THE EFFECT OF VARIOUS NITROGEN FERTILIZERS ON SAFFRON (*Crocus sativus* L.) YIELD

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Abstract

Saffron (*Crocus sativus* L.) is one of the world's highest priced medicinal and aromatic plants from which dried stigmas are used. This study was carried out in Kocaeli-Turkey to determine the effect of various nitrogen fertilizers on number of flower, length of leaf, fresh and dried saffron yield in 2004-2005 growing seasons. Experiments were conducted in a randomized blocks design with three replications using four different nitrogen fertilizers (ammonium nitrate, ammonium sulphate, urea, calcium ammonium nitrate) and control. Before planting saffron corms, 4 kg/da fertilizers in the form of NPK were applied to all parcels and after 25 day of planting, different nitrogen fertilizers were applied as pure nitrogen 6 kg/da to each parcel. The highest numbers of flowers, 14330 per da were obtained from urea treatment while the lowest numbers of flowers, 8330 per da, were obtained from control treatment. There were no significant differences among fertilizers treatments in leaf length trait. The highest fresh saffron yields of 431 g/da were obtained from urea treatment while the least fresh saffron yield of 224 g/da was obtained from parcel with ammonium sulphate. The highest dried saffron yield of 78 g/da was harvested on urea treatment while the least 40 g/da was harvested on ammonium sulphate treatment.

Keywords: Saffron, Nitrogen Fertilizer, Yield

Farklı Azotlu Gübre Çeşitlerinin Safran (*Crocus sativus* L.) Verimi Üzerine Etkisi

Özet

Safran (*Crocus sativus* L.) dünyanın tıbbi ve aromatik açıdan değerli bitkilerinden birisi olup kurutulmuş stigmalarından yararlanılmaktadır. Bu araştırma, farklı azotlu gübre uygulamalarının safranın yaş ve kuru stigmalarına, çiçek sayısına ve yaprak uzunluğuna olan etkisini belirlemek amacıyla 2004-2005 yetişme sezonunda, Kocaeli ilinde yürütülmüştür. Tesadüf blokları deneme desenine göre 3 tekerrürlü olarak yürütülen çalışmada; 4 farklı azotlu gübre (amonyum nitrat, amonyum sülfat, üre, kalsiyum amonyum nitrat) ve kontrol uygulamaları ele alınmıştır. Safran kormlarının dikiminden önce bütün parsellere 4 kg/da olacak şekilde NPK gübresi verilmiş, işlemden 25 gün sonra azotlu gübre çeşitleri saf azot 6 kg/da hesabıyla her bir parsele uygulanmıştır. Dekara en fazla çiçek sayısı 14330 ile üre uygulamasından, en az çiçek sayısı ise 8330 ile kontrol uygulamasından elde edilmiştir. Yaprak uzunluğuna bakıldığında kontrol ve gübre çeşitleri arasında önemli bir fark görülmemiştir. En yüksek taze safran verimi 431 g/da ile üre, en düşük taze safran verimi ise 224 g/da ile amonyum sülfat uygulamasından elde edilmiştir. En yüksek kuru safran verimi 78 g/da ile üre, en düşük kuru safran verimi ise 40 g/da ile amonyum sülfat uygulamasından elde edilmiştir.

Anahtar Kelimeler: Safran, Azotlu Gübre, Verim

1. Introduction

Saffron, Iridaceae family, (*Crocus sativus* L.) has been spreading out in the tropical and subtropical regions of the northern hemisphere over the world (Vurdu *et al.* 2002a). It is grown in several countries; France, India, Iran, Italy, Spain, Pakistan and Kashmir. In Iran, saffron is grown in the eastern part of the country, primarily in Khorasan province. Behnia *et al.* (1999) reported that saffron, the world's most expensive spice, is the dry style and three red-orange-colored stigmas of the flower of saffron. Saffron is used mainly dye, food, drug and pharmacology industries.

