

## SEED YIELD AND OIL CONTENT OF SAFFLOWER AS AFFECTED BY GENOTYPES AND SOWING DATES

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### ABSTRACT

The experiment was conducted at two locations; Grdarasha and Sumail of Erbil and Duhok governorates respectively, in Kurdistan region, during spring season 2013 and winter season 2013-2014 to study the effect of sowing dates on seed yield and oil content of safflower genotypes. A split-plot arrangement in a randomized complete block design was used with three replicates; sowing dates were assigned to main plots and genotypes to sub-plots. The results revealed that the first sowing date of spring (April 11<sup>th</sup>) and winter (November 13<sup>th</sup>) seasons produced the highest seed yield 1277.6 and 1583.7 kg ha<sup>-1</sup> in spring season and 2676.5 and 1904.2 kg ha<sup>-1</sup> in winter season at Grdarasha and Sumail locations respectively. In winter season; Rabee 500 genotype at Grdarasha location and Aurduny genotype at Sumail location surpassed other genotypes in seed yield (2246.7 and 1636.2 kg ha<sup>-1</sup>). In spring season; seeds of early date (April 11<sup>th</sup>) and Aurduny genotype were characterized by recording the highest oil percentage (30.28 and 29.58%) at Grdarasha location and (31.81 and 31.77%) at Sumail location respectively. In contrast, in winter season the fourth sowing date and G2018 genotypes seeds were characterized by the highest oil percentage (28.62 and 29.13%) at Grdarasha location and (29.11 and 28.14%) at Sumail location.

Keywords: seed yield, oil yield, spring seeding, winter seeding.

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حاصل البذور ومحتوى الزيت للعصفور بتأثير التراكيب الوراثية ومواعيد الزراعة

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المستخلص

اجريت التجربة في موقعين؛ كردهرشه وسميل التابعين لمحافظة اربيل ودهوك على التوالي /اقليم كردستان خلال الموسم الربيعي 2013 والموسم الشتوي 2013-2014 لدراسة تأثير مواعيد الزراعة على حاصل البذور ومحتوى زيت التراكيب الوراثية لمحصول العصفور. استخدم ترتيب الالواح المنشقة في تصميم القطاعات الكاملة المعشاه وبثلاثة مكررات، خصصت مواعيد الزراعة الى الالواح الرئيسية والتراكيب الوراثية الى الالواح الثانوية. أظهرت النتائج بان الموعد الاول للموسم الربيعي والشتوي انتجت أعلى حاصل البذور (1277,6 و 1583,7 كغم. ه<sup>-1</sup>) في الموسم الربيعي و(2676,5 و 1904,2 كغم. ه<sup>-1</sup>) في الموسم الشتوي للموقعين كردهرشه وسميل على التتابع. في الموسم الشتوي؛ تفوق التركيب الوراثي ربيع 500 للموقع كردهرشه واردني للموقع سميل على بقية التراكيب الوراثية في حاصل البذور (22,46,7 و 1636,2 كغم. ه<sup>-1</sup>). في الموسم الربيعي؛ حصلت أعلى نسبة للزيت (29.58%) للموقع كردهرشه على نقيض ذلك، في الموسم الشتوي؛ إتسمت بذور الموعد الرابع والتركيب الوراثي G2018 بأعلى نسبة زيت (28.62 و 29.13%) للموقع كردهرشه و(28.14 و 29.11%) للموقع سميل.

كلمات مفتاحية : حاصل البذور، حاصل الزيت، زراعة ربيعية وشتوية.

**INTRODUCTION**

Safflower (*Carthamus tinctorius* L., Asteraceae) is one of the most valuable oil crops, and the by product meal after oil extraction is used for animal feed, since it is rich in protein. Growth traits of safflower and seeds yield are affected by various factors such as genotype, environment and agronomic practices. Among the agronomic practices affecting yield is sowing date, which is associated with changing day length and temperature. The choice of the appropriate sowing date is one of the key points in crop management to obtain high yield quantity and quality. Several studies in safflower revealed that seed yield and oil content were affected by sowing dates (spring or winter) and cultivars. Moghanlou et al. (12) found that sowing on May 8<sup>th</sup> produced the highest seed yield (5144 kg ha<sup>-1</sup>), while Badri et al. (2) showed that sowing on March 16<sup>th</sup> produced the highest seed yield (1558.7 kg ha<sup>-1</sup>). The results of Emami et al. (6) and Mohamadzadeh et al. (14) reported that sowing dates on November 5<sup>th</sup> and December 6<sup>th</sup> at Iran produced the highest seed yield (1877.7 and 1225.0 kg ha<sup>-1</sup>) respectively. Sowing date can be a major factor that affects oil content at the time of

