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EFFECTS OF ORGANIC FERTILIZER ON YIELD AND QUALITY OF SAFFLOWER (*Carthamus tinctorius* L)

SUMMARY

Safflower (*Carthamus tinctorius* L) is one of the alternative oil crops increasing planted area in Turkey recently, especially in Central Anatolia. Organic farming is also an alternative farming system increasing in Turkey. For this purpose, this study was conducted to determine the yield and quality of safflower with application three organic fertilizers in Konya region. Research was carried out in 2009 at the Selcuk University Sarayönü Vocational School experiment field. Dincer was used as safflower variety and three organic fertilizers (OF1, OF2 and OF3) have been applied, both with diammonium phosphate and without. Yield, thousand kernel weight, protein and oil content of kernel were evaluated in the experiment. Diammonium phosphate application was significantly important ($p < 0.01$) and organic fertilizers were significantly differ ($p < 0.01$) from control but there is no difference among them. OF_1, OF_3 and OF_2 with diammonium phosphate application were in the first groups in terms of yield, 2652.8, 2531.3 and 2447.9 kg ha^{-1} respectively. There was no significantly difference among the organic fertilizer applications in terms of thousand kernel weight. Organic fertilizer applications increased oil content of kernel with and without diammonium phosphate application.

Keywords: *Carthamus tinctorius* L., organic fertilizer, yield, oil content.

INTRODUCTION

Safflower is an annual oil crop which can be grown in rainfed conditions (İlkdoğan, 2012). Its seed is mainly used for obtaining birdseed and vegetable oil. Besides, safflower is used in many branches of industry such as dye, varnish, feed and medicine (Corleto et al., 1997**;** Eryılmaz et al., 2014). Turkey has quite an appropriate ecology for safflower cultivation in terms of climate and soil conditions. Ecological factors are effective on seed and oil yield, oil acid composition and the characteristics of oil related to fuel oil (Katmer et al., 2005). On the other hand, safflower is one of the alternative crops which can be utilized especially in dry farming due to its high tolerance to drought and relatively to salinity. Considering the cultivation problems led by global warming due to its

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endurance to drought, importance of safflower is supposed to be increased. As a result of breeding, the oil ingredient of safflower seeds has been increased (Öğüt et al., 2007). In Turkey, safflower can grow in any climate condition in which cereals are grown (Öğüt et al., 2012).

In Central Anatolia region, plant rotation which is wheat and fallow has been done for many years. Therefore, chemical and physical properties of soil have degraded. Including the new plants appropriate for the conditions of the region into the farming design will provide great contribution. In this sense, safflower is an alternative crop. Using safflower which can be grown in dry areas in the region will help the quality of soil to recover and also it will keep the sustainability of productivity growth obtained from the soil. Safflower is a plant of which production can be made in dry conditions depending on the mechanization and cultivation techniques which are the same with cereal types such as wheat and barley. It is an important advantage in terms of cultivation.

Since some oil crops grown up in Turkey such as olive trees, sunflower, corn, cotton, soy bean and sesame require to be irrigated, their production areas are limited. Since it includes oil to 38 % and it can be grown in soils which are low in efficiency and depth and in dry conditions, safflower is an important oil crop (Coşge and Kıralan 2007). Safflower, which is used for its stem, leaf, seed and flowers, is an oil crop that has been ignored and has not gotten what it deserves. It has been sold in India and Pakistani by herbalists with the purpose of using as a cure for different diseases (Dajue and Mündel, 1996). Tea made from safflower leaves has been used to protect from infertility and abortion by women **(**Weiss, 1983**).** Its flowers have been utilized in food, cosmetic, dye and medicine industry (Dajue and Mündel, 1996). The most obvious characteristic of safflower oil is that its saturated oil acid proportion is low and unsaturated oil acid proportion is high. As it has very low or no linolenic acid in the composition of oil acid, there is no depth of colour. With this quality, safflower is consumed as vegetable butter, mayonnaise and salad oil in Western countries (Arslan, 2004**;** Uysal et al., 2006; Öğüt et al., 2007)**.**

Safflower pulp which remains after taking its oil is a good feed source for animal breeding with the crude protein percentage of around 25%. Safflowers include water-soluble *carthamidin* and red-colored *carthamin* which is not water-soluble. These natural dye substances can be used in coloring the food products and fabric dyeing **(**Eryılmaz, 2014**).** Due to this characteristic, safflower has an important potential for organic food and ecologic-textile products. Safflower is also essential because of the substance named tocopherol which has similar properties with vitamin E in the composition of safflower oil **(**Yılmazlar, 2008).

