

# EFFECT OF SOWING AND HARVESTING TIME ON THE YIELD AND SUGAR RECOVERY OF SUGAR BEET UNDER D. I. KHAN CONDITION

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## ABSTRACT

To ascertain the optimum time of planting and harvesting under D.I. Khan conditions, studies were conducted at the Research Farm of Al Moiz Industries, D.I. Khan. The three years studies, starting from 2008-09 to 2010-2011, included five planting dates (1<sup>st</sup> October, 15<sup>th</sup> October, 1<sup>st</sup> November, 15<sup>th</sup> November and 1<sup>st</sup> December) and five harvesting dates (1<sup>st</sup> April, 15<sup>th</sup> April, 1<sup>st</sup> May, 15<sup>th</sup> May and 1<sup>st</sup> June). The experiment was laid out in split plot design, placing sowing dates in main plot while harvesting dates as sub plots superimposed on main plots; all randomly distributed in four replications.

The data indicate that October planting with May harvesting gave significantly the highest yields around 85 – 90 t ha<sup>-1</sup> with sugar recoveries of 11.50 – 11.80%. Compared to October, Sowing the crop on 1<sup>st</sup> Nov, 15<sup>th</sup> Nov. and 1<sup>st</sup> Dec. gave a yield reduction of 10.43%, 25.27% and 39.25%, respectively. Sowing the crop on 1<sup>st</sup> Nov, 15<sup>th</sup> Nov. and 1<sup>st</sup> Dec. gave a yield reduction of 10.43%, 25.27% and 39.25%, respectively. On the other hand harvesting on 1<sup>st</sup> April and 15<sup>th</sup> April reduced yield by 36.74% and 25.00%, respectively, while harvesting the crop on 1<sup>st</sup> June also dropped the yield by 5.50%. Compared to the month of May, harvesting on 1<sup>st</sup> April and 15<sup>th</sup> April reduced sugar recovery by 14.81% and 9.94%. To promote better yields and recoveries longer growth period should be preferred with a condition to avoid sowing beyond October and harvesting beyond May.

## INTRODUCTION

Sugar beet is a crop of temperate regions and is planted as summer crop, however under sub tropical and continental conditions the crop is planted as a winter crop before the onset of severe cold. The temperature is the most important factor for managing its sowing, growth and harvesting operations. Under temperate conditions optimum day time temperature for first 90 days of plant growth is 16 to 27°C; after 90 days of emergence to harvest, bright sunny days

are required with 18° to 27°C followed by night time temperature of 5 to 10°C. These conditions help maximize yield and quality in sugar beet. (Cattanack, Dexter and Oplinger), 1991. According to Terry (1970), the optimum temperature for plant growth is about 24° C, and 17-20° C for root growth. Cool weather with temperature around 15° C favors sugar accumulation in the roots, while temperature above 30°C retard sugar accumulation. Sugar in beet root remains at high level at 14° C to slightly mild

temperature, but at the temperature above 30°C accumulation of sugar in roots and sucrose percentage drastically decline (Ustimenko, 1983). Regions with long day length are most suitable for plant growth and yields. In Pakistan, sugar beet cultivation is yet confined in Mardan, Peshawar and D, J, Khan Districts. Sugar beet is grown as a winter crop and sowing is done before winter to avail of conditions favorable for seed germination and early plant growth. Sowing and harvesting dates are one of

the most important management factors that affect plant growth, yield and quality of beet roots. A number of studies have been carried out on its planting and harvesting times. Amin et al (1989) recorded beet root yield of  $68.49 \text{ t ha}^{-1}$  by planting sugar beet on 1<sup>st</sup> Oct. followed by a gradual reduction in yield by delayed planting of beet on 15<sup>th</sup> Oct. ( $64.80 \text{ t ha}^{-1}$ ), 1<sup>st</sup> Nov. ( $48.25 \text{ t ha}^{-1}$ ) and 15<sup>th</sup> Nov. ( $46.78 \text{ t ha}^{-1}$ ). Late planting also showed corresponding reduction in sugar yield. Earlier studies by Amin et al (1987) and Amin (1988) also proved that sowing sugar beet in Oct. gave higher yield than late planting. Higher yield in earlier planting was attributed to a longer period of favorable environments for plant emergence, and root growth and development than its late planting. In Mardan, sugar beet root yield of 60, 55, 45 and 35 tons per hectare was reported from 9, 8, 7 and 6 months crop duration, respectively. To harvest a reasonable yield it was recommended that beet crop should avail of longer stay in the field. (Jan, 1964).