seed development (15). Khoulenjani et al. (9) showed that May 19<sup>th</sup> recognized better because of oil content compared to April 18<sup>th</sup> sowing date. There is little information about spring and winter sowing dates of the crop, especially under climatic conditions of Kurdistan region environment. The objective of this study was to evaluate the effects of sowing dates on yield and oil content of three safflower genotypes.

**MATERIALS AND METHODS**

The experiment was carried out at two locations at Kurdistan region; Grdarasha, the Research Station of College of Agriculture-University of Salahaddin (Latitude 36° 07' N, and Longitude 44° 01' E, 411 masl), which is located 5 km south of Erbil governorate. Sumail, farm of Faculty of Agriculture - University of Duhok (Latitude 36° 84' N, and Longitude 40° 01' E, 411 583 masl), which is located 15 km west of Duhok governorate. This experiment was performed at two growing seasons; spring 2013 and winter of 2013-2014 to evaluate the effect of sowing dates on growth, yield and quality of safflower genotypes. The soil samples were taken at 0-30 cm depth and their chemical and physical properties were analyzed as shown in table 1.

**Table 1. Some chemical and physical properties at two locations (Grdarasha<sup>1</sup> and Sumail<sup>2</sup>)**

Location	PSD			Soil texture	pH	EC (ds m <sup>-1</sup> )	O.M (g kg <sup>-1</sup> )	Total N (g kg <sup>-1</sup> )	P (mg kg <sup>-1</sup> ) soil	Soluble Cations K <sup>+</sup> (m mole L <sup>-1</sup> )
	Clay (%)	Silt (%)	Sand (%)							
Grdarasha	45.0	42.5	12.5	Silt clay	7.42	0.2	10.9	0.18	3.75	0.10
Sumail	48.8	46.4	4.8	Silt clay	7.97	0.3	15.0	1.12	4.01	0.14

1-The soil properties tests were conducted at the Directorate of Agriculture Research Center, Ankawa /Erbil

2- The soil properties tests were conducted at the Laboratory of Soil and Water Science Department, Faculty of Agriculture-University of Duhok .

**Table 2. Monthly mean values of temperature and rainfall for both experimental locations (Grdarasha<sup>1</sup> and Sumail<sup>2</sup>) in 2013- 2014**

Months	C)Average temperature (				Rainfall (mm)	
	Grdarasha		Sumail		Grdarasha	Sumail
	Min.	Max	Min	Max		
2013						
April	12.72	27.40	10.90	25.32	14.5	26.8
May	18.51	33.32	15.90	31.92	31.2	21.4
June	22.83	39.63	18.60	38.19	0.0	0.0
July	25.81	43.16	20.30	41.88	0.0	0.0
August	25.50	42.62	21.00	41.68	0.0	0.0
September	20.34	37.09	15.50	35.48	0.0	0.0
October	18.60	31.08	11.60	28.14	12.2	0.0
November	12.15	22.51	9.87	21.04	21.3	64.4
December	4.31	14.02	1.0	11.81	82.3	61.5
2014						
January	1.9	18.0	2.55	13.94	47.8	171.8
February	-0.9	25.0	2.95	16.45	6.9	7.6
March	5.5	27.2	7.87	19.95	85.1	151.4
April	3.7	36.0	10.78	26.48	11.7	18.7
May	14.3	39.3	16.16	33.34	0.5	6.4

1-Agricultural Meteorology of Erbil Governorate, prepared by Erbil General Directorate of Agriculture

