OKU Fen Bilimleri Enstitüsü Dergisi
5(2): 720-728, 2022

OKU Journal of The Institute of Science and Technology, 5(2): 720-728, 2022

Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi

Osmaniye Korkut Ata University Journal of The Institute of Science and Technology

Aspir (*Carthamus tinctorius* L.) Çeşitlerinin Besin İçeriği Üzerine Farklı Kükürt Dozlarının Etkileri

Ruveyde TUNCTURK[1*], Lutfu NOHUTCU[2], Muhammed Said YOLCI[3], Ezelhan SELEM[4], Tulay TOPRAK[5], Murat TUNCTURK[6]

[1,2,3,4,5,6] Department of Field Crops, Faculty of Agriculture, Van Yuzuncu Yil University, 65080, Van, Turkey

[1]https://orcid.org/0000-0002-3759-8232
[2]https://orcid.org/0000-0003-2250-2645
[3]https://orcid.org/0000-0002-5304-7342
[4]https://orcid.org/0000-0003-4227-5013
[5]https://orcid.org/0000-0002-5576-2526
[6]https://orcid.org/0000-0002-7995-0599
*Corresponding author: ruveydetuncturk@yyu.edu.tr

Araştırma Makalesi

Makale Tarihçesi:
Geliş tarihi: 23.12.2021
Kabul tarihi:18.02.2022
Online Yayınlanma: 18.07.2022

Anahtar Kelimeler:
Aspir
Carthamus tinctorius L.
Çeşit
Kükürt
Besin içeriği

ÖZ

Bu çalışma, sulu koşullar altında 2011 ve 2012 yılları yazlık vejetasyon döneminde aspir (*Carthamus tinctorius* L.) çeşitlerinin besin içerikleri üzerine kükürt dozlarının etkilerini belirlemek amacıyla yapılmıştır. Arazi denemeleri, Van Yüzüncü Yıl Üniversitesi Ziraat Fakültesi deneme alanında Tesadüf Blokları ParselDeneme Deseni' ne göre üç tekerrürlü olarak yürütülmüştür. Faktör olarak üç farklı kükürt dozu (0, 25, 50 kg/ha) ve üç aspir çeşidi kullanılmıştır. Çalışmada aspir tohumunun makro ve mikro besin elementi içerikleri incelenmiştir. Kükürt uygulamalarının tohumların Ca, Fe ve Mn içerikleri dışında K, Mg, Zn ve Cu gibi besin element içeriklerini önemli ölçüde etkilemediği belirlenmiştir. Ayrıca aspir çeşitleri arasında Mg ve Cu dışında, K, Ca, Fe, Mn ve Zn besin içeriği bakımından istatistiksel olarak önemli farklılıklar tespit edilmiştir.

Effects of Different Sulphur Doses on Nutrient Contents of Safflower (*Carthamus tinctorius* L.) Cultivars

Research Article

Article History:
Received: 23.12.2021
Accepted: 18.02.2022
Published online: 18.07.2022

Keywords:
Safflower
Carthamus tinctorius L.
Cultivar
Sulphur
Nutrient content

ABSTRACT

This study was carried out to determine the effects of sulphur doses on the nutrient contents of safflower (*Carthamus tinctorius* L.) cultivars under irrigated conditions in the 2011- and 2012-years spring periods. Field trials were conducted with a randomized complete block split-plot design with three replications in the experimental area of Van Yuzuncu Yıl University, Faculty of Agriculture. As a factor, three different sulphur doses (0, 25, 50 kg ha^{-1}) and three safflower cultivars were used. In the study, macro and micronutrient element contents of safflower seed were investigated. It was determined that wasn't affected significantly by nutrient element contents such as K, Mg, Zn, and Cu except for Ca, Fe, and Mn contents of seed by sulphur applications. In addition, statistically significant differences were found among safflower varieties in terms of the nutrient content of K, Ca, Fe, Mn, and Zn, except for Mg and Cu.

