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Effect of Sowing Time and Plant Population on Root Yield and Accumulation of Sugar in Sugar Beet

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Abstract: In a field experiment sugar beet cv. Daz was tested during 1995-96 at different dates of sowing (November 1st, 11th, 21st and December 1st, 11th and 21st) with planting density of 75, 100, 125 and 150 thousand plants ha^{-1} for its production and sugar accumulation. Results showed significant differences among the planting dates for all the characters studied, while interaction between the plant population and planting dates were non significant. The highest brix value (16.77 %), POL (13.10 %), beet root yield of (65.09 tones ha^{-1}) and sugar yield of 8.5 tones ha^{-1} were obtained from the crop sown on early date i.e. November 1st, 1995-96. While lowest beet root yield 26.23 tones ha^{-1} and sugar yield 2.17 tones ha^{-1} were recorded in the plots sown on December 21st, 1995-96 indicating that beet root yield and sugar yield decreased with delayed sowing. In case of plant population, 75,000 plants ha^{-1} gave consistently higher brix (14.87 %) and POL (11.17 %) values. Root and sugar yield was also decreased with increasing the plant population ha^{-1}.

Key words: Beta Vulgaris, Sowing Time, Plant Population, Sugar

Introduction

The sugarbeet (*Beta Vulgaris* L.) Crossed group J. Helm belongs to the chenopodiaceae family. Sugarbeet is grown nearly in 40 countries and accounts 40 to 45 % of the total world sugar production. It is successfully cultivated as a summer crop in the area situated in 30^0 N where sugar cane is a predominantly tropical crop and is grown 30^0 latitude north south. But there is an intermediate zone (30^0 - 35^0) where both sugar sane and sugarbeet as winter crops are cultivated and NWFP falls in that region. NWFP enjoys a unique position throughout Pakistan where sugar beet can be successfully cultivated. sugarbeet is a short season winter crop and is sown in September-October and harvested in May-June. In D.I.Khan region the beet crop is comparatively short season crop. Time of sowing is a very important variable for determination of proper growth period required for proper photosynthetic activities of the crop. Heath and Cleal (1992) noticed 5 % more yield from the early transplanting of sugarbeet than late planting. Campbell and Enz (1991) concluded that early planting of sugarbeet has best germination than the late planting affected due to low temperature. Webb and Jaggard (1980) observed that planting and harvesting of sugarbeet crop on different dates influences the sugar yield. Anonymous (1994), Amin *et al.* (1987), Amin *et al.* (1989) and Amin (1986) proved that the early sowing of sugar beet in NWFP during October gave higher beet root yield as well as higher sugar content than late sowing. Sugarbeet sown in November gave highest root and sugar yield and low chances of insect pest infestation (Hammad *et al.*, 1981).

Plant population also play a major role in affecting crop yield and sugar accumulation in sugarbeet. Root yield decreases at higher plant population because of increase in top and root ratio decrease the water percentage in the root. Minx (1992) determined that highest sugar content was obtained with plants 10 cm apart and maximum sugar yield was found in plants at 23 cm apart. Highest brix value with lowest plant density was noticed by Hecker (1991). Akinerdem *et al.* (1994) and Amin *et al.* (1982) manifested that Plant population at the rate 100,000 and 85,000 ha^{-1} gave the highest root and sugar yield but the decreased root yield with raised sugar content were obtained with decreasing plant population. Akram *et al.* (1988) stated that sugar percentage increased from 13.45 at 40,000 plants ha^{-1} to 14.5 % at 120000 plants ha^{-1} in June and significantly highest sugar yield of 9.1 tons ha^{-1} was obtained at 80,000 plant population ha^{-1}. Hassanain (1993) found that 50 cm apart rows produced longer, thicker and heavier beet roots with highest sugar yield as compared to 25 and 15 cm apart rows.

Sugarbeet being a new crop in D.I.Khan, has a bright future in NWFP and a larger area can be brought under its cultivation. D.I.Khan emerged as a second potential region of NWFP for sugarbeet production and may provide an ideal range for higher beet yield and sugar production. The desired plant population ha^{-1} needs to be studied and should be determined based on soil type and other climatic conditions.

Materials and Methods

In order to ascertain, the effect of different dates of sowing and plant population on the growth, production and sugar accumulation in sugarbeet, the study was conducted at Agricultural Research Institute, D.I.Khan during 1995-96. The experiment was carried out on medium fertile clay loam soil by using split plot Design with four replications with a sub plot size of 5 x 2.25 m^2. The basal dose of 120 kg ha^{-1} of phosphorus was applied to soil before ridge formation. Nitrogen at the rate of 90 kg was applied into two split doses, half during thinning and half before earthing up. Ridges were erected 45 cm apart. Sugarbeet variety "DEZ" was planted at the rate of 8 kg ha^{-1}. A light irrigation was given to the plots just after each sowing. The uniform cultural practices were applied to all the treatments. However the plants were thinned according to prescribed plant spacing to get the desired plant population in each treatment.

