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Effects of different radicle sowing date and harvest date on quantity and quality of Shirin cultivar

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ABSTRACT

To determine proper radicle sowing and harvest date, an experiment was conducted in Ardabil Agricultural Research Station (Alarough) in 2003-04. Sugar beet variety Shirin was evaluated in split plot experiment based on randomized complete block design with four replications. The treatments consisted of four sowing dates including 5th March, 20th March, 4th April and 19th April in main plots, and four harvest dates including 15, 30, 45 and 60 days after 50% flowering stage in subplots. The maximum number of main stem (2.7 per plant), lateral stem (42.4 per plant) were recorded on second and first sowing dates. Plant height decreased from 128.03 cm in first planting to 106.5 cm in fourth planting. Plant dry weight on first, second, third, and fourth sowing dates was 389.6, 409.14, 344.9 and 300.9 g/plant, respectively. The highest seed yield and standard seed extraction coefficient was obtained in first planting date. Harvest date had significant effect on seed yield, seed size, and unfilled grain. Harvest at 45 days after flowering resulted in significant increase seed yield (2735.8 kg/ha) and 3.5-4.5 seed size percentage. Also, the highest rate of unfilled grain (%17.2) was obtained at first harvest date. It is recommended that to plant sugar beet radicle at first sowing date and seeds harvested 45 days after flowering.

Keywords: harvest date, morphological properties, sowing date, seed quantity, seed quality, radicle, sugar beet

INTRODUCTION

Seed quality is one of the most important characteristics for root yield determination in sugar beet. Achieving the principles and techniques of sugar beet seed production especially for monogerm seed can be so beneficial for seed producers. Ardabil climatic condition provides the ecological needs for sugar beet cultivation and has long been considered for commercial seed production. From the ecological point and in order to minimize damage, sugar beet seed production is carried out in regions with cold winter (sufficient for vernalization) and in which freezing does not last for a long period. Long days in spring (at least 16 hours) and summer is the outmost importance for stem growth and flower formation. Since sugar beet is an autogamous plant, wind has important role in inoculation of flowers at pollination. Arid climate, raining, and low temperature at pollination and seed formation influence the seed quality. Arid climate and high humidity cause uniform seed ripening and low temperature (below 9 °C) increases sensitivity to bolting in root of next year crop. Sowing date may cause changes in both vegetative and reproductive growth by accommodating different growth stages with climatic conditions. Proper sowing date resulted in achieving higher performance compared with other sowing dates (Khajehpor 1997). Kew and Mirand (1978) study showed that early radicle sowing had a remarkable impact on seed quantity and quality. Early radicle sowing in spring will cause the development of root system, rapid stem growth, stem elongation, greater flowering and increase in seed

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Table 1. Distribution of temperature and rainfall in 2004-05.

		March	April	May	June	July	August	September	October
Rainfall (mm)	2004	11	14.6	19	21.7	24	26.2	23	22.6
	2005	-	12	19.8	22.4	24.2	27.9	23.2	-
Maximum temp (°C)	2004	0.6	-2	7.1	8	12.2	12.6	10	6
	2004	-	0.2	7.4	8.6	12	12.6	10.3	-
Minimum temp (°C)	2004	11	14.6	19	21.7	24	26.2	23	22.6
	2004	-	12	19.8	22.4	24.2	27.9	23.2	-

yield (Faoro *et al*. 1985). Podalski (1987) indicated that delay in sowing from the first decade of May to early June in Ukraine resulted in seed yield reduction from 1.26 to 1.40 t/ha and also reduction in 1000 grain weight from 13.8 to 13.2 g. Sadeghzadeh Hemaiaty (2001) reported that in Ardabil region, with delay in sowing from about the second half of March to the first and second half of April, the gross seed yield (1235.09 kg/ha) decreased by 19.5 and 44.4%, respectively, and seed pure yield decreased from 880.15 kg/ha in the second half of March to 675.6 and 476.36 kg/ha in the first and second half of April, respectively. He also reported that delay in sowing caused delay in sugar beet phenological growth and increase in the probability of coincidence between reproductive stage and unfavorable environmental conditions (high temperature and low relative humidity). Lack of synchronization between vegetative and reproductive growth stages in maternal parent and unlimited reproductive growth in sugar beet, makes it difficult to determine the proper harvest date. Ideal harvest time is at seed physiological maturity. In addition to physiological maturity, harvest should be done when the maximum seed yield is achievable and the seed quality is acceptable. Therefore, early seed harvest will cause decrease in vigour and yield owing to seed immaturity and small seed size. Late harvest will cause reduction in yield as a result of seed loss (Cook and Scoot 1993). In order to achieve high yield, harvest should be done when grains located on top rachides have reached maturity and only a small number of mature seeds are shattered. Seed shattering can be tested by shaking seedling at intervals for one or two days. Harvest tests and practical experiences have shown that seed maturity occurs when larger seeds in one third of the bottom seeds turn into brown and embryo completes milky stage. Seed color has correlation with seed coat dry matter. Most of the green seeds are still in milky stage and with increase in dry matter, their coat becomes brown. Therefore, seed maturity is determined with respect to seed color, seed texture, embryo, and seed shattering rate (Cook and Scoot 1993). When 50% of the seeds located on primary rachides turned brown, it's a proper time for harvest. At this time, seed has powdery characteristic and the seed coat color is red to brown. Grimwade *et al*. (1987) showed that 20 days after pollination, sugar beet seeds were capable for germination but seed maturity was achieved 55 days after inoculation (after receiving 500 units temperature). During seed maturity, dry matter increases and in general, seeds with 55-60% dry matter have the highest germination percentage. Sroller (1991) reported that harvest at several different dates together with seed maturity increased yield, vigour, and seed bunch weight compared with one time harvest. Due to specific climatic condition of Ardabil region and the necessity of seed production with high quality and quantity, determination of the best radicle sowing and seed harvest date is necessary.

MATERIALS AND METHODS

This study was conducted in Ardabil Agricultural and Natural Resources Research Station (Alargh) in 2004-05 (12 km south of Ardabil). It has a semi-arid cold climate with altitude of 1350 m above sea level (Longitude 48^o 28´E and Latitude 38^o 15´N). Average temperature and rainfall during the growing season are summarized in Table 1.

Experiment was carried out in split plot design in randomized complete block design arrangement with four replications. The treatments consisted of four sowing dates including 5th March, 20th March, 4th April and 19th April in main plots, and four harvest dates including 15, 30, 45 and 60 days after 50% flowering stage in subplots. Each subplot constituted 6 sowing rows (2 side rows as parental and four inside rows as maternal) with 6 meter length and 65 cm row distance. Radicle distance was 50 cm (3.08 plants per m^{-2} density). In this study a diploid cultivar, Shirin (hybrid 191) was used. This cultivar has been registered in OECD list in 1999. After normal tillage in autumn, phosphorous fertilizer was applied and experimental field was leveled using disc together with furrow creating (65 cm row spacing). In late winter and early spring, radicles were taken out from silo and after separating, intact roots with 70-100 g weight were planted on pre-determined dates. Immediately after sowing, irrigation was conducted for root establishment. After emergence, thinning and soil adding were performed and nitrogen fertilizer added in each thinning stage. For morphological trait measurement such as main and lateral stems, seed dry matter, seed yield per plant, and total dry matter, five plants per plot were randomly selected and in laboratory, main and lateral stem number was counted. Main stem diameter was measured from 10 cm above crown of the tallest stem. Seed, leaf and stem dry matter and fresh weight were measured, and samples were dried at 75 °C for 48 h in an oven. Qualitative and quantitative traits such as raw seed yield, 3.5-4.5 mm round seed yield (Ø), 3.5 mm or above 4.5 mm round seed (Ø) percentage, 2.25-3.2 mm seed percentage (≠, standard), unfilled grains, 1000 grain weight, and vigour were measured in Seed Control Laboratory. Vigour was measured according to ISTA guidelines. Data were analyzed using SAS software and mean data were compared by LSD test at the 5% level.

RESULTS AND DISCUSSION

Plant morphology

ANOVA results for both years (2004-05) showed that sowing date had significant effect on main stem number (*P* < 0.01) but sowing × harvest date interaction was not significant (Table 2). Results showed that early radicle sowing caused an increase in main and lateral stem number. Combined analysis results showed that main stem number per plant in different years was significant (*P* < 0.01) so that the highest (2.88) and lowest (2.06) main stem number was obtained in sowing on 20th March and 18th April in 2004, respectively and in 2005, sowing on 5th March had the highest number (2.6) of main stem per plant (Table 3). Results of combined analysis comparison showed that average number of main stems in first sowing date was significantly higher than other dates (*P* < 0.01, Table 4 and 5).

Sowing date had significant (*P* < 0.01) effect on lateral stem number in both years (Table 2) with the highest number achieved on 5th March (Table 3). Combined analysis of variance results showed that lateral stem number was different in each

Table 2. Mean squares of morphological traits in 2004 and 2005

S.O.V.	df	Mean square													
		Main stem number		Lateral stem number		Plant height		Leaf dry matter		Stem dry weight		Seed dry weight		Total dry weight	
		2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Replication (r)	3	0.52	0.27	15.31	61.83	174.75	131.06	136.46	175.8	17707.6	814.86	1674.3	264.3	30873.78	1033.69
Sowing date (a)	3	1.93**	4.73**	210.19**	520.57**	1095.75**	2474.1**	137.5*	207	8236.37**	142265.7**	14909.0**	2702.11**	50140.54**	32063.6**
Error (a)	9	0.267	0.19	30.21	19.45	51.51	197.34	131.77	122.92	1117.42	1622.4	479.44	1155.67	1237.57	5087.7
Harvest date (b)	3	0.88*	0.27	48.46	106.31	23.71	85.37	3147.9**	3586.4**	2323.05**	7649.9**	6740.7**	10850.9**	9364.46**	18867.5**
a × b	9	0.36	0.087	27.69	10.94**	40.7	148.15	99.76*	136.4	285.14	880.69	719.54**	230	153147*	1306.4
error (b)	36	0.173	0.15	18.34	14.37	44.31	184.4	42.96	344	242.37	628.4	225.3	488.9	582.2	1660.97
CV (%)		16.47	17.87	10.88	10.86	5.55	11.49	13.22	33.43	8.24	12.2	13.5	19.8	6.9	10.94

*,** are significant at 5 and 1% probability level, respectively.

Table 3. Mean comparison of morphological traits in different sowing and harvest dates (2004-05)

Treatment		Main stem number		Lateral stem number		Plant height (cm)		Leaf dry matter (g/plant)		Stem dry weight (g/plant)		Seed dry weight (g/plant)		Total dry weight (g/plant)	
		2004	2005	2004	2005	2004	2005	2004	2004	2005	2004	2005	2004	2005	2004
Planting	5th March	2.65 a	2.6 a	43.58 a	41.24 a	127.088 a	128.98 a	50.16 a	59.1 a	193.18 ab	231.72 a	119.85 b	125.23 a	363.18 b	416.05 a
	20th March	2.88 a	2.53 a	41.24 a	37.7 a	126.613 a	127.63 ab	52.77 a	57.01 a	216.66 a	230.75 a	144.4 a	118.54 ab	413.87 a	404.42 a
	3rd April	2.5 a	2.05 b	36.32 b	32.32 b	115.03 b	117.25 b	49.69 a	55.13 a	184.07 bc	182.35 b	109.69 b	107.03 ab	343.44 b	346.39 b
	18th April	20.6 b	1.42 c	36.38 b	28.35 c	110.67 b	102 c	67.45 a	50.66 a	161.84 c	179.97 b	71.03 c	95.73 b	278.55 c	323.36 b
LSD (0.05)		0.43	0.349	4.396	3.53	5.74	11.23	9.18	8.87	26.73	32.22	17.51	27.19	28.136	57.05
Harvest	15 days after 50% flowering	2.2 b	1.69 b	37.11 b	31.8 b	120.76 a	117.45 a	66.22 a	74.93 a	174.7 c	181.87 b	84.76 d	78.73 c	325.7 c	335.23 b
	30 days after 50% flowering	2.51 a	2.17 a	38.99 ab	35.9 a	120.68 a	117.06 a	54.86 b	57.6 b	184.6 bc	192.2 b	119.88 b	103.17 b	359.3 b	352.98 b
	45 days after 50% flowering	2.66 a	2.23 a	41.07 a	37.8 a	119.84 a	117.42 a	43.3 c	50 bc	202.83 a	223.6 a	132.99 a	135.84 a	379.14 a	409.45 a
	60 days after 50% flowering	2.7 a	2.23 a	40.3 a	36 a	118.14 a	122.34 a	33.9 d	39.36 c	193.6 ab	224.4 a	107.4 c	128.78 a	334.87 c	392.57 a
LSD (0.05)		0.298	0.276	3.07	2.72	4.77	9.81	4.7	13.3	11.16	17.97	10.76	15.86	17.3	29.22

Means with the same letter in each column are not significantly different.

year and sowing date had significant effect on it ($P < 0.01$). The highest (42.4) and lowest (32.36) number of lateral stem were recorded on 5th March and 18th April, respectively (Table 3). Sowing date had significant effect on plant height so that the highest and lowest plant height was recorded on 5th March and 18th April, respectively. Combined ANOVA results also showed that sowing date had significant effect on plant height so that the plant height on first, second, third, and fourth sowing dates was 128.03, 127.12, 116.14, and 106.5 cm, respectively (Table 5). Sowing date had only significant ($P < 0.05$) effect on leaf dry matter in 2004. Sowing date × harvest date interaction was not significant (Table 2). The highest and lowest leaf dry matter was recorded on 5th march and 18th April, respectively (Table 3). Combined analysis results showed that sowing date had significant effect on leaf dry matter (Table 4) and sowing on 5th March recorded the highest leaf dry matter (Table 5). Sowing and harvest dates had significant effect on stem dry weight but their interaction was not significant (Table 2) and the highest stem dry weight was achieved at 1st, 2nd, 3rd, and 4th planting dates (Table 3). In combined analysis results, the stem dry weight at 1st, 2nd, 3rd, and 4th sowing dates was 212.4, 223.7, 183.2, and 169.4 g $plant^{-1}$, respectively and at 1st, 2nd, 3rd, and 4th harvest dates was 178.14, 188.4, 213.2, and 209.01 g $plant^{-1}$, respectively (Table 5). Effects of sowing and harvest date on seed dry weight was significant but their interaction was not significant (Table 2). Mean comparison showed that the highest seed dry weight was recorded on early planting dates and also at third harvest date (45 days after flowering, Table 3). Combined analysis results of two years experiment (Table 4) confirmed the annual analysis results and showed that seed dry weight at 1st, 2nd, 3rd, and 4th sowing date was 122.53, 131.5, 108.4, and 83.4 g $plant^{-1}$, respectively and at 1st, 2nd, 3rd, and 4th harvest date was 81.74, 111.5, 134.42, and 118.08 g $plant^{-1}$, respectively (Table 5). Both sowing and harvest dates had significant effect on total dry weight in both years (Table 2) with early sowing dates having higher rates (Table 3). Similar results were obtained by combined analysis (Table 4). Mean comparison of the combined analysis results showed that total dry weight at 1st, 2nd, 3rd, and 4th sowing date was 389.62, 409.14, 344.92, and 300.96 g $plant^{-1}$, respectively and at 1st, 2nd, 3rd, and 4th harvest date was 330.4, 365.16, 394.3, and 363.72 g $plant^{-1}$, respectively with higher total dry weight at 1st and 2nd sowing date. In this study, with delay in

Table 4. Mean square of combined ANOVA for morphological traits (2003-05)

S.O.V.	Df	Main stem number	Lateral stem number	Plant height	Leaf dry matter	Stem dry weight	Seed dry weight	Total dry weight
Year	1	4.42^{**}	639.9^{**}	19.7	1116.87^{*}	8722.07^{**}	4.54	16626.2^{**}
Error	6	0.39^{*}	38.57^{*}	150.9	156.14	9261.23^{**}	969.3^{*}	15948.7^{**}
Planting date (a)	3	6.2^{**}	682^{**}	3308.64^{**}	278.96	20299.55^{**}	14101.66^{**}	47677.5^{**}
Year × planting date	3	0.48^{*}	48.8^{*}	201.2	65.57	2202.5^{*}	3509.5^{**}	7526.6^{*}
Error	18	0.23	24.8	124.4	127.34	1369.9^{**}	817.55^{*}	3162.7^{*}
Harvest date	3	1.06^{**}	148.3^{**}	16.9	6684.25^{**}	8918.35^{**}	15510.45^{**}	22098.2^{**}
Year × harvest date	3	0.094	6.4	92.2	50.07	1054.6	2081.14^{*}	6133.8^{*}
Planting date × harvest date	9	0.27	23.5	100.24	118.9	1054.6	435.05	1389.5
Year × planting date × harvest date	9	0.18	15.16	88.6	117.27	516.9	514.5	1448.4
Error	72	0.16	16.39	115.85	193.5	435.38	357	1121.59
CV		17.12	10.89	9.01	26.48	10.58	16.95	9.27

*,** are significant at 5 and 1% probability level, respectively.

Table 6. Mean squares of seed quality and quantity traits in two-years (2004-05)

S.O.V.	df	Seed yield	3.5 mm round seed (%)	3.5-4.5 mm round seed (%)	Above 4.5 mm round seed (%)	2.25-3.25 mm round seed (%)	Vigour (%)	1000 grain weight
Year	1	41009292.4^{**}	71606^{**}	839.2^{**}	891^{**}	4.2	29.07	0.095
Error	6	2264293.05^{**}	71.5^{*}	80.4^{**}	119^{**}	243.4	3.3	0.156
Sowing date (a)	3	61733447.4^{**}	1288^{**}	518.7^{**}	925.14^{**}	1220.3^{*}	210.2^{**}	0.63^{*}
Year × sowing date	3	1882974.7^{**}	183.9^{**}	155.2^{**}	18.5	100.46	185.1^{**}	0.52^{*}
Error	18	432518.3^{**}	108^{**}	57.07^{**}	68.64^{**}	57250	39.23^{*}	0.223
Harvest date	3	5896498.94^{**}	2197.7^{**}	792.34^{**}	1373.8^{**}	254.2	663.9^{**}	7.81^{**}
Year × harvest date	3	400557.3^{*}	22.5	48.16	8.9	268.3	266.4^{**}	1.6^{**}
Sowing date × harvest date	9	191311.82	18.5	10.72	23.2	237.5	15.9	0.21
Year × sowing date × harvest date	9	118803.13	12.56	11.89	27	237.5	13.45	0.147
Error	72	110949.3	28.6	20.75	16.96	219.5	14.96	0.189
CV		14.35	17.58	14.5	17.5	64.5	4.47	4.6

*,** are significant at 5 and 1% probability level, respectively.

sowing, main and lateral stem number, plant height, and total dry weight were decreased which are similar to other studies (Ghalibaf *et al*. 2000). Therefore, owing to vegetative growth period reduction in late sowing, main and lateral stem elongation were reduced and flowering time coincided with heat and warm wind which resulted in grain yield reduction. Early sowing increased the lateral stem number, leaf production, photosynthetic materials, stem dry matter, and total dry weight (Haj Mohammadnia Ghalibaf *et al*. 2000). Delay in harvest caused dry matter increase especially in stem weight and continued until 3rd harvest date and decreased by leaves drying. Higher stem dry weight was probably due to a greater number of main and lateral stems and as the flowers were formed on lateral stems, higher lateral stem number increased sample dry weight (Durant and Loads 1990). With delay in harvest, leaf dry weight reduced. Same results were also reported by other researchers (Pod laski 1987; Kew and Mirand 1978). Ranji *et al*. (1996) also reported that delay in sowing reduced sugar beet production.

B- Seed quantitative and qualitative traits

Two years mean comparison showed that different sowing and harvest dates had significant effect ($P < 0.01$) on seed yield. First year × harvest date effect was also significant ($P < 0.05$, Table 6) which indicates that the effects of year and harvest date on seed yield were variable. Mean comparison of the seed yield showed that with delay in sowing, seed yield decreased and at 3rd harvest (45 days after 50% flowering), the highest yield was achieved (Table 7). Seed yield at 1st, 2nd, 3rd, and 4th sowing dates was 2762.7, 2597.4, 2116.43, and 1805.8 Kg/ha and at 1st, 2nd, 3rd, and 4th harvest dates was 1760.4, 2225.6, 2735.88, and 2560.48 Kg/ha (Table 8). Both sowing and harvest dates had significant effect ($P < 0.01$) on 3.5-4.5 mm round seed percentage (Table 6). Early harvest decreased 3.5-4.5 mm round seed percentage so that it decreased from 24.8% (harvest on 15 days after 50% flowering) to 36.34% (harvest on 45 days after 50% flowering) (Table 7). ANOVA results showed that the 3.5 mm and above 4.5 mm round seed percentage were influenced by sowing and harvest dates (Table 6) so that with delay in sowing and by early harvest, 3.5 mm

Table 5. Mean comparison of morphological traits in different sowing and harvest dates (2004-05)

Treatment		Main stem number		Lateral stem number		Plant height (cm)		Leaf dry matter (g/plant)		Stem dry weight (g/plant)		Seed dry weight (g/plant)		Total dry weight (g/plant)	
		2004	2005	2004	2005	2004	2005	2004	2004	2005	2004	2005	2004	2005	2004
Planting	5th March	2.625 a	42.4 a	128.03 a	54.6 a	212.44 b	122.53 b	389.62 b	2.625 a	42.4 a	128.03 a	54.6 a	212.44 b	122.53 b	389.62 b
	20th March	2.7 a	39.48 b	127.12 a	53.95 a	223.7 a	131.5 a	409.14 a	2.7 a	39.48 b	127.12 a	53.95 a	223.7 a	131.5 a	409.14 a
	3rd April	2.27 a	34.32 c	116.14 b	53.35 a	183.2 c	108.4 c	344.92 c	2.27 a	34.32 c	116.14 b	53.35 a	183.2 c	108.4 c	344.92 c
	18th April	1.74 b	32.36 d	106.5 c	48.17 b	169.4 d	83.4 d	300.96 d	1.74 b	32.36 d	106.5 c	48.17 b	169.4 d	83.4 d	300.96 d
LSD (0.05)		0.413	0.679	0.685	1.82	2.357	2.53	3.202	5.68	0.679	0.685	1.82	2.357	3.53	3.202
Harvest	15 days after 50% flowering	2.08 a	34.47 d	119.1 a	70.57 a	1748.14 d	81.74 d	330.4 d	2.08 a	34.47 d	119.1 a	70.57 a	178.14 d	81.74 d	330.4 d
	30 days after 50% flowering	2.34 a	36.47 c	119.86 a	56.23 b	188.4 c	111.5 c	356.16 c	2.34 a	36.47 c	119.86 a	56.23 b	188.4 c	111.5 c	356.16 c
	45 days after 50% flowering	2.45 a	39.43 a	118.6 a	46.7 c	213.2 a	134.42 a	394.3 a	2.45 a	39.43 a	118.6 a	46.7 c	213.2 a	134.42 a	394.3 a
	60 days after 50% flowering	2.48 a	38.2 b	120.2 a	36.62 d	209.01 b	118.08 b	363.72 b	2.48 a	38.2 b	120.2 a	36.62 d	209.01 b	118.08 b	363.72 b
LSD (0.05)		0.68	0.685	1.82	2.36	3.53	3.202	5.67	0.68	0.685	1.82	2.36	3.53	3.202	5.67

Means with the same letter in each column are not significantly different.