Studies on planting sugar beet on 1<sup>st</sup> of Sept., Oct. and Nov. revealed that Oct. planting gave the highest yield of beet roots than earlier or late planting (Leilah et al, 2005). In Egypt, studies on planting sugar beet on 1<sup>st</sup> and 15<sup>th</sup> of Sept., Oct. and Nov. revealed higher beet root yield from 15<sup>th</sup> Oct. to 15<sup>th</sup> Nov. (Rafay, 2012). It was

observed that very early planting induce more gaps in plant stand. Earlier sowing prolong growth period which is one of the most crucial yield determining factors (Oleson, et al, 1990). Poor yield from late planting was due to availability of limited growth period and low temperature that suppress growth. Short vegetation period in the late sowing reduced root yield and sugar contents ((Sogut and Arioglu, 2004). From the crop harvested at 180, 195 and 210 days after sowing (7-12 Oct), the later harvesting resulted in greater yield of beet roots and sugar contents than earlier harvesting (Hussein et al, (2012). The planting and harvesting time has direct impact on overall growth period of the crop that affected the yield of sugar beet. Sugar beet avails six to eight months of growing period in Pakistan. Considering very cold spell soon after sowing and very hot weather at harvesting, we are left with very short time for sowing and harvesting operations. Studies have been undertaken to ascertain very suitable time of planting and harvesting for getting good yield and sugar recovery.

## **MATERIAL AND METHODS**

The three years project study (2008-09 to 2010 – 2011), financially sponsored by the Pakistan Agricultural Research Council, Islamabad, was conducted at the research farm of Al-Moiz industries, Dera Ismail Khan,

over a three years project duration of 2008-09 to 2010 - 2011. The study included five planting dates, viz: 1<sup>st</sup> October, 15<sup>th</sup> October, 1<sup>st</sup> November, 15<sup>th</sup> November and 1<sup>st</sup> December with five harvesting dates, viz: 1<sup>st</sup> April, 15<sup>th</sup> April, 1<sup>st</sup> May, 15<sup>th</sup> May and 1<sup>st</sup> June. Planting was done in split plot design placing planting time in main plot and harvestings time as sub plot super imposed on the main ; randomly laid out in four replications. Each sub plot measured 3.75 m; covering five rows of 6 meters length each having row to plants space of 75 cm x 20 cm. The land was deep prepared and well pulverized to attain good tilth. Two bags of DAP and one bag of SOP were applied after seedbed preparation prior to planting. Planting was done with a tractor operated mechanical planter, followed by irrigation. As the field came in moist stage it was sprayed with a herbicide "Dual Gold". On latter stage weeds were controlled by manual weeding. The 75 Kg of Urea was applied in two split doses, first one four weeks after sowing and the last dose applied eight weeks of sowing. The irrigations were applied as and when needed.

At the time of harvesting five beet roots of almost uniform size were picked from each plot and sent to the sugar mills laboratory for sugar analysis tests. Beet roots of central three rows of each plot were manually dug, leaves with crown section

were cleaned off and beet roots weighed for beet root yield data. The beet root yield and recovery data were got statistically analyzed and are discussed hereunder.

