Journal of Horticultural Science & Ornamental Plants 6 (2): 71-81, 2014
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2014.6.2.1140

Effect of Sowing Dates, Organic and Chemical Fertilization on Growth, Flowering and the Chemical Composition of *Carthamus tinctorius* L. Plants

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Abstract: A study was carried out at the Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during the two successive seasons: 2011/2012 and 2012/2013 to investigate the suitable sowing dates and the effect of different fertilization treatments (organic as compost and chemical fertilization as potassium sulfate) on growth, flowering and the chemical composition of *Carthamus tinctorius* L. plants. Eight different fertilization treatments were applied combined with four sowing dates (Oct., Feb., Mar. and Apr.). The results showed that the best sowing date is October month for producing the tallest plants, the greatest number of branches, the largest number of flowers, phosphorus and potassium percentages. However, March sowing date is the best for increasing the total chlorophyll contents. In case of carotenoids content February is the best sowing date. The best fertilizer treatment is mixture from compost at the rate of 200gm/pot30cm plus potassium sulfate at the rate of 7.5gm/pot30cm for producing the tallest plants and the greatest number of branches producing from compost at the rate of 200gm/pot or potassium sulfate at the rate of 7.5gm/pot30cm while the maximum number of flowers producing from potassium sulfate at the rate of 7.5 gm. However, total chlorophyll and carotenoids content the best treatment is mixture form compost at the rate of 200gm plus potassium sulfate at the rate of 5gm/pot30cm. In case of phosphorus percentages the best treatment is potassium sulfate at the rate of 7.5gm. However for potassium percentages a mixture from compost at the rate of 100 gm plus potassium sulfate at the rate of 7.5gm is the best. The interaction treatments indicated that October sowing date plus fertilizer by potassium sulfate at the rate of 7.5gm/pot is most effective treatment that can be recommended for producing the tallest plant height, maximum number of branches/plant and number of flowers. However for total chlorophyll and carotenoids content the best sowing dates is March and February respectively, fertilized with a mixture from compost at the rate of 200gm plus Potassium sulfate at the rate of 5gm/pot. Phosphate nutrient indicated that October and potassium sulfate at the rate of 7.5gm is the best, however for potassium October and compost at the rate 100gm/pot plus potassium sulfate at the rate of 7.5gm is the most effective treatments.

Key words: Compost · Potassium sulfate · Sowing dates · Organic · Chemical fertilization · *Carthamus tinctorius* L.

INTRODUCTION

The genus *Carthamus* from the Asteraceae family consists of 25 species, distributed worldwide. Among the 25 safflower species, the cultivated safflower grown around the world is only *Carthamus tinctorius* L., but the others are either wild or weeds [1-4]. The English name *safflower* probably evolved from various written forms of *usfar*, *affore*, *asfiore* and *saffiore* to safflower [5].

Safflower, a multipurpose crop, has been grown for centuries in India for the orange-red dye (carthamin) extracted from its brilliantly colored flowers and for its quality oil rich in polyunsaturated fatty acids

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(linoleic acid, 78%). Carthamus flowers are known to have many medicinal properties for curing several chronic diseases and they are widely used in Chinese herbal preparations [6].

In safflower the relative importance of each yield component is affected by many factors, including genotype, environmental conditions and cultural practices. Sowing dates and nutrient management are important parameters affecting yield and yield components in safflower. Sowing date is one of the most important factors affecting crop yield and other agronomic traits [7].

The choice of the appropriate sowing date is one of the key points in crop management to obtain high quality and quantity yield so suggestion of most appropriate sowing date to farmers increase their yield, profit and also their tendency to cultivate a specific crop as safflower [8].

Several studies conducted in different parts of the world have shown that safflower could be grown as a winter crop in areas with mild temperatures or as a spring crop in cooler areas, although autumn sowing produces a significant increase in seed yield over that sown in spring [9, 10].

It is known that potassium is one of the most important elements in plant nutrition. Potassium improves drought resistance, the plant needs it in a large quantity to assimilate and improve growth and yield [11]. The main source of K for plant comes from mineral and organic- K sources. In plants, the function of K has several roles such as enzyme activation, stimulation of assimilation and transport of assimilate anion /action balance as well as water regulation through control of stomata [12]. Also, Hart and Quick [13] found that K promotes translocation of newly synthesized to different rate. Potassium is effective in the synthesis, transport of carbohydrates, carbon dioxide and it is necessary for the formation of thick-walled cells. Potassium enhances product quality, increases efficiency photosynthesis, increases plant resistance against some diseases. Potassium is essential for the formation of large grain resistant stem in cereal [14]. Organic fertilization is a very important factor for providing plants with their nutritional requirements without having an undesirable impact on the environment. Organic matter is not only necessary for plant nutrition but also essential for efficient plant production system [15]. The compost must be added to conventional NPK fertilizer to improve soil structure, making the soil easier to cultivate, encouraging root development, providing plant nutrients and enabling their increased uptake by plants. Moreover, compost aids water absorption and retention by soil, reducing erosion, run-off, thereby protecting surface waters from sedimentation, help binding agricultural chemicals, keeping them out of water ways and protecting ground water from contamination [16].