The Brix percentage, polarized sugar percentage (POL), root yield tones ha^{-1} and sugar yield tones ha^{-1} were studied. The data on root yield were recorded after the harvesting of crop at 8th May 1996. sugar yield ha^{-1} was calculated by the following formula.

$$\text{Sugar yield } ha^{-1} = \frac{\text{POL \%age x yield } ha^{-1}}{100}$$

All the Data were statistically analyzed by using MSTAT Computer programme and subsequently the means were separated through $LSD_{0.05}$.

The following variable were included in the experiment.

Main plots		Sub plots	
Planting dates		Plant population ha^{-1}	
D1	1st November	P1	75,000
D2	11th November	P2	1,00,000
D3	21st November	P3	1,25,000
D4	1st December	P4	1,50,000
D5	11th December		
D6	21st December		

Results and Discussion

The results pertaining to the analysis of variance for brix %, POL %, Root yield (tones ha^{-1}) and sugar yield (tones ha^{-1}) showed that dates of sowing and plant population had significant differences for all characters (Table 1). The interaction between date of sowing and plant population was significant for POL % and non significant for brix %, root yield and sugar yield.

Brix percentage: The mean data of brix % presented in Table 2 revealed that the highest brix value of 16.78 % was recorded from the plot sown on Ist November, 1995 followed by 11th and 21st November, 1995 with values of 15.94 and 15.21 %, respectively. The lowest brix value (12.74) was recorded from the late plantation of crop on 21st December, 1995. It was however statistically at par with the value obtained from December 11 planting. It means that brix % in sugar beet gradually decrease with delay in planting.

In plant population, it is evident from the Table 2 the maximum brix value (15.23) was recorded from the plot with plant population of 75,000 plants ha^{-1} and gradually decreased with further increase in plant population. However from earlier plantation, maximum brix percentage was recorded due to healthy beet root, where on delaying the sowing which not only produced poor and weak root but also showed lowest brix %. These results are in the agreement with Hecker (1991), Akinerdem *et al.* (1994) and Amin (1982) who also observed highest brix value in early planting with low plant density in sugar beet.

Table 1: Effect of Different Dates on Sowing and Plant Population in Sugar Beet

Source of Variation	D.f	Brix %	Pol %	Root Yield	Sugar Yield
Replications	3	10.355	0.395	23.114	0.406
Dates	5	38.880**	44.338**	3206.630**	79.622**
Error	15	1.481	0.619	16.639	0.366
Population	3	9.551*	1.822**	117.846**	2.409**
Interaction	15	1.045 N.s	0.791*	31.287 N.s	0.603 N.s
Error	54	3.235	0.352	19.504	0.425

*, ** Significant and Highly Significant at 0.05 level of probability.

Table 2: Brix and Pol Percentage (In Parenthesis) as Affected by Different Dates of Sowing and Plant Population in Sugar Beet

Date of Sowing	Plant Population Ha^{-1}				Mean
	75000	1,00000	125,000	150,000	
Ist Nov.	17.42	16.66	16.77	16.32	16.78 a
	(13.18)	(12.67)	(11.89)	(12.76)	(12.87)
11th Nov.	16.11	16.22	15.70	15.72	15.94 ab
	(16.11)	(12.90)	(12.48)	(12.25)	(12.28a
21th Nov.	15.49	15.51	15.68	14.19	15.21 bc
	(11.63)	(11.08)	(10.84)	(10.34)	(10.97)b
Ist Dec.	15.21	13.96	14.86	13.30	14.33 c
	(10.74)	(9.90)	(10.63)	(10.09)	(10.34)c
11th Dec.	13.70	14.44	13.22	11.74	13.27 d
	(10.15)	(10.54)	(9.13)	(8.77)	(9.65)d
21st Dec.	13.47	13.59	12.29	11.63	12.74 d
	(8.38)	(8.83)	(8.50)	(7.87)	(8.39)e
Mean	15.23 a	15.06 a	14.75 Ab	13.18 B	
	(11.02)a	(10.95)a	(10.59)a	(10.45) B	

Table 3: Root Yield Tones/ha and Sugar Yield Tones/ha (In Parenthesis) as Affected by Different Date of Sowing and Plant Population

Date of Sowing	Plant Population Ha^{-1}				
	75000	1,00000	125,000	150,000	Mean
Ist Nov.	63.51	62.33	63.51	61.99	62.83 a
	(8.04)	(8.20)	(8.18)	(7.92)	(8.09) a
11th Nov	60.51	57.77	54.30	56.66	57.31 b
	(7.58)	(6.87)	(678)	(7.02)	(7.06) b
21st Nov.	56.02	55.34	54.14	42.22	51.93 c
	(6.53)	(6.00)	(6.00)	(4.37)	(5.72) c
Ist Dec.	49.89	49.87	49.88	49.96	49.90 c
	(5.36)	(5.30)	(4.93)	(5.04)	(5.16) d
11th Dec.	36.70	49.64	29.98	27.66	32.24 d
	(3.72)	(3.16)	(3.16)	(2.45)	(3.72) c
21st Dec.	28.36	27.35	27.43	25.41	27.14 e
	(3.72)	(3.16)	(3.16)	(2.45)	(2.28) f
Mean	49.17 a	47.88 ab	46.56 b	43.98 c	
	(5.60)	(5.28)	(5.25)	(4.83) b	

