J. Agr. Sci. Tech. (2023) Vol. 25(1): 115-124

Effects of Some Weed Control Methods on Stigma in Saffron (*Crocus sativus* L.) Cultivation

H. Asil[1]*, F. Celik[2], S. Tasgin[2], M. Celik[2], and I. Uremis[3]

ABSTRACT

Saffron is an important medicine, spice, dye, and cosmetic plant, and weeds limit its production and increase the related costs of management. This study aimed to determine effective control methods against weeds in saffron cultivation and find the effects of weed control on crown development, stigma yield, and daughter corm yield and quality. The study was established in the production periods of 2019-2021, at Hatay Olive Research Institute, Hassa Station, Turkey, based on completely randomized blocks design with 14 treatments and 3 replications. Results indicated that the highest effect (100%) on weeds was recorded for U5 (pine sawdust+benfluralin) and U6 (textile mulch) applications and the lowest effect was obtained from U13 (2,4-D amine) application at the first and second year of the study. The best quality criteria of saffron were achieved in U6 and U4 (pine sawdust) applications for corm production, and U6, U5, and U4 applications for quality daughter corm production.

Keywords: Daughter corm yield, Pine sawdust, Textile mulch.

INTRODUCTION

Saffron (*Crocus sativus* L.) has been known in the world for more than 4000 years. Today, it is mostly grown in Iran, India, Afghanistan, Greece, Morocco, Spain, and Italy (Cardone *et al*., 2019). Iran is considered the world's largest producer with 90% of global production (Kothari *et al*., 2021). In recent years, there has been a decrease in saffron production in all countries, except Iran (Khan *et al*., 2011).

Weed competition begins in the fall, and especially in the spring, during the flowering period when the leaves are still green (Shokrpour, 2019). Saffron, a perennial plant, is suppressed by many annual, biennial, and perennial weed species. Saffron is a weak plant against weed competition due to its short and weak crown structure (Soufizadeh *et al*., 2006). Weeds prevent cultural practices in any crop and host disease pathogens and insect pests, whose poisonous seeds mix with the product and adversely affect human and animal health (Uludag *et al*., 2018; Kaya and Uremis, 2020). Further, weeds compete with saffron for light, water and nutrients, reducing the qualitative and quantitative yield of saffron (Hosseini-Evari *et al*., 2020). In addition, weed roots penetrate the saffron corms, reducing the corm quality and yield (Galavi *et al*., 2008).

Weed control in saffron production areas is mostly done mechanically or manually. Although these traditional methods are effective and environmentally friendly, they are costly, time-consuming, and labor-intensive (Cirujeda *et al*., 2014). Therefore, it is clear that effective weed control is necessary to produce quality saffron. On the other hand, mechanical control can cause

[1] Altınozu Vocational School of Agricultural Sciences, Medicinal and Aromatic Plants Program, Hatay Mustafa Kemal University, Hatay, Turkey.
[2] Olive Research Institute, Hatay, Turkey.
[3] Department of Plant Protection, Hatay Mustafa Kemal University, Hatay, Turkey.
* Corresponding author; e-mail: hasan.asil@hotmail.com

serious damage in saffron production due to the narrow spacing between rows and plants (Soufizadeh *et al*., 2006). To minimize the problems caused by weeds and to increase yield and quality, it is obvious that effective control of weeds is necessary (Uludağ *et al*., 2018). Weed control in saffron cultivation in Turkey is the biggest input item that increases the cost of saffron cultivation. Weed control is done only by hand (2-5 times a year depending on seasonal conditions) (Asil, 2018). Currently, there is no licensed herbicide for saffron in Turkey. In addition, there is no study on weed control in saffron.

This study was aimed to find the effective weed control methods in saffron cultivation. Also, the effects of the control applications on the crown development, stigma yield, and yield quantity and quality of the offspring were determined.

MATERIALS AND METHODS

Studies were done at Hatay Olive Research Institute, Hassa Station, Turkey, at 36° 42' 39" North and 36° 30' 20" East coordinates, at an altitude of 288 m. Soil organic matter content was 0.61%, pH of 7.13, with Electrical Conductivity (EC) of 70 µS cm^{-1}. This study was carried out in the 2019-2021 production periods in the land with a loamy (45.1%) texture.

Material

In the study, saffron corms weighing between 5 and 7 g were used as production material. Cultural applications and herbicides used in weed control are given in Table 1.