2- Meteorological Station. Faculty of Agriculture -University of Duhok

The experimental design was randomized complete block with split-plot arrangement of treatments with three replicates. In spring season, four sowing dates (April 11<sup>th</sup>, April 25<sup>th</sup>, May 9<sup>th</sup> and May 23<sup>th</sup>) at Grdarasha/Erbil governorate and four sowing dates (April 11<sup>th</sup>, April 25<sup>th</sup>, May 11<sup>th</sup> and May 25<sup>th</sup>) at Sumail/Duhok governorate, while at winter season, the sowing dates were (November 13<sup>th</sup>, November 27<sup>th</sup>, December 18<sup>th</sup> and December 31<sup>th</sup>) at Grdarasha/Erbil and (November 23<sup>th</sup>, December 2<sup>nd</sup>, December 24<sup>th</sup> and January 8<sup>th</sup>) at Sumail/Duhok, these dates were applied as main plots, while the three genotypes (Rabee 500, Aurduny and G2018) represented as sub-plots which are used in two seasons and two locations. The experimental unit was (3 m × 3.6 m) The genotypes seeds were seeded in furrows, with 90cm between furrows and 25 cm with furrows, plant population 44444 plant ha<sup>-1</sup>. Nitrogen fertilizer was applied at a rate of 120 N kg ha<sup>-1</sup> in the form of urea (46% N) at three intervals; the first at sowing date, the second at flowered buds formation and the third at flowering stage. P<sub>2</sub>O<sub>5</sub> was applied at sowing date by rate of 80 kg ha<sup>-1</sup> in form of triple superphosphate (46% P<sub>2</sub>O<sub>5</sub>). Data were recorded when 50% of plants had opened flowers to determine the number of days from sowing to flowering and the data of 80% of heads in a plot had brown color to determine the number of days from sowing to maturity. Plant height, number of primary branches per plant and number of heads per plant were calculated as an average of five harvested plants per plot. Seed yield was obtained by harvesting plants samples from the mid furrow. Oil was extracted from safflower seeds using Soxhlet apparatus by hexane extract and oil percentage was estimated according to Association of Official Analytical Chemists (1). Analysis of variance was done to obtain data of each season and location and combined analysis of split-plot arrangement in a randomized complete block design at two locations were compared by using Statistical Analysis System (16). Duncan's multiple range tests was used to determine the differences among means (4).

## RESULT AND DISCUSSION

**Number of days from flowering to maturity:** In spring season; planting dates,

genotypes and their interaction combination had significant effect on number of days which the plant needed from onset of flowering to maturity stage excluding planting dates at Sumail location (Tables 3 and 4). Plants of second date at Grdarasha location took 38.44 days from flowering to maturity, while the fourth date; elapsed 19.33 days. This variation may be due to the differences in temperature which influencing on plants growth and development to reach maturity starting from flowering. It is noticed also that the G2018 genotype (which did not differ statistically from Aurduny genotype) at Grdarasha location and resemble Aurduny genotype and Rabee 500 genotype at Sumail location (Table 3). The longest periods were 41.00 and 22.00 day by G2018 and Rabee 500 genotypes when were planted on April 25<sup>th</sup> at Grdarasha location and May 25<sup>th</sup> at Sumail location for the same genotypes respectively (Table 4). In winter season; planting dates, genotypes and their interaction had significant effect on this trait (Tables 5 and 6). Plants of the first date (November 13<sup>th</sup> and November 23<sup>th</sup>) at both locations elapsed 36.89 and 37.67 day from flowering to maturity respectively, followed by Rabee 500 genotype at Sumail location needed more duration between flowering and maturity (35.25 days), also the longest periods were scored by Rabee 500 genotype when planted on November 13<sup>th</sup> and 23<sup>th</sup> at both locations respectively. Tables 3 and 5 indicated that the highest number of days from onset of flowering to maturity took at Grdarasha location in spring season reaching 30.03 days, while at Sumail location took the shortest days (19.33). In contrast to winter season, the longest days at Sumail location was 34.53 days that was attributed to weather variation between seasons and between locations (Table 2).

### Plant height

It is showed that plants of first sowing date in the two seasons at both locations attained the highest plant height, while the shortest was for plants planted in last sowing date (Tables 3 and 5), that is due to penetration and distribution of sunlight more efficiently at the plant base in last date, leading to auxins breakdown and resulted in increasing of stalk thickness and shortened plants internodes (14).

These results were in agreement with Mirzakhani et al. (11) who claimed that plant height reduced significantly at the late planting date. Likewise, plants of Aurduny genotype produced the highest length (which did not differ statistically from G2018 genotype) at Grdarasha location in winter season, compared to Rabee 500 genotype plants (Table 5). The results were coincided with those of Soleymani et al. (19) who reported that such variation between cultivars.

**Number of primary branches per plant** The results in Table 3 revealed that plants planted in April 11<sup>th</sup> at both locations produced the highest number of primary branches comparing with the un other dates at both locations. However, plants planted at first date produced highest primary branches than the rest of dates at both locations (Table 5). Such reduction in branches number was due to shortened of growing season which led to shortage of assigned duration to promote the sprouts of primary branches, consequently number of branches (10). The Rabee 500 genotype at Grdarasha location and G2018 genotype at Sumail location produced the highest number of primary branches (17.50 and 11.94) respectively, such variation attributed to genetically potential of cultivars. Number of primary branches at Grdarasha location surpassed Sumail location in two seasons (Tables 3 and 5).

#### **Number of heads per plant**

The number of heads / plant produced from (table3 and 4) early sowing at locations and both seasons; this increase was wrrelated with plants height and number of primary branches increasing which has adverse effect on number of heads per plant. Rabee 500 genotype's plants planted at both locations in winter season produced the highest number of heads (78.80 and 36.00) respectively. The highest number of heads per plant at Grdarasha location was 65.10, but the least number of heads was 27.4 at Sumail location (Table 5).

#### **Number of seeds per head**

Data of table 3 revealed that planting at April, 11<sup>th</sup> produced the highest number of seeds per head (28.87 and 28.72) for both locations, respectively in comparison to the fourth date. Aurduny genotype recorded the highest

number seeds per head (37.56 and 27.36) at both locations respectively (Table 5).

#### **Seed weight**

The results in Tables 3 and 5 revealed in consisting in100-seed weight, as the highest values were recorded by early planting dates in spring and winter seasons at both locations. These results are in harmony with (6).

#### **Seed yield**

The results in the Tables 3 and 5 indicate that planting in the first date produced the highest seed yield (1277.6 and 1583.7 kg ha<sup>-1</sup>) in spring season and (2676.5 and 1904.2 kg ha<sup>-1</sup>) in winter season at both locations respectively, while lateness in planting dates caused reduction in yield by (57.4 and 56.9%) in first season and (54.8 and 41.9%) in second season at both locations respectively,. These results are in agreement with (8 and 18) they found that the highest seed yield of safflower was obtained in the early sowing date (2000 kg ha<sup>-1</sup>), moreover, they observed that 9-18 day delaying in sowing date, decreased seed yield by 510-850 kg ha<sup>-1</sup>, these result contradict to those of Mohamadzadeh et al. (13) who reported that the highest seed yield was obtained at December 6<sup>th</sup>. The declination of yield in late sowing dates is due to reduction in one or more of its components such as heads number/plant, seeds number/head and 100-seed weight and also to the reduction in length of growth period through acceleration of maturation time (20) The reasons of yield increment is due to existence more number of primary branches and longer growing season of first date, this resulted in higher dry matter accumulation, better translocation of photosynthetic products to flower, more pollination rate and then heads formation. Also it is found from table 5 that Rabee 500 genotype at Grdarasha location and Aurduny genotype at Sumail location surpassed in seed yield (2246.7 and 1636.2 kg ha<sup>-1</sup>) the rest genotypes. It is obvious clear from tables (3) and (5) that Grdarasha location superior to Sumail location, this may be due to the increment of stem length, number of primary branches, number of heads, seeds of head and 100-seed weight which resulted in greater seed yield at Grdarasha location, also due to climatically conditions, soil chemical and

physical properties differences between both locations (Tables 1 and 2).

#### Oil content (%)

The data in spring season revealed that seeds of early planting (April 11<sup>th</sup>) were characterized by recording the highest oil percentage (30.28 %) and (31.81%) at both locations respectively, (Table 3), in contrast, in winter season the fourth date seeds were characterized by highest oil content (28.62%) at Grdarasha location and (29.11%) at Sumail location (Table 5). This declination in oil percentage of fourth date in spring season and first date in winter season could be attributed temperature rising during seed-filling (Table 2) at both locations respectively, which accompanied with growing and formation of seed (7). The results of spring season contradict with the results of Khoulenjani et al. (9) who showed that May 19<sup>th</sup> sowing date was well recognized for oil content compared with April 18<sup>th</sup> sowing date. The results of winter season are in harmony with Bagheri (3), who showed that the seed oil increased by 2.3% per a 12 day delay in cultivation. Aurduny genotype in spring season and G2018 genotype in winter season produced the

highest oil percentage (Tables 3 and 5), this is due to genetically potential, in addition to the variation in response of some genotypes at seed-filling stage (flowering-maturity) to temperature recorded at different planting dates (17). The highest oil percentage (31.18%) was recorded at Sumail location in spring season comparing to the second location, while the second season had non-significant between locations effect on oil percentage (Tables 3 and 5). The results is not in agreement with COSGE et al. (5), who recommended that the best sowing time was winter season in terms of oil content. From the results of this experiment we can concluded that in spring season the sowing date April 11<sup>th</sup> at both locations gave the highest seed yield and oil percentage, while in winter season, the highest seed yield obtain at sowing date November 13<sup>th</sup> and 23<sup>th</sup> and the highest oil percentage on December 31<sup>th</sup> and January 8<sup>th</sup> and the highest seed yield for Rabee 500 genotype and G2018 genotype at both locations respectively. Grdarasha location in two seasons was recognized by its high yield, while Sumail location by its high oil content in spring season.

**Table 3. The effect of planting date and genotypes on some traits of safflower for both locations in spring season 2013**

Location	Planting date	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	April 11	33.89b	69.81a	13.89a	56.00a	28.87a	6.00a	1277.6a	30.28a
	April 25	38.44a	61.00b	12.40b	52.72a	27.33a	6.13a	849.3b	29.63b
	May 9	28.44c	53.06c	12.44b	51.28ab	19.30b	6.12a	811.2b	29.10c
	May 25	19.33d	49.78c	12.39b	42.92b	13.94b	5.10b	544.6c	28.31d
Sumail	April 11	19.33	88.14a	16.34a	57.33a	28.72a	3.41a	1583.7a	31.81a
	April 25	19.22	76.54b	12.37b	52.16a	26.30a	3.66a	116.3b	30.00c
	May 11	19.33	54.50c	5.28c	43.92b	16.48b	3.53a	683.8c	31.00bc
	May 25	19.44	47.14d	3.53c	46.08a	13.69b	3.04b	683.4c	31.12b
Location	Genotypes	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	Rabee 500	28.92b	59.92	12.93	51.86	22.98	6.23	956.5	28.99b
	Aurduny	30.25a	56.57	12.63	50.54	23.85	6.09	812.9	29.58a
	G2018	30.91a	58.75	12.79	49.79	20.23	5.80	839.6	29.42a
Sumail	Rabee 500	20.67b	68.12	10.15	50.56	22.38	3.46	922.2	31.15b
	Aurduny	19.08b	65.51	9.51	51.53	21.94	3.30	1053.3	31.77a
	G2018	18.28b	66.13	10.73	47.53	19.58	3.33	1075.1	30.64c
Means of locations	Grdarasha	30.03a	58.41	12.78a	50.73	22.35	6.04a	1870.7a	29.33b
	Sumail	19.33b	66.58	10.13b	49.87	21.30	3.36b	1016.8b	31.18a

Values designed a different letters within columns indicates significantly differences according to Duncan's multiple rang test

Table 4. The effect of interaction between planting date and genotype on some safflower traits for both locations in spring season 2013