## RESULTS

### Beet root yield

The data on beet root yields as affected by various sowing and harvesting dates for the period 2008-09, 2009-10 and 2010-11 are presented in Table-1. Sowing dates. The data show significant differences in the means of cane yield, during the experimental periods. During 2008 the beet planted on 15<sup>th</sup> October gave the highest yield of 80.95 t ha<sup>-1</sup>. The low yield during 1<sup>st</sup> October was due to infestation of pest (Grey weevil) that badly affected crop stand of the crop. The planting done beyond 15<sup>th</sup> October affected the crop yields adversely. The lowest yields of 59.25 and 50.10 t ha<sup>-1</sup> were observed during 15<sup>th</sup> Nov. and 1<sup>st</sup> Dec., respectively. During 2009-10 and 2010-11 periods, Oct. planting gave the highest yields of beet roots per hectare and the means were significantly different from Nov. and Dec. sowings. However, yields of 1<sup>st</sup> and 15<sup>th</sup> Oct. were statistically alike. Compared to Oct. planting sugar beet on 1<sup>st</sup> Nov., 15<sup>th</sup> Nov. and 1<sup>st</sup> Dec. showed a large reduction in yield which was to the tune of 10.43%, 25.26% and 39.25%, respectively. According to

Oleson et al (1990), early sowing is the crucial yield determining factor that prolong growth to attain good growth.

**Harvesting dates.** The data in Table 1 show significant differences in the means of cane yield recorded during the three years of experimental period. During 2008-09, harvesting the crop on 15<sup>th</sup> May and the latter dates showed non significant differences in their means. The lowest yields were observed on 1<sup>st</sup> April with a little rise on 15<sup>th</sup> April harvest.

During 2010-11, harvesting on 1<sup>st</sup> May gave the highest yield of beet roots (90.64 t ha<sup>-1</sup>) and its means were significantly different from rest of the dates., followed by 15<sup>th</sup> May and 1<sup>st</sup> June. Harvesting on 1<sup>st</sup> April recorded the lowest yield (33.09 t ha<sup>-1</sup>), with considerable yield increase on April 15. Unusually low yield of April month is due to severe attack of grey weevils on a few plots that the plots had to be re-sown. During 2010 – 2011 interaction showed significant differences wherein October planting with 15<sup>th</sup> May harvesting gave the highest yield of 105 – 107 t ha<sup>-1</sup>.

### Sugar Recovery

The data in Table-2 show significant differences in means of both sowing and harvesting dates during the period 2009-10 and 2010-2011. However, during 2008 - 09, means were not significantly different.

**Sowing dates.** The Oct. planting has shown the highest recoveries, and the means were significantly different from Nov. and Dec. sowing during both the years.

### Harvesting dates.

During 2009-10 the crop harvested on 1<sup>st</sup> May gave the highest sugar contents of 11.11% and was significantly different from rest of the harvesting dates. The 15<sup>th</sup> May was next best in recovery, significantly followed by 1<sup>st</sup> June. Sugar beet harvested in April has shown the lowest recoveries. During 2010-11 harvesting in May and June gave equally good recoveries, significantly followed by April harvesting. In this year weather was not much harsh to show wide variation in sugar contents during May and June periods.

### Mean beet root yield and sugar recoveries

The data in Table-3 indicates that October planting and May harvesting have yielded 76.86 and 75.48 tons beet root per hectare, respectively. The Sugar recovery data in Table-4 indicate that highest sugar recoveries of 10.87% and 11.06% were obtained from October sowing and May harvesting, respectively. With subsequent delay in sowing beyond October on 1<sup>st</sup> Nov, 15<sup>th</sup> Nov and 1<sup>st</sup> Dec., sugar contents were reduced to 10.33%, 10.10% and 9.93%, respectively. The interaction of sowing with harvesting indicate that Oct. sowing with May harvesting

yielded the highest beet root weight of 85-90  $\text{tha}^{-1}$  with the highest sugar contents of 11.58 – 11.81%.

