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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

The effects of different cultivation practices on yield and characteristics of saffron (*Crocus sativus* L.) corm grown in field and greenhouse conditions

Farklı yetiştiricilik uygulamalarının tarla ve sera koşullarında yetiştiriciliği yapılan safran (*Crocus sativus* L.) korm verimi ve özellikleri üzerine olan etkileri

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Ö Z E T / A B S T R A C T

Aims: This study aimed to determine the effects of different cultivation practices on yield and characteristics of saffron corm grown in field and greenhouse conditions.
Methods and Results: Two different saffron corm sizes, with an average weight of 12 g and 6 g, were used as production material. The cultivation of saffron corms was carried out in areas where 4 different treatments were applied such as silt (fine stream sand), cockpeat, peat + perlite and cockpeat + perlite. Field studies were set up according to the randomized blocks split-plot design experimental design, and greenhouse studies were set up according to the randomized plots design with 3 replications. The highest corm yield, corm increase rate per unit and the harvested corm weight were obtained in field conditions where silt applications were made.
Conclusions: In field and greenhouse conditions, silt application has been determined as the most suitable cultivation treatment for the production of corm as seed material in a short time, as well as the corm properties of saffron.
Significance and Impact of the Study: It has been demonstrated that the field conditions are more effective than the greenhouse conditions and the silt treatment is more effective than other applications used for saffron corm production.

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INTRODUCTION

Saffron (*Crocus sativus* L.) is a perennial herb of the Iridaceae family (Sarihan and Asil, 2013). Although there is no definite information about the origin of saffron, the plant is considered to grow in Anatolia and Iran (Winterhalter and Straubinger, 2000; Asil and Ayanoğlu, 2018). Today, saffron is mainly grown in Iran, India, Spain, Greece and Italy. Apart from these countries, small quantities of saffron are also cultivated in Morocco, France, Switzerland, Turkey, Israel, Azerbaijan, Pakistan, China, Egypt, UAE, Japan, Afghanistan, Iraq, Tasmania, Australia and Mexico (Abdullaev, 2002; Koç, 2012; Tekeli et al., 2014: Asil, 2018). The main part of the saffron plant is its stigmas. The dried saffron stigmas have been used for different purposes including medicinal, aromatic, food additive, textile dyeing, etc. since ancient times (Omidbaigi,

2005; Iqbal et al., 2012). Saffron and its main ingredients are traditionally used as pharmaceutical agents. Current experimental research projects also demonstrate a wide range of disease treatment applications of Saffron and its components. Safranal represents about 70% of the saffron flavor and is the most important pharmacological agent of saffron. Safranal has proven antioxidant, cytotoxic, antitussive, anticonvulsant, antinociceptive, neuroprotective, antidepressant, and many pharmacological effects (Nemati et al., 2014; Erden and Özel, 2016).

Saffron is a sterile triploid plant and is only vegetatively reproduced by its corms (Iqbal et al., 2012; Koocheki and Seyyedi, 2015). Therefore, the selection of efficient corms is the most important factor in saffron production. Studies have shown that corm size has a positive effect on saffron blooming (İpek et al., 2009; Çavuşoğlu, 2010). Flowering in saffron occurs in a limited period of time about 2-3 weeks, and each corm produces 1-4 flowers depending on its size. Amplification of saffron occurs with the cormlets which form from corms. Depending on its weight, each corm contains 1-4 buds forming flowers and leaves. Between the horizontal lines of the corms, many small brown spots generate cormlets. The weight of each corm varies between 1-20 g (Iqbal et al., 2012; Kırıcı et al., 2018).

Saffron production is accomplished by traditional methods and the production technology has not significantly changed for a long time. Saffron production generally results in lower income for the farmers due to high production costs resulting from its relatively short flowering period, low average yield, manual harvesting of stigmas and drying period (Maggio et al., 2006; Asil, 2018; Sevindik et al., 2018). Especially in the Mediterranean basin, a significant decrease in saffron production has been reported due to the increased labor costs (Negbi, 1999).

Although saffron lost its importance in Turkey in the 1900s, it is considered that this valuable plant should attract attention of farmers again in Turkey for both commercial and medicinal purposes. The main purpose of the cultivation of saffron should also be not only to increase the amount of production of saffron but also apply the most efficient way for its farming including laborious process from planting to harvesting (Çınar and Önder, 2019). Considering its commercial and medicinal values, necessary precautions should be taken to increase the annual production of saffron in Turkey. Various studies were carried out to increase the number of corms species and the quality of saffron, but these studies are not sufficient to achieve these aims (Çınar and Önder, 2019).

