Journal of Sugar Beet
http://jsb.sbsi.ir/
Journal of Sugar Beet 2013, 29(1)

Study of autumn sowing of sugar beet (*Beta vulgaris* L.) in Fasa area

G. Ashraf Mansouri[(1)*], M. Sharifii[(2)], F. Hamdi[(3)]

[(1)] *Instructor of Sugar Beet Research Department, Fars Agricultural and Natural Resources Research Centre, Shiraz, Iran.*
[(2)] *M.Sc. of Sugar Beet Research Department, Fars Agricultural and Natural Resources Research Center, Shiraz, Iran.*

Ashraf Mansouri G, Sharifii M, Hamdi F. Study of autumn sowing of sugar beet (*Beta vulgaris* L.) in Fasa area. J. Sugar Beet. 2013; 29(1): 37-43.

Received August 07, 2011; Accepted May 20, 2013

ABSTRACT

To investigate the possibility of autumn sowing of sugar beet (*Beta vulgaris* L.) in prone areas of Fars province, a study was conducted in split split plot design with randomized complete block design arrangement in four replications for three years starting from 2005 in Fasa region. The treatments consisted of three sowing dates including 27th September, 17th October, and 6th November in main plots, two cultivars viz. multi-germ BR1 and mono-germ Rasoul in split plots, and three harvest dates including 30th April, 26th May, and 20th June in split split plots. During the growing season, different traits including plant number, bolted plants, missing plants and the growth score were recorded. At harvest, after counting the root number and weighing, brie sample was prepared for sugar content, impurities (potassium, sodium, and amino N) and molasses sugar determination. The results showed that sowing date treatments significantly affected bolting percentage ($p<0.01$). Sowing on 27th September had the highest bolting (18.409%) whereas 17th October and 6th November sowing dates had the loweset bolting percentage by 5.420% and 2.870%, respectively. Both cultivars BR1 and Rasoul had no significant difference for bolting percentage, root yield, sugar percentage, and white sugar yield. The highest bolting percentage (9.96%) was related to harvest on 20th June. Higher root (58.486 t/ha) and white sugar (5.36 t/ha) yields were obtained in sowing on 20th June and harvest on 27th September. Due to increased yield of sowing on 27th September and harvest on 20th June, it is recommended to use cultivars resistant to bolting for quality and quantity improvement.

Keywords: autumn sowing, bolting, cultivar, harvest date, sowing date, sugar beet

INTRODUCTION

Since the efficient use of water is important in sugar beet production and owing to consecutive droughts and water shortages in the southern regions of Iran and also long growing season of the sugar beet, more attention has been paid to autumn sowing of sugar beet owing to rainfall usage (Koulivand 1988). Autumn sowing of sugar beet has been developed due to the reduction of pest and disease damages (Rhizomania, curly top, and root rots), reception by sugar factories in the province (Kavar, Fasa, and Mamasani), and also increase in its cultivation, which demands more studies in this area. Jaggard and Werker (1998) showed that spring sowing had 26% more benefit than autumn sowing but because of different diseases this benefit was lost. With determination of the optimum time for sowing, harvesting and tolerant cultivars to bolting with proper qualitative and quantitative characteristics, favourable conditions for the development of autumn sowing may be provided. In this type of sowing, due to the exposure of plant growing season to relatively cold autumn, water and different toxins usage decreased and as a result not only it caused economic saving through reduction in water and toxin usage but also the sugar production of the province increased which could enhance farmers income and employment, and also would be a step towards self-sufficiency in sugar production (Ashrafmansoori 2006). Owing to gradual global warming, it is predicted that spring sowing of sugar beet will be replaced by autumn sowing but autumn sowing has the risk of bolting (Draycott 2006). In