Textile mulch material used in the study was black, water and air permeable, 100 cm wide, 50 m long, and a unit weight of 40 g m^{-2}. Sawdust (pine) applications were applied at a thickness of 5 cm from the soil surface after planting. Within the scope of mechanical control for weeds, hand hoeing was done twice a year after the soil surface was covered with 10-20% weeds. In the second year, sawdust was also applied to the plots with a thickness of less than 5 cm. The herbicides used in the study were prepared in the volume of 200 L ha^{-1} water at recommended doses and used.

Methods

The study was carried out on 7 Oct. 2019, with 14 treatments and 3 replications according to the randomized blocks experimental design. In each plot, 30 corms were planted in 3 rows with 40 cm spacing between rows and 10 cm on the rows, and plots were formed with a corm weight of 60 g for each row. Trial plots were 2 m^2 (170×120 cm) and a distance of 1 m (safety strip) was considered between the blocks and plots.

Existing weeds in the experimental area were determined and the species were identified. Evaluations were made at 7, 14, and 28 days after the chemical weed control in the plots and the 28^{th}-day evaluations were taken as the basis for the decision. Pre-sowing herbicides were applied 2 days before planting and mixed into the soil with a hand hoe. Pre-emergence applications were applied to the soil surface 1 week after planting. Post-emergence herbicides were applied in the first week of March. All implementation dates are given in Table 1.

At both years of the study, plant height (cm), number of leaves and the treatment efficiencies were measured. In the second year of the study, the effects of the treatments were determined by recording yield of stigma, corm, and quality characteristics.

Statistical Analysis

The obtained data were subjected to Arcsine transformation. Statistical analyses were made according to the transformed data. The variance analysis of the mean

Table 1. Cultural and herbicide treatments and application dates for weed control in saffron.

Application Code	Application material/ Active ingredient	Application amount/ Dose	Application time	Application dates	
				1st Year	2nd Year
U1	%60 Benfluralin	2500 g ha^{-1}	Pre-sowing	07.10.2019	30.10.2020
U2	917 g L^{-1} S-Metolachlor+45 g L^{-1} Benoxacor	1500 mL ha^{-1}	Pre-sowing	07.10.2019	30.10.2020
U3	%60 Benfluralin +	2500 g ha^{-1}	Pre-sowing	07.10.2019	30.10.2020
	47 g L^{-1} Tepraloxydim	1000 mL ha^{-1}	Post-emergence	09.03.2020	12.03.2021
U4	Sawdust (Pine)	5 cm thickness	Pre-emergence	07.10.2019	30.10.2020
U5	Sawdust (Pine) +	5 cm thickness	Pre-emergence	07.10.2019	30.10.2020
	%60 Benfluralin	2500 g ha^{-1}	Pre-emergence	07.10.2019	30.10.2020
U6	Textile Mulch	Covering	Pre-emergence	07.10.2019	30.10.2020
U7	450 g L^{-1} Pendimethalin	3000 mL ha^{-1}	Pre-emergence	11.10.2019	10.11.2020
U8	600 g L^{-1} Metribuzin	750 g ha^{-1}	Pre-emergence	11.10.2019	10.11.2020
U9	450 g L^{-1} Pendimethalin +	3000 mL ha^{-1}	Pre-emergence	11.10.2019	10.11.2020
	47 g L^{-1} Tepraloxydim	1000 mL ha^{-1}	Post-emergence	09.03.2020	12.03.2021
U10	Mechanical Weed Control (Hand hoeing)	Twice	Pre-emergence	11.10.2019	10.11.2020
			Post-emergence	09.03.2020	05.03.2021
U11	47 g L^{-1} Tepraloxydim	1000 mL ha^{-1}	Post-emergence	09.03.2020	12.03.2021
U12	47 g L^{-1} Tepraloxydim+	1000 mL ha^{-1}	Post-emergence	09.03.2020	12.03.2021
	2,4 Dimethylamin Salt	2000 mL ha^{-1}	Post-emergence	10.04.2020	05.03.2021
U13	2,4 Dimethylamin Salt	2000 mL ha^{-1}	Post-emergence	10.04.2020	05.03.2021
U14	Control	No application was made			

values of the characters obtained from the experiment was made with the MSTAT-C statistical package program and the differences between the averages were determined by the Duncan test (Barjasteh *et al*., 2021; Ziaei-nejad *et al*., 2021).