To Cite: Tuncturk R., Nohutcu L., Yolcı MS., Selem E., Toprak T., Tuncturk M. Effects of Different Sulphur Doses on Nutrient Contents of Safflower (*Carthamus tinctorius* L.) Cultivars. Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi 2022; 5(2): 720-728.

1. Introduction

Carthamus tinctorius L., belonging to the family Asteraceae, is a multipurpose oilseed crop grown mainly for its high-quality edible oil (Beyyavas et al., 2011). The eastern part of the Mediterranean region is regarded as the center of origin of the safflower genus (Ashri and Knowles, 1960). The seeds of this plant contain 15-20 % protein, and 35-50 % oil (Rahamatalla et al., 2001). Safflower is an important oilseed crop that has been widely cultivated as a source of edible oil and dyes in the world. The average fatty acid composition of the safflower oil is about 78 % linoleic 10 % oleic 9 % stearic and 5% palmitic acid (Yadav and Srivastava, 2013). Safflower is also grown for its flowers which are used as cut flowers, in coloring and flavoring food, in textile dyes, as livestock forage, as a vegetable, in herbal teas, and for medicinal purposes (Mohammadi et al., 2014). Safflower has a high degree of tolerance to drought and salinity which possessing deep roots makes it able to meet its water requirements from a lower layer of soil (Naderi and Bijanzadeh, 2014).

S is required by the plants in amounts similar to phosphorus (P) and is important to the plants for protein formation and other functions (Rani et al. 2009). Sulphur application decreased soil reaction and increased uptake of nutrients by plants (Yener, 1997). Sulfur is particularly effective in the root development of plants. Although sulfur (S) has been an essential well macro element for plant growth for more than two centuries, its use in agricultural production is not common (Jianeng and Haibo, 2015). This study aimed to explore the effects of sulphur doses on some macro and micro nutrition elements content of safflower cultivars.

2. Materials and Methods

The research was conducted in experimental areas of Van Yuzuncu Yil University, Faculty of Agriculture, Field Crops Department in 2010 and 2011. Soil properties of the trial field were clay, loam, high in clay (17.9 %), low in salt (0.021 %), and light alkaline (pH 8.4). Experimental soil had low concentrations of organic material (1.85 %) and nitrogen (0.092 %). Available phosphorus content of the soil was highly low (6.70 ppm) and available potassium content was sufficient (488 ppm). Climatic data of the years in which the research was conducted were 377.4-516.9 mm rainfall, 11.20-9.45 ºC mean temperature, and 53.5 %- 56.5 % mean humidity, respectively. Seed sowings, in the ratio of 30 kg/ha, by hand were realized in both experimental years. Field trials were designed in factorial order according to randomized complete block design (RCBD) with three replications. As factor, three different sulphur doses (0 kg/ha, 25 kg/ha, and 50 kg/ha) and three different safflower cultivars (Dinçer (C1), Remzibey (C2), and Yenice (C3)) were used. Seeds were sown by hand on April 6, 2010, and April 19, 2011, in the experimental years. Each plot sizes were 3m x 1.8m = 5.4 m^2 and row spacing was 30 cm in 6 rows. The area harvested was 2.4 m^2 and plants were harvested by hand when seeds were ripened.

Nutrient element contents of the plant samples were determined as follows; dried plant samples were ashed in a furnace with hydrochloric and nitric acid (AOAC). After this process, distilled water (50

ml) was added to samples in a volumetric flask. All analyzes were repeated three times and standard materials were used for chemical analyses. Atomic Absorption Spectrometry was used for the determination of mineral compositions. All data were subjected to Analysis of Variance and the significance of mean values was tested by Duncan Multiple Range Test using COSTAS (version 6.3) software (Duzgunes et al., 1987).

3. Results and Discussion

Depending on the effects of the factors applied in the study, the averages of two years are given in Tables 1, 2, 3, 4, 5, 6, and 7). The results of this study showed that, affected Fe and Mn contents of seed by sulphur doses, while K, Ca, Mg, Zn, and Cu contents were not affected. However, concerning Mg and Cu contents were no significant differences among cultivars while among cultivars in other minerals (K, Ca, Fe, Mn, and Zn) were found significant differences. Effects on the Ca, Fe and Mn contents were found significant while on effects the K, Mg, Zn, and Cu were not found significant. of the sulphur doses and cultivar interaction (S x C).