*Corresponding author's email: g_ashm@yahoo.com

the years in which the average temperature of winter months reaches below 10 ^{o}C, vernalization occurs and in spring because of flowering stem emergence, roots become hard and fibrous. The excess of flowering stems will decrease sugar content, root yield and the purity of crude syrup (Sadeghian 1999). In autumn and early spring sowing regions and where sugar beet is exposed to low temperature, usage of tolerant cultivars to bolting is very important (Lexander 1987). Sugar beet is well adapted to the irrigated agriculture in temperate regions. It is mainly sown in arid and semi-arid regions under irrigated conditions and also its sowing has developed to tropical and semi-tropical regions (Koocheki and Soltani 1997). In addition to genetic (cultivar) and climatic factors, agronomic factors such as sowing and harvesting dates have a significant effect on quantity and quality of sugar beet (Koulivand 1988). One of the best ways to increase root and sugar yield in tropical and semi-tropical regions is the usage of appropriate cropping calendar (Alexander 1979). Recently, due to water scarcity in arid and semi-arid areas, including Fasa and Darab, and long growth period of the plant, spring sowing acreage of this plant has declined (Ashrafmansoori 1997). Based on an experiment on spring sowing in Kermanshah, the earliest sowing date compared with the medium and late sowing dates had 14.49 and 17.87 t/ha added yield, respectively (Koulivand 1988). According to experiments conducted in different parts of the country, each region has its own optimum sowing and harvesting dates (derived from research reports of Sugar Beet Seed Institute, Karaj, Iran). Numerous experiments showed that if the early sowing occurs in optimum soil and climate conditions, roots with good qualities will be produced. The significance of early sowing and optimum climate conditions in relation to sugar extraction from the roots is taken into consideration by the majority of researchers (Cook and Scott 1993). Abshahi (1972) reported that plants harvested later (in longer growing season) were in a better situation for yield and sugar content, and the growth rate, root yield increase and sugar content were higher in April, May, and June, and sugar yield per hectare showed similar trend to root weight. In study by Shishegar (1972), a significant difference was found between sowing and harvesting dates in terms of root yield and qualitative traits. Sharifi and Orazizadeh (1996) reported that the average root yield in early and late harvest trials in Dezful were 45.63 and 52.22 t/ha, respectively and sugar content was 13.84 and 14.83%, respectively in which harvest in late May had superiority to April. Gohari (1991) reported a positive correlation between growing season (from sowing to harvest) and the amount of root yield ($p<0.01$), but no significant difference was found for sugar content in different harvest times. Sharifi (1989) stated that sowing in the third week of September (early) was much better than the following sowing s and with delay in harvest, root yield, sugar content and sugar yield per hectare increased. Several studies conducted in temperate (spring) and autumn regions showed that dry matter accumulation and root yield were influenced by sowing date, N fertilizer and harvest date (Lee et al. 1987; Carter and Nelson 1978; Traveller 1981). Carter and Traveller (1981) studied the effect of early and late harvest on quantity and quality of the crop and reported that earlier than usual harvest operation may decrease the potential production of sucrose up to 35%. Delay in harvest caused an increase in root yield by 8.43 and 2.59 t/ha in direct sowing and transplanting (pot cultivation), respectively (Ivanek and Martinic 1989). Nelson (1978) reported that the growth rate of roots harvested in May to July in central Arizona were similar to different sowing dates. Since sugar beet sowing areas have different climates, breeding for adaptation to a combination of specific environmental variables has been done and one should not expect that all varieties respond similarly to environmental stresses such as temperature and water rate (Johnson et al. 1971). Halvorson and Hartman (1980) reported that some new sugar beet genotypes have a good adaptability to early harvest and have high sugar content. Joseph and Lauer (1997) showed that genetic differences between varieties in terms of yield and quality are more observable in early sowing compared with late sowing. They also stated that producers (farmers) should use genotypes with higher root yield for early sowing and late harvest to benefit the entire season, but for the fields in which late sowing and early harvest occurs, genotypes with average root and sugar yield should be used.

The present study aimed to determine the optimal time for sowing and harvesting of two autumn sugar beet cultivars (BR1 and Rasoul) in suitable areas allocated to autumn sugar beet sowing in Fasa, Fars province.

MATERIALS AND METHODS

This study was conducted at Fasa sugar factory

Table 1. Results of the soil physico-chemical analyses for each of the test sites at a depth of 0-30 cm in different years

Year	Soil texture	Soil reaction	Electrical conductivity (dS/m)	Organic carbon (%)	Absorbable phosphate (mg/kg)	Absorbable potassium (mg/kg)
2005-06	Clay-loam	7.90	1.28	1.18	12.20	365
2006-07	Clay-loam	8.10	1.80	1.32	8.40	322
2007-08	Clay-loam	7.70	2.28	1.24	12.80	318

Studied soil had no restriction for salinity and soil fertility.

Table 2. Some meteorological information of Fasa region for the years 2005-08.