RESULTS AND DISCUSSION

The Analysis Of Variance (ANOVA) of the parameters of the effects of the applications for weed control in saffron (*Crocus sativus* L.) cultivation is given in Table 2. The F values of the traits [Weed Control (A)] were found to be statistically significant.

In the study, plant height, the number of leaves per plant, and the effect of weed control applications against weeds were evaluated over two years. The average values and Duncan groups are given in Table 3.

Effect of Treatments on Leaf Length and Number of Leaves

The leaf length was significantly (P< 1%) affected by the treatments in the first study year, while it did not show significant response during the second year. In the first year, the highest leaf length was obtained from U9 with 31.1 cm, followed by U14 treatment with 31.0 cm, and no difference

Table 2. Analysis Of Variance (ANOVA) on saffron growth and yield and weed control affected by weed control practices.

Parameters	F Value (Replication)	F Value (Application)	Coefficient of variation
Leaf length (1st Year) (cm)	1.36	2.95**	8.63
Leaf length (2nd Year) (cm)	0.39	0.59 ns	16.00
Number of leaves (1st Year)	0.07	2.26**	27.29
Number of leaves (2nd Year)	1.19	0.47	34.82
Dried stigma yield (g block^{-1})	0.16	4.77**	35.06
Total daughter corm weight (g block-1)	2.40	4.24**	21.84
Unit corm weight (g pc^{-1})	1.40	20.53**	22.60
Daughter corm weight ratio - less than 5 g (%)	2.35	6.69**	31.69
Daughter corm weight ratio - 5 to 10 g (%)-	1.88	11.88**	16.83
Daughter corm weight ratio - greater than 10 g (%)	3.95	16.67**	28.18
Effects of applications on weeds density (1st Year) (%)	0.66	76.42**	6.37
Effects of applications on weeds density (2nd Year) (%)	3.51*	28.13**	10.32

*, **, ns: It is significant at 0.05 and 0.01 levels, respectively, and there is no statistical difference between the averages shown with the same letter.

was observed between them. In the second year, the highest leaf length was obtained from the U8 application with 34.9 cm (Table 3). In studies on saffron in Hatay conditions, leaf length in different fertilizer applications was between 17.5 and 39.6 cm (Asil and Ayanoğlu, 2017), indifferent cutting methods and GA_3 doses, the average leaf length was between 21 and 27.0 cm (Asil and Ayanoglu, 2018). Literature studies show similarities with the findings in this study. It was concluded that the treatments for weed control did not have a negative effect on saffron leaf length.

The highest number of leaves per plant (15.4) was found in the U13 application. In the second year, the highest number of leaves was obtained from 44.6 U7 applications, and there was no difference between applications (Table 3). Gull *et al*. (2018) found it between 17.87 and 28.00. In studies on saffron in Hatay conditions, the average number of leaves in different fertilizer applications was between 4.7 and 10.7 per plant (Asil and Ayanoğlu, 2017). According to the literature studies, it seems that the number of leaves per plant is compatible with the weed control study. However, the number of leaves per plant in the second year of applications was more than the literature average. This revealed that, when weed control is provided, the plant will take more nutrients from the soil and, therefore, the number of leaves per plant will increase (Uludag *et al*. 2018).

Effect of Applications in Weed Control

Some characteristics of weeds growing in the experimental area are given in Table 4. Nineteen annual, 1 biennial, and 7 perennial weeds were recorded. Of these, 21 were broad-leaved and 7 narrow-leaved plants. There are no weed control studies on saffron weeds in Turkey. The highest effect of weed control was observed in the U5 and U6 applications with 100% effect, and the lowest effect (70%) was in the U13 application in the first and second years of the study (Table 3). No phytotoxicity was detected in the saffron plant in two-year herbicide applications. According to a study conducted in Mashhad and Gonabad areas in Iran, herbicide with the active ingredient of metribuzin was effective in weeds control and did not harm the saffron plant (Norouzzadeh *et al*. 2007). Corm harvesting was easier because the soils where sawdust and textile mulch were applied were more humid than in other places.

Table 3. Effects of weed control treatments on vegetative growth of saffron and weeds.