The main objective of this work is to study the effect of sowing dates and fertilization treatments (using different organic and chemical fertilizers) on growth, flowering and chemical composition of *Carthamus tinctorious* L. plants to be used for producing good quality flowering plants.

MATERIALS AND METHODS

The present study was carried out at the Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza. during two successive seasons: 2011/2012 and 2012/2013 to investigate the suitable sowing date (Oct., Feb., Mar. and Apr.) and the effect of different fertilization treatments (organic as compost and chemical fertilizers as potassium sulfate) on growth, flowering and chemical composition in order to produce a good quality flowering plants of *Carthamus tinctorius* L.

Plant Materials: Seeds of *Carthamus tinctorious* plants cv. (Giza-1) were used in this study. The seeds were obtained from Oil Crop Department, Agricultural Research Center (ARC), Giza, Egyptian Ministry of Agriculture in the two successive seasons.

The seeds were sown on the four sowing dates (Oct., Feb., Mar. and Apr.) in both seasons 2011/2012 and 2012/2013 in plastic pots30cm. The plastic pots were filled with sandy soil and phosphorus fertilizer (calcium superphosphate 15.5 p_2o_5 at the rate of 5gm/pot30cm were added to the soil before sowing.

Two seeds were sowing in each pot and after generation (15-21days) the generated seeds were thin to leave one seedling/pot. The pots were placed in sunny area.

The Used Soil: The physical and chemical properties of used soil are presented in Tables A and B.

Metrological Data: The maximum, minimum and average air temperature of the experimental farm (Farm of Faculty of Agriculture, Cairo University during the growing period are presented in Table (C).

Table A: Physical properties of the used soil

Soil particle size distribution %					
Coarse sand	Fine sand	Silt	Clay	Textural class	O.M.* %
4.5	84.13	5.85	5.53	Sandy	0.26

O.M.* Organic Matter

Table B: Chemical properties of the used soil

Soluble anions (meq/l)				Soluble cations (meq/l)				Available manure (mg/kg soil)					
SO_4 □	Cl^-	HCO_3^-	CO_3 □	Ca^{++}	Mg^{++}	Na^+	K^+	N	P	K	S.P.**	E.C.***	pH 1: 2.5
10.87	34.5	2.21	-	12.5	10.06	24.4	0.62	161.39	1.27	26.14	21.68	4.37	8.16

S.P.** Saturation percentage E.C.*** Electrical Conductivity (ds/cm)

Table C: Monthly average of metrological data of the experimental farm during seasons of 2011/2012 and 2012/2013 Months.

	2011/2012		2012/2013	
	Temperature (°C)		Temperature (°C)	
Months	Max.	Min.	Max.	Min.
Jan.	13	23	11	20
Feb.	14	23	12	23
Mar.	11	23	14	27
Apr.	17	31	16	29
May	21	34	21	35
June	24	38	24	37
July	26	39	24	37
Aug.	27	38	25	39
Sept.	23	35	23	36
Oct.	22	32	18	31
Nov.	18	27	17	29
Dec.	12	21	11	21

Table D: Physical and chemical analysis of the used compost and the organic fertilization of *Carthamus tinctorius* plants

Properties	Quantity	Properties	Quantity
Dry weight	600-700 kg/m3	Total P %	0.4-0.8 %
Fresh weight	450-550 kg/m3	Total K%	0.8-1.8 %
Humidity	25-30%	Fe	1500-2000 ppm
PH	7.5-8.5	Mn	100-150 ppm
E.C.	4.5-6.5 ds/m	Cu	160-240 ppm
S.P.	200-300%	Zn	40-80 ppm
Total N %	1.4-1.8%	Weed seeds	----------
O.M. %	40-48%	Nematodes	----------
Organic C %	23.2-27.8%	Parasites	----------
C/N ratio	1:15.4-1:16.6	----------	----------

Experimental Procedures: During the two successive years 2011/2012 and 2012/2013 respectively, four sowing dates (Oct., Feb., Mar. and Apr.) were done. Eight fertilizer treatments were used as following:

- Potassium sulfate 5 gm/pot
- Potassium sulfate 7.5 gm/pot
- Compost 100 gm/pot
- Compost 200 gm/pot
- Compost 100 gm + Potassium 5 gm/pot
- Compost 200 gm + Potassium 5 gm/pot
- Compost 100 gm + Potassium 7.5 gm/pot
- Compost 200 gm + Potassium 7.5 gm/pot

Fertilizers

Organic Fertilization: Plants receiving organic fertilization were supplied as Al-Neel compost, which was mixed with soil before planting with rates 100 or 200 gm/pot30cm.