Along with the traditional production of saffron, many attempts have been made worldwide to produce saffron under controlled conditions to increase saffron yield and reduce production costs (Maggio et al., 2006). Modern production methods should replace traditional methods to increase saffron production and obtain high-quality saffron. (Mollafilabi and Shoorideh, 2009). Saffron cultivation could be successful under controlled conditions in plastic tunnels and hydroponic systems. In this cultivation system, the growth and nutrition environments of the plants are controlled correctly; higher yield and better quality are possible. Growing systems under controlled conditions may be a viable alternative to traditional saffron cultivation (Mollafilabi et al., 2012).

The kinds of soil are another factor affecting the development of saffron corms and thus its flowering capacity. It has been reported that when saffron is planted in light-textured soils, it is more favorable for the formation of daughter corms. Climate significantly improves the vegetative growth and improves the reproductive characteristics of corm plants (Aghhavani et al., 2015; Shajari et al., 2020). As a result, cultivation in controlled environments using hydroponic systems has been proposed as a way to increase saffron yield while reducing production costs (Molina et al., 2005). In addition, many studies on different plants showed that the effects of different growing environments were different. There are the limited number of studies on the development of saffron corms in different soil cultures (Yıldırım and Hatipoğlu, 2020). In saffron cultivation, the three most important goals are reducing labor cost, increasing stigma yield, and large size corm production (Çavuşoğlu et al, 2009).

This study aimed to determine the effects of different cultivation practices, such as silt (find stream sand), cocopeat, peat+perlite and cocopeat+perlite, on yield and yield characteristics of saffron corm grown in both field and greenhouse conditions.

MATERIALS and METHODS

Material

This study was carried out at the Olive Research Institute in Hassa (36°42'42"N 36°30'19"E) between September 28, 2018 and May 13, 2019. In the study, an average weight of 12 g (10 to 14 g) for the large size of saffron corms and an average weight of 6 g (5 to 7 g) for the small size of saffron corms were weighed and used for the experiments. The corms used in the study, the

corms separated from the previous studies as production material was used.

Methods

As a growth and development environment, planting of the planting was carried out in four different growing environments (silt (fine stream sand)(S), cocopeat (C), peat + perlite (PP)(1/1), and cocopeat + perlite (CP)(1/1)). The experiment was established with 3 replications, field conditions were according to the randomized blocks split-plot design, and greenhouse conditions were according to the design of the randomized plot. 10 corms were planted in each plot (1.1 m^2) with 0.10 m rows, 0.10 m planting depth, and 10 corms in each plot, and plots were formed with a total weight of 120 g for large corms and 60 g for small corms. After planting, each parcel was irrigated for both the greenhouse and field environments. No other irrigation was carried out for the field conditions. To meet the nutrient needs of the plant in different soil cultures, Max Plus ZN zinc-containing liquid foliar fertilizer was applied at a dose of 75 cc/decare after the plant leaves exceeded 10 cm in height (December 28, 2018). Foliar fertilizer was applied once.

Experimental corms were started to be harvested in May 13, 2019. When they dried, corms were weighted and sized. The harvested corms were weighed and collected into three groups according to their weights including less than 5 g, between 5-10 g, and greater than 10 g. The number of corms in a parcel, the weights of the corms in the parcel and the number of parcel in the cores were separately evaluated according to this classification. Total corm weight (g $parcel^{-1}$), corm weight < 5 g (g $parcel^{-1}$), corm weight between 5-10 g (g $parcel^{-1}$), corm weight > 10 g (g $parcel^{-1}$), total number of corms (pieces $parcel^{-1}$), number of corms < 5 g (pieces $parcel^{-1}$), number of corms between 5-10 g (pieces $parcel^{-1}$), number of corms > 10 g (pieces $parcel^{-1}$) , number of eyes in corms < 5 g (pieces $parcel^{-1}$), number of eyes in corms between 5-10 g (pieces $parcel^{-1}$), number of eyes in corms parcel > 10 g (pieces $parcel^{-1}$), the number of corm parcel < 5 g (pieces $parcel^{-1}$), the number of corm parcel between 5-10 g (pieces $parcel^{-1}$),the number of corm parcel > 10 g (pieces $parcel^{-1}$), harvested unit corm weight (g) daughter corm ratio (%) and unit corm increase ratio (%) traits were also investigated in this study.