Month	2005		2006		2007		2008	
	Average temperature	Number of frost days	Average temperature	Number of frost days	Average temperature	Number of frost days	Average temperature	Number of frost days
April	15.8	2	16.0	0	15.5	0	18.2	0
May	21.4	0	22.9	0	22.7	0	22.5	0
June	26.0	0	26.8	0	28.1	0	27.9	0
July	30.9	0	30.5	0	31.1	0	30.3	0
August	29.7	0	30.4	0	29.5	0	30.6	0
September	26.9	0	15.8	0	27.2	0	27.4	0
October	21.5	0	21.7	0	21.4	0	22.3	0
November	15.1	0	16.6	2	16.7	0	16.1	0
December	12.4	0	7.6	12	11.0	10	9.4	11
January	8.0	13	5.2	23	6.1	17	8.0	17
February	10.9	8	8.5	8	8.1	15	9.1	12
March	12.3	4	11.3	1	13.0	6	14.0	1

area (28°58´N and Longitude 53°41´E with 1300 m elevation above sea-level). Before sowing, soil samples were taken randomly at a depth of 0-30 cm from different parts of the field and a composite sample was sent to the Soil and Water Research Laboratory Department of the province for determination of some physicochemical properties and based on the results, the required amount of fertilizer was determined (Table 1). Meteorological information of the region such as average temperature, number of frost days, etc., are summarized in Table 2. The experiment was laid out in a split split plot design with randomized complete block design arrangement in four replications for three years period starting from 2005 in Fasa region. Three different sowing dates viz. 27th September, 17th October, and 6th November were allocated to the main plot, two cultivars namely multi-germ BR1 and mono-germ Rasoul to the split plots, and three harvest dates viz. 30th April, 26th May, and 20th June to the split split plots. Each split split plot size was eight meter long with 4 rows of 50 cm apart. The experimental field received 250 kg of P_2O_5 ha^{-1}, equa to 115 kg P_2O_5 , and furrows were built. Sowing was done according to agronomic calendar using hand driller and dry sowing method, and was irrigated at the same day. After weed emergence, Betanal Progress herbicide (7.5 per mil) was used and for pest control, Decis toxin (2 per mil) was used. Thinning was performed as to leave on-row spacing of 20 cm in the sixth week after sowing. After using cultivator, breaking crust, and rebuilding furrows, N at a rate of 250 kg N.ha^{-1}, equal to 115 kg pure nitrogen per hectare, was applied as top dressing in two stages. During vegetative period and after thinning and final weed control, different traits including plant number, missing plant number, and the growth score were recorded for the two middle rows. In late April of each year, in sowing date treatments, the number of plants went to stem elongation stage was counted. Harvest was carried out from the two middle rows of each plot in 7 m long (after omitting 0.5 m from upside and downside of each plot). After counting root numbers and weighing them, root brie sample of each treatment was sent to Sugar Beet Seed Institute for sugar content, impurities (potassium, sodium and amino N) and molasses sugar determination. Root and white sugar yields per unit area were estimated. Collected data were subjected to analysis of variance using SAS software and mean separation was performed by the Duncan test.

RESULTS

Assuming year as random effect, combined analysis of variance was done based on expected mean squares (Table 3). Results showed that year had significant effect (p<0.01) on root yield, bolting percentage, sugar content, impurities, alkaline

Table 3. Mean squares of combined analysis of variance for root yield and some qualitative traits of sugar beet in the experimental years 2005-08