## Discussion

The planting and harvesting dates have most conspicuous role in successful crop production. The importance of planting time is with respect to providing conditions favorable for germination, initial crop stand and growth and development of beet root plants. On the other side harvesting time regulate maturity period so as to harvest maximum sugar yield per unit area. Both planting and harvesting times also determine the growth period optimally required for sugar beet root growth and development. In view of the results discussed in **Table-3** the October planting, giving higher beet root yield, seem to be the ideal period of planting sugar beet. Sowing the crop on 1<sup>st</sup> Nov., 15<sup>th</sup> Nov. and 1<sup>st</sup> Dec. gave a yield reduction of 10.43%, 25.27% and 39.25%, respectively. This clearly indicate that to get economic yields the sowing should be completed in the month of October. On the other hand compared to May, harvesting on 1<sup>st</sup> April and 15<sup>th</sup> April reduced yield by 36.74% and 25-00%, respectively, while harvesting the crop on 1<sup>st</sup> June also dropped the yield by 5.50%. It could be concluded that beet root yield is gradually reduced with any delay in planting beyond Oct. Similarly compared to May, harvesting

in April and June result in marked reduction in yield. To obtain better yields longer crop cycles has also been recommended by Jan (1964). With respect to sugar contents, subsequent delay in sowing beyond October on 1<sup>st</sup> Nov, 15<sup>th</sup> Nov and 1<sup>st</sup> Dec., showed sugar reduction by 4.96%, 7.08% and 9.93% respectively. As for harvesting, the month of May appear to be the most suitable period for harvesting sugar beet to get the highest average sugar contents (11.06%). Compared to the month of May, harvesting on 1<sup>st</sup> April and 15<sup>th</sup> April reduced sugar recovery by 14.81% and 9.94%. The data further indicate that increase in beet root yield and sugar contents are greatly correlated with overall growth period of the crop. The relationship of growth duration with beet root yield and sugar recoveries are shown in **Table-5**. The data indicate that Oct. sowing with May harvesting yielded the highest beet root weight of 85-90  $\text{tha}^{-1}$  with the highest sugar contents of 11.58 – 11.81%. These yield ranges were obtained from the growth duration of 197 – 227 days. On the other hand Nov. – Dec. sowing with April 1- 15 harvesting gave yield ranges of only 28 – 45  $\text{t ha}^{-1}$ . These trends were observed from shorter growth duration of 136 – 166 days. Infact Nov. and Dec. planting while slows down the growth due to low temperature, reduced the growth period, while June

harvesting has physiological effect of beet root rotting. The philosophy of higher yield from Oct. planting and May harvesting is that the October planted crops get well established to attain good growth before onset of winter. It is important to obtain full leaf cover as early as possible during growth to harvest higher yield of sugar beet. This crops cycle also avails of longer growth period than Nov. & Dec. planted and April harvested crop. The data in **Table-5** indicate that both crop yields and quality are mostly associated with longer growth period. Thus the data are in conformity with findings of Hussein et al (2012). Though Oct. sowing with June harvesting avail of longer growth period but the crop is subject to scorching heat and fermentation due to high temperature which results in severe yield and quality losses. April harvesting have always shown drastic reduction in beet yield and sugar recoveries. It is because after termination of cold spell in February crop does not avail of longer period of proper root development and sugar synthesis and accumulation. Yield reduction from short vegetation period has also been reported by Asiogler(200). Nevertheless, some early maturing varieties may be selected to harvest better sugar yields per unit area.



The mean monthly temperature data of D.I. Khan (**Table-6**) indicate that the month of October offers most suitable weather conditions for sowing sugar beet. With delay in sowing to Nov. and then Dec. temperatures gradually drops too low for its germination. December, January and even February

As for harvesting April appears to be the best in D.I. Khan while the month of May show marginal temperature ranges for harvesting a healthy crop; the month of June has too high temperatures. To harvest good sugar yields, sugar beet varieties may be searched out to initiate harvesting in April and vacate the fields with the termination of May.