Table 1. Effects of sulphur doses on K (%) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	0.49	0.54	0.56	0.53 b
Remzibey (C2)	0.66	0.57	0.60	0.61a
Yenice (C3)	0.56	0.57	0.63	0.59ab
Means	0.57	0.56	0.60	
LSD (0.05)	0.059			
CV (%)	10.32			
Sulphur Doses (S)		ns		
Cultivars (C)		*		
Sulphur Doses (S) X Cultivars (C)		ns		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** P < 0.01; * P < 0.05.

On the K content, the differences among only cultivars were found statistically significant (5%), while it was not found significant the effects of sulphur doses applications and sulphur x cultivars interaction. The highest K content was obtained as 0.61 % from the Remzibey cultivar and also the lowest value was determined as 0.53 % from the Dincer cultivar. With sulphur doses, K content was recorded between 0.56-0.60%. Potassium regulates the osmotic pressure of the plant and it has an important role in starch synthesis In similar studies related to the subject; Day et al. (2017) determined that the K content was obtained between 45.4- 72.1 g/kg from the Remzibey cultivar, while K content was obtained between 52.6-69.2 g/kg from the Yenice cultivar. In related to sulphur applications, Yılmaz (2017) determined that the highest K content was obtained as 4.67 % from 20 kg S ha^{-1}.

Table 2. Effects of sulphur doses on Ca (%) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	0.31 d	0.38 d	0.36 d	0.35 b
Remzibey (C2)	0.90 a	0.43 d	0.56 c	0.63 a
Yenice (C3)	0.63 bc	0.46 d	0.66 b	0.58 a
Means	0.61 a	0.42 b	0.53 a	
LSD (0.05)	0.09			
CV (%)	17.12			
Sulphur Doses (S)		**		
Cultivars (C)		**		
Sulphur Doses (S) X Cultivars (C)		**		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** $P < 0.01$;* $P < 0.05$.

The effects of all trial factors and interaction on Ca content were found significant at the 1% level. In terms of calcium content, the highest value was obtained as 0.61 % from 0 kg ha^{-1} (control) sulphurs doses. It is the same group with a 50 kg/ha sulphur dose. The lowest Ca content (0.42 %) was determined from a 25 kg/ha sulphur dose. Also, among the cultivars, the highest value was recorded as 0.63 kg/ha from the Remzibey cultivars. However, it is seen that there is no statistically significant difference between the C3 cultivar (Table 2). In relation to the Sulphur Doses (S) x Cultivars (C), the best results were recorded as 0.90 % from the control group of sulphur, in the Remzibey variety. Calcium functions as an essential plant nutrient and as a structural element in the plant cell wall (Perochon et. al., 2011). Day et al. (2017) recorded that Ca content was determined between 7.7-11.0 g/kg from the Remzibey cultivar, while Ca content was obtained between 8.7-12.2 g/kg from the Yenice cultivar. In addition, it was recorded that obtained from control (0 kg S ha^{-1}) applications as 1.22 % highest Ca content of canola plant, in a study carried out by Yılmaz (2007).

Table 3. Effects of sulphur doses on Mg (%) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	0.28	0.29	0.30	0.29
Remzibey (C2)	0.30	0.27	0.30	0.29
Yenice (C3)	0.30	0.27	0.33	0.30
Means	0.29	0.28	0.31	
LSD (0.05)	0.04			
CV (%)	16.80			
Sulphur Doses (S)		ns		
Cultivars (C)		ns		
Sulphur Doses (S) X Cultivars (C)		ns		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** $P < 0.01$; * $P < 0.05$.

Both factors used in the experiment did not significantly affect the magnesium content. In terms of cultivars, Mg content was between 0.29-0.30 %, and sulfur applications were found between 0.28-

0.31%. Yılmaz (2017), determined that Mg content was found between 0.23-0.24 % in canola plants. It is slightly higher our research results than the findings of the researcher.