The physical and chemical composition of the used compost in this experiment are shown in Table D.

Chemical Fertilization: Potassium sulfate fertilizer (48% k) was used as sources of potassium. The fertilizer was applied at the rates of 5 and 7.5 g/plant after 45 days from the sowing dates.

Data Recorded: At the end of flowering periods the following data were recorded:

Vegetative Growth: Plant height (cm), number of branches /plant and number of flower /plant.

Chemical Composition: Total chlorophyll a, b and total carotenoids contents (mg/gm of fresh matter) were determined in leaf samples according to Nornai [17], Phosphorus percentage in the foliage was determined colorimetrically according to the method of Jackson [18] and Potassium percentage in the foliage were determined against a standard using flame-photometer [19].

Layout of the Experiments and Statistical Analysis: The layout of the experiment was a complete randomized block design was used for analysis all data, with the main plots assigned to the sowing dates (four dates Oct., Feb., Mar. and Apr.) while the sub-plots were

assigned to the fertilization treatments (eight treatments), with three replicates. Therefore 32 treatments replicated 3 times and in each replicate 7 pots30cm were used. The statistical analysis was carried out according Snedecor and Cochran [20], Mastat-c program [21]. L.S.D. (The least significant differences) at 0.05 was used to compare the differences between means of different treatments.

RESULTS AND DISCUSSION

Seeds of *Carthamus tinctorius* were sowing in four planting dates October, February, March, April in both seasons 2011/2012 and 2012/2013. In this paper, we discuss only one season 2011/2012. However the second season will be discussed in the thesis since the two seasons gave the same trend.

Plant Height (cm): The data in Table (1) indicated the following points: The different sowing dates had a highly significant effect on plant height of safflower plants. The plant height ranged from (29.96 to 66.13cm). The highest plants (66.13cm) resulted from October sowing date which showed a highly significant increase compared to the other sowing dates which were used. The shortest plants height (29.96cm) resulted from April planting. This means that the seasonal variations had a great effect on plant height. In October plants, the environmental conditions such as light and temperature are suitable for producing the taller plants, however in April the temperature as well as the day length and light intensity not suitable compare to October month, these factors had a highly significant effect in producing the shortest plants.

The best sowing date for safflower plants is October month. However, the later sowing date April month had a bad effect on plant height and produced the shortest plants.

As a matter of fact, the chemical and organic fertilization had also a significant effect on plant height. The tallest plants resulted from plants which were treated with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm/pot30cm. This treatment produce the tallest plant (46.50cm) whereas, the shortest plant (40.67cm) resulted from plants fertilized with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 5gm/pot30cm. This means that increasing both compost from 100 to 200 gm and potassium sulfate from 5 to 7.5gm/pot caused a significant increase in plant height.

From this experiment one can conclude that planting safflower plants in October month and using a mixture from compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm/pot30cm was the best treatment in order to obtain the tallest plants.

In case of the interaction between the sowing dates and fertilization treatments, the data in (Table 1) revealed that the tallest plants 89.33cm resulted from plants which were sown in October month and fertilized with potassium sulfate at the rate of 7.5gm/pot. Whereas, the shortest plants (20.33cm) resulted from plants which were sown in April month and fertilized with potassium sulfate at the rate of 7.5gm/pot. This means that the environmental factors play a great role in plant height.

These results are in agreement with the findings of Yau [10] and Rajput, *et al*. [22] on safflower. Cosge and Kaya [23] on safflower also Esendal, *et al*. [24] on *Carthamus tinctorius.* Yadav and Khurana [25] on fennel plant. Baruah [26] on fennel. Masood *et al*. [27] on fennel (*Foeniculum vulgare*). Singh, *et al*. [28] on *Coriandrum sativum*. Abd E1-Raoof [29] on basil (*Ocimum basilium*). El-Desuki, *et al.* [30] on *Foeniculum vulgare*. El-Gendy, *et al.* [31] on *Ocimum basilicum*.

In conclusion: The best sowing dates for safflower is October month however The best fertilizer treatment which can be recommended to be used is a mixture from compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm/pot30cm, this treatment produce a significant taller plants. The interaction between sowing dates and fertilizer treatments indicated that October sowing date and fertilized by potassium sulfate at the rate of 7.5gm/pot was the most effective treatments in producing the tallest plants compared to the other treatments.