In 2013, safflower has been planted in an area which is approximately 782.641 hectare in the world and 647.373 tons safflower seed has been produced. Average of yield is around 827 kg ha^{-1} **(**Anonymous, 2014). By making the 29.2% of world's safflower production, India is placed on the top. United State of America follows India with a percentage of 17.0, and then comes Mexico with a percentage of 14.7. Turkey is on the 7^{th} place in world ranking with the 3.1 %

after China (5.3%). While cultivation areas of safflower in Turkey formed small areas by 2005, after that year the cultivation areas increased rapidly and reached a record level in 2009, an area of 21 523 hectare. After that year, it started to decline again. In 2012, this number was recorded as 15 591 hectare **(**Anonymous, 2013).

Recently, the use of vegetable oil in production of biodiesel has increased the importance of oilseed plants. Included in biofuels, biodiesel can be made from vegetable oil, animal oil, waste cooking oil and alga. Commonly used vegetable oils are rapeseed, soybean, sunflower, cotton seed, safflower, corn and palm oil (Oğuz et al., 2012).

Since organic fertilizers are essential sources providing substance and food formation. Balanced fertilizer use along with organic manures is considered as promising agro-technique to sustain yield, increase fertilizer use efficiency and restore soil fertility (Mishra et al., 2011).

In this study, with the scope of organic farming which uses less chemical and which is more environment-friendly than conventional farming (Eckhoff et al., 2005), the effect of organic origin fertilizer on yield and some quality features of safflower was investigated.

MATERIAL AND METHODS

In the study, safflower cultivar *Dincer*, was used as material and the experiment was carried out in the field of Sarayönü Vocational School, Selcuk University in 2009. The soil characteristic were clay-loamy, slightly alkali, slightly salty, a normal level of organic matter and with much of lime (Table 1).

Table 1. Some soil characteristics of the experimental fields

Texture	pH	E.C. (mS/cm)	Lime (%)	Organic matter (%)	Phosphor (kg ha^{-1})	Potassium (kg ha^{-1})
Clay loam	7.75	4.34	18.91	2.35	63.3	2016.6

The altitude of the experimental field is 1055 m and the climatic data of the field in 2009 is shown at Table 2.

Table 2. Meteorological data for experimental field area in 2009

Climate Elements	***Years***	***Months***											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average Max. Temp.(°C)	2009	13.1	14.7	19.5	21.2	29.6	33.3	34.6	34.4	31.2	27.6	19.8	16.4
	long	4.7	6.8	12.0	17.4	22.2	26.8	30.2	30.0	26.1	20.0	13.0	6.7
Average Temp. (°C)	2009	1.7	3.3	4.2	9.4	21.4	20.3	31.0	24.9	12.3	15.0	6.2	4.9
	long	-0.2	1.2	5.7	11.0	15.7	20.2	23.6	23.0	18.6	12.5	6.1	1.8
Average Min. Temp.(°C)	2009	-19	-8.4	-6.7	-4.0	3.6	7.3	11.2	6.8	2.0	0.7	5.7	-4.7
	long	-4.1	-3.3	0.0	4.5	8.6	12.9	16.2	15.7	11.2	6.1	0.8	-2.2
Amount of Precip.(mm)	2009	41.4	23.9	22.0	32.7	48.5	6.0	20.7	0.0	8.5	27.1	24.8	18.0
	long	35.3	28.2	27.1	34.0	43.6	23.2	6.9	5.6	11.2	31.3	33.1	44.8

Source: The General Directorate of Agricultural Enterprises (TİGEM) Konuklar Station

In the experiment which was established as four replications according to the experimental design of randomized blocks (Düzgüneş et al., 1987), the seeds were planted by hand as 40 x 5 cm row spaces and the plots with 4 rows and 4-meters-long. Di Ammonium Phosphate (DAP) (18-46%) fertilizer was applied as 200 kg ha^{-1} during planting time at the half of experiment field. Three organic fertilizers used in the study were OF1 (*B5A: organic matter 5%,total humic + fulvic acids 2%,mineral matter 90% and pH 6-8*), OF2 (*Avant crop: organic matter 33%,total humic + fulvic acids 24 %,mineral matter 8.023% and pH 4.7*) and OF3 (*Bioplasm: 2x107 alg/ml,macro and micro elements, amino acids and vitamins (Lysin, Methionin, Cystin, Trytophan, Histidin, Isoleucin, Leucin, Phenylanin, Vailin, Arginin, Biotin, A, B1, B2, C, E) and pH 7*)