Location	Planting date	Genotypes	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	April 11	Rabee500	34.67b	73.33a	11.87	40.77b	32.00ab	5.53	773.5bc	28.90cde
		Aurduny	33.67b	70.00ab	13.00	40.00ab	23.23a-d	5.83	807.3bc	29.27c
		G2018	33.33b	66.00abc	12.33	40.00b	28.25abc	5.73	967bc	32.67a
	April 25	Rabee500	34.67b	60.00cde	12.67	51.33ab	33.26a	6.50	1568.6a	31.53b
		Aurduny	39.67a	60.67cd	11.67	45.50ab	27.27a-d	5.93	1127ab	29.10cd
		G2018	41.00a	62.33bcd	12.83	61.33ab	24.47a-d	5.93	1137.1a	28.27ef
	May 9	Rabee500	27.33d	55.17de	14.00	51.00ab	19.03cde	6.21	905.2bc	27.93f
		Aurduny	27.67d	50.83df	13.50	54.50ab	21.97bcd	6.83	751.8bc	31.63b
		G2018	30.33c	53.17def	14.17	40.33ab	16.90def	5.90	766.5bc	27.73f
	May25	Rabee500	19.00e	51.17ef	13.17	64.33a	7.60f	6.60	590.5bc	27.60fe
		Aurduny	20.00e	44.67f	12.33	54.16ab	22.93a-d	5.77	565.5c	28.33def
		G2018	19.00e	53.50def	11.83	49.50ab	11.30ef	5.63	477.7c	29.10cde
Sumail	April 11	Rabee500	18.67cd	90.43a	17.57a	50.10b	31.33a	3.67a	1448.8abc	31.63b
		Aurduny	20.67ab	87.10a	15.23ab	51.23ab	32.37a	3.10bcd	1590.9ab	32.40b
		G2018	18.67cd	86.90a	16.23ab	55.13ab	22.67abc	2.87d	1711.3a	31.40c
	April 25	Rabee500	20.67ab	77.20b	15.43ab	53.57ab	27.77ab	3.53a	1016.3cde	31.33c
		Aurduny	19.00bcd	77.43b	14.33b	65.57a	28.33ab	3.70a	1236.9bcd	31.37c
		G2018	18.00cd	75.00b	16.33ab	52.87ab	22.90abc	3.73a	1095.8cde	29.70d
May 11	Rabee500	21.33a	46.67e	4.8cd	47.67b	17.90bcd	3.33a-d	537.6f	32.00bc	
	Aurduny	19.33bc	45.83e	4.57cd	44.00b	18.71cd	3.43abc	679.5ef	28.53e	
	G2018	17.33d	48.93de	6.47c	40.10b	15.83cd	3.83a	833.2def	32.47b	
May25	Rabee500	22.00a	58.17c	2.86d	50.90ab	12.70cd	3.30a-d	686.0ef	29.63d	
	Aurduny	17.33d	51.67de	3.90cd	45.33b	11.47d	2.96cd	705.6ef	34.73a	
		G2018	19.00bcd	53.67cd	3.90cd	42.00b	16.90cd	2.87d	659.9ef	29.00ed

Values designed a different letters within columns indicates significantly differences according to Duncan's multiple rang test

**Table 5. The effect of planting date and genotypes on some traits of safflower for both locations in winter season 2013-2014**

Location	Planting date	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	November13	36.89a	145.07a	18.22a	92.41a	36.53	8.24a	2676.5a	25.12c
	November27	29.33b	136.50b	15.34ab	64.89b	34.81	8.22a	2132.9b	27.52b
	December18	26.89d	119.91c	14.57ab	43.82c	30.80	7.79a	1209.1c	27.97b
	December31	24.00c	114.07c	13.34b	59.29bc	32.31	6.97b	1307.0c	28.62a
Sumail	November23	37.67a	121.63a	13.52a	33.55a	23.93	4.63a	1904.2a	24.18c
	December2	33.33b	110.81b	10.59b	28.33a	23.78	4.62a	1171.3b	27.10b
	December24	33.67b	101.59c	10.63b	27.78a	23.52	4.57a	1189.5b	29.02a
	January8	33.44b	95.29d	9.33b	18.88b	20.19	4.02b	1106.4b	29.11a
Location	Genotypes	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	Rabee500	27.50	120.66b	17.50a	78.80a	34.16ab	7.47	2246.7a	27.38b
	Aurduny	28.08	131.88a	14.83ab	61.33b	37.56a	7.99	1612.0b	25.33c
	G2018	27.75	134.28a	14.13b	55.18b	29.13b	7.96	1635.4b	29.13a
Sumail	Rabee500	35.25a	107.11	9.97b	36.00a	21.28b	4.37	1283.9b	26.38c
	Aurduny	34.58ab	107.06	11.14ab	24.28b	27.36a	4.04	1636.2a	27.58b
	G2018	33.75b	107.83	11.94a	21.88b	19.92b	4.60	1308.4b	28.14a
Means of locations	Grdarasha	27.78b	128.94a	15.37a	65.10a	33.61a	7.81a	1831.4a	27.35
	Sumail	34.53a	107.34b	11.01b	27.38b	22.85b	4.34b	1342.8b	27.30

Values designed a different letters within columns indicates significantly differences according to Duncan's multiple rang test-

Table 6. The effect of interaction between planting date and genotype on some safflower traits for both locations in winter season 2013-2014

Location	Planting date	Genotypes	Flowering to Maturity (days)	Plant height (cm)	No. of primary branches/plant	No. of heads/plant	No. of seeds/head	100-seed weight	Seed yield (kg ha <sup>-1</sup> )	Oil content (%)
Grdarasha	November13	Rabee500	41.67a	135.23bcd	20.90a	127.33a	35.37ab	7.53abc	3580.0a	26.63c
		Aurduny	34.67b	149.47ab	16.77abc	69.90bc	43.13a	8.67a	1893.8cd	25.60cd
		G2018	34.33b	150.40a	17.00ab	80.00b	31.00ab	8.53a	2555.7bc	31.67a
	November27	Rabee500	29.33d	126.80cde	16.77abc	75.10b	34.73ab	8.00abc	2746.3b	28.07b
		Aurduny	31.33c	139.47abc	16.23abc	63.77bc	39.43ab	8.43ab	1879.5cd	25.50bc
		G2018	27.33e	143.23ab	13.03bc	55.80bcd	30.27ab	8.23abc	1772.8de	32.30a
	December18	Rabee500	18.67g	112.23ef	15.70abc	56.33bcd	26.73b	7.47abc	1407.9de	28.13b
		Aurduny	20.33g	123.13de	11.30c	36.90d	37.90ab	7.97abc	1127.4e	26.37c
		G2018	23.67f	124.37de	13.03bc	38.33d	27.77b	7.93abc	1092.1e	28.07b
	December31	Rabee500	20.33g	108.87f	15.23bc	56.43bcd	39.80ab	6.87c	1252.5ed	26.67c
		Aurduny	26.00e	115.33ef	15.00bc	74.77b	29.77ab	6.90bc	1547.5ed	23.87e
		G2018	25.67e	119.10ef	13.46bc	46.67cd	27.37b	7.13abc	1121.0e	24.83de
November23	Rabee500	38.67a	123.22a	12.45abc	29.11ab	18.11d	4.62ab	1833.4abc	23.40g	
	Aurduny	37.67a	124.77a	12.33abc	27.11ab	32.00a	4.17bcd	1976.0a	24.63f	
	G2018	36.67a	116.90ab	15.78a	27.11ab	21.67bc	5.10a	1903.1ab	24.50f	
December2	Rabee500	33.33bc	108.49bc	7.89d	51.56a	24.00bcd	4.68ab	1117.6bcd	27.50d	
	Aurduny	33.33bc	105.33bc	11.11bcd	24.33ab	27.11abc	4.50ab	1379.5a-d	26.57e	
	G2018	33.33bc	118.67a	12.78ab	24.78ab	20.22cd	4.69ab	1016.9d	27.23de	
December24	Rabee500	34.33bc	100.67cd	10.67bcd	42.00ab	22.00cd	4.12bcd	1409.8a-d	30.73b	
	Aurduny	34.00bc	107.67bc	13.22ab	29.22ab	30.00ab	3.69d	929.0d	26.73e	
	G2018	32.67bc	96.45de	8.00d	13.78b	18.55d	4.41bc	1229.7a-d	29.60c	
January8	Rabee500	34.67b	96.11de	8.89cd	21.33ab	21.00gd	4.05bcd	774.8d	24.13f	
	Aurduny	33.33bc	90.44e	7.89d	16.44ab	20.34cd	3.30cd	1460.4a-d	31.97a	
	G2018	32.33c	99.32cde	11.21bcd	21.87ab	19.22d	4.20bcd	1083.9cd	31.23b	

Values designed a different letters within columns indicates significantly differences according to Duncan's multiple range test



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