Application Code	Leaf length (cm)		Number of leaves		Effects of applications on weeds density (%)	
	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
U1	30.5 ab	30.2 ns	9.9 a-c	34.4 ns	80.0 c	80.0 a-c
U2	28.0 ab	34.6 ns	14.1 ab	31.1 ns	80.0 c	73.3 c
U3	29.6 ab	31.0 ns	13.2 a-c	30.9 ns	85.0 bc	73.3 c
U4	30.2 ab	30.2 ns	7.7 c	28.0 ns	91.7 a-c	90.0 a-c
U5	24.4 b	27.6 ns	12.7 a-c	36.4 ns	100.0 a	100.0 a
U6	25.8 ab	28.9 ns	12.7 a-c	36.6 ns	100.0 a	100.0 a
U7	25.3 ab	32.6 ns	8.7 bc	44.6 ns	85.0 bc	86.7 a-c
U8	28.9 ab	34.9 ns	9.1 bc	28.3 ns	81.7 c	86.7 a-c
U9	31.1 a	30.2 ns	10.4 a-c	35.0 ns	80.0 c	78.3 bc
U10	26.0 ab	30.3 ns	7.9 c	31.7 ns	95.0 ab	96.7 ab
U11	29.2 ab	33.6 ns	8.2 c	32.7 ns	63.3 d	71.7 c
U12	30.5 ab	28.9 ns	10.6 a-c	26.4 ns	80.0 c	83.3 a-c
U13	25.3 ab	29.6 ns	15.4 a	32.3 ns	63.3 d	70.0 c
U14	31.0 a	32.2 ns	8.7 bc	34.6 ns	0.0 e	0.0 d

Table 4. Some characteristics of weeds observed in the study area.

No	Latin name	Common name[a]	Family	Definition[b]	Life time [c]
1	*Alopecurus myosuroides* Hudson	Black-grass	Poaceae	NL	A
2	*Anagallis arvensis* L.	Scarlet pimpernel	Primulaceae	BL	A
3	*Anthemis arvensis* L.	Corn chamomille	Asteraceae	BL	A
4	*Avena sterilis* L.	Sterile wild oat	Poaceae	NL	A
5	*Bromus tectorum* L.	Downy brome	Poaceae	NL	A
6	*Calendula arvensis* L.	Field marigold	Asteraceae	BL	A
7	*Capsella bursa pastoris* (L.) Medik.	Shepherd's purse	Brassicaceae	BL	A
8	*Cerastium* spp.	Mouse-ear chickweed	Caryophylaceae	BL	A
9	*Cichorium intybus* L.	common chicory	Asteraceae	BL	P
10	*Cynodon dactylon* (L.) Pers.	Bermuda grass	Poaceae	NL	P
11	*Cyperus rotundus* L.	Purple nutsedge	Cyperaceae	NL	P
12	*Erodium cicutarium* (L.) L'Hér. ex Aiton	Redstem filaree	Apiaceae	BL	P
13	*Fumaria officinalis* L.	Common fumitory	Papaveraceae	BL	A
14	*Lactuca serriola* L.	Prickly lettuce	Asteraceae	BL	B
15	*Medicago* spp.	Medick	Fabaceae	BL	A
16	*Melilotus officinalis* (L.) Desr.	Yellow sweetclover	Fabaceae	BL	B (A)
17	*Phleum* spp.	Timothy grass	Poaceae	NL	A
18	*Raphanus raphanistrum* L.	Wild radish	Brassicaceae	BL	A
19	*Rumex* spp.	Sorrels	Polygonaceae	BL	P
20	*Senecio vernalis* Waldst. and Kit.	Eastern groundsel	Asteraceae	BL	A
21	*Sinapis arvensis* L.	Wild mustard	Brassicaceae	BL	A
22	*Sonchus oleraceus* L.	Annual sowthistle	Asteraceae	BL	A (B)
23	*Sorghum halepense* (L.) Pers.	Johnson grass	Poaceae	NL	P
24	*Stellaria media* (L.) Vill.	Chickweed	Caryophyllaceae	BL	A
25	*Tragopogon latifolius* Boiss.	Great leaves salsify	Asteraceae	BL	A (B)
26	*Trifolium* spp.	Clover	Fabaceae	BL	A (B)
27	*Trifolium fragiferum* L.	Strawberry clover	Fabaceae	BL	P
28	*Vicia* spp.	Vetch	Fabaceae	BL	A

[a] and [b] BL: Broad-Leaf, NL: Narrow-Leaved, [c] A: Annual, B: Biennial, P: Perennial.