One of the cultivation care procedures applied to increase productivity during saffron production is fertilization. At this field, there are limited numbers of researches. Behzad *et al.* (1992a) conducted an 8 year study to compare the effects of different combination of NPK and cow

manure on saffron production. Their results showed that nitrogen has the most effect on increasing the amount of flower yield. Addition of P or K to N fertilizer in some cases had little but not statistically significant effect on flower yield. It was appeared that in some soils which are poor in organic carbon cow manure is the most important factor for promoting saffron production.

In order to decrease the effects of excessive application of chemical fertilizers and alkalinity to most cultivated soils, foliar fertilization is required to be applied.

Previous studies have been conducted to determine the effects of foliar fertilization on saffron yield. The highest yield obtained from application of compound fertilizer once on 5 March that accounted for 33 % increase in yield. In biology of saffron, February and March have considerable importance. Young corms formed on the mother corms through February have no roots. In order to continue vital activities during March and April, saffron plant relies on its leaves for photosynthesis and absorbing nutrients from rainfall. Therefore, application of foliar fertilizers during March is very useful (Hosseini *et al*., 2004).

A study conducted to compare effects of different rates of urea, ammonium phosphate and cow manure on saffron production showed that 100 kg/ha of urea had the best effect in increasing the flower numbers. However, application of more urea decreased the yield. In some cases application of 30 tons of cow manure plus 50 kg ammonium phoshpate increased the yield but was not statistically significant (Behzad *et al*., 1992b).

The objective of the present study was to determine the effects of application of different nitrogen fertilizers on fresh and dry stigmas, flower number and leaf length of saffron (*Crocus sativus* L.).

2. Materials and Methods

This study was carried out under natural conditions of Kocaeli Province of Turkey between 2004 and 2005. Plant material, saffron, was provided from a farmer from Davutobası village of Safranbolu in 2003. Plants were cultivated at the Arslanbey Campus of Kocaeli University in 2003 and 2004. Plants were uprooted, maintained and aired at 25°C using procedures described in Molina *et al*. (2003).

Experiments were conducted in a randomized blocks design with three replications using 5 different applications (control, ammonium nitrate, ammonium sulphate, urea, calcium ammonium nitrate). Before planting saffron corms, the soil characteristics were examined. The soil samples taken from in a depth of 0 to 20 cm were analyzed in the Soil and Ecology laboratory of the Research Institute for Poplar and Rapid Growing Forest Trees of Province Kocaeli. Soil characteristics of experiment fields are shown in Table 1. Results of the soil analyses indicated that the soil of trial area had sandy and silty texture. The lime content of the soil was 3.59 %, less limy and without saltiness problem (Moltay, 1979). The pH of the soil was 8.61 which is alkali according to the limit values as notified by Kellog (1952). The organic matter content of the soil was high (4.38 %) according wet oxidation method. Before planting saffron corms, 4 kg/da fertilizers in the form of NPK (15-15-15) were applied to all parcels. Corms with diameters between 15 and 50 mm were shared in order to equally distribute to each replication. Saffron corms were planted in 20 cm distance between rows and within rows in 8 cm depth. After 25 day of planting, different nitrogen fertilizer types were applied. Trials consisted of six rows and six columns for 36 plant materials.

Table 1. Soil properties of the experimental fields

Sandy (%)	Clay (%)	Silt (%)	Total $CaCO_3$	EC x 10^3 (Mhos/cm)	pH	Organic matter (%)	P_2O_5 (Kg/Ha)	K_2O (Kg/Ha)	N (%)
44.61	30.73	24.67	3.59%	257	8.61	4.38	85.72	612.7	0.876

Table 2: Effect of various nitrogen fertilizers on saffron yield properties

Fertilizers	Yield Properties			
	Flower number (no/da)	Plant height (cm/plant)	Fresh saffron weight (g/da)	Dry saffron weight (g/da)
Control	8330	21.60	237	41
Ammonium Nitrate	12330	23.54	312	56
Ammonium Sulphate	8666	23.28	224	40
Urea	14330	23.52	431	78
Calcium Ammonium Nitrate	12660	23.64	354	64