Number of Branches/Plant: The data in Table (2) indicated the following points: The sowing dates had a highly significant effect on number of branches of safflower/plants. The number of branches ranged from 1.25 to 5.80. The highest value (5.80) resulted from October sowing date which showed a highly significant increase compared to the other sowing dates which were used. The lowest number of branches (1.25) resulted from April planting. This means that the seasonal variations had a great effect on number of branches. In October plants, the environmental conditions such as light, temperature are suitable for producing the high number of branches/plants, however in April the temperature as well as the daylength and light intensity not suitable. These factors had a highly significant effect in producing the low number of branches/plants.

Table 1: Effect of sowing dates and fertilizer treatments on plant height (cm) of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	73.86 b	28.81 k-n	34.74 h-m	30.03 j-m	41.86 bc
Potassium sulfate 7.5 gm	89.33 a	26.84 mn	32.79 i-m	20.33 n	42.32 abc
Compost 100 gm	52.71 def	40.33 ghi	44.73 fg	27.63 lmn	41.35 bc
Compost 200 gm	54.95 de	50.33 ef	39.72 ghi	28.87 k-n	43.47 abc
Compost 100 gm + Potassium 5 gm	59.62 cd	38.00 g-j	35.01 h-m	29.96 j-m	40.67 c
Compost 200 gm + Potassium 5 gm	60.27 cd	41.39 gh	38.50 g-j	34.43 h-m	43.65 abc
Compost 100 gm + Potassium 7.5 gm	71.81 b	39.63 ghi	37.19 g-k	32.83 h-m	45.37 ab
Compost 200 gm + Potassium 7.5 gm	66.46 bc	38.24 g-j	45.71 fg	35.58 h-l	46.50 a
Mean	66.13 a	37.95 b	38.56 b	29.96 c	

Means followed by a same letter are not significantly different at 0.05 level of probability.

Table 2: Effect of sowing dates and fertilizer treatments on number of branches of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	4.98 bcd	0.67 d	4.33 bcd	2.23 bcd	3.05 ab
Potassium sulfate 7.5 gm	15.83 a	0.33 d	1.33 d	0.33 d	4.46 a
Compost 100 gm	1.13 d	4.00 bcd	5.00 bcd	0.78 d	2.73 ab
Compost 200 gm	3.44 bcd	13.00 a	1.00 d	1.11 d	4.64 a
Compost 100 gm + Potassium 5 gm	3.55 bcd	0.45 d	1.00 d	1.22 d	1.55 b
Compost 200 gm + Potassium 5 gm	3.92 bcd	1.00 d	1.00 d	1.42 cd	1.83 b
Compost 100 gm + Potassium 7.5 gm	7.13 b	1.17 d	0.67 d	1.30 d	2.57 ab
Compost 200 gm + Potassium 7.5 gm	6.44 bc	0.67 d	1.11 d	1.58 cd	2.45 ab
Mean	5.80 a	2.66 b	1.93 b	1.25 b	

Means followed by a same letter are not significantly different at 0.05 level of probability.

Table 3: Effect of sowing dates and fertilizer treatments on number of flower of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	4.38 cd	1.18 e	1.62 e	2.50 de	2.42 bcd
Potassium sulfate 7.5 gm	14.67 a	1.06 e	1.29 e	1.08 e	4.52 a
Compost 100 gm	1.70 e	2.20 de	2.22 de	1.30 e	1.85 bcd
Compost 200 gm	2.43 de	5.67 bc	1.28 e	1.51 e	2.72 bcd
Compost 100 gm + Potassium 5 gm	1.72 e	1.43 e	1.33 e	1.64 e	1.53 d
Compost 200 gm + Potassium 5 gm	1.89 e	1.33 e	1.40 e	1.76 e	1.60 cd
Compost 100 gm + Potassium 7.5 gm	6.95 b	1.26 e	1.38 e	1.74 e	2.83 bc
Compost 200 gm + Potassium 7.5 gm	6.78 bc	1.11 e	1.84 e	2.03 de	2.94 b
Mean	5.06 a	1.90 b	1.55 b	1.70 b	

Means followed by a same letter are not significantly different at 0.05 level of probability.

Therefore, the best sowing date for safflower plants to be sowing in October month. However, the later sowing date April had a bad effect on decreasing the number of branches and produced the smallest number of branches/plants.