S.O.V	df	Sum of squares										
		Root yield	Bolting	Impure sugar	Sodium	Potassium	Amino N	Alkaline coefficient	Extractable sugar	Extraction coefficient	Molasses sugar	White sugar yield
Y[†]	2	2868.65**	1018.30**	470.21**	185.60**	216.54**	248.23**	268.08**	492.53**	7487.01**	33.20**	83.47**
R (Y)	9	92.53	89.26	7.85	3.46	2.99	6.84	13.71	5.88	107.98	0.37	2.85
SD	2	4604.29**	4997.48**	21.26^{ns}	18.39*	8.49^{ns}	16.33^{ns}	0.69^{ns}	46.78^{ns}	454.24*	4.95^{ns}	96.13**
Y × SD	4	804.04**	161.57^{ns}	13.11^{ns}	2.65^{ns}	4.16**	8.26*	5.00^{ns}	18.57^{ns}	57.51^{ns}	1.21^{ns}	14.82**
R (Y × SD)	18	78.44	78.43	6.04	3.80	0.83	2.80	2.83	9.25	123.54	0.63	2.62
C	1	1.49^{ns}	54.22^{ns}	0.30^{ns}	3.80^{ns}	2.55^{ns}	1.27^{ns}	3.33^{ns}	0.22^{ns}	0.06^{ns}	0.06^{ns}	0.11^{ns}
Y × C	2	1.44^{ns}	46.27^{ns}	1.53^{ns}	0.66^{ns}	3.57*	2.54^{ns}	1.02^{ns}	1.00^{ns}	35.73^{ns}	0.43^{ns}	0.36^{ns}
SD × C	2	21.03^{ns}	91.27*	8.02^{ns}	2.76^{ns}	2.65^{ns}	1.52^{ns}	2.83^{ns}	11.70^{ns}	107.20^{ns}	0.60^{ns}	1.84^{ns}
Y × SD × C	4	26.65^{ns}	11.70^{ns}	3.93^{ns}	4.69^{ns}	3.42**	6.34**	1.17^{ns}	5.01^{ns}	51.82^{ns}	0.28^{ns}	1.70^{ns}
R (Y × SD × C)	27	30.26	38.48	3.93	2.64	0.85	1.03	1.97	4.38	41.96	0.30	1.16
HD	2	1115.00**	79.98^{ns}	6.99^{ns}	0.27^{ns}	0.53^{ns}	2.30^{ns}	1.72^{ns}	6.37^{ns}	24.44^{ns}	0.11^{ns}	8.96**
Y × HD	4	29.55*	22.67*	2.42^{ns}	0.46^{ns}	0.63^{ns}	0.52^{ns}	0.59^{ns}	2.62^{ns}	21.13^{ns}	0.15^{ns}	1.03^{ns}
SD × HD	4	7.15^{ns}	6.04^{ns}	0.59^{ns}	0.81^{ns}	1.17^{ns}	1.04^{ns}	1.77^{ns}	0.98^{ns}	3.47^{ns}	0.16^{ns}	0.28^{ns}
Y × SD × HD	8	11.370^{ns}	7.93^{ns}	0.93^{ns}	0.91^{ns}	1.42^{ns}	0.88^{ns}	1.24^{ns}	1.29^{ns}	14.98^{ns}	0.24^{ns}	0.46^{ns}
C × HD	2	1.38^{ns}	9.35^{ns}	3.21^{ns}	3.45^{ns}	1.34^{ns}	0.73^{ns}	0.33^{ns}	3.50^{ns}	33.15^{ns}	0.48**	0.60^{ns}
Y × C × HD	4	5.41^{ns}	6.04^{ns}	3.54^{ns}	0.63^{ns}	2.85^{ns}	0.35^{ns}	0.59^{ns}	2.51^{ns}	36.63^{ns}	0.02^{ns}	0.83^{ns}
SD × C × HD	4	0.82^{ns}	14.94^{ns}	2.	0.73^{ns}	0.97^{ns}	0.74^{ns}	1.50^{ns}	2.20^{ns}	32.40^{ns}	0.19^{s}	0.33^{ns}
Y × SD × C × HD	8	5.95^{ns}	7.86^{ns}	05^{ns}	2.07**	0.42^{ns}	1.59*	2.28^{ns}	3.26^{ns}	34.09^{ns}	0.21^{ns}	0.44^{ns}
Error	108	12.11	7.64	2.65^{ns} 1.52	0.85	0.93	0.72	131.60	200.68	2874.04	19.39	40.89
CV		8.93	31.04	8.76	20.24	12.81	20.83	29.18	14.44	7.61	10.52	16.39

ns=not significant, *p<0.05, **P<0.001

[†]Y: year; R: replication; SD: sowing date; C: cultivar; HD: harvest date

Table 4. Classification of average yield and yield components of sugar beet root in different years