Pol percentage: The maximum POL value of 12.87 % was obtained by the treatment sown on Ist November 1995, followed by second and third sowing (11th November and 21st November 1995), with POL values of 12.28 and 10.97 %, respectively (Table 2). The lowest POL value of 8.39 % was manifested by the plot sown on 21st December 1995. The result predicts that POL percentage decreased gradually with delay in the planting time. These results are in corroboration with the findings of Amin *et al.* (1987).

As regards the plant population it was found that maximum POL value of 11.02 % (Table 2) was obtained at a population of 75,000 plants ha^{-1} and this value was gradually decreased with further increase in planting density. The minimum POL value of 10.45 % was recorded at a population of 1,50,000 plants ha^{-1}. The interaction between date of sowing and plant population revealed that the sowing made on Ist November 1995, coupled with plant density of 75,000 plants ha^{-1} gave the highest POL value of 13.18 %. The POL percentage in sugar beet root decreased with delay in sowing as well as increase in plant densities which ultimately decrease the POL value (7.87 %) recorded from sowing made on 21st December 1995, with plant density of 1,50,000 plants ha^{-1}.

Root yield: It is evident from Table 3 that the highest beet root yield of 62.83 tones ha^{-1} was harvested from the plot sown on Ist November 1995, followed by the plots planted on 11th November and 21st November 1995, possessing the yield of 57.31 and 51.93 tones ha^{-1}, respectively. The lowest yield of 27.14 tones ha^{-1} was produced by the plot planted on 21st December 1995. The results indicated that root yield gradually decreased with increasing the interval (10 days) in sowing. The results also showed that early plantation received favourable conditions for crop root development and consequently produced more yield. The crop enjoyed the maximum favourable period for enlargement of full leaf and the food material synthesized in the leaves which was translocated to the root for increasing the final yield. Whereas the poor yield obtained from late sown crop was due to the availability of limited growth period and low temperature during the month of December 1995. The low temperature had also affected the crop emergence and kept slow the physiological activities at early stages of plant growth. These results are in agreements with the findings of Akinerdem *et al.* (1994), Heath and Cleal (1992), Hecker (1991) and Amin *et al.* (1989).

In plant population (Table 3), the maximum root yield of 49.17 tones ha^{-1} was obtained from planting density of 75,000 plants ha^{-1}. Whereas the minimum yield of 43.98 tones ha^{-1} was harvested from plant population of 1,50,000 plants ha^{-1}. The low yield in rest of planting densities was due to plant competition in per unit area. These results are in line with Akinerdem *et al.* (1994), Hecker (1991) and Amin *et al.* (1982), Who also observed the low yield of sugar beet when grown on a dense population.

Sugar yield: The maximum value of sugar yield (Table 3) of 8.09 tones ha^{-1} was recorded from the sowing on Ist November 1995, and it was consistently decreased with the delay in sowing. The lowest sugar yield of 2.28 tones ha^{-1} was recorded from last sowing on 21st December 1995. Generally the crop followed the same pattern in sugar yield production as in the case of root yield and predicts a decline with the delay in sowing. The reason may be the same as discussed earlier in case of root yield. The early planted crop might have developed the maximum leaf area, resulting into maximum light interception and sugar yield production. These results are in agreement with the findings of Webb and Jaggard (1980).

In case of plant population (Table 3), it was found that crop maintained at a population of 75,000 plants ha^{-1} gave highest sugar yield of 5.60 tones ha^{-1}. The yield was statistically at par with the plant population of 1,00,000 and 1,25,000 plants ha^{-1} produced sugar yield of 5.28 and 5.25 tones ha^{-1}, respectively. The least sugar yield of 4.83 tones ha^{-1} was obtained from treatment sown with planting density of 1,50,000 plants ha^{-1}. The reason could be that the more spaced plants of sugar beat had fully utilized all available nutrients, light and moisture with minimum plant competition and accumulated the higher sugar in their roots. The results are in close conformity with those of Anonymous (1994), Hassanain (1993), Minx (1992) and Akram *et al.* (1988).

Conclusion: These results revealed that the early sowing of sugarbeet on Ist November coupled with crop density of 75,000 plants ha^{-1} were most desirable for getting the higher root and sugar yield under the agro-climatic conditions of D.I.Khan. It is further added that if the local sugar mills of the southern areas of NWFP (D.I.Khan and Bannu divisions) install the plant for crushing the sugarbeet will directly establish and increase the area under beet crop.

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