A greenhouse results in Adana province, showed that mulch textile were 100% effective against all weeds in comparison with vegetable mulches (corn stalk mulch and peanut shell powder mulch), cut hoe, and hand hoe (Arslan and Uygur, 2014). In a study for weed control in blueberries, it was reported that sawdust mulch alone had a significant effect on weed control (Strik *et al*., 2020). However, since the saffron plant is perennial and the leaves cover a larger area after the second year, it is recommended to have a minimum diameter of 10 cm of textile mulch applications in the first year planting.

In a study on weed density in 15 fields in the Ghayenat area in Iran, the most important weed species according to the dominance index were *Bromus danthoniae*, *Hordeum murinum*, *Bromus scoparius, Bromus tectorum, Hordeum vulgare, Cirsium arvense, Sophora alepecuroides*, and *Heliotropium europaeum*. Annual weeds had the highest species diversity with 45 species, biennial weeds with the lowest species diversity with 4 species, and perennial weeds with two groups of 35 species, 88% broad-leaved and 12% narrow-leaved weeds (Javadzadeh, 2019).

Kafi et al. (2018) found that among the main weeds found in the saffron fields of Kashmir, there are weed species, for example, *Euphorbia helioscopia, Papaver rhoeas, Lepidium virginicum, Salvia moorcroftiana, Chorispora tenella, Galium tricorne, Tulipa stellata, Erodium cicutarium, Lithospermum arvense, Ranunculus arvensis, Medicago lupulina, Filago arvensis, Poa bulbosa, Crepis saneta, Descurainia sophia, Polygonum aviculare* and *Chenopodium album*. When compared with literature studies, Avena spp., Bromus tectorum, *Capsella bursa* pastoris, *Cynodon dactylon* (L.) Pers, *Cyperus* spp., Erodium cicutarium, *Fumaria officinalis* L., *Lactuca serriola* L., *Medicago* spp, Rumex spp., *Stellaria media* and *Vicia* spp. species were determined as similar weed species in this study.

Effects of Applications on Daughter Corm Characters

The corms harvested in the weed control study were divided according to their weights as less than 5 g, between 5-10 g, and greater than 10 g, and their averages are given in Table 5. When the effects of the applications on the weight ratios of the harvested corms were examined, the highest rate of 52.9% on daughter corm was found in the U11 application, the application that formed the highest daughter corm at the rate of 5-10 g was obtained from the U1 application with 38.7%. The application with the highest rate of daughter corm greater than 10 g was obtained from U6 with a rate of 83.5% (Table 5).

When the effect of weed control applications on corm weight was examined, the highest corm weight was found in U6 with 1198 g and U4 with 1191 g. When the harvested corms were analyzed in terms of unit corm weight, and the highest was 13.7 g in the U6 application (Table 5).

Yildirim *et al*. (2017) obtained the highest unit weight of corms (10.348 g) from small size corms harvested once every two years. In the study on different removal times and planting depths, the highest corm yield was obtained from large corms (527.33 g^2 m^{-2}) removed in two years and planted at a depth of 15 cm. The lowest was obtained from small-sized corms (84.33 g^2 m^{-2}) removed every year and planted 5 cm deep (Yildirim *et al*., 2017).

It has been shown that the main corm size plays a critical role in increasing flower number and stigma yield. For example, it was reported that in the first and second years, when large size (>10 g) main bulbs were planted, they achieved maximum flower number and stigma yield (Koocheki *et al*., 2016). This is very important in terms of corm quality. In our study, corms greater than 10 g were obtained in U5 and U6 applications, and corms with a unit corm weight of 10 g were obtained in U6, U5, and U4 applications. When weed is controlled in

Table 5. Effects of treatments on daughter corm traits.

Application code	Daughter corm weight ratio (%)			Total daughter corm weight (g block^{-1})	Unit corm weight (g pc^{-1})
	Less than 5 g	5 to 10 g	Greater than 10 g		
U1	47.3 ab	38.7 a	14.0 ef	797.0 a-d	3.5 c
U2	45.6 ab	36.3 a	18.1 d-f	800.2 a-d	3.5 c
U3	52.2 a	35.7 ab	12.2 f	692.8 b-d	3.3 c
U4	10.2 cd	23.4 bc	66.4 ab	1191.0 a	10.2 b
U5	11.4 cd	9.4 d	79.2 a	849.7 a-d	10.5 b
U6	6.2 d	10.3 d	83.5 a	1198.0 a	13.7 a
U7	29.2 a-d	38.5 a	32.3 c-f	950.4 a-d	4.9 c
U8	47.9 ab	36.9 a	15.3 ef	888.1 a-d	3.6 c
U9	23.2 b-d	31.8 a-c	45.1 bc	1147.0 ab	5.8 c
U10	36.2 a-c	37.7 a	26.1 c-f	1036.1 a-c	4.6 c
U11	52.9 a	29.0 a-c	18.1 d-f	500.1 d	3.0 c
U12	29.1 a-d	29.1 a-c	41.8 cd	604.0 cd	4.2 c
U13	37.1 a-c	22.4 c	40.5 c-e	633.0 cd	4.7 c
U14	44.4 ab	35.9 a	19.7 c-f	727.9 a-d	3.6 c

saffron, it seems possible to produce quality corm.