Greenhouse and field conditions

The study was conducted at an altitude of 290 m, in a greenhouse (alan = 48 m^2, height = 3.5 m) of the Olive Research Institute in Hassa / Hatay, located at 39°42' north latitude and 36° 30' east longitude, and the width of the table is 2.5 m. It is 1.15 m wide and 0.28 m deep. Greenhouse average temperature = 25.5 °C, maximum temperature = 33.5 °C, minimum temperature = 17.4 °C, average relative humidity = 31.6%, maximum relative humidity = 90.8% and minimum relative humidity = 64.9%. Greenhouse trays are heated from the bottom and have a misting irrigation unit.

Field conditions were carried out in open field conditions at the end of the greenhouse. The total amount of precipitation in the region is 1120 mm for many years, and the total precipitation between September/2018 and May/2019 during the study period was 1626 mm. For many years, the average temperature in the region is 18.4 °C and the lowest temperature was 6.7 and the highest temperature was 26.4 °C during the growing period. The relative humidity during the experiment in autumn is a little low and moisture increases in the summer and winter months. Relative humidity range was 55-95%. Plant growth conditions and experimental area are shown in Figure 1.

Figure 1. Saffran plant and growth conditions where experiments were conducted

Experimental environment and meteorological conditions

The physical properties of the growing media used in the experiments are as follows:

Silt (fine stream sand): pH 7.75, salt-free, little lime, medium amount of organic matter, loamy soil, poor

nitrogen, very high useful phosphorus, and low useful potassium.

Cocopeat growing medium: weight per volume 0.13 g cm^3, total porosity 91%, aeration capacity 35%, water holding capacity 62%.

Peat + perlite growing medium: weight per volume 15.28 g cm^3, total porosity 79%, aeration capacity 43%, water holding capacity 52%.

Cocopeat + perlite growing medium: weight per volume 15.25 g cm^3, total porosity 79%, aeration capacity 43%, water holding capacity 50%.

Data analysis

The variance analysis of the mean values of the characters obtained from the experiment was accomplished using MSTAT-C statistical package program and the differences between the averages were determined by the Duncan test.

RESULTS and DISCUSSION

In this study, the effects of growing environments and cultivation practices on the corm properties of saffron were investigated in field and greenhouse conditions. Field and greenhouse conditions were separately evaluated and Tables 1 and 2 summarize the results of the variance analysis and Duncan groups. The harvested corms were weighed and collected into three groups according to their weights including less than 5 g, between 5-10 g, and greater than 10 g. The number of corms in a parcel, the weights of the corms in the parcel and the number of parcel in the cores were separately evaluated according to this classification. The total number of parcels and total corm weights in a parcel were given in Table 1. The purpose of the classifications of the harvested corms into three groups is to guide the production planning for the next growing season. According to the literature and observations in our previous studies, after planting corms heavier than 10 g bloom after planting, but corms weighting between 5-10 g bloom next year. Therefore, the classification of corms is important for the production planning of saffron according to the harvested corm size.

Effects of different cultivation practices on the corm properties of saffron under field conditions

The obtained outcomes of the study for the effects of different habitats and corm heights under the field conditions with the variance analysis results are summarized in Table 1.

Total corm weight in a parcel

When the effect of different cultivation practices and corm sizes on total parcel corm weight (g) was examined, this effect was found to be 1% statistically significant. Corm weights for all studies were also found to be 1% statistically significant. According to the cultivation environment, the highest harvested corm weights were 373.55 g in the silt growing medium. The highest harvested corm weights for corms weighting less than 5 g was found to be 96.42 g in the silt growing medium. The highest harvested corm weights for corms weighting between 5-10 g was found to be 86.55 g in the silt growing medium. Corms weighting above 10 g resulted in 165.43 g of the highest harvested corm weights in the silt growing medium. When the total parcel corm weights are examined according to the size of the corm, the highest corm weight for the total parcel was 379.21 g for the large-sized corm planting. 93.64 g of it was for corm weighting less than 5 g, its 105.67 g for corm weighting between 5-10 g and 179.93 g for corm weighting above 10 g (Table 1).

Number of corms in harvested parcels

The effect of cultivation practices on the harvested number of corms (number of corms weighting less than 5 g, between 5-10 g and greater than 10 g) in each parcel was found to be statistically insignificant. According to the planted corm size evaluation, the effect of number of corms in each parcel corms weighting less than 5 g and 5-10 g was found to be statistically significant. Corms weighting greater than 10 g were also found to be statistically significant. When the growth environments are evaluated in terms of the number of corms, the highest average number of corms in parcels was found to be 55.00 obtained under silt culture medium. The highest average number of corms weighting less than 5 g of corms was 25.67. It was found to be 12.67 average number of the corms weighting between 5-10 g and 11.17 average number of the corms weighting above 10 g obtained under silt culture medium.