The chemical and organic fertilization had a significant effect on the number of branches. The greatest number of branches/plants resulted from plants which were treated with compost at the rate of 200gm/pot or potassium sulfate at the rate of 7.5gm/pot30cm (4.64 and 4.46) respectively. Whereas, the smallest number of branches (1.55) resulted from plants fertilized with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 5gm/pot30cm. This means that increasing both compost from 100 to 200gm and potassium sulfate from 5 to 7.5gm/pot caused a significant increase in the number of branches/plants.

From this experiment one can observe that planting safflower plants in October month and using compost at the rate of 200gm/pot or potassium sulfate at the rate of 7.5gm/pot30cm were the best fertilizer treatment to obtain the greatest number of branches/plants.

In case of the interaction between the sowing dates and fertilizer treatments, the data revealed that the highest number of branches/plants (15.83) resulted from plants which were sown in October month and fertilized with potassium sulfate at the rate of 7.5gm/pot. Whereas, the lowest number of branches/plants (0.33) resulted from plants which were sown in February and April months and fertilized with the same treatment potassium sulfate at the rate of 7.5gm/pot30cm.

These results are in agreement with the findings of Rajput, *et al*. [22] on safflower Singh *et al*. [28] on *Coriandrum sativum*. Naguib, *et al.* [32] on *Ruta graveolens*. El-Gendy *et al.* [31] on *Ocimum basilicum*. Khalil, *et al*.[33] on *Tagetes erecta*. Khalil and El-Sherbeny [34] on Mentha species. Shaalan [35] on borage plant. Khalil *et al*. [36] on *Foeniculum vulgare* and *Salvia officinalis.* Abdullah *et al*. [37] on *Rosmarinus officinalis* plants.

In conclusion: The best sowing date is October month for producing the greatest number of branches/plants while the best fertilizer treatment compost at the rate of 200gm/pot or potassium sulfate at the rate of 7.5gm/pot30cm.The interaction between sowing dates and fertilizer treatment showed that October sowing date and fertilized by potassium sulfate at the rate of 7.5gm/pot was the most effective treatment.

Number of Flowers: The different sowing dates had a highly significant effect on number of flowers of safflower plants. The number of flowers ranged from 1.55 to 5.06. The maximum number of flower (5.06) resulted from October sowing date which showed a highly significant increase compared to the other sowing dates. The minimum number of flowers (1.55) resulted from March planting. This means that the seasonal variations had a great effect on number of flowers.

One can say that the best sowing date for safflower plants to be sown in October month. However, the later sowing date March had a bad effect on number of flowers and produced the minimum number of flowers.

As a matter of fact, the chemical and organic fertilization had also a significant effect on number of flowers. The maximum number of flowers resulted from plants which were treated with potassium sulfate at the rate of 7.5gm/pot30cm.This treatment produce the maximum number of flowers (4.52) whereas, the minimum number of flowers (1.53) resulted from plants fertilized with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 5gm/pot30cm.

From this experiment one can conclude that planting safflower plants in October month and using potassium sulfate at the rate of 7.5gm/pot30cm was the best treatment to obtain the greatest number of flowers.

In case of the interaction between the sowing dates and fertilizer treatments, the data in (Table 3) revealed that the maximum number of flowers 14.67 resulted from plants which were sown in October month and fertilized with potassium sulfate at the rate of 7.5gm/pot.

These results are in agreement with the findings of Ansari, *et al.*[38] on safflower resulted that maximum number of capsules in the 15 th November. Uslu [39] on safflower sown during winter produced higher values of heads per plant compared to spring sowing (heads/plant). Rajput, *et al*.[22] on safflower reported that 29 October sowing dates recorded the higher values on number of flower. Cosge and Kaya [23] indicated that effect of late-autumn sowing dates of safflower had positive and significant increase the plant height compared to late-spring sowing dates.

In conclusion: The best sowing date is October month for producing the greatest number of flowers/plants while the best fertilizer treatment potassium sulfate at the rate of 7.5gm/pot30cm.The interaction between sowing dates and fertilizer treatment showed that October sowing date and fertilized by potassium sulfate at the rate of 7.5gm/pot was the most effective treatment.

Total Chlorophyll (mg/gm of Fresh Matter): The different sowing dates had a highly significant effect on total chlorophyll of safflower plants. The total chlorophyll ranged from 13.49 to 4.51. The maximum amount of total chlorophyll reached (13.49) resulted from March sowing date which showed a highly significant increase compared to the other sowing dates. The minimum amount of total chlorophyll (4.51) resulted from February planting.

The chemical and organic fertilization had a significant effect on total chlorophyll. The maximum amount of total chlorophyll resulted from plants which were treated with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 5gm/pot30cm.This treatment produce the maximum amount of total chlorophyll (10.60) whereas, the minimum amount of total chlorophyll (6.13) resulted from plants fertilized with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm /pot30cm. This means that fertilizing with compost at rate of 200 gm and decreasing potassium sulfate from 7.5 to 5 gm/pot caused a significant increase in total chlorophyll.

