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"Corm Enrichment by Foliar Application of Nutrients Improves Saffron Quality"

توسط: " Hamid-Reza Fallahi, Sohrab Mahmoodi, Mahsa Aghhavani-Shajari, Hossein Karimpour, Zahra Maraki, Seyyed Amir-Hossein Hosseini, Mahdi Rezghi and Ferdinando Branca"

در **پنجمین همایش ملی گیاهان دارویی و طب سنتی** که روز پنجشنبه مورخ ۲۰ مهرماه ۱۴۰۲ در دانشگاه تربت حیدریه برگزار شد، به صورت سخنرانی ارائه گردید. توفیق روزافزون ایشان را در عرصه های علمی و پژوهشی کشور آرزومندیم.

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Corm Enrichment by Foliar Application of Nutrients Improves Saffron Quality

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ABSTRACT

Saffron, a member of Iridaceae, is well known as a precious medicinal plant. Saffron yield and quality is influenced by agronomic practice. Previous studies have shown positive effects of application of chemical and organic fertilizers on saffron growth and flowering concluding that saffron crop responses positively to nutrients availability. In order to investigate the effect of nutrient foliar spraying on saffron quality we carried out an experimental trial at Sarayan faculty of agriculture, University of Birjand (Iran) during 2016-18. We evaluate the effect of chemical fertilizer, containing 12% N, 8% P_2O_5, 4% K_2O, 2000 ppm Fe, 1000 ppm Zn, 1000 ppm Mn and 500 ppm Cu, provided by Dalfard company, adopting a randomized complete block design, with three replications. Plant nutritive spraying was done two times during March 2017 and 2018 in order to evaluate its effects on stigma quality of the next foreseen flowering time (November 2018). Effects of foliar application of nutrients were significant and positive on stigma color and on crocin, picrocrocin and safranal. All stigma quