^{-1}). However, it was on par with October I FN (139.7 mg kg^{-1}).

The alfa amino-N content of sugar beet was not influenced significantly either due to genotypes or interaction effects of sowing dates and genotypes.

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 [16].

3.2.3 Potassium content

Potassium content of sugar beet was significantly influenced by sowing dates and genotypes on pooled basis (Table 3).

Potassium content was recorded significantly low in September I FN sown crop (1040.90 mg kg^{-1}) which was on par with October I FN (1074.60 mg kg^{-1}) sown crop. Significantly higher potassium content was observed in March I FN (1764.50 mg kg^{-1}) sown crop which was on par with April I FN (1648.70 mg kg^{-1}) sown crop. The genotype Cauvery (1377.50 mg kg^{-1}) recorded significantly lower potassium content than Indus (1454.10 mg kg^{-1}).

Interaction effect between sowing dates and genotypes was not significant for potassium content in tubers.

3.2.4 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 above mentioned two observations can be explained on the basis of weather conditions prevailed during crop season and the studies made by the other workers notably by Ulrich (1956) in California. Ulrich (1956) reported that low night temperature increases the sucrose content. He observed a linear increase in sucrose content as the night temperature was decreased from 30^{0}C (7% sucrose) to 2^{0}C (12% sucrose). In the present study, the October and September I FN sown tuber crops were harvested in the month of January and February. During the whole year November, December, January and February are the cool months having lower both day and night temperature. The crop sown in September and October experienced longer cold period in sugar beet during tuber growth and sucrose formation. Similarly, the [17] from UK and O'Conns (1972) from Ireland reported that delay in sowing resulted in 25-50 kg ha^{-1} sugar loss with each day delay in sowing.

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 [18].

3.2.5 Impurity index

Impurity index of sugar beet was significantly influenced by sowing dates and genotypes on pooled basis (Table 3).

Significantly lower impurity index was observed in October I FN sown crop (282) compared to other dates of sowing. The genotype Cauvery (393) recorded significantly lower potassium content than Indus. Interaction effect between sowing dates and genotypes was not significant for potassium content in tubers.

Genotype Cauvery at October I FN sowing

Genotype Indus at October I FN sowing

Plate 1. Effect of sowing dates (October I FN) on sugar beet genotypes

Table 1. Monthly meteorological data for the experimental years (2005-06 and 2006-07) and the mean of past 30 years (1986-2005) of Agricultural Research station, Bailhongal, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)			Deviation (mm)		Mean temperature (°C)						Relative humidity (%)		
	1986-2005	2005-06	2006-07	2005-06	2006-07	Maximum			Minimum			1986-2005	2005-06	2006-07
						1986-2005	2005-06	2006-07	1986-2005	2005-06	2006-07			
	Normal	Actual	Actual			Normal	Actual	Actual	Normal	Actual	Actual	Normal	Actual	Actual
August	69.4	18.6	105.2 (6)	-50.8	+35.8	27.0	27.1	26.3	20.3	20.4	19.6	86	81	85
September	114.8	148.6	171.6 (14)	+33.8	+56.8	28.6	27.5	29.2	19.9	20.3	19.9	82	85	77
October	107.8	231.8	134.4 (21)	+124.0	+26.6	30.1	29.6	30.0	18.4	19.1	19.1	76	70	67
November	86.5	104.8	89.5 (14)	+18.3	+3.0	30.2	29.4	29.2	15.9	14.9	18.1	68	51	70
December	116.1	215.1	56.9 (5)	+99.0	-59.2	29.4	28.9	29.1	12.5	13.1	12.8	63	53	61
January	80.2	230.4	25.0 (3)	+150.2	-55.2	29.6	29.9	29.9	14.7	12.9	12.9	63	52	52
February	34.2	6.4	25.6 (2)	-27.8	-8.6	32.5	33.4	32.4	16.4	14.8	14.8	51	62	59
March	6.6	--	--	-6.6	-6.6	36.5	34.1	36.8	19.6	18.1	19.8	56	45	46
April	2.1	--	--	-2.1	-2.1	37.4	36.3	37.1	19.8	21.3	20.3	76	53	49
May	0.8	--	--	-0.8	-0.8	33.7	37.0	35.3	21.4	21.5	20.9	66	55	61
June	5.0	--	4.0 (0)	-5.0	-1.0	28.8	30.9	29.5	21.5	21.4	20.6	81	76	78
July	35.6	41.4	5.4 (1)	+5.8	-30.2	29.2	27.4	26.6	21.0	21.5	20.4	87	83	87
Total	659.1	997.1	617.6	-2.1	-41.5									

Figures in parentheses are number of rainy days (> 2.5 mm rainfall)

Table 2. 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		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	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
Januaryl 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
Februaryl 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

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Table 3. 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	**S.Em.±**	**CD @ 5%**		**S.Em.±**	**CD @ 5%**		**S.Em.±**	**CD @ 5%**		**S.Em.±**	**CD @ 5%**		**S.Em.±**	**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
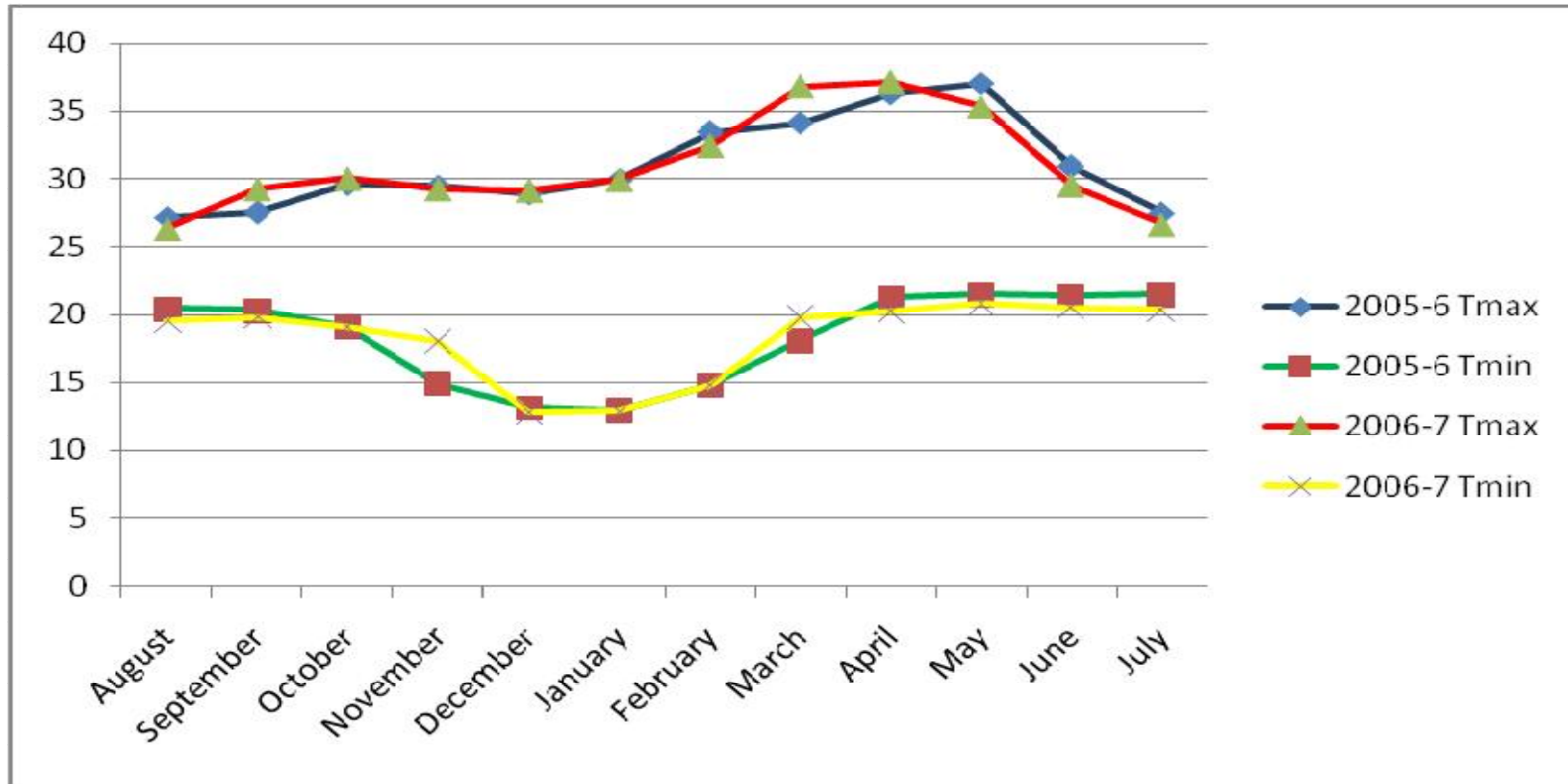
Fig. 1. Maximum (Tmax) and minimum (Tmin) temperature prevailing during different dates of sowing of sugar beet during 2005-6 and 2006-7
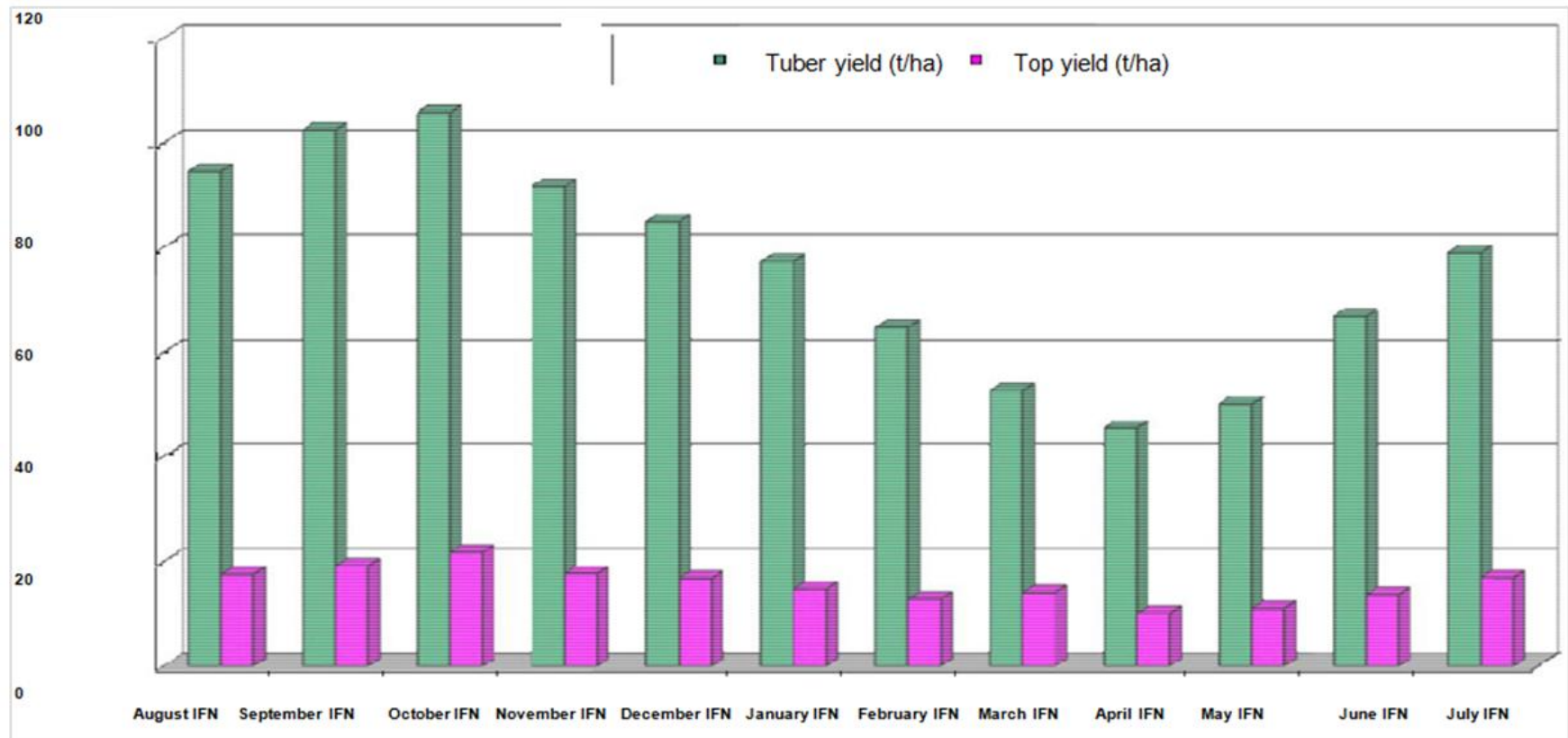
Fig. 2. Tuber and top yield of sugar beet as influenced by sowing dates and genotypes (pooled data of 2005-06 and 2006-07)

Table 4. Schedule of sowing date and harvesting date carried out in the experiment –I during 2005-06 and 2006-07

Sowing date treatment	2005-06		2006-07	
	Date of sowing	Date of harvesting	Date of sowing	Date of harvesting
August I FN	12-08-2005	16-01-2006	13-08-2006	18-01-2007
September I FN	10-09-2005	18-02-2006	11-09-2006	17-02-2007
October I FN	11-10-2005	16-03-2006	12-10-2006	16-03-2007
November I FN	13-11-2005	20-04-2006	11-11-2006	21-04-2007
December I FN	10-12-2005	16-05-2006	10-12-2006	19-05-2007
January I FN	12-01-2006	18-06-2006	12-01-2007	16-06-2007
February I FN	10-02-2006	16-07-2006	13-02-2007	19-07-2007
March I FN	12-03-2006	18-08-2006	12-03-2007	18-08-2007
April I FN	14-04-2006	17-09-2006	11-04-2007	20-09-2007
May I FN	12-05-2006	17-10-2006	10-05-2007	19-10-2007
June I FN	10-06-2006	16-11-2006	11-06-2007	19-11-2007
July I FN	09-07-2006	18-12-2006	11-07-2007	20-12-2007

The correlation studies between sucrose content impurities and impurity index showed that the impurity index was positively correlated with impurities present in the Juice like alfa-amino nitrogen, sodium and potassium and negatively correlated with sucrose content in juice. The lowest impurity index observed in October and September I FN sown tuber was mainly attributed to the higher sucrose content due to better accumulation of sucrose under cool favorable temperature during tuber development and maturity and minimum quantity of impurities in lower quantity *viz.*, alfa-amino nitrogen (134.0 – 139.7 mg kg^{-1}), sodium (339.0 – 353.6 mg kg^{-1}) and potassium (1040.9 – 1074.6 mg kg^{-1}) as compared to other sowing dates. Similar results were also obtained by sowing during September to October as reported by [10,11,12]. Sugar beet quality is not only dependent on the sucrose content in the tubers, but also the levels of impurities *viz.*, alfa-amino nitrogen, potassium content and sodium content in the juice. These impurities must be removed during sugar refining to get quality sugar. The October and September I FN sown sugar beet recorded significantly lower impurity index (282.3 and 286.0, respectively) as compared to rest of the sowing dates (Table 3), while the highest impurity index was recorded with March and April I FN sown sugar beet (525.5 – 563.9).

4. CONCLUSION

- The present study inferred that sowing of sugar beet genotype Cauvery in I fortnight of October was favorable to harvest more yield and sugar for getting higher income.

- Sowing of sugar beet crop either in winter season or monsoon gave higher yield and sowing in April month was not suitable as it gave very low yields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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