According to the planted corm sizes, the highest average number of corms in the parcel was 58.42. The highest average number of corms (weighting less than 5 g) was 30.99. It was found to be 15.04 average number of the corms weighting between 5-10 g and 12.38 average number of the corms weighting higher than 10 g (Table 1).

Table 1. Effects of different cultivation practices on the corm properties of saffron under field conditions

Measured characters	Planted corm dimensions	Cultivation practices				Average
		PP	S	CP	C	
Total corm weight (g parcel^{-1})	Large	299.87	464.67	389.80	362.50	379.21 A*
	Small	203.83	282.43	188.37	156.00	207.66 B*
	Average	**251.85 B***	**373.55 A***	**289.08 AB***	**259.25 B***	
Corm weight < 5 g (g parcel^{-1})	Large	72.70	117.93	93.33	90.60	93.64 A*
	Small	32.23	74.90	37.30	35.90	44.83 B*
	Average	**51.97**	**96.42**	**65.32**	**63.25**	
Corm weight between 5-10 g (g parcel^{-1})	Large	95.87	130.93	77.23	118.63	105.67 A*
	Small	31.80	42.17	54.17	44.47	43.15 B*
	Average	**63.83**	**86.55**	**65.70**	**81.55**	
Corm weight > 10 g (g parcel^{-1})	Large	131.30	215.87	219.27	153.30	179.93 A**
	Small	140.80	165.43	96.93	75.70	119.72 B**
	Average	**136.05**	**190.65**	**158.10**	**114.50**	
Total number of corms (pieces parcel^{-1})	Large	50.00	70.00	55.33	58.33	58.42 A*
	Small	21.90	40.00	26.00	24.67	28.14 B*
	Average	**35.95**	**55.00**	**40.67**	**41.50**	
Number of corms < 5 g (pieces parcel^{-1})	Large	26.63	36.67	30.00	30.67	30.99 A*
	Small	8.47	25.67	11.67	12.90	14.68 B*
	Average	**17.55**	**31.17**	**20.83**	**21.78**	
Number of corms between 5-10 g (pieces parcel^{-1})	Large	13.33	19.00	11.00	16.83	15.04 A*
	Small	4.03	6.33	7.00	6.23	5.90 B*
	Average	**8.68**	**12.67**	**9.00**	**11.53**	
Number of corms > 10 g (pieces parcel^{-1})	Large	10.03	14.33	14.33	10.83	12.38 A**
	Small	9.40	8.00	7.33	5.57	7.58 B**
	Average	**9.72**	**11.17**	**10.83**	**8.20**	
Number of eyes in corms < 5 g (pieces parcel^{-1})	Large	**6.13**	**7.90**	**8.23**	**7.47**	7.43
	Small	**5.77**	**6.0**	**6.23**	**7.10**	6.28
	Average	**5.95**	**6.95**	**7.23**	**7.28**	
Number of eyes in corms between 5-10 g (pieces parcel^{-1})	Large	**6.77**	**9.57**	**10.87**	**11.67**	9.72
	Small	**8.23**	**9.80**	**11.33**	**10.67**	10.01
	Average	**7.5**	**9.68**	**11.10**	**11.17**	
Number of eyes in corms parcel > 10 g (pieces parcel^{-1})	Large	**12.10**	**15.90**	**16.90**	**12.20**	14.28
	Small	**14.15**	**14.87**	**13.0**	**13.23**	
	Average	**13.33 BC****	**15.38 A****	**14.95 AB****	**12.72 C****	
The number of corm parcel < 5 g (pieces parcel^{-1})	Large	6.13	7.90	8.23	7.47	7.43
	Small	5.77	6.00	6.23	7.10	6.28
	Average	**5.95**	**6.95**	**7.23**	**7.28**	
The number of corm parcel between 5-10 g (pieces parcel^{-1})	Large	6.77	9.57	10.87	11.67	9.72
	Small	8.23	9.80	11.33	10.67	10.01
	Average	**7.50**	**9.68**	**11.10**	**11.17**	
The number of corm parcel > 10 g (pieces parcel^{-1})	Large	12.10	15.90	16.90	12.20	14.28
	Small	14.57	14.87	13.00	13.23	13.92
	Average	**13.33 BC****	**15.38 A****	**14.95 AB****	**12.72 C****	
Harvested unit corm weight (g)	Large	6.40	6.67	7.13	6.70	6.73
	Small	9.97	7.20	7.48	6.57	7.80
	Average	**8.18**	**6.93**	**7.30**	**6.63**	
Daughter corm ratio (%)	Large	500.00	700.00	553.33	583.33	584.17 A*
	Small	219.03	400.00	260.00	246.67	281.43 B*
	Average	**359.52**	**550.00**	**406.67**	**415.00**	