Table 4: Effect of sowing dates and fertilizer treatments on total chlorophyll of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	3.99 i-m	3.80 i-m	9.51 c-g	8.23 e-i	6.38 c
Potassium sulfate 7.5 gm	9.53 c-g	1.79 m	8.17 e-i	9.79 c-f	7.32 bc
Compost 100 gm	6.88 f-k	4.67 h-m	12.17 b-e	7.29 f-j	7.75 bc
Compost 200 gm	4.29 h-m	8.67 d-h	14.89 b	6.89 f-k	8.68 ab
Compost 100 gm + Potassium 5 gm	2.73 klm	4.08 i-m	13.14 bcd	6.54 f-l	6.62 bc
Compost 200 gm + Potassium 5 gm	2.88 j-m	5.29 g-m	26.07 a	8.18 e-i	10.60 a
Compost 100 gm + Potassium 7.5 gm	2.22 lm	5.22 g-m	13.87 bc	7.05 f-k	7.09 bc
Compost 200 gm + Potassium 7.5 gm	4.06 i-m	2.61 klm	10.11 c-f	7.73 e-i	6.13 c
Mean	4.57 c	4.51 c	13.49 a	7.71 b	

Means followed by a same letter are not significantly different at 0.05 level of probability.

From this experiment one can conclude that planting safflower plants in March month and using a mixture from compost at the rate of 200gm/pot plus potassium sulfate at the rate of 5gm/pot30cm was the best treatment in order to obtain the maximum amount of total chlorophyll.

In case of the interaction between the sowing dates and fertilizer treatments, The data in (Table 4) revealed that the maximum amount of total chlorophyll (26.07) resulted from plants which were sowing in March month and fertilized with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 5gm/pot30cm.Whereas, the minimum amount of total chlorophyll (1.79) resulted from plants which were sowing in February month and fertilized with potassium sulfate at the rate of 7.5gm/pot30cm.

These results showed that climatic conditions had great effect on the synthesis and accumulation of the different pigments, as an indicator for playing a role in the formation of the secondary products. In this matter, Ahmed [40] found that early sowing dates resulted in an increase in chlorophyll a+b content in the leaves, while delaying the sowing dates decreased them.

In conclusion: The best sowing dates in March month while the best fertilizer treatment is a mixture from compost at the rate of 200gm and potassium sulfate at the rate of 5gm/pot30cm.The interaction between sowing dates and fertilizer treatments indicated that the highest total chlorophyll contents were obtained from March sowing date and fertilized with a mixture from compost at the rate of 200gm and potassium sulfate at the rate of 5gm/pot30cm.

Carotenoids (mg/gm of Fresh Matter): The different sowing dates had a highly significant effect on carotenoids of carthamus plants. The carotenoids treatment ranged from 4.41 to 1.24. The maximum amount of carotenoids (4.41) resulted from February sowing date which showed a highly significant increase compared to the other sowing dates which were used. The minimum amount of carotenoids (1.24) resulted from March planting. This means that the seasonal variations had a great effect on carotenoids. In February plants, the environmental conditions such as light and temperature are suitable for producing the maximum amount of carotenoids, however in March the temperature as well as the daylength and light intensity not suitable. These factors had a highly significant effect in producing the minimum amount of carotenoids contents.

One can say that the best sowing date for safflower plants to be sown was February month. However, the later sowing date March had a bad effect on decreasing carotenoids and produced the minimum amount of carotenoids.

The chemical and organic fertilization had also a significant effect on carotenoids. The maximum amount of carotenoids resulted from plants which were treated with compost at the rate 200gm/pot plus potassium sulfate at the rate 5gm/pot30cm. This treatment produce the maximum amount of carotenoids (3.67) whereas, the minimum amount of carotenoids (1.58) resulted from plants fertilized with compost at the rate 200gm/pot plus potassium sulfate at the rate 7.5gm/pot30cm. This means that fertilizing with compost at rate of 200gm/pot and decreasing potassium sulfate from 7.5 to 5gm/pot caused a significant increase in carotenoids.

From this experiment one can conclude that planting safflower plants in February month and using a mixture from compost at the rate 200gm/pot plus potassium sulfate at the rate 5gm/pot30cm was the best treatment in order to obtain the maximum amount of carotenoids contents.