Table 4. Effects of sulphur doses on Fe (ppm) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	82.8 g	90.0 efg	94.9 def	89.2 c
Remzibey (C2)	120.2 b	89.1 fg	101.9 cd	103.7 b
Yenice (C3)	103.1 c	95.1 de	128.7 a	108.9a
Means	102.0b	91.3c	108.5a	
LSD (0.05)	5.08			
CV (%)	5.05			
Sulphur Doses (S)		**		
Cultivars (C)		**		
Sulphur Doses (S) X Cultivars (C)		**		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** P < 0.01 * P < 0.05.

The effects of all trial factors and interaction on Fe content were found significant at the 1% level. While the maximum Fe content was detected as 108.5 ppm from 50 kg/ha sulphur applications, the minimum Fe content was obtained as 91.3 ppm from 25 kg/ha sulphur applications. According to cultivars, the best results related to Fe content were determined as 108.9 ppm from the Yenice cultivar, also the lowest value was determined as 89.2 ppm from the Dincer cultivar. Aytac et al., (2014) recorded that the highest Fe content (61.53 mg/kg) was obtained from the UC-1 cultivar and the lowest value (43.13 mg/kg) was obtained from the Remzibey cultivar. However, Naderi and Bijanzadeh (2014) determined that the Fe content was obtained between 65.82-91.41 mg/kg in the two different safflower cultivars. In the Sulphur Doses (S) x Cultivars (C) interaction the highest Fe contents were recorded as 128.7 ppm from 50 kg/ha sulphur application in the Yenice variety. In a study conducted on the canola plant by Yılmaz (2017), the highest Fe content (80.0 mg/kg) was obtained from 40 kg/ha sulphur dose application, the lowest value (71.0 mg/kg) was obtained from the control plot. Our research results were found to be considerably higher than the researcher's findings.

Table 5. Effects sulphur doses on Mn (ppm) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	22.6 c	24.6 c	25.0 c	24.1 b
Remzibey (C2)	27.7 b	25.0 c	23.6 c	25.5 b
Yenice (C3)	24.3 c	22.7 c	34.9 a	27.3 a
Means	24. 9 b	24.1 b	27.8 a	
LSD (0.05)	1.45			
CV (%)	5.69			
Sulphur Doses (S)		**		
Cultivars (C)		**		
Sulphur Doses (S) X Cultivars (C)		**		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** P < 0.01; * P < 0.05

The effects on the Mn content were found, statistically significant (1%) of cultivars, Sulphur doses, and S x C interaction. In terms of sulphur fertilizer doses, the maximum Mn content (27.8 ppm) was recorded from 50 kg/ha sulphur (S) applications. The minimum value was obtained as 24.1 ppm from 25 kg/ha sulphur (S) applications. However, it was determined that there are no statistically important differences between control plots. In the study, the highest Mn content (27.3 ppm) was determined from the Yenice cultivar, also the lowest value (24.1 ppm) was determined from the Dincer cultivar. But, there are no statistically important differences between Dincer with Remzibey cultivars. About the Sulphur Doses (S) x Cultivars (C), the best results were detected as 34.9 ppm from 50 kg/ha sulphur applications in the Yenice variety. The other study conducted on the different safflower cultivars (Dincer, Remzibey, Yenice, UC-1, and V50/63) determined that the highest Mn content was 15.10 mg/kg from the Dincer cultivar and the lowest value (10.53 mg/kg) was obtained from Yenice cultivar (Aytac et al., 2014). Naderi and Bijanzadeh (2014) determined that Mn content obtained between 120.32-122.2 mg/kg in the two different safflower cultivars. While our research results were higher than Aytac et al., (2007), it was found to be much lower than Naderi and Bjanzadeh (2014).