Table 1 (continued). Effects of different cultivation practices on the corm properties of saffron under field conditions

Unit corm increase ratio (%)	Large	245.10	372.83	304.77	287.73	302.61
	Small	339.67	470.73	313.90	260.03	346.08
	Average	**292.38 B***	**421.78 A***	**309.33 B***	**273.88 B***	

*, ** indicate significance at 0.01 and 0.05 levels, S: silt , C: cocopeat, PP: peat + perlite and CP: cocopeat + perlite should be added each table as footnote-

Unit corm weights

When the weights of the harvested unit corms were examined, the cultivation environments and corm sizes were found to be statistically insignificant. According to the growing medium, the highest unit corm weight with 8.18 g was obtained from a peat-perlite mixture. According to the planted corm sizes, the highest unit corm weight with 7.80 g was observed from small size planted corm (Table 1).

Unit corm increase ratio

The effect of the cultivation practices on the corm ratio was found to be statistically significant. In terms of cultivation mediums, the highest unit corm increase ratio with 421.78% was observed in the silt culture medium. Regarding to the planted corm sizes, the highest unit corm increase ratio with 346.08% was obtained from small size corm planting (Table 1).

Daughter corm ratio

When the effect of the average data in terms of daughter corm ratio was examined, the effect of planted corm sizes was found to be statistically significant.

According to the growing environment, the highest daughter corm ratio with 550.00% was found to be in silt culture medium.According to the planted corm sizes, the highest daughter corm ratio with 584.17% was obtained from large size corm planting (Table 1).

Effects of different cultivation practices on the corm properties of saffron under greenhouse conditions

Total corm weight in the parcel

When the effect of different growing medium and corm sizes on total parcel corm weight (g) was examined, this effect was found to be 1% statistically significant. Corm weights for all studies were also found to be 1% statistically significant. According to the cultivation environment, the highest harvested corm weights were 202.32 g in the cocopeat growing medium. The highest harvested corm weights for corms weighting less than 5 g was found to be 49.50 g in the silt growing medium. The highest harvested corm weights for corms weighting between 5-10 g was found to be 83.62 g in the silt growing medium. Corms weighting above 10 g resulted in 79.57 g of the highest harvested corm weights in the cocopeat growing medium. When the total parcel corm weights are examined according to the size of the corm, the highest corm weight for the total parcel was 249.41 g for the large-sized corm planting. 56.58 g of it was for corm weighting less than 5 g, its 104.31 g for corm weighting between 5-10 g and 55.83 g for corm weighting above 10 g (Table 2).

Table 2. Effects of different cultivation practices on the corm properties of saffron under greenhouse conditions

Measured characters	Planted corm dimensions	Growth and development media				Average
		PP	S	CP	C	
Total corm weight (g parcel^{-1})	Large	199.67 b*	283.33 a*	223.03 b*	291.60 a*	249.41 A*
	Small	104.10 cc*	98.30 c*	110.53 c*	113.03 c*	106.49 B*
	Average	**151.88**	**190.82**	**166.78**	**202.32**	
Corm weight < 5 g (g parcel^{-1})	Large	45.33 c**	73.00 a**	49.67 bc**	58.33 b**	56.58 A*
	Small	24.00 d**	26.00 d**	21.00 d**	27.33 d**	24.58 B*
	Average	**34.67**	**49.50**	**35.33**	**42.83**	
Corm weight between 5-10 g (g parcel^{-1})	Large	69.90 c**	131.60 a**	97.27 bc**	118.47 ab**	104.31 A*
	Small	33.50 d **	35.63 d**	33.67 d**	40.67 d**	35.87 B*
	Average	**51.70**	**83.62**	**65.47**	**79.57**	
Corm weight > 10 g (g parcel^{-1})	Large	84.43	78.73	76.10	114.83	88.53 A*
	Small	46.63	36.67	55.87	45.00	46.04 B*
	Average	**65.53**	**57.70**	**65.98**	**79.92**	

Table 2 (continued). Effects of different cultivation practices on the corm properties of saffron under greenhouse conditions

