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Evaluation of sowing and harvesting date effects on yield and quality of five sugar beet cultivars in Jiroft region (autumn planting)

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ABSTRACT

As water is the most restrictive factor in national agricultural production, it is necessary to take decreased water consumption and increased water us efficiency in crop production into consideration. Nowadays, spring sugar beet production areas are concentrated in the region with water limitation and hence, the increase in spring production area contradicts the principle of water and soil conservation. Using new regions for autumn sugar beet sowing allows the increase in warm and semi-warm beet production areas. To develop sugar beet production in Province of Kerman and to find new climates, the study was conducted in Jiroft area in strip split split plots based on Randomized Complete Block Design (RCBD) with three replications during 2007-2008. Three sowing dates (September 6, October 7 and November 6), five cultivars (Rasoul, Monatuna, 9597, SBSI002 and SBSI003) and three harvesting dates (April 4, May 5 and June 5) were evaluated. Results showed significant effects of sowing and harvesting dates on white sugar yield. The effects of sowing date variations were greater than those of harvesting date so that growth period shortened by two months (due to delayed sowing date) decreased white sugar yield by 72.5% whereas and growth period prolonged by the same amount (due to delayed harvesting date) increased the white sugar yield by 55.1%. The highest white sugar yield (13.71 ton.ha^{-1}) was obtained by early sowing (September 6) of SBSI002 and harvesting in May 5(with 240 days growth period). Considering favorable agro-climatic conditions in Jiroft region belonging to warm zone of Province of Kerman, it seems that the region has the potential for fall cultivation of sugar beet.

Keywords: autumn cultivation, cultivar, harvesting date, sowing date, sugar beet

INTRODUCTION

Sugar beet autumn sowing started in Iran in 1963. During the recent years, many studies have been carried out on the various aspects of agronomy, breeding, pathology, economics, qualities and other traits of autumn sugar beet cultivation in Iran (Sharifi et al. 2000). The results confirm that sugar beet could be introduced as an important crop in the rotation of potential areas. The most significant factor, as a firm reason for autumn cultivation of sugar beet as compared to spring sowing, is the optimum use of precipitation during the growth period, and consequently the enhancement of water use efficiency (Sharifi et al. 2000). This issue would gain more importance when water is the main limiting factor in Iran. The studies showed that the autumn sugar beet cultivation areas, especially in Dez and Karkhe rivers bank, could be developed (Kashani et al. 1996).

In addition to Khuzestan province in which it is easily possible to develop the autumn sowing of sugar beet (Gohari et al. 1993; Kashani et al. 1990; Sharifi et al. 2000), in other regions such as Ilam, Fars, Kerman, and Kermanshah provinces, this type of sugar beet cultivation could also be realized (Ashraf Mansouri 2000; Basati et al. 2002;

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Javaheri 2002). Even by breeding methods and using more bolt-resistant varieties and other complementary research, probably autumn sugar beet sowing could be expanded in Khorasan and Golestan provinces and Moghan area (Gohari et al. 1993; Taleghani and Moharamzadeh 2002, Taleghani et al. 2002).

At present, the autumn sugar beet cultivation is being developed or studied in different countries of the world. The idea even exists in the west-north European countries (Jaggard and Werker 1999). On the other hand, bolting, as an unfavorable phenomenon in sugar beet and a limiting factor in its autumn cultivation, has vastly been studied, and the resistant varieties and breeding more resistant ones have come to flourish (Longden and Thomas 1989; Sadeghian and Sharifi 1999). In some countries like Spain, during the recent years, autumn sugar beet cultivation has successfully been developed. In the studies, carried out by Kafka (1996) in U.S., this cultivation method is mentioned as suitable in sustainable agriculture and possibility of this method, in the potential areas of the country, has been emphasized.

Since the autumn sugar beet cultivation in many regions is encountered with the peril of bolting affected by genetic, environmental and physiological factors (Sadeghian 1993), the development of this kind of method in those areas where winters are long (south of Spain) and the new regions in Iran, which are estimated to be the suitable for the autumn cultivation, necessitate the perfect bolt-resistant varieties (Sadeghian 2002). In the past, the bolting of early-sown sugar beet plants was considered as the main barrier to take advantage of autumn sowing, but, at present, with the improved bolt-resistant varieties, sugar beet could be cultivated early in the temperate regions, with no serious problem (Fortune et al. 1999). On the other hand, bolting could be avoided with the combination of sowing date and selection of bolt-resistant varieties, even for the seed production in the areas (Ranji 1998).

Many studies have been conducted on the agronomical aspects of autumn sugar beet cultivation. Carter and Traveller (1981) showed that the dry matter accumulation and sugar beet are affected by sowing date, N- fertilizers and harvest time. Jaggard and Werker (1998) showed that the efficiency of spring sugar beet cultivation is 26% more than that of autumn sowing, but the existence of different viral, powdery mildew and nematode diseases could negate this efficiency. Some researchers have reported that root yield in autumn cultivation is considerably higher than that in spring sowing (Wood and Scott 1975, Longden and Thomas 1989). The growth period is considered as the main determinant for sugar beet yield. The evaluation of the influences of environmental factors on the growth and yield of 6 sugar beet varieties in 62 different regions has shown that sowing date has the highest effect on the interaction between variety and environment (Beckett 1982). Therefore, sowing date is one of the important determining factors of sugar beet yield and quality (Feller and fink 2004). Of course, the increase of yield, resulted from early sowing in the years of suitable climate, is more tangible (Dillon and Schmehl 1971). The suitable sowing date of sugar beet in each region is influenced by the previous crop, the climate of the region, the convention contracted between farmers and sugar factory, and the sown variety (Kandil et al. 2004). In the autumn cultivation, early sowing caused yield enhancement (Kandil et al.2004, Leilah et al. 2005). In Iran, the evaluation of possibility for autumn sugar beet cultivation in the warm regions determined that the best sowing date is the late August (Kermanshah, Kerman, Mashad, Moghan) and it was reported that in most regions, delay in sowing could diminish yield and increase root impurities (Basati et al. 2004). Javaheri (2002) conducted a research in Orzooyie, one of the warm regions of Kerman province, and showed that the Dez variety had more white sugar yield and root yield than BR1 at 5% level of probability, but the root impurity and bolt percent in Dez variety was significantly higher than that in BR1, in comparison. The best sowing date was August 22 with root and white sugar yield of 85.09 and 9.64 t/ha, respectively and the best harvest time was 4 June with white sugar yield of 9.38 t/ha.

Considering the unique climate conditions of the country, it seems necessary to introduce new horizons for autumn sugar beet production in Iran. On the other hand, the unfulfilled capacity of sugar factories, in some of the regions, could be compensated by autumn sugar beet production. Since the sugar beet production in Kerman province is done just in spring, and there is no autumn sowing in the history of Kerman at commercial level, the present study was carried out to evaluate the possibility of autumn sugar beet production in Jiroft.

MATERIALS AND METHODS

This research was done at Jiroft Agricultural

Table 1. Results of soil analysis of some physical and chemical characteristics in the experimental location, Jiroft, 2007

Soil texture (%)			Absorbable Potassium Oxide (ppm)	Absorbable Phosphate (ppm)	Neutral materials (%)	Organic Carbon (%)	Acidity	Electrical conductivity (mmohs/cm)	Sampling depth (cm)
Clay	Silt	Sand							
15	12	73	98	8	0.2	1.75	7.7	3.18	0-30
12	14	73	56	6	0.2	1.84	7.8	3.50	30-60

Education Centre (Ali-abad region in the town of Anbar-abad, located in 28° 35' N latitude and 57° 4' of longitude and at height of 607 m from sea level) in 2008-2009. After plowing, disking and leveling, the experimental plots were prepared. After leveling, based on the soil physical and chemical analytical results and Kerman Soil and Water Department recommendations, 200kg phosphate Ammonium and 80 kg Urea (1/3 Urea) fertilizers were distributed and disked smoothly, before sowing. The plots, based on time calendar, were sown by manual row planting through dry farming and at the same day, the irrigation was done. Until emergence, the soil moisture was preserved at the field capacity level and then the irrigation was adjusted on the basis of humidity, precipitation and plant need. In all treatments, at 2-4 leaf stage, the first, and one month later, the second weeding and thinning were carried out manually. After the second weeding and thinning, 1/3 of Urea fertilizer was distributed and irrigation was done the same day. Comparing the climate conditions of Jiroft with that of Dezful shows typical areas of autumn sugar beet cultivation where the average of the minimun, mean and maximum daily temperatures in Jiroft region are 17.5, 26.3, 33.0 C°, compared with Dezful's which are 15.8, 24.0, 32.2 °C, respectively.The total precipitations of the year, in the two regions are 174.8 and 203.7 mm, respectively (Figure 1). The experiment was carried out as split-split blocks in the randomized complete block design with 3 replications in 2008. In this research, 3 sowing dates of 5th September, 6th October and 5th November of 2008 were assigned to main plot, 5 varieties of Rasoul (the bolting semi-tolerant), Monatuna(the tolerant), 9597 (bolting sensitive) and SBSI 002 and SBSI 003 (the bolting tolerant promising hybrids) to sub-plots and the 3 harvesting dates of 3th April, 4th May and 4th June in 2009 to the sub-sub-plots. Each plot included 6 sowing rows of 8 m length and 50cm spacing. At the harvesting time, after the removing the first and 6throws of each plot and 0.5m from both ends of each row, the area of 14m^2 was harvested.

During the plant growth, the total plant number per plot, the missed plant number, and the growth scores were not recorded. The harvesting was done, according to the predicted dates. After harvesting, the number of roots per plot was counted and weighed, from which pulps were provided and sent to Sugar Beet Seed Institute laboratory in Karaj for quality analysis. On the basis of data collected, the statistical analyses were done by MSTAT software. The comparison of means for the evaluated characteristics was done through Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Root yield

The changes of sowing dates had a significant influence on the sugar beet root yield at 1% probability level so that with a delay in sowing, the

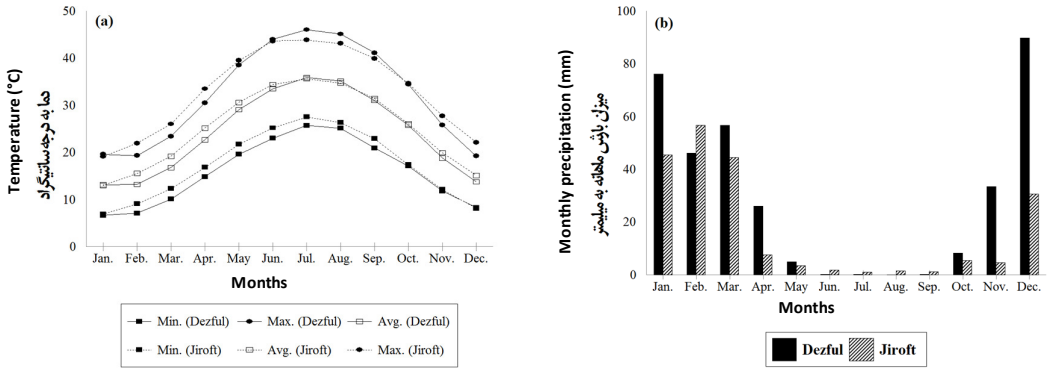

Fig. 1. Variations of long-term months average of (a) minimum, mean and maximum temperature and (b) mean monthly precipitation in Dezful and Jiroft

Table 2. Mean of squares of the combined analysis of some quality and quantity characteristics of sugar beet for sowing date, variety and harvesting date, Jiroft, 2008

Source of variation	Degrees of freedom	Root yield	Sugar content	White sugar yield	Molasses sugar	Sugar impurities		
						sodium	potassium	Nitrogen
Replication	2	6057.76*	60.60**	22.87^{ns}	3.49**	14.40**	1.08^{ns}	1.47*
Sowing date	2	37319.21**	3.26^{ns}	447.60**	2.60**	1.49^{ns}	17.80**	2.47**
Error (Ea)	4	2002.21	12.10	10.47	0.49	1.50	1.08	0.22
Variety	4	658.26^{ns}	5.37^{ns}	9.86^{ns}	0.21^{ns}	0.78^{ns}	0.24^{ns}	0.38^{ns}
Error (Eb)	8	1078.64	0.63	4.93	0.47	2.34	0.46	0.43
A×B	8	1453.74^{ns}	6.58^{ns}	19.85*	0.76^{ns}	2.50^{ns}	2.22*	0.38^{ns}
Error (Ec)	16	884.87	5.28	10.06	0.51	1.80	1.35	0.35
Harvest date (C)	2	4740.96*	12.03^{ns}	76.05**	1.65*	22.17**	1.61^{ns}	0.44^{ns}
A×C	4	3323.78*	2.78^{ns}	15.43^{ns}	0.67^{ns}	0.88^{ns}	2.63*	0.14^{ns}
B×C	8	1036.14^{ns}	1.63^{ns}	3.49^{ns}	0.23^{ns}	0.39^{ns}	0.50^{ns}	0.43^{ns}
A×B×C	16	1473.32^{ns}	8.80^{ns}	3.59^{ns}	0.36^{ns}	0.92^{ns}	1.42^{ns}	0.49^{ns}
Error (Ed)	59	1428.08	4.98	8.45	0.42	0.99	0.92	0.31
Total error (E)	87	1322.44	4.96	8.52	0.44	1.29	0.96	0.31

*, ** and ns are significant at levels of 5%, 1% and insignificant, respectively. As F test was insignificant for the experimental errors, the pooled error was used.

root yield decreased (Tables 2 and 3). The quantity of decrease in the root yield was in a way that, compared with the sowing date of 5th September (root yield of 78.38 t/ha), 30 and 60 days of delay in sowing date caused to decrease the root yield to 39.21 and 22.23 t/ha, respectively (Table 3). On the other hand, for each day of delay in the sowing date in comparison with 5th September, the sowing dates of 6th October and 5th November decreased the root yield to 1306 and 636 kg/ha, respectively. Sowing has influenced the canopy through growth, numbers, size and age of green leaves and, thereby could affect the light intercepted by the plants during the growth period (Rinaldi and Vella 2006). Delay in the seedling emergence could decrease dry matter accumulation in plant, which this difference would remain up to the end of the plant growth period (Stibble and Marlander 2002). In Egypt, by sugar beet sowing in 15 October, the single root weigh after 120 and 150 days was found to be 468 and 608 g, respectively (Kandil et al. 2004). Garcia et al. (2004), compared 3 sowing dates (October, November and December), two plant densities (80000 and 100000 per hectare) and 3 varieties, during the autumn sugar beet cultivation in a Mediterranean condition and found that the active growth of sugar beet would begin 160 days after sowing (late winter) and consequently, it would reach to the maximum accumulation of dry matter (20-25 g/m^2 per day) and Leaf Area Index (3.9-5.0). Comparison of 10 sugar beet varieties, in autumn culti-

Table 3. Grouping of mean of some sugar beet quality and quantity characteristics in the experiments of sowing date, variety and harvesting date, Jiroft, 2008

Variables	Root yield (t/ha)	Sugar content (%)	White sugar yield (t/ha)	Molasses sugar (%)	Root impurities		
					Na	K	N
					meq/100 gr of root pulp		
Sowing date							
6th September	78.38^{a}	16.90^{a}	10.99^{a}	2.90^{b}	1.99^{a}	6.45^{b}	2.36^{a}
7th October	39.21^{b}	17.28^{a}	5.68^{b}	2.75^{b}	1.85^{a}	6.50^{b}	1.92^{b}
6th November	22.23^{b}	16.76^{a}	3.02^{c}	3.22^{a}	2.21^{a}	7.56^{a}	2.02^{b}
Variety							
Rasoul	40.36^{a}	17.34^{a}	5.82^{b}	2.92^{a}	1.97^{a}	6.62^{a}	2.01^{a}
Monatuna	49.29^{a}	16.50^{a}	6.71^{ab}	2.94^{a}	1.96^{a}	6.73^{a}	2.00^{a}
9597	53.13^{a}	16.93^{a}	7.33^{a}	3.08^{a}	2.08^{a}	6.95^{a}	2.26^{a}
SBSI002	46.60^{a}	16.62^{a}	9.34^{ab}	2.99^{a}	2.26^{a}	6.81^{a}	2.05^{a}
SBSI003	43.66^{a}	17.53^{a}	6.42^{ab}	2.84^{a}	1.80^{a}	6.78^{a}	2.19^{a}
Harvesting date							
4th April	35.39^{b}	16.43^{a}	4.82^{b}	2.82^{b}	1.50^{a}	6.98^{a}	1.99^{a}
5th May	51.89^{a}	17.08^{a}	7.37^{a}	2.87^{b}	1.73^{b}	6.91^{a}	2.16^{a}
5th June	52.54^{a}	17.45^{a}	7.51^{a}	3.17^{a}	2.82^{a}	6.62^{a}	2.16^{a}

*Means with the same letter in each column have no significant differences at 5% level.

vation in the south of Italy showed that the root and sugar yields in the sowing dates of 28th October (65.35 and 10.96 t/ha) were significantly higher than those in the sowing dates of 27th November (57.69 and 9.43 t/ha (Giordano and D'Amato 1976). The influence of varieties on the root yield was not significant and 5 varieties were put in one statistical group (Tables 2 and 3).

The harvest time had a significant influence on the root yield at 5% probability level (Table 2). The harvesting time delayed from 3th April (35.39 t/ha) to 5th May (51.89 t/ha) caused that the root yield was significantly increased for 16.5 t/ha, but postponing the sowing date until 4th June had no significant influence on the root yield (Table 3). One of the reasons of increasing root yield in the early sowings is due to the prolonged growth period (Olsen et al. 1990). On this basis, not only the early sowing, but also the delayed harvest could increase the root yield. It was shown that the delayed harvest for one month had the same influence as early sowing for 18 days (Lauer 1997). In the present study, the influence of one month delay in harvest (16.5 t/ha) was equal to 13 days of early sowing (Table 3). The studies during 1963-1967 showed that the average daily increase of root yield during October (spring sowing) was approximately 30 kg/ha and during November was around 10 kg/ha per day (Dony et al. 1981). In the present study, the quantity of root yield increase from 3th April to 4th May, and from 3th April to 4th June were 550 and 286 kg/ha per day, respectively.

Table 2 shows that the interaction of sowing date × harvesting time on the root yield is not significant. On the other hand, for all the sowing dates, the delayed harvest until 4th May caused a significant increase in the root yield; therefore, the highest root yield was related to the sowing date of 5th September and the harvesting time of 4th May (74.53 ton/ha), with the growth period of 270 days. Although the delayed harvest could enhance the root yield and white sugar content (Lauer 1995), but the importance of additional time for the plant in early-sowing at spring time is more than that in the delayed sowing (Lauer 1997). Anyhow, realizing the highest potentiality of the crop yield necessitates the earliest possible time of sowing and delayed harvesting (Cakmakci and Oral 2002).

Sugar content

The sowing date had no significant influence on sugar content (Table 2). The review of literature in this regard also represented that in spite of the negative influence of delayed sowing on the elongation of seedling emergence period and consequently on root yield decrease, this matter had no influence on the quality components of sugar beet (Stibbe and Marlander 2002). Meanwhile, in Qasim and Al-Rawi's studies (1971), postponing the sugar beet sowing date, from October to November, caused the reduction of the root yield from 67.2 to 48.4 t/ha, and enhancement of sugar content, from 10.9% to 13%.

The studied varieties, at 1% probability level, had significant influence on sugar content (Table 2) and the variety SBSI003 produced the maximum sugar content (17.53) (Table 3). The difference of 5.8% in the studied sugar content (16.5-17.53%) was coincided with the reported figures of 6% (17.3-18.5) in Lauer's study (1997).

The evaluation of sugar content variation in the different harvesting dates showed the significant influence of this agronomic factor on the sugar content of root at 1% probability level (table 2). The harvest time of 4th June, with sugar content of 17.45%, had higher sugar content in comparison with the first harvest time (16.43%), (Table 3). It was expected that with the temperature and respiration enhancement at the third harvest time, the sugar content would be decreased, but, unexpectedly, the white sugar content was increased at the end of growth season. It seems that since 75% of root dry matter includes sucrose (Tognetti et al. 2003), the reason for the higher sugar content at delayed harvest is the increase of the root dry matter percent. Also, in another study, postponing the harvest time improved sugar beet quality but sugar content loss and technical quality of sugar beet after harvest and during storage in silo, in early sowing and delayed harvest, decreased to the minimum (Malec 1992).

White sugar yield

The sowing date influenced white sugar yield significantly, at 1% probability level (Table 2). The highest white sugar yield (10.99 t/ha) was related to the sowing date of 5th September, and the delayed sowing of 30 and 60 days, with the decrease of 48.3% and 72.5%, reduced white sugar yield to 5.68 and 3.02 t/ha , respectively (Table 3). Various reasons have been mentioned for the increase of the crop yield in early sowing, including the linear relation between sugar yield and light interception quantity (Storer et al. 1973; Biscoe et al. 1979; Furtune et al. 1999). Different studies show the significant influence of sugar beet sowing and har-

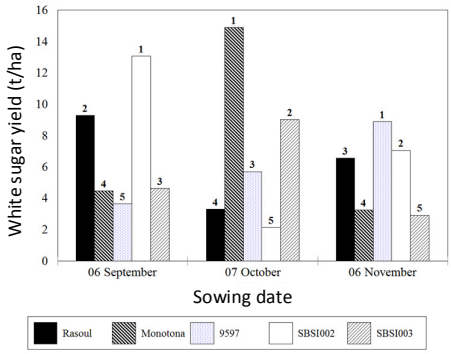

Fig. 2. Ranking of studied cultivars in terms of white sugar yield under different sowing dates

vest dates on the crop yield, although the relation is not linear (Durrant et al. 1993; Jaggard et al. 1995; Freckleton et al. 1999). Some researchers have reported that the relations between the yield and quality of sugar beet and sowing and harvesting dates are linear (Lauer 1997). In the present study, 30 and 60 days delay from 5th September sowing date resulted in the daily decrease of 177 and 133 kg/ha in the white sugar yield, respectively.

In this experiment, the influence of variety on white sugar yield was not significant (Table 2). The interaction of sowing date × variety also had no significant influence on white sugar yield (Table 2). It is expected that the varieties which have high sugar yield at early sowing, would keep their superiority in the delayed harvest too (Rimon et al. 1977). In the present study, however, the order of superiority of the varieties at the various sowing dates, changed (Figure 2). Totally, the varieties performance and efficiency in utilization of agronomical inputs would be realized through elongation of growth period (by early sowing or delayed harvesting) (Lauer 1997). In these experimental conditions, with delayed sowing, standard deviation (3.82, 2.89 and 2.34 t/ha, respectively) and variance of white sugar yield (14.62, 8.34, 5.52, respectively) among various varieties were decreased, and showed that, with elongation of growth period (early sowing), the differences among varieties were increased. Therefore, it is recommended that the early maturing genotypes would be used for early sowing and late-maturing genotypes would be applied for delayed sowing or early harvesting (Lauer 1997). In this study, although the interaction of sowing date × variety was not significant (Table 2), considering the different yields of varieties in the different sowing dates, SBSI003 as middle-maturing and 9597 as early-maturing varieties produced the highest white sugar yields (Figure 2).

The influence of white sugar yield, at 1% probability level, was significant and delayed harvesting caused the significant increase of white sugar yield (Table 2). White sugar yield in sowing date of 3th April was 4.82 t/ha and each day delay in harvest resulted in 33 and 43 kg/ha increase in the white sugar yields at the harvest times of May and 4th June, respectively (Table 3).

The interaction of sowing date × harvest date on WSY was not significant (Table 2). Meanwhile, in the sugar beet autumn cultivation, it has been shown that the delayed sowing, from 5th September to 6th October, had no influence on the sugar yield and sugar content (Nelson 1978). Nelson (1978) reported that the sugar beet cultivation in second decade of October, compared with that of September, in the case of harvest in July and August, had no influence on the sugar yield, but harvest in June would have considerable loss in sugar yield. In the sugar beet autumn cultivation, the studies on the interaction of variety × sowing date × harvest time in Palestine showed that the sugar yields in sowing dates of 25th September and 6th October were more than 10 t/ha with 85% recovered white sugar, whereas in the sowing dates of 5th November and 13th December, they were less than 7t/ha with the recovery index of 63% (Rimonet al. 1977). In this study, the maximum white sugar yield (13.04 t/ha) was related to the sowing date of 5th September and harvest time of 4thMay for the variety SBSI002.