In case of the interaction between the sowing dates and fertilization treatments, the data in (Table 5) revealed that the maximum amount of carotenoids (8.35) resulted

Table 5: Effect of sowing dates and fertilizer treatments on carotenoids of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	2.01 g-k	4.69 cd	2.03g-k	2.27 gh	2.77 b
Potassium sulfate 7.5 gm	1.42 g-m	1.43 g-m	1.70 g-m	1.85g-l	1.60 d
Compost 100 gm	1.98 g-k	3.73 de	0.70 mn	2.42 fg	2.21 c
Compost 200 gm	2.13 g-k	3.39 ef	0.84 lmn	2.32 gh	2.17 c
Compost 100 gm + Potassium 5 gm	1.20 i-n	5.55 bc	1.08 k-n	2.27 gh	2.53 bc
Compost 200 gm + Potassium 5 gm	1.83 g-l	8.35 a	2.10 g-k	2.40 fg	3.67 a
Compost 100 gm + Potassium 7.5 gm	1.32 h-n	6.02 b	1.16 j-n	2.22 ghi	2.68 bc
Compost 200 gm + Potassium 7.5 gm	1.73 g-m	2.11 g-k	0.28 n	2.20 g-j	1.58 d
Mean	1.71 c	4.41 a	1.24 d	2.25 b	

Means followed by a same letter are not significantly different at 0.05 level of probability

from plants which were sown in February month and fertilized with compost at the rate 200gm/pot plus potassium sulfate at the rate 5gm/pot30cm.Whereas, the minimum amount of carotenoids (0.28) resulted from plants which were sown in March month and fertilized with treatment compost at the rate 200gm/pot plus potassium sulfate at the rate 7.5gm/pot30cm.

These results are agreement with Ahmed [40] found that early sowing dates resulted in an increase in carotenoides content in the leaves, while delaying the sowing dates decreased them.

In conclusion: The best sowing dates in February month while the best fertilizer treatment is a mixture from compost at the rate of 200gm and potassium sulfate at the rate of 5gm/pot30cm.The interaction showed that the amount of carotenoids content which was obtained from February sowing date and fertilized by a mixture from compost at the rate of 200gm and potassium sulfate at the rate of 5gm/pot30cm was the best treatment.

Phosphorus Content (%): The different sowing dates had a highly significant effect on phosphorus of safflower plants. The phosphorus % ranged from 0.61 to 0.35. The highest content of phosphorus reached (0.61) resulted from October sowing date which showed a highly significant increase compared to the other sowing dates. The lowest content of phosphorus (0.35) resulted from April planting.

The best sowing date for safflower plants to be sowing in October month.

The chemical and organic fertilization had also a significant effect on phosphorus, the maximum amount of phosphorus resulted from plants which were treated with potassium sulfate at the rate of 7.5gm/pot30cm. This treatment produce the highest content of phosphorus (0.70) whereas, the minimum content of phosphorus (0.36) resulted from plants fertilized with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 5gm/pot30cm. This means that increasing potassium sulfate from 5 to 7.5gm/pot without using the compost caused a significant increase in phosphorus.

From this experiment one can conclude that planting safflower plants should be sown in October month and using potassium sulfate at the rate of 7.5gm/pot30cm was the best treatment in order to obtain the maximum content of phosphorus.

In case of the interaction between the sowing dates and fertilizer treatments, the data in (Table 6) revealed that the highest phosphorus percentage (2.02) resulted from plants which were sown in October month and fertilized with potassium sulfate at the rate of 7.5gm/pot30cm. Whereas, the lowest phosphorus percentage (0.14) resulted from plants which were sown in February month and fertilized with compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm/pot.

The obtained date are in agreement with those published by Herrera, *et al.* [41] on *Angelica archaugalica*, *Marrubium vulgare* and *Thymus vulgaris* and Chen *et al.* [42] on *Houttuynia cordate*. El-Desuki *et al.* [30] on *Foeniculum vulgare* mentioned that application of 12 ton/fed compost significantly increased the contents of P. Khalil, *et al*. [33] on *Tagetes erecta* L. They concluded that P contents increased with increasing rates of compost. Abou El-Magd, *et al.* [43] studied four rates of potassium sulphate, showed higher content P in tissues of sweet fennel leaves and bulbs were obtained with plants treated with 75 kg K2O/ fed.

In conclusion: The best sowing date in October month while the best fertilizer treatment is potassium sulfate at the rate of 7.5gm/pot30cm.The interaction indicated that the highest percentages of phosphorus were obtained from October sowing date and fertilized the plants with potassium sulfate at the rate of 7.5gm/pot30cm.

Table 6: Effect of sowing dates and t fertilizer treatments on phosphorus of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	0.39 b	0.72 b	0.31 b	0.32 b	0.44 a
Potassium sulfate 7.5 gm	2.02 a	0.31 b	0.23 b	0.25 b	0.70 a
Compost 100 gm	0.26 b	0.74 b	0.27 b	0.48 b	0.44 a
Compost 200 gm	0.44 b	0.69 b	0.51 b	0.30 b	0.49 a
Compost 100 gm + Potassium 5 gm	0.53 b	0.22 b	0.65 b	0.39 b	0.45 a
Compost 200 gm + Potassium 5 gm	0.39 b	0.47 b	0.32 b	0.25 b	0.36 a
Compost 100 gm + Potassium 7.5 gm	0.53 b	0.34 b	0.65 b	0.40 b	0.48 a
Compost 200 gm + Potassium 7.5 gm	0.33 b	0.14 b	0.64 b	0.40 b	0.38 a
Mean	0.61 a	0.45 a	0.45 a	0.35 a	

Means followed by a same letter are not significantly different at 0.05 level of probability.

Table 7: Effect of sowing dates and fertilizer treatments on potassium of *Carthamus tinctorius* plants during 2011/2012

	Sowing date				
Treatments	Oct.	Feb.	Mar.	Apr.	Mean
Potassium sulfate 5 gm	1.91 c	1.23 i-m	1.53 def	1.54 de	1.55 bc
Potassium sulfate 7.5 gm	2.03 bc	1.26 i-m	1.35 f-k	1.38 e-i	1.51 cd
Compost 100 gm	3.20 a	1.18 klm	0.91 o	1.25 i-m	1.63 b
Compost 200 gm	2.15b	1.19 j-m	1.30 h-l	1.37 e-j	1.50 cd
Compost 100 gm + Potassium 5 gm	2.14 b	1.11 mn	1.26 i-m	1.26 i-m	1.44 d
Compost 200 gm + Potassium 5 gm	2.15 b	1.32 g-k	0.97 no	1.33 g-k	1.45 d
Compost 100 gm + Potassium 7.5 gm	3.28 a	1.13 lmn	1.49 d-g	1.47 d-h	1.84 a
Compost 200 gm + Potassium 7.5 gm	1.58 d	1.36 e-j	1.33 g-k	1.47 d-h	1.44 d
Mean	2.31 a	1.22 c	1.27 c	1.38 b	

Means followed by a same letter are not significantly different at 0.05 level of probability

Potassium Content (%): The different sowing dates had a highly significant effect on potassium of safflower plants. The potassium % ranged from 2.31 to 1.22. The maximum content of potassium (2.31) resulted from October sowing date which showed a highly significant increase compared to the other sowing dates.

One can say that the best sowing date for safflower plants is October month.

The chemical and organic fertilization had a significant effect on potassium. The maximum amount of potassium resulted from plants which were treated with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 7.5gm/pot30cm. This treatment produce the maximum amount of potassium (1.84) whereas, the minimum amount of potassium (1.44) resulted from plants fertilized with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 5gm/pot30cm and also treatment of compost at the rate of 200gm/pot plus potassium sulfate at the rate of 7.5gm /pot30cm.

From this experiment one can conclude that planting safflower plants in October month and using compost at the rate of 100gm/pot plus potassium sulfate at the rate of 7.5gm /pot30cm was the best treatment in order to obtain the maximum amount of potassium.

In case of the interaction between the sowing dates and fertilizer treatments, the data in (Table 7) revealed that the maximum amount of potassium (3.28) resulted from plants which were sown in October month and fertilized with compost at the rate of 100gm/pot plus potassium sulfate at the rate of 7.5gm /pot30cm.

These results are in agreement with the findings of Herrera, *et al.* [41] on *Angelica archaugalica*, *Marrubium vulgare* and *Thymus vulgaris* and Chen, *et al.* [42] on *Houttuynia cordate*. El-Desuki, *et al.* [30] on *Foeniculum vulgare* mentioned that application of 12 ton/fed compost significantly increased the contents of K. Khalil, *et al*. [33] applied various rates of compost on *Tagetes erecta* L. They concluded that K contents increased with increasing rates of compost. Abou El-Magd, *et al.* [43] studied four rates of potassium sulphate and showed higher content K in tissues of sweet fennel leaves and bulbs were obtained with plants treated with 75 kg K2O/ fed.

In conclusion: The best sowing dates is October month while the best fertilizer treatment is mixture from compost at the rate of 100gm plus potassium sulfate at the rate of 7.5gm/pot30cm. The interaction showed that the highest percentages of potassium can be obtained from

October sowing date and fertilized the plants with compost at the rate of 100gm/pot30cm plus potassium sulfate at the rate of 7.5gm /pot30cm.

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