Measured characters	Planted corm dimensions	Growth and development media				Average
		PP	S	CP	C	
Total number of corms (pieces parcel^{-1})	Large	45.33 c**	73.00 a**	49.67 bc**	58.33 b**	56.58 A*
	Small	24.00 d**	26.00 d**	21.00 d**	27.33 d**	24.58 B*
	Average	**34.67 B****	**49.5 A****	**35.33 B****	**42.83 AB****	
Number of corms < 5 g (pieces parcel^{-1})	Large	29.67 bc**	56.00 a**	33.67 b**	39.00 b**	39.58 A*
	Small	15.33 d**	13.67 d**	12.00 d**	17.00 cd**	14.50 B*
	Average	**22.50 B****	**34.83 A****	**22.83 B****	**28.00 AB****	
Number of corms between 5-10 g (pieces parcel^{-1})	Large	11.67	11.33	11.00	16.00	12.50 A*
	Small	6.00	5.33	8.00	6.00	6.33 B*
	Average	**8.83**	**8.33**	**9.50**	**11.00**	
Number of corms > 10 g (pieces parcel^{-1})	Large	4.00	5.67	5.00	3.33	4.50
	Small	2.67	7.00	1.00	4.33	3.75
	Average	**3.33 B****	**6.33 A****	**3.00 B****	**3.83 B****	
Number of eyes in corms parcel < 5 g (pieces parcel^{-1})	Large	8.10	6.33	6.20	8.53	7.29
	Small	6.23	4.90	6.13	6.13	5.85
	Average	7.17	5.62	6.17	7.33	
Number of eyes in corms parcel between 5-10 g (pieces parcel^{-1})	Large	14.0	12.33	13.90	13.00	13.31 A**
	Small	14.30	8.57	11.47	13.10	11.86 B**
	Average	14.15 A*	10.45 B*	12.68 AB*	13.05 A*	
Number of eyes in corms parcel > 10 g (pieces parcel^{-1})	Large	13.47	16.23	14.23	13.57	14.38 A**
	Small	8.53	13.57	4.00	14.10	10.05 B**
	Average	11.00 BC**	14.90 A**	9.12 C**	13.83 AB**	
The number of corm parcel < 5 g (pieces parcel^{-1})	Large	8.10	6.33	6.20	8.53	7.29
	Small	6.23	4.90	6.13	6.13	5.85
	Average	**7.17**	**5.62**	**6.17**	**7.33**	
The number of corm parcel between 5-10 g (pieces parcel^{-1})	Large	14.00	12.33	13.90	13.00	13.31 A**
	Small	14.30	8.57	11.47	13.10	11.86 B**
	Average	**14.15 A***	**10.45 B***	**12.68 AB***	**13.05 A***	
The number of corm parcel > 10 g (pieces parcel^{-1})	Large	13.47	16.23	14.23	13.57	14.38 A**
	Small	8.53	13.57	4.00	14.10	10.05 B**
	Average	**11.00 BC****	**14.90 A****	**9.12 C****	**13.83 AB****	
Harvested unit corm weight (g)	Large	4.40	3.87	4.47	5.00	4.43
	Small	4.37	3.80	5.27	4.167	4.40
	Average	**4.38**	**3.83**	**4.87**	**4.58**	
Daughter corm ratio (%)	Large	453.33 c**	730.00 a**	496.67 bc**	583.33 b**	565.83 A*
	Small	240.00 d**	260.00 d**	210.00 d**	273.33 d**	245.83 B*
	Average	**346.67 B****	**495.00 A****	**353.33 B****	**428.33 AB****	
Unit corm increase ratio (%)	Large	159.07	224.87	178.97	233.17	199.02
	Small	173.50	163.83	184.20	188.37	177.48
	Average	**166.28**	**194.35**	**181.58**	**210.77**	

*, ** indicate significance at 0.01 and 0.05 levels, S: silt , C: cocopeat, PP: peat + perlite and CP: cocopeat + perlite should be added each table as footnote.