Different years	Average traits										
	Root yield (t/ha)	Bolting (%)	Impure sugar (%)	Sodium / Potassium / Amino N			Alkalinity	Extractable sugar (%)	Extraction coefficient	Molasses sugar	White sugar yield (t/ha)
				Sugar beet root brie (meq/100 g)							
2005-06	31.835 b	12.221 a	14.703 b	3.372 b	7.805 b	4.063 b	2.915 b	11.034 a	78.339 a	3.348 c	3.662 b
2006-07	41.006 a	9.668 a	11.256 c	6.384 a	5.657 c	2.231 c	6.100 a	6.628 b	58.001 c	4.022 b	2.725 c
2007-08	43.934 a	4.817 b	16.247 a	3.913 b	9.080 a	5.944 a	2.333 b	10.941 a	66.858 b	4.706 a	4.873 a

Means with the same letter in each column are not significantly different (p<0.05)

coefficient, extractable sugar percentage, extraction coefficient of sugar, molasses sugar, and white sugar yield. The highest root yield (43.93 t/ha), sugar content (16.25%), and the lowest bolting percentage (4.82%) were achieved in the third year (2007-08) (Table 4, Fig. 1). White sugar yield in the year 2007-08 was 4.873 t/ha. Average quality traits are given in Table 4. The effect of sowing date on bolting percentage was significant (p<0.01) (Table 3). Sowing on 27 September had the highest bolting percentage (18.41%) and sowing on 17 October and 6 November had the lowest bolting percentage (5.42 and 2.87%, respectively) (Table 5). Cultivars Rasoul and BR1 had no significant difference for bolting percentage (Table 6). Sowing and cultivar interaction was significant for bolting percentage (p<0.05) (Table 3) but the effect of harvest date on bolting percentage was not significant (Table 3). The highest bolting percentage (9.96%) was in the harvest on 20 June (Table 5). Sowing and harvest date interaction had no significant effect on bolting percentage (Table 3). This test showed that early sowing had more significant effect on bolting emergence compared with different harvest dates and if sowing occurs earlier, bolting percentage would be higher which implies that increase in growth period may increase bolting percentage (Table 5). Results showed that sowing and harvest dates had significant effect on root yield (P<0.01) (Table 3). The highest yield (47.77 t/ha) was achieved in the sowing on 27 September and the greatest effect was from the late harvest on 20 June. Root yield for sowing on 17 October and 06 November was 36.69 and 32.21 t/ha, respectively (Table 5). Cultivars Rasoul and BR1 were placed in the same group for root yield (Table 3). Root yield of cultivars Rasoul and BR1 was 38.841 and 39.008 t/ha, respectively. Sowing and harvest date interaction was not significant for root yield (Table 3). Sowing

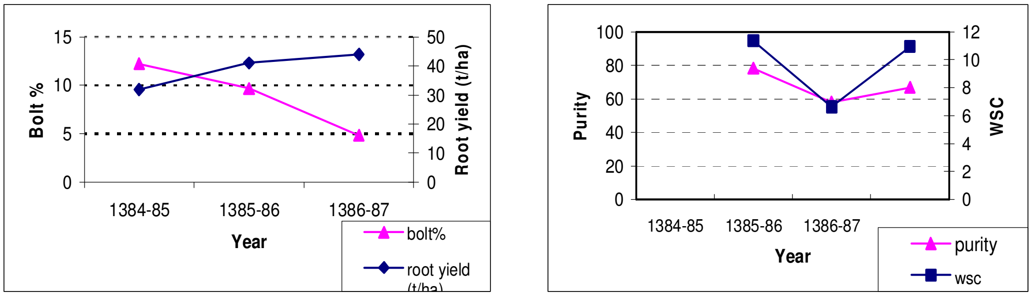

Fig. 1. Root yield variation, bolting percentage, white sugar content, and purity (extraction coefficient of sugar) degree in the experimental years

Table 5. Classification of average bolting percentage and root yield in different sowing and harvest dates

Harvest date	Harvest date							
	Bolting (%)			Average bolting (%)	Root yield (t/ha)			Average root yield (t/ha)
	30 April	26 May	20 June		30 April	26 May	20 June	
27 September	16.220 a	17.051 a	21.956 a	18.409 a	38.508 b	46.325 b	58.486 a	47.773 a
17 October	4.251 b	5.610 b	6.399 b	5.420 b	34.121 bc	36.490 bc	39.750 b	36.787 ab
6 November	3.097 b	3.988 b	1.537 b	2.870 b	33.085 bc	32.583 c	30.974 c	32.214 c
Mean	7.856 b	8.883 b	9.965 a		35.238 c	38.466 b	43.068 a	

Means with the same letter in each column are not significantly different (p<0.05)

Table 6. Classification of average bolting percentage of two sugar beet cultivars on different sowing dates.

Harvest date	Bolting (%)		Mean
	Rasoul	BR1	
27 September	16.280 a	20.538 a	18.409 a
17 October	4.520 b	6.320 b	5.420 b
6 November	4.420 b	1.348 c	2.870 b
Mean	8.400 a	9.402 a	

Means with the same letter in each column are not significantly different (p<0.05)

date had significant effect on extraction ($p<0.05$), sodium percentage ($p<0.05$) and white sugar yield ($p<0.01$) (Table 3). The highest sugar content, white sugar content, extraction percentage, and white sugar yield were achieved on 27 September (Table 7). Treatments interaction had no significant effect on sugar content (Table 3). No significant difference was observed between cultivars for the studied traits (Table 8). Harvest date had significant effect on white sugar yield ($p<0.01$) (Table 3). Harvest on 26 May and 20 June resulted in the highest sugar percentage (14.40%) and white sugar yield (4.06 t/ha), respectively. The means of other traits are listed in Table 9. Most interactions such as year × harvest date, sowing date × harvest date, harvest date × cultivar, and sowing date × cultivar × harvest date were not significant for the studied traits.

Discussion and Conclusion

Results of this study showed that qualitative and quantitative characteristics of sugar beet are affected by year. Bolting percentage was strongly influenced by sowing and harvest dates. Early (27 September) and late sowing had the highest and lowest bolting, respectively. Variation in climatic condition in different years caused a difference in the number of bolted plants. In the third year, bolting percentage was low but sugar and white sugar yields were high. Sowing date had signifi-

Table 7. Classification of average sugar content, impurities, alkaline coefficient, white sugar percentage, molasses sugar and white sugar yield on different sowing dates.

Sowing date	Sugar content	Impurities (meq/100g of sugar beet brie)			Alkalinity coefficient	Extractable sugar (%)	Extraction coefficient (%)	Molasses sugar (%)	White sugar yield (t/ha)
		Sodium	Potassium	Amino N					
27 September	14.696 a	4.042 a	7.118 a	3.563 a	3.685 a	10.569 a	70.593 a	3.727 b	5.059 a
17 October	13.746 b	4.575 a	7.728 a	4.172 a	3.780 a	9.207 b	66.721 ab	4.126 a	3.341 b
6 November	13.764 b	5.052 a	7.697 a	4.502 b	3.882 a	9.141 b	65.885 b	4.222 a	2.861 b

Means with the same letter in each column are not significantly different (p<0.05)

Table 8. Classification of average cultivars on white sugar yield and root yield components for the cultivars studied.

Cultivars	Sugar content	Impurities (meq/100g of sugar beet brie)			Alkalinity coefficient	Extractable sugar (%)	Extraction coefficient (%)	Molasses sugar (%)	White sugar yield (t/ha)
		Sodium	Potassium	Amino N					
Rasoul	14.031 a	4.689 a	7.405 a	4.002 a	3.907 a	9.607 a	67.749 a	4.008 a	3.730 a
BR1	14.106 a	4.424 a	7.623 a	4.156 a	3.658 a	9.671 a	67.710 a	4.042 a	3.777 a

Means with the same letter in each column are not significantly different (p<0.05)

Table 9. Classification of average white sugar yield and yield components in different harvest dates

Harvest date	Sugar content	Impurities (meq/100g of sugar beet brie)			Alkalinity coefficient	Extractable sugar (%)	Extraction coefficient (%)	Molasses sugar (%)	White sugar yield (t/ha)
		Sodium	Potassium	Amino N					
30 April	14.029 ab	4.628 a	7.613 a	4.236 a	3.738 a	9.594 ab	67.692 a	4.060 a	3.366 c
26 May	14.398 a	4.516 a	7.453 a	4.117 ab	3.654 a	9.956 a	68.334 a	4.033 a	3.838 b
20 June	13.779 b	4.526 a	7.476 a	3.884 b	3.955 a	9.366 b	67.171 a	3.983 a	4.056 a