In the study conducted in Iran on the tolerance of saffron to some herbicides, the highest corm weight per m^2 was obtained in the control application with 27.93 g plant^{-1}. They reported that the corm weights decreased at different herbicides and doses compared to the control application (Hosseini-Evari *et al*. 2020). In our study, in the corm weights, when herbicide applications were compared with the U14 control application, U13, U12, and U11 applications had lower corm weight in the control application, while higher corm efficiency was obtained in the other applications. There was no negative impact of herbicide applications on the corm yield as in the literature, except for some applications.

Weeds emerged after the effective time of the spraying had elapsed in the plot where U1, U2, and U8 were applied. Broad-leaved weeds emerged in the parcels where aromatic herbicides had been applied. Therefore, the number of small corms was high. When the effect of the herbicide was over in the plots where U8 was applied, weeds started to emerge again. Due to the effect of weeds, the number of small corms and the rate of daughter corms was higher in these plots. It is thought that the difference between the applications, especially in the U4, U5, and U6, is that where there is no weed growth in the blocks, the soil moisture is more, so, the daughter corms become larger. In a study on blueberries in the Oregon State of the Northwest United States, (Strik *et al*., 2020).

It has been reported that sawdust application increases root development and dry matter amount in the plant compared to black and green textile mulches. Since sawdust provides insulation between the soil and the plant root and reduces the soil temperature, sawdust treatment, therefore, has a positive effect on root growth.

Effect of Treatments on Dry Stigma Yield

Flowering did not occur in the first year depending on the size and weight of the planted corm in this study. In the weed control study of saffron plant, when the effects of applications on dry stigma yield

were examined, the difference between applications was found to be statistically significant (P< 1%) (Table 6). When the effects of the treatments on the stigma yield were examined, the highest dry stigma yield was obtained from U5 with 0.388 g and U6 with 0.348 g (Table 6). In the study conducted in Iran on the tolerance of saffron to some herbicides, the highest dry stigma yield per m^2 was obtained in the control application with 0.54 g m^{-2}. They reported that stigma yield decreased with different herbicides and doses compared to the control (Hosseini-Evari *et al*. 2020).

Again, in the same study, the dry stigma yield was 0.49 g m^{-2} in the herbicide containing the same active ingredient, i.e. metribuzin, in this study, and a lower amount of stigma yield was obtained in the control (Hosseini-Evari *et al*. 2020). However, in this study, 0.138 g m^{-2} was used in the U8 application and a higher result was obtained than the stigma efficiency of the U14 application, which is the control application. In the plot where metribuzin was applied, there was no yield loss like the study in Iran. Among the 6 different herbicide applications used in our study, it was determined that only U12 application did not have a negative effect on stigma yield. In addition, U7, U9, and U9 among herbicide applications and U5, U6, and U4 applications in other weed control treatments significantly increased the stigma yield in saffron. When the results are compared with other studies, some differences are observed. The reason for this is that in our study, the planting density was as 40×10 cm in order to better see the effect of the applications. Therefore, our dry stigma yields were different from other studies.

Table 6. Effects of different treatments on dry stigma yield.

Application code	Dry stigma yield (g $block^{-1}$)
U1	0.160 c
U2	0.216 a-c
U3	0.174 bc
U4	0.256 a-c
U5	0.388 a
U6	0.348 ab
U7	0.236 a-c
U8	0.138 c
U9	0.235 a-c
U10	0.208 bc
U11	0.118 c
U12	0.080 c
U13	0.159 c
U14	0.097 c

CONCLUSIONS

One of the most important problems encountered in saffron cultivation is the lack of suitable methods for weed control, and lack of sufficient studies on this subject. In the present study, among the weed control treatments, U5 and U6 applications for stigma yield, U6 and U4 applications for corm yield, and U6, U5, and U4 applications for production of quality daughter corm are at the forefront of economic production of saffron. It is expected that production costs will decrease with the provision of weed control, and profitability will increase with the rise in the yield of saffron stigma and the amount of corm production.