Number of corms in harvested parcels

The effect of growing media on the harvested number of corms in each parcel was found to be 5% statistically significant. The planted corm size was also found to be 1% statistically significant. According to the harvested corm size evaluation, the effect of the growing media on the size of the planted corms weighting less than 5 g was found to be 5% statistically significant. The effect of the growing media on the size of the planted corms weighting between 5-10 g was found to be 1% statistically significant. When the growth environments are evaluated in terms of the number of corms, the

highest average number of corms in parcels was found to be 49.50 obtained under silt culture medium. The highest average number of corms weighting less than 5 g of corms was 34.83. It was found to be 11.00 average number of the corms weighting between 5-10 g under cocopeat medium and 6.33 average number of the corms weighting above 10 g obtained under silt culture medium. According to the planted corm sizes, the highest average number of corms in the parcel was 56.58. The highest average number of corms weighting less than 5 g of corms was 39.58. It was found to be 12.50 average number of the corms weighting between 5-10 g and 4.50 average number of the corms weighting higher than 10 g (Table 1).

Number of eyes in the corms

According to the number of eyes on the harvested corms, the effect of the cultivation environment on the number of eyes in the corms weighting between 5-10 g and higher than 10 g was respectively found to be 1% and 5% statistically significant. Evaluation of the number of eyes in the corm according to the planting environment showed that the highest average number of eyes was 7.33 for the corms weighting less than 5 g in the cocopeat culture medium and 14.15 for the corms weighting between 5-10 g in the peat+perlite culture medium. The highest average number of the parcel in corms weighting higher than 10 g was 14.90 in silt culture medium (Table 2).

Unit corm weights

When the weights of the harvested unit corms were examined, the cultivation environments and corm sizes were found to be statistically insignificant. According to the growing medium, the highest unit corm weight with 4.58 g was obtained from a cocopeat. According to the planted corm sizes, the highest unit corm weight with 4.43 g was observed from large size planted corm (Table 2).

Unit corm increase ratio

The effect of the cultivation mediums on the unit corm increase ratio was found to be statistically insignificant. In terms of cultivation mediums, the highest unit corm increase ratio with 210.77% was observed in the cocopeat culture medium. Regarding to the planted corm sizes, the highest unit corm increase ratio with 199.02% was obtained from small size corm planting (Table 2).

Daughter corm ratio

When the effect of the average data in terms of daughter corm ratio was examined, the effect of planted corm sizes was found to be 1% statistically significant. Growing medium and planted corm size interaction was found to be 5% statistically significant. According to the growing environment, the highest daughter corm ratio with 495.00% was found to be in silt culture medium. According to the planted corm sizes, the highest daughter corm ratio with 565.83% was obtained from large size corm planting. In the cultivation medium *, the highest rate of interaction of the planted corm size was 730.00% in the silt medium in large-size corm planting (Table 2).

When the field and greenhouse conditions were compared according to the weights of the harvested corms from the parcel, the total corm weight in the parcel from the large-sized corm planting was found to be 379.21 g in the field conditions. 373.55 g of corms were obtained from the silt growing environment. The total corm weight in the parcel from the large-sized corm planting was found to be 249.41 g under the greenhouse conditions. 202.32 g of corms were obtained from the cocopeat growing environment. According to the obtained outcomes, the highest weight of corms was obtained in field conditions. As the planted small-size corms grow during the growing period, an increase in the large-size corm ratio is expected. On the contrary, it is expected that the number of daughter corms should be increased and the average corm size should be decreased with planting large-sized corms (Yıldırım et al., 2017a). Yıldırım et al. (2017a) reported that the highest unit corm weight with 10,348 g was obtained from small size corms harvested every two years. The effect of the different soil mediums showed that the highest average unit corm weight with 1.89 g was obtained from peat application and the lowest average unit corm weight with 0.97 g was obtained from the silt application (Yıldırım and Hatipoğlu, 2020).

In a study conducted on different animal fertilizers, 3 g of corm was used in planting, and it was reported that the measured unit corm weights were obtained mostly from the control (without fertilizer), worm fertilizer, and cow fertilizer applied parcels (1.98; 1.92; 1.91 g, respectively) (Yıldırım et al., 2017c). In the study conducted on different harvesting periods and planting depth, the highest corm yield with 527.33 g / parcel was obtained from planting large size corms in two years and planted in 15 cm depth. The lowest yield with 84.33 g / parcel was obtained from small-size corms harvested every year and planted in 5 cm deep (Yıldırım

et al., 2017a). In a study conducted on different corm lengths and planting depth of saffron, they reported that parcel yields varied between 87.33-219.00 g (Yıldırım et al., 2017b).

In the study on different soil cultures, the highest corm yield with 41.51 g was obtained from peat application. The lowest average corm weight with 21.62 g was obtained from the silt environment (Yıldırım and Hatipoğlu, 2020). In the study conducted on different animal fertilizers; 3 g of corm was used in planting and the highest corm weight in terms of the harvested corm weights was obtained as 17.78 g / pot from the control (without fertilizer) application. The lowest yield with 1.73 g/pot was obtained from poultry fertilizer application (Yıldırım et al., 2017c). Compared to the previous studies, promising results were observed in this study in terms of the obtained unit corm weights although a one-year study caried was out for the harvesting.