Means with the same letter in each column are not significantly different (p<0.05)

cant effect on bolting percentage (p<0.01). The highest bolting percentage (18.41%) was in the sowing on 27 September whereas the lowest bolting percentages (5.42 an 2.87, respectively) were in the sowing dates on 17 October and 6 November. Assessments carried out in Moghan plain showed that all the studied lines and hybrids for bolting tolerance were highly sensitive to sowing date to the extent that early sowing caused 41% increase in bolting and thus, September sowing had superiority to August sowing (Moharamzadeh 2008). In regions with climatic conditions similar to Fasa, early sowing results in longer exposure of the plants to cold weather which may cause an increase in the number of bolted plants. In later sowing, this period is shorter, bolting percentage decreases, and the maximum yield can be only achieved in longer growing season without any limitation for plant growth. Studies on different sowing and harvesting dates at Safiabad in Dezful showed that early sowing resulted in an increase in root yield and sugar percentage, and in case that harvest was delayed more, root yield was higher. In Khuzestan, sugar beet strongly reacts to harvest date. In this region, sowing by mid-October caused an increase in root and sugar yield, and sowing by mid-September caused an increase in sugar content, while, with increase in the growing season period and delay in harvest, root yield and sugar content increased (Orazizadeh 1997; Sharifi 1996; 1997; 2002). Cultivars Rasoul and BR1 had no significant difference for bolting percentage. In climatic condition of Fasa, depending on the time of sowing, these two cultivars, more or less produced flowering stems. Therefore, in early sowing it is essential that cultivars have tolerance to bolting. Undesirable bolting phenomenon in sugar beet which is a limiting factor in autumn sowing of this crop was studied widely and resistant cultivars were developed, and also breeding of more resistant cultivars become possible (Longden and Thomas 1989; Sadeghian 1999). This study illustrated that the highest root yield (47.77 t/ha) was achieved in the sowing in September. A positive correlation was found between sowing date and yield. Rasoul and BR1 cultivars had no significant difference for root yield. However, in study by Ahmadi et al. (2005) on evaluation of commercial cultivars potential for autumn sowing in Khorasan province (sowing in September and harvest in May), significant difference was found among cultivars for root yield, white sugar, and bolting percentage. The highest sugar content, white sugar, extraction coefficient, and white sugar yield was belonged to sowing on 27 September. The highest white sugar yield (4.06 t/ha) was in the harvest on 20 June. Study on the effect of sowing and harvest dates on qualitative and quantitative characteristics of autumn-sown sugar beet in Izeh region of Khuzestan province showed that optimum time for sowing was from mid-October until mid-November. Early sowing may decrease qualitative and quantitative yield of sugar beet owing to the risk of bolting and in late sowing (December) due to the coincidence of sowing time with rainy season (Sharifi et al. 1996). Experiments done in warm regions of Fars province (at sugar factory area in Fasa) proved the potential of these areas for autumn sugar beet sowing (Ashrafmansoori 2006).

Recommendations

- Sowing on 27 September and harvest on 20 June is recommended due to the higher root and white sugar yields harvest.
- Cultivars considered for sowing in regions similar to Fasa should have more resistance to bolting than Rasoul and BR1 cultivars.
- Early sowing (27 September) with usage of resistant cultivars to bolting, will guarantee better quality and quantity.

References

Abshahi A. Investigation of sugar beet. Dezful irrigation project. Agricultural Research Centre Safiabad of Dezful. 1972. pp 23. (in Persian)

Ahmadi M, Taleghani F, Maleki M. Investigation of potential of commercial sugar beet varieties for fall planting in Khorasan Provience. 26th seminar of sugar beet factories in Mashhad-Iran.2005. (in Persian)

Alexander JT. Factors affecting quality. In. Johnson, R.T. Alexander, J. T., G. E. Rush and Hawkes, G. R. (Eds.). Advances in sugar beet production: Principals and practices in sugar beet, Iowa, State Univ. Press. Iowa. U.S.A. 1979; Pp. 80-92.

Ashrafmansoori GhR. Comparisons of qualitative and qualitative characteristics of domestic and foreign varieties of autumn sugar beet in Fasa. Proceeding of the 9th Crop Production and Plant Breeding Congress, Aug 27-29, Tehran, Iran. Aboureyhan Campus University of Tehran.2006. (in Persian)

Ashrafmansoori GhR. The effect of growth period and stage on quality and quantity of autumn sugar beet (*Beta Vulgaris L.*) in Fasa. Research project final report No. 89/443 .Fars Research Center for Agricultural and Natural Resources Publications.1997. pp 36 (in Persian)

Carter JN, Traveller DJ. Effect of time and amount of nitrogen uptake sugar beet growth and yield. Agron. J.1981; 73: 665 – 671.