**2008-09**

Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	LSD05
1st Oct.	59.18	69.25	73.55	75.33	68.95	69.25 b	9.70
15-Oct	70.63	75.33	88.75	86.05	83.95	80.95 a	
1st Nov.	61.25	66.88	68.45	79.18	69.58	69.33 b	
15-Nov	47.30	51.75	62.20	74.48	60.63	59.25 c	
1st Dec.	33.85	46.63	57.60	60.00	52.40	50.10 c	
Mean yield	54.45 c	61.98 bc	70.10 a	75.00 a	67.10 ab		
LSD05	7.98						

Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	LSD <sup>05</sup>
1st Oct.	65.75	75.45	75.30	85.95	78.08	76.10 a	6.11
15-Oct	71.90	67.28	73.05	92.93	78.63	76.75 a	
1st Nov.	59.38	66.85	62.63	80.23	69.80	67.78 b	
15-Nov	41.05	46.40	45.65	63.55	51.38	49.60 c	
1 <sup>st</sup> Dec.	31.00	35.40	35.80	48.85	41.83	38.58 d	
Mean yield	53.80c	58.28bc	58.48bc	74.30a	63.95b		
LSD <sup>05</sup>	6.06						

Planting time	1st April	15-Apr	1st May	15-May	1st June	Meanss	LSD <sup>05</sup>
1st Oct.	44.64 k	68.95ghi	107.54a	95.08bcd	84.80def	80.20a	5.05
15-Oct.	45.50 k	59.24ij	105.23ab	92.87cde	86.79def	77.85a	
1st Nov.	32.45 l	50.17jk	98.18abc	82.62ef	85.30def	69.67b	
15-Nov.	33.07mn	39.46kl	78.85fg	84.39def	81.43f	61.45c	
1st Dec.	19.18 n	31.04imn	63.30i	66.60hi	76.41fgh	51.40d	
Mean yield	33.09 d	49.72 c	90.64a	84.33B	82.94b		
LSD <sup>05</sup>	5.05						
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**Table- 2 Effect of different planting and harvesting dates on the sugar recovery of sugar beet during 2008 – 2011 periods.**

2008-09		Harvesting time – sugar recovery %					
Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	LSD <sup>05</sup>
1st Oct.	10.22	10.85	11.25	12.00	9.46	10.76	NS
15-Oct.	10.02	10.90	11.18	11.95	9.45	10.78	
1st Nov.	9.57	9.75	10.53	11.70	10.29	10.37	
15-Nov.	9.95	10.70	10.86	11.68	10.59	10.76	
1st Dec.	9.47	10.40	10.53	11.53	10.64	10.51	
Mean yield	9.85	10.42	10.87	11.77	10.17		
LSD <sup>05</sup>	NS						
2009-10		Harvesting time - sugar recovery %					
Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	LSD <sup>05</sup>
1st Oct.	9.74	9.94	11.84	10.69	10.74	10.59 a	0.297
15-Oct	9.50	9.88	11.56	11.08	10.43	10.49 a	
1st Nov.	9.01	9.66	11.24	10.53	10.35	10.16 b	
15-Nov	8.54	9.39	10.79	10.79	10.13	9.93 b	
1 <sup>st</sup> Dec.	7.90	9.25	10.11	10.36	10.34	9.59 c	
Mean yield	8.94e	9.62d	11.11a	10.69b	10.40c		
LSD <sup>05</sup>	0.266						
2010-11		Harvesting time - sugar recovery %					
Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	LSD <sup>05</sup>
1st Oct.	10.50	11.08	12.35	12.05	11.30	11.45 a	0.265
15-Oct	10.35	10.50	12.35	11.88	10.93	11.20 a	
1st Nov.	9.98	9.55	10.92	11.98	9.88	10.28 b	
15-Nov	9.68	9.38	9.85	9.88	10.58	9.87 b	
1st Dec.	9.18	8.23	9.00	9.28	10.70	9.25 c	
Mean yield	9.94b	9.75b	10.90a	10.83a	10.68a		
LSD <sup>05</sup>	0.265						