When the field and greenhouse conditions were compared according to the average number of corms harvested from the parcel, 58.42 pieces of corms were obtained from large-sized corm planting in field conditions and 55.00 pieces of corms were obtained from silt growing medium. In greenhouse conditions, 56.58 pieces of corms were obtained from large-sized corm planting and 49.5 pieces of corms were obtained from silt growing medium. According to both results, higher corm weights were obtained in field conditions. In the study conducted on different harvesting periods, the researchers found that the highest number of corms was obtained from the parcels (50.67 pieces/parcel) in the second year and planted in 5 cm deep. They reported that the lowest number of corms was obtained from parcels (14.44 pieces/parcel) harvested every year and planted in 5 cm deep (Yıldırım et al., 2017a). In a study conducted on different corm lengths and planting depths of saffron, an average of 6.67-21.67 pieces/plot of corm was obtained (Yıldırım et al., 2017b). In another study on different soil cultures, it was reported that the highest number of corms was obtained from the silt environment (22.92 pieces/parcel), followed by the peat environment (22.42 pieces/parcel) (Yıldırım and Hatipoğlu, 2020). This study shows good and promising results compared to the previous reports although it was a one-year study in both conditions.

In traditional cultivation in Turkey, saffron is harvested every three or four years. Sufficient corm cannot be reproduced. Therefore, corm prices are high and production areas cannot be increased (Asil, 2018). In our study, corm production was achieved in the only first year of planting compared to the similar report achieved in the second in the second year of planting (Yıldırım et al. (2017a)). Therefore, these outcomes are considered to be economically great importance. As the corm length of the harvested corms increases, the number of parcel in the cores also increases. There is no literature study on cell counts in a corm. It has been revealed that the unit corm increase is better in the field conditions than greenhouse conditions, and the silt environment will be better as culture media.

In conclusion, one of the most important problems in saffron production is insufficient corm production. Therefore, the cost of corm is high. In addition to that, corms are removed from the field every three or four years in traditional saffron production. This limits the production of corm.

In this study, it has been revealed that corms can be harvested in one year for corm production in terms of its efficiency. For this purpose, it is recommended that large size corms in silt culture medium under field conditions should be planted for efficient corm production. In addition, higher number of parcel in the corms may be effective to obtain more flowers, stalks and daughter corms in the next production. Further research needs to be carried out to discover these effects and improve studies on the production of saffron corms.

ÖZET

Amaç: Bu çalışmada, tarla ve sera koşullarında yetiştirilen safran bitkilerinde korm verimi ve verim özelliklerine farklı yetiştiricilik uygulamalarının etkilerini belirlemeyi amaçlanmıştır.

Yöntem ve Bulgular: Çalışmada üretim materyali olarak ortalama 12 g ve 6 g ağırlığındaki iki farklı korm materyal olarak kullanılmıştır. Safran kormlarının yetiştiriciliği kum, kokopit, torf+perlit ve kokopit+perlit olmak üzer 4 farklı uygulama yapılmış alanlarda gerçekleştirilmiştir. Tarla çalışmaları tesadüf blokları bölünmüş parseller deneme desenine göre ve sera çalışmaları ise tesadüf parseller deneme desenine göre 3 tekerrürlü olarak kurulmuştur. En yüksek korm verimi, birim aranda korm artış oranı ve hasat edilen korm ağırlığı kum uygulamaların yapıldığı tarla koşullarında elde edilmiştir.

Genel Yorum: Tarla ve sera koşullarında kum uygulaması safranın korm özelliklerinin yanısıra kısa sürede tohumluk materyal olarak korm üretimi için en uygun yetiştiricilik uygulaması olarak belirlenmiştir.

Çalışmanın Önemi ve Etkisi: Korm üretimi için tarla koşullarının sera koşullarına göre ve kum uygulamasının

ise kullanılan diğer uygulamalara göre daha etkili olduğu ortaya konulmuştur.

Anahtar Kelimeler: Kokopit, korm verimi, yavru korm oranı, korm sayısı, birim korm ağırlığı.

CONFLICT OF INTEREST

The authors declare no conflict of interest for this study.

AUTHOR'S CONTRIBUTIONS

The contribution of the authors is equal.

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