ACKNOWLEDGEMENTS

This work was supported by Hatay Mustafa Kemal University Coordinatorship of Scientific Research Projects (project # 20.GAP.006). Also, the authors would like to sincerely thank Assoc. Prof. Dr. Khawar JABRAN for scientific criticism and diligent proofreading of this manuscript.

REFERENCES

1. Arslan, Z. F. and Uygur, F. N. 2014. Some New and Effective Methods against Weeds in Vegetable Production: Mulch Textile,

Brush Weeder and Push Hoe. *Bitki Koruma Bülteni,* **54(3).**

2. Asil, H. 2018. Safran (*Crocus sativus* L.) Yetiştiriciliğinde Yaşanan Sorunlar. *Conference 1, International Mediterranean Symposium,* Mersin/Hatay, **1:** 273-280.
3. Asil, H. and Ayanoglu, F. 2017. The Effects of Planting Densities and Fertilizer Applications on Yield and Yield Components of Saffron (*Crocus sativus* L.). MESMAP-3 Abstracts, Girne-Turkish Republic of Northern Cyprus, 275 PP.
4. Asil, H. and Ayanoglu, F. 2018. The Effects of Different Gibberellic Acid Doses and Corm Cutting Methods on Saffron (*Crocus sativus* L.) Yield Components in Turkey. *Fresenius Environ. Bull.,* **27(12 A):** 9222-9229.
5. Barjasteh, S., Dashab, G.R., Rokouei, M., Shariati, M. and Vafaye Valleh. M. 2021. Impact of Imputation, Reference Population Structure, and Single Nucleotide Polymorphism Panel Density on Accuracy of Genomic Evaluation in Purebred and Crossbred Populations. *J. Agr. Sci. Tech.,* **23(1):** 27-40.
6. Cardone, L., Castronuovo, D., Perniola, M., Cicco, N. and Candido, V. 2019. Evaluation of Corm Origin and Climatic Conditions on Saffron (*Crocus sativus* L.) Yield and Quality. *J. Sci. Food Agric.* **99(13):** 5858-5869.
7. Cirujeda, A., Marí, A. I., Aibar, J., Fenández-Cavada, S., Pardo, G. and Zaragoza, C. 2014. Experiments on Mechanical Weed Control in Saffron Crops in Spain. *J. Plant Dis. Prot.,* **121(5):** 223-228.
8. Galavi, M., Soloki, M, Mousavi, S.R. and Ziyaie, M. 2008. Effect of Planting Depth and Soil Summer Temperature Control on Growth and Yield of Saffron (*Crocus sativus* L.). *Asian J. Plant Sci.,* **7(8):** 747-751.
9. Gull, S., Mahmood, M., Ishfaq, A., Ramzan, S. and Iqbal, Z. 2018. Extraction of Natural Colorants from Two Varieties of Saffron (*Crocus sativus*) and Their Dyeing Evaluation on Goat Leather. *World J. Pharm. Res.,* **7:** 45-52.
10. Hosseini-Evari, Z., Izadi-Darbandi, E., Kafi, M. and Makarian, H. 2020 Saffron *Crocus sativus* L. Tolerance to Some Herbicides. *Crop Prot.,* **9(4):** 721-731.
11. Kafi, M., Kamili, A. N., Husaini, A. M., Ozturk, M. and Altay, V. 2018. An Expensive Spice Saffron (*Crocus sativus* L.): A Case Study from Kashmir, Iran, and Turkey. In: "*Global Perspectives on Underutilized Crops*". Springer, Cham, PP. 109-149.
12. Khan, M. A., Naseer, S., Nagoo, S. and Nehvi, F. A. 2011. Behaviour of Saffron (*Crocus sativus* L.) Corms for Daughter Corm Production. *J. Phytol.,* **3(7).**
13. Kaya, H. and Üremiş, İ. 2020. Studies on Weed Control in Onion Areas in Hatay Province. *MKU. J. Agric. Sci.,* **25(1):** 27-35.
14. Koocheki, A., Ebrahimian, E. and Seyyedi, S. M. 2016. How Irrigation Rounds and Mother Corm Size Control Saffron Yield, Quality, Daughter Corms Behavior and Phosphorus Uptake. *Sci. Hortic.,* **213**: 132-143.
15. Kothari, D., Thakur, R. and Kumar, R. 2021. Saffron (*Crocus sativus* L.). Gold of the Spices: A Comprehensive Review. *Hortic. Environ. Biotechnol.,* **62**: 661–677.
16. Javadzadeh, S. M. 2019. Identification and Determination of Density for the Dominant Weeds of Saffron (*Crocus sativus* L.) Fields in Ghayenat. *J. Saffron Res.,* **7(1):** 69-81.
17. Norouzzadeh, S., Abbaspoor, M., Delghandi, M. and Razavi, K. 2007. Chemical Weed Control in Saffron Fields of Iran. *Acta Hortic.,* **739:** 119.
18. Shokrpour, M. 2019. Saffron (*Crocus sativus* L.) Breeding: Opportunities and Challenges. In: "*Advances in Plant Breeding Strategies: Industrial and Food Crops*". Springer, PP. 675-706.
19. Soufizadeh, S., Zand E., Baghestani, M. A., Kashani, F. B., Nezamabadi, N. and Sheibany, K. 2006. Integrated Weed Management in Saffron (*Crocus sativus* L.). *Acta Hort.*, **739**: 133-137.
20. Strik, B. C., Davis, A. J., Bryla, D. R. and Orr, S.T. 2020. Individual and Combined Use of Sawdust and Weed Mat Mulch in a New Planting of Northern Highbush