Table 6. Effects of sulphur doses on Zn (ppm) contents of safflower cultivars

Parameters	**Control (0 kg/ha)**	**25 kg/ha**	**50 kg/ha**	**Means**
Dincer (C1)	59.1	63.8	67.3	63.4 b
Remzibey (C2)	72.3	83.0	74.2	76.5 a
Yenice (C3)	67.1	68.3	65.8	67.0 b
Means	66.2	71.7	69.1	
LSD (0.05)	5.62			
CV (%)	8.15			
Sulphur Doses (S)		ns		
Cultivars (C)		**		
Sulphur Doses (S) X Cultivars (C)		ns		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** $P < 0.01$; * $P < 0.05$

Zinc is required for various chemical reactions such as protein and DNA synthesis, growth, and immune system function (Maiti et al., 2016). On the zinc content, the differences among only cultivars were found statistically significant (5%), while it was not found significant the effects of sulphur doses applications and sulphur x cultivars interaction. In this research, the Zn ratio of the safflower cultivar was determined between 66.2-71.7 ppm. The best result for zinc was detected at 76.5 ppm from the Remzibey cultivar, the lowest results were obtained at 63.4 and 67.0 ppm from Dincer and Yenice cultivars, respectively. Between both cultivars, there are no differences statistically. The study conducted on the different safflower cultivars (Dincer, Remzibey, Yenice, UC-1, and V50/63) determined that the highest Fe content was obtained as 46.73 mg/kg from the Remzibey cultivar and the lowest value (34.37 mg/kg) was obtained from V50/63 cultivar (Aytac et al. 2014). Naderi and Bijanzadeh (2014) recorded that Zn content obtained between 32.28-32.87 mg/kg in the two different

safflower cultivars. Our research findings were found to be considerably higher than the researcher's findings.

Table 7. Effects of sulphur doses on Cu (ppm) contents of safflower cultivars

Parameters	Control (0 kg/ha)	25 kg/ha	50 kg/ha	Means
Dincer (C1)	35.4	39.8	40.8	38.6
Remzibey (C2)	41.5	39.8	41.1	40.8
Yenice (C3)	41.8	36.8	45.9	41.5
Means	39.6	38.8	42.6	
LSD (0.05)	5.51			
CV (%)	13.67			
Sulphur Doses (S)		ns		
Cultivars (C)		ns		
Sulphur Doses (S) X Cultivars (C)		ns		

Different letters above columns indicate significance levels of means according to Duncan's Multiple Range Test. ** $P < 0.01$; * $P < 0.05$.

According to the results of this research, of none of the research factors, the effect on the content of copper wasn't found to be statistically significant. Copper is an essential biometal for humans, animals, and certain types of plants (Nikolica et. al., 2014). The Cu content was obtained between 38.8 and 42.6 ppm in the different sulphur doses applications. For cultivars, copper content was detected between 38.6-41.5 ppm. The study conducted in the five different safflower cultivars (Remzibey, Yenice, Dincer, UC-1, and V50/63) conducted by Aytac et al., (2014) recorded that the highest Cu content (16.35 mg/kg) was obtained from UC-1 cultivar, while the lowest value (3.30 mg/kg) from V50/63 cultivar. Naderi and Bijanzadeh (2014) reported that Cu content was obtained between 15.31-15.77 mg/kg in the two different safflower cultivars.

4. Conclusions

It was determined that was affected significantly the nutrient elements contents such as Ca, Fe, and Mn except for K, Mg, Zn, and Cu by different sulphur doses applications. Only, it had been determined that Mg and Cu weren't affected by both application factors. Also, it was recorded a significant difference statistically among safflower cultivars in K, Ca, Fe, Mn, and Zn contents.

Minerals are of great importance for cell protection and healthy tooth, bone, and skin structure. Apart from this, they play an important role in blood pressure, heart rhythm, muscle functions, maintaining fluid balance in the body, reproduction, and many other functions. As a result of scientific research, mineral loss and deficiency directly affect our health. As a result of the research, it was determined that significant increases occurred in the Fe and Mn content especially the Yenice variety with sulfur applications in safflower seed, which is an important oil plant.

Conflict of Interest Statement

The authors of the article declare that there is no conflict of interest between them.

Contribution Rate of Researchers Statement Summary

The authors declare that they have contributed equally to the article.