**Table-3 Mean yield of sugar beet for the period 2008-09 to 2010-2011.**

		Harvesting time - Mean yield – t ha <sup>-1</sup>					
Planting time	1st April	15-Apr	1st May	15-May	1st June	Mean	Mean variation %
1st Oct.	56.62	71.21	85.45	85.47	77.28	75.19	
15-Oct	62.67	67.23	89.00	90.64	83.11	78.53	
1st Nov.	50.89	61.28	76.44	80.67	74.90	68.84	
15-Nov	40.45	45.89	62.26	74.14	64.48	57.44	
1st Dec.	28.22	37.66	52.23	58.48	56.87	46.69	
Mean yield	47.75	56.65	73.08	77.88	71.33		
Mean variation %							

**Table-4 Mean sugar recoveries of sugar beet for the period 2008-09 to 2010-2011.**

Planting time	Harvesting time					Mean	Mean variation %
	1st April	15-Apr	1st May	15-May	1st June		
1st Oct.	10.15	10.62	11.81	11.58	10.50	10.93	
15-Oct	9.96	10.43	11.70	11.64	10.40	10.82	
1st Nov.	9.52	9.65	10.91	11.40	10.17	10.33	
15-Nov	9.39	9.82	10.50	10.78	10.43	10.10	
1 <sup>st</sup> Dec.	8.85	9.29	9.88	10.39	10.56	9.79	
Mean yield	9.57	9.96	10.96	11.16	10.41		
<b>LSD<sup>05</sup></b>							

**Table-5a. Mean yield of beet roots t ha<sup>-1</sup> in relation to various growth periods - days**

Planting time	1st April		15-Apr		1st May		15-May		1st June		Mean
	yield	Days	yield	Days	yield	Days	yield	Days	yield	Days	
<b>1st Oct.</b>	56.62	182	71.21	197	85.45	212	85.47	227	77.28	243	<b>75.19</b>
<b>15-Oct</b>	62.67	166	67.23	182	89.00	197	90.64	212	83.11	227	<b>78.53</b>
<b>1st Nov.</b>	50.89	151	61.28	166	76.44	182	80.67	197	74.90	212	<b>68.84</b>
<b>15-Nov</b>	40.45	136	45.89	151	62.26	166	74.14	182	64.48	197	<b>57.44</b>
<b>1st Dec.</b>	28.22	121	37.66	136	52.23	151	58.48	166	56.87	182	<b>46.69</b>
<b>Mean</b>	<b>47.75</b>		<b>56.65</b>		<b>73.08</b>		<b>77.88</b>		<b>71.33</b>		

**Table- 5b Mean sugar recoveries in relation to various growth periods - days**

Planting time	1st April		15-Apr		1st May		15-May		1st June		Mean
		Days		Days		Days		Days		Days	
<b>1st Oct.</b>	10.15	182	10.62	197	11.81	212	11.58	227	10.50	243	<b>10.93</b>
<b>15-Oct</b>	9.96	166	10.43	182	11.70	197	11.64	212	10.40	227	<b>10.82</b>
<b>1st Nov.</b>	9.52	151	9.65	166	10.91	182	11.40	197	10.17	212	<b>10.33</b>
<b>15-Nov</b>	9.39	136	9.82	151	10.50	166	10.78	182	10.43	197	<b>10.10</b>
<b>1st Dec.</b>	8.85	121	9.29	136	9.88	151	10.39	166	10.56	182	<b>9.79</b>
<b>Mean</b>	<b>9.57</b>		<b>9.96</b>		<b>10.96</b>		<b>11.16</b>		<b>10.41</b>		

**Table-6. Mean monthly temperature and precipitation during growth period of sugar beet crop in D.I. Khan**

Month	Temperature C°-mean daily			Precipitation “mm”
	High	Low	Mean	
September	36.7	23.8	30.2	17.6
October	33.4	17.3	25.3	4.8
November	27.7	10.5	19.1	2.1
December	21.9	5.3	13.6	10.4
January	20.3	4.2	12.2	10.0
February	22.1	7.3	14.7	17.5
March	26.9	12.9	19.9	34.8
April	33.5	18.5	26.0	21.7
May	38.7	23.2	30.9	17.2
June	41.5	26.8	34.2	14.4

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