Blueberry. I. Impacts on Plant Growth and Soil and Canopy Temperature. *HortSci.,* **55(8):** 1280-1287.
21. Uludag, A., Uremis, I. and Arslan, M. 2018. *Biological Weed Control, Non-Chemical Weed Control*. (Eds.): Jabran, K. and Chauhan, B. S. Academic Press, PP.115-132.
22. Uluğ, E., Kadıoğlu, İ., and Üremiş, İ. 1993. *Türkiye'nin Yabancı Otları ve Bazı Özellikleri.* TC Tarım Orman ve Köyişleri Bakanlığı, Zirai Mücadele Araştırma Enstitüsü Müdürlüğü, Yayın No 78, Adana, 513 PP.
23. Yildirim, M. U., Asil, H. and Sarihan, E. O. 2017. Effects of Different of Harvesting Periods and Planting Depths on the Development of Saffron (*Crocus sativus* L.) Plant and It's Agricultural Characteristics. *Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi*, **26:** 142-148.
24. Ziaei-nejad, S., Hosseini, S. M., Seyed Mortezaei, S. R. 2021. Effects of Selenium Nanoparticles Supplemented Feed on Biochemical Indices, Growth and Survival of Yellow-Tail Seabream (*Acanthopagrus latus*). *J. Agr. Sci. Tech.,* **23(5):** 1001-1011.

تأثیر برخی روش‌های کنترل علف‌های هرز بر کلاله در کشت زعفران (*Crocus sativus* L.)

ه. اشیل، ف. شلیک، س. تاشگین، م. شلیک، و ی. اورمیس

چکیده

زعفران یک گیاه دارویی، ادویه‌ای، رنگ‌زا و آرایشی مهم است و علف‌های هرز تولید آن را محدود کرده و هزینه‌های مربوط به مدیریت را افزایش می‌دهند. این مطالعه با هدف تعیین روش‌های کنترل موثر علیه علف‌های هرز در کشت زعفران و بررسی تأثیر کنترل علف‌های هرز بر رشد طوقه، عملکرد کلاله و عملکرد و کیفیت بنه دختر انجام شد. این تحقیق در دوره های تولید ۲۰۱۹-۲۰۲۱ در موسسه تحقیقات زیتون هاتای ایستگاه حسا ترکیه بر اساس طرح بلوک های کاملاً تصادفی با ١٤ تیمار و ۳ تکرار انجام شد. نتایج نشان داد که بیشترین تأثیر (۱۰۰ درصد) روی علف‌های هرز برای کاربردهای U5 (خاک اره کاج+ بنفلورالین) و U6 (مالچ نساجی) و کمترین اثر مربوط به کاربرد2 ، U13 (D-4آمین)در اولین و دومین سال مطالعه بود. بهترین معیارهای کیفی زعفران در کاربردهای U6 و U4 (خاک اره کاج) برای تولید بنه و کاربردهای U6 ، U5 و U4برای تولید بنه دختر با کیفیت به دست آمد.