Root impurities

The sowing date, at 5% probability level, had significant influence on K and alpha-amino N, but no effect on Na and molasses sugar (Table 2). This influence was in such a way that the delayed sowing caused significant increase and decrease in K and alpha-amino N, respectively (Table 3). The increase of K, in sugar beet root, was reported as the consequence of the delayed sowing (Bravo et al. 1989). This matter was assigned to the increase of K absorption, compared with the internal consumption of the element in the delayed sowing (Falvay and Vukov 1997). In this study, the delayed sowing for two months, from 5th September, caused the increase of 1.11 meq K per 100 g root pulp (Table 3). The significant influence of changes in sowing date on alpha-amino N has been reported by Sogut and Aroglu (2004). Some researchers (Azizi 1999; Ashraf-Mansouri 2000) showed that the delayed sowing has related to the decrease in alpha-amino N. The tested varieties had no signifi-

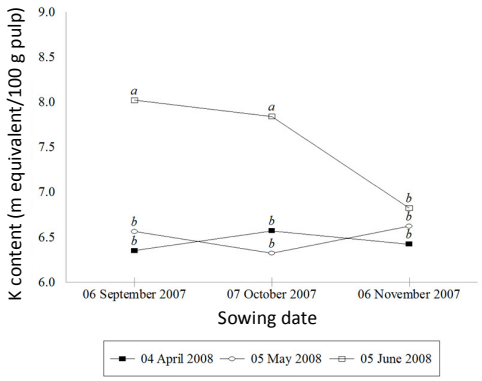

Fig. 3. Interaction between sowing date and harvest date for K content of sugar beet roots

cant differences for their root impurities and molasses sugar (Table 2). The harvest dates, at 1% and 5% probabilities levels, had significant influences on K and N levels, respectively (Table 2). The delayed harvest, from 3th April to 4th May, caused 1.32 meq per 100 g root pulp increase in Na and 35% increase in molasses sugar (Table 3). The interaction of sowing date × harvest time on root K quantity, at level of 5% probability, was significant. It was in such a way that K quantity in two sowing dates of 5th September and 5th November with a delay in harvest, was increased. But with the same sowing date of 6th November, the harvest time of 3th April had more K quantity than that of 5th May (Figure 3).

CONCLUSION

Considering the Agro climatic region of Jiroft, it seems that the region is suitable for sugar beet autumn cultivation. On the other hand, since the average minimum monthly temperature of Jiroft is more than that of Dezful, the importance of choosing the appropriate bolt-resistant variety in this region is less so that in the present study, none of the 5 tested varieties was bolted. The evaluation of temperature conditions of Jiroft showed that the 21-year average of minimum annual temperature was 17.5 ± 1/1°C. The minimum and maximum of minimum annual temperature were 16.1 (year 1992) and 20.9°C (year 2010), respectively, and the minimum average of minimum monthly temperature (4.7±1/4°C) was in January and the maximum average of the minimum monthly temperature (26.3±1.3°C) was in July (Figure 4a).

The average maximum annual temperature of this region was 33.0±0.9°C (Figure 4b) and the average annual temperature was 26.3±1.4° C (Figure 4c). Five years of 21 years of studies (24%) lacked the days of the minimum daily temperature or below 0° C. During the same period, the minimum daily temperature (-3.6°C) occurred in 15th December of year 2003, and the maximum daily temperature (49°C) was in 26th June of year 2006. In comparison, as seen in Figure 4, Dezful region is relatively colder than Jiroft. Based on statistics, the average of minimum average and maximum of annual temperature in Dezful region was 15.8, 24.7 and 32.0°C. On the other hand, in about 10 of 19 studied statistical years (1987-2005), the temperature was decreased down to below 0°C.

The results of this study represented the significant influence of sowing and harvesting dates on white sugar yield. The influence of variation in sowing dates was more than that in harvesting-time in such a way that the decrease of growth period to 2 months (due to the delayed sowing) caused decrease in white sugar yield to 72.5% and the increase of the growth period, in the same quantity (due to the delayed harvest) just resulted in the increase in the white sugar yield to 55.8%. The maximum white sugar yield (13.77 t/ha) was the outcome of early sowing (5th September) and harvest time of 4th May (the growth period of 240 days) when variety SBSI002 was cultivated.

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