Urea, ammonium nitrate, ammonium sulphate and calcium ammonium nitrate fertilizers were given to each plot based on pure nitrogen 6 kg/da calculated according to soil test results. Flowers were collected early in the morning and they were daily dried in a drying oven at 80°C. Fresh saffrons collected daily from each replication and dry saffrons obtained using the drying process were weighted on an analytical scale to define their weights. Upon finishing of flowering period, the average flower numbers were calculated based on the repeats. As suggested in Vurdu *et al.* (2002b) flower collection was made very carefully and early in the morning to facilitate separation of petals from stamens and stigmas. In the period of study, the fresh and dry stigmas of *Crocus sativus* L. flower numbers and plant heights were examined. The values obtained have been evaluated in SPSS statistical analysis computer program.

3. Results and Discussion

Results of this study showeds that the highest value of fresh saffron weight was obtained from urea fertilizer with 431 g/da, and the lowest value from ammonium sulphate fertilizer with 224 g/da (Table 2). The fresh saffron weight was found as 237 g/da in control application. As for the dry saffron weight, the highest value was obtained from urea treatment with 78 g/da and the lowest value from ammonium sulphate fertilizer with 40 g/da. In control application, the dry saffron weight was determined as being 41 g/da. Saffron flower (Figure 1A) on urea treatment and various nitrogen fertilizers treatment obtained dry saffron stigmas were shown in Figure 1B. Considering all the plots, the beginning of flowering was on 19 October, 2004 and the end of flowering was on 30 November, 2004. The highest numbers of flowers were obtained from urea with 14330 per da and the lowest values were obtained from control plot with 8330 per da. Behnia *et al.* (1999) suggested that the applications of phosphorus fertilizer had no impact on saffron productivity and fresh flower weight, but the application of nitrogen fertilizer of 10 kg/da and 5 kg/da increased saffron productivity and fresh flower

Figure 1A. Saffron flower in urea treatment; 1B. Nitrogen fertilizer treatments on dry saffron stigmas.

weight. According to Kacar and Katkat (1998), Aktaş (2004) and Güneş *et al.* (2004) flowering and fruit gripping decreased in case of lock of nitrogen. Upon examination of plant heights, the impact of fertilizer types was not seen in this study. The highest value has been obtained from calcium ammonium nitrate with 23.64 cm/plant, and the lowest value from control application with 21.60 cm/plant. When the fertilizer ranges were compared to fresh and dry saffron weights, there were not statistically significant differences on flower numbers and plant heights. Behzad *et al.* (1992b) did not find any statistical difference among saffron productivity and fertilizer types of ammonium phosphate and urea on saffron production. Behzad *et al.* (1992a) has also studied the effect of mineral elements (NPK) on saffron production; however, they found that the relation among saffron production and fertilizer ranges was not statistically significant. Our results are in good agreements with the finding of Sampathu *et al*. (1984), Dhar *et al*. (1988), Vurdu *et al*. (2002b), and Molina *et al*. (2003).

4. Conclusions

Under the field conditions of Kocaeli-Turkey, urea fertilizer had the most effect on the fresh and dry weights of saffron plant in comparison to control. Ammonium sulphate treatment caused the productivity losses compared with that of the control. These losses probably resulted from acidic physiological character of the fertilizer. The highest value of flower number was obtained from urea fertilizer and the lowest value from control applications.

The soils where saffrons are being cultivated must have a texture of sandy and clay which is rich in terms of organic materials (middle texture). Well aeration slack soils with water permeability characteristics are the best soils where the cultivation of saffron can be realized best. In this study results indicated that urea fertilizer had the most effect on the fresh and dry weights of saffron; however, effects were not statistically significant. Therefore, further studies are required to confirm our findings.

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