Organic fertilizers were used three times with recommended amount and during the different developing periods (rosette formation period, branching and 50% flowering periods). Accordingly, 15 L ha^{-1} from OF1 fertilizer, 2 L ha^{-1} from OF2 fertilizer and 1.5 L ha^{-1} from OF3 fertilizer were applied. In order to ensure emergency of the plants, experiment was irrigated by sprinkling right after the planting. Harvest of the experiment was done by hand. As the safflower is weak to compete with weeds during the period between the first emergency and the time when it had 3-5 leaves, weeds were removed in a mechanical way. The all measurements were taken in two rows at the middle and the first and the last rows were ignored as side effect.

Statistical analysis was made by using MSTAT-C computerized based program.

RESULTS AND DISCUSSION

This study aimed to identify the effects of the application of three different organic fertilizers applied in different growing times with DAP and without DAP application on yield and quality features of safflower *cv* 'Dincer'. The results of the study are shown at the Table 3.

Table 3. Average yield and quality components of safflower *cv* Dincer

Application	Fertilizer	Yield (kg ha^{-1})	1000 seed weight (g)	Protein (%)	Ash (%)	Oil (%)
Organic Fert.	OF1	2652.8 A	44.31	20.74	1.99	25.90
	OF2	2447.9 A	46.93	23.40	1.97	24.85
	OF3	2531.3 A	47.18	21.41	5.40	28.70
	Control	1656.3 D	47.43	20.28	2.11	21.70
DAP + Org. Fert.	OF1	1968.8 BC	43.41	23.40	3.75	26.92
	OF2	1875.0 BCD	42.40	19.71	4.91	26.02
	OF3	2062.5 B	44.34	21.42	2.19	24.70
	Control	1740.8 CD	45.66	21.28	5.98	18.69

The effect of three different organic fertilizers applied to the leaf of safflower which was planted with and without DAP application on yield is statistically important at the level of $P<0.01$. Organic fertilizers applied to the plants (without DAP) are included in the first group (respectively; OF1: 2652.8

kg ha^{-1}, OF3: 2531.3 kg ha^{-1}, OF2: 2447.9 kg ha^{-1}), organic fertilizers applied to plants (with DAP) are included in the second group. The last group is consist of control plots.

Although there are differences between the applications in terms of 1000 seed weight, these differences were not statistically significant. According to the applications, 1000 seed weight of safflower ranges from 42.40 g to 47.43g and the highest value is obtained from the control plot without DAP application. The lowest value has been obtained in the OF2 organic fertilizer with DAP application.

It is observed that crude protein percentage ranges between 19.71 and 23.40 by examining the applications in terms of protein percentage in seed composition. Accordingly, while the lowest ratio of protein, which is 19.71%, has been observed in OF2 n with DAP application, the highest value has been observed as 23.40% in OF2 without DAP application and in OF1 with DAP application.

When the ash ratio is examined, differences between the ratios in terms of applications range between 1.97% and 5.98%. Whereas the lowest ratio of ash is obtained in OF2 application (1.97%) without DAP, the highest ratio of ash obtained in the control plots to which DAP has been applied.

Oil percentages differ among the applications, ranging from 18.69% to 28.70%. The highest oil percentage, 28.70%, is observed in the OF3 application without DAP fertilizer and the lowest percentage of oil is seen in control plots with DAP, which is 18.69%.

CONCLUSIONS

The effects of three different organic fertilizers applied at the different development periods of the safflower *cv.* 'Dincer' has been proved to have important effects on yield. According to the result of the study, it has been observed that organic fertilizers applied to leaf at different periods of development directly without DAP application have increased the yield significantly. It has been concluded that application of DAP with different organic fertilizers did not any affect to increase yield and quality aspects of safflower. According to results of this study, we can conclude that when using organic fertilizers on safflower, there is no significant effect to use chemical fertilizer as supplementary in order to increase yield and quality features of safflower.

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