Table 7. Mean comparison of seed quality and quantity in different sowing and harvest dates (2004-05)

	Treatment	Seed yield (Kg/ha)	3.5 mm round seed (%)	3.5-4.5 mm round seed (%)	Above 4.5 mm round seed (%)	2.25-3.25 mm round seed (%)	Vigour (%)	1000 grain weight
Sowing date	5th March	2762.7 a	25.03 c	34.53 a	28.52 a	30.93 a	88.8 a	9.35 b
	20th March	2597.4 a	25.03 c	34.77 a	27.09 a	24.64 b	88.25 a	9.62 a
	3rd April	2116.43 b	33.34 b	29.6 b	21.86 b	19.02 bc	85.4 b	9.4 ab
	18th April	1805.8 c	37.97 a	26.46 c	16.7 c	17.25 c	83.34 c	9.3 b
LSD (0.05)		166	2.66	2.27	2.05	7.38	1.92	0.216
Harvest date	15 days after 50% flowering	1760.4 d	41.48 a	24.8 d	15 c	21.27 a	79.7 b	8.68 b
	30 days after 50% flowering	2225.6 c	31.9 b	30.49 c	21.8 b	20.89 a	88.12 a	9.68 a
	45 days after 50% flowering	2735.88 a	22.9 c	36.34 a	29.14 a	27 a	88.25 a	9.69 a
	60 days after 50% flowering	2560.48 b	25.4 c	33.75 b	28.2 a	22.65 a	89.75 a	9.63 a
LSD (0.05)		166	2.66	2.27	2.05	7.38	1.92	0.216

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

round seed percentage increased and for above 4.5 mm seed size, the percentage decreased. With delay in sowing from 5th March to 18th April, 3.5 mm round seed percentage increased from 25.03 to 37.97 and for above 4.5 mm seed size, it decreased from 28.52% to 16.7% (Table 7). Sowing date had significant effect on 2.25-3.25 mm round seed percentage (standard seed) ($P < 0.05$) with 1st and 4th sowing date having the highest (30.93%) and lowest (17.25%) standard seed. The highest standard seed percentage was achieved at 45 days after 50% flowering harvest (Table 7). Sowing date had significant effect ($P < 0.05$) on vigour percentage in 2004. Harvest date in both years had significant effect on vigour percentage and harvest at 60 days after 50% flowering resulted in the highest vigour percentage in both years (Table 7). Similar to vigour percentage, sowing date had only significant effect on 1000 grain weight in 2005 but harvest date influenced 1000 grain weight trait in both years. Combined ANOVA results had correlation with annual results (Table 7). These results are similar to Kew and Mirand (1978) and Ranji *et al*. (1996), who also pointed out that with delay in sowing, seed quality and quantity decreased. Proper sowing date is important for the achievement of maximum yield since it influences both vegetative and reproductive growth stages (Pod laski and Chrobak 1980). Too many factors influencing the inconsistency of both vegetative and reproductive growth stages and most of the time plants do not follow uniform maturity. In this study, with delay in harvest, seed yield increased but with more delay, yield decreased. Our results support Wu and Salunke (1976) results. The extension of seed growth duration and proper environmental condition decreased 3.5 mm round seed percentage. Negative correlation was found between vigour percentage and unfilled grain percentage. Delay in sowing increased significantly unfilled grain percentage and decreased vigour percentage. In late sowing, the coincidence of pollination and seed formation with high temperature resulted in pollen infertility and impaired ovule growth (Gizbullin 1984). In early harvest, due to insufficient opportunity for material transportation into seed, unfilled grain percentage increased. Csapody (1980) reported that the coincidence of sugar beet flowering with unfavorable temperature and humidity resulted in unfilled grain percentage increase. With delay in harvest, 1000 grain weight increased but with more delay together with dryness and respiration, 1000 grain weight decreased (Pod laski and Chrobak 1980). At maturity, 1000 grain weight increased and on 55 days after pollination it reached its maximum level (Grimwade *et al*. 1987). Favourable environmental condition at flowering stage increased 1000 grain weight (Csapody 1980). In this study, treatments which had higher 1000 grain weight, were also had higher vigour. As far as the seeds become heavier and richer in terms of materials, the embryos will growth better and vigour will increase. Delay in sowing from first decade of May to early June (in Ukraine) decreased seed yield (1.62 to 1.40) and 1000 grain weight (13.8 to 13.2) (Pod laski 1987).

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