References

AOAC. Official Method of Analysis 962.09 (17 Th Edition) Volume I. Association of Official Analytical Chemists 2020; Inc., Maryland, USA.

Ashri A., Knowles P.F. Cytogenetics of safflower *Carthamus tinctorius* L. species and their hybrids. Agronomy Journal 1960; 52(1): 11.

Aytac Z., Gulmezoglu ND., Sirel Z., Alkan TI., Torun A. The effect of zinc on yield, yield components, and micronutrient concentrations in the seeds of safflower genotypes (*Carthamus tinctorius* L.). Not. Bot. Horti. Agrobo. 2014; 42(1): 202-208.

Beyyavas V., Haliloglu H., Çopur O., Yılmaz A. Determination of seed yield and yield components of some safflower (C*arthamus tinctorius* L.) cultivars, lines and populations under the semi-arid conditions. Afr J Biotechnol 2011; 10(4): 527.

Day S., Cıkılı Y., Aasim M. Screening of three safflower (*Carthamus tinctorius* L.) cultivars under boron stress. Acta Sci. Pol. Hortorum Cultus 2017; 16(5): 109-116.

Duzgunes O., Kesici T., Kavuncu O., Gurbuz F. Research and experimental methods. Statistical Methods-II). Ankara University, Agr Fac Press 1987; 1021: 295.

Jianeng G., Haibo J. Preparation of ceramic honeycomb monolithic catalyst and catalytic performance in oxidative dehydrogenation of cyclohexane oxid. Commun 2015; 38(4): 1645.

Maiti R., Rodriguez HG., Degu HD., Kumari CA. Sarkar NC. Macro and micronutrients of 44 medicinal plant species used traditionally in Nuevo Leon, Mexico. International Journal of Bio-resource and Stress Management 2016; 7(5): 1054-1062.

Mohammadi M., Tavakoli A., Saba J. Effects of foliar application of 6-benzylaminopurine on yield and oil content in two spring safflower *(Carthamus tinctorius* L.) cultivars. Plant Growth Regul. 2014; 73: 219.

Naderi R., Bijanzadeh E. Organic amendment sand nitrogen effects on growth and chemical composition of two cultivars of safflower (*Carthamus tinctorius* L.). Aust J Crop Sci. 2014; 8(4): 577-581.

Nikolica RS., Kocicb GM., Kostica DA., Nikolicb NG., Jovanovica JM., Krstica NSA. Study on the protective role of lipoic acid in case of acute heavy metal (Cd, Pb, Cu) intoxication through the activity of the dnase in the liver and kidneys. Oxidation Communications 2014; 37(4): 1103-1110.

Perochon A., Alden D., Galaud JP., Ranty B. Calmodulin and calmodulin- like proteins in plant calcium signaling. Biochimie 2011; 93: 2048-2053.

Rahamatalla AB., Babiker EE., Krishna AG., Tinay AE. Changes in fatty acids composition during seed growth and physico chemical characteristics of oil extracted from four safflower cultivars. Plant Food Hum Nutr. 2001; 56: 385.

Rani KU, Sharma KL., Nagasri K., Srinivas K., Murthy TV., Shankar GRM., Korwar GR., Sankar KS., Madhavi M., Grac JK. Response of sunflower to sources and levels of sulfur under rain fed semi-arid tropical conditions. Commun Soil Sci Plant. 2009; 40: 2926.

Yadav G., Srivastava HC. Fatty acid composition and oil content of some safflower (C*arthamus tinctorius* L.) cultivars of Indian origin. Asian J Res Chem. 2013; 6(7): 634.

Yener H. The effect of sulphur application on growth nutrient uptake and yield of plants in alluvial soils of Gediz plain. Phd Thesis, Ege University, Izmir, Turkey. 1997.

Yılmaz R. The effect of sulphur fertilization on yield and some quality parameters in canola plant (*Brassica napus* L.). Namık Kemal University Graduate School of Natural and Applied Sciences Department of Soil Science and Plant Nutrition Msc. Thesis. Page no: 55. Tekirdağ, Turkey, 2017.