Cook DA, Scott RK. The Sugar Beet Crop: Science in to Practice. In Persian by Faculty Members of SBSI. Karaj. Iran. 1998. 731p.

Gohari J. Effect of panting and harvesting time on quality and quantity of sugar beet in Moghan. Journal of Scientific-Technical Sugar beet. 1991. Vol. 8. pp15. (in Persian)

Halvorson A, Hartman GP. Response of several sugar beet cultivars to N fertilization yield and crown tissue production. Agron. J. 1980; 72: 665-669.

Hossain poor M. Effect of nitrogen management of irrigation water and period growth during on water and light use efficiency in winter sugar beet. Phd thesis, Tarbiat Modares Compose. 2007. (in Persian)

Ivanek V, Martinic M. Effect of harvesting date on the yield of roots and sugar of sown and trans planted sugar beet cultivars. Poljoprivredna Znastvena smotra 1989; 54(3-4): 167-178.

Jaggard KW, Werker AR. An evaluation of potential benefits and costs of autumn-sown sugar beet in NW Europe. J. of Agric. Sc. 1998,132:91-102.

Johnson RT, Alexander JT, Rush GE. Advance in sugar beet production: Principles and practices. Towa state uni. Press. Ames.1971; Pp: 3-15.

Joseph G, Lauer JG. Sugar beet performance and interactions with planting date, genotype, and harvest date. Agron. J.1997; 89: 469-475.

Koocheki A, Soltani A. The sugar beet crop. Press Mashhad University Jihad. 1997. pp 200. (in Persian)

Koocheki A. Agriculture in arid regions. Press Mashhad University Jihad. 1997. Vol. 2. pp 202. (in Persian)

Koulivand M.The sugar beet crop. Press and Cultural department of Shahid Beheshti University Jihad. 1988. pp 246. (in Persian)

Lee GS, Dunn G, Schmehl WR. Effect of date of planting and nitrogen fertilization on growth components of sugar beet. J. A. Soc. Sugar Beet Tech.1987; 24: 80-100.

Lexander K. Characters related to the vernalization requirement in sugar beet. In: J.C.Atherton (Ed). Manipulation flowering1987: 147-158. Butterworths, London.

Moharamzadeh M. Evaluation of sugar beet lines and hybrids for resistance to bolting. Final report .Sugar beet Seed Institute. 2008. (in Persian)

Nelson JM. Influence of planting Date. Nitrogen rate, and Harvest Date on yield and sucrose concentration of fall planted sugar beet in central Arizona. J. A. S. S. B. T.1978.

Orazizadeh MR. Determination of the most appropriate sowing date of seed of three monogerm cultivars of sugar beet for obtains the best plant density per hectar. Final report No. 7934 .Agricultural research center Safiabad of Dezful. 1997. (in Persian)

Sadeghian Motahar Y. Bolting, undesirable phenomenon in sugar beet. Promotional publication. Dissemination of agricultural education. 1999. No. 12. (in Persian)

Sharifi H, Orazizadeh MR, Gohari J. Possible investigation of autumn sugar beet cultivation in Izeh region. Final report of research project in Agricultural Research Center Safiabad of Dezfool. No. 9797. 1996. (in Persian)

Sharifi H, Orazizadeh MR. Investigation early varieties of sugar beet in Dezful. Final report of research project in Agricultural Research Center Safiabad of Dezful. No. 12178. 1996. pp 28. (in Persian)

Sharifi H. Effect of planting and harvesting time on the newly introduced varieties of sugar beet. Final report of research project in Agricultural Research Center Safiabad of Dezful. No. 87/45. 2002. (in Persian)

Sharifi H. Effect of planting date and different amount of nitrogen fertilizer during the growing season on the quality and quantity of winter sugar beet in Dezful. Final report of research project in Agricultural Research Center Safiabad of Dezful. No. 82/480. 1997. (in Persian)

Sharifi H. Final report of the research project in Agricultural research centre Safiabad of Dezful.1989. pp 58. (in Persian)

Shishegar M. Studies on suagr beet planting in Safiabad of Dezfool. Dez irrigation project. Agricultural Research Centre Safiabad. 1972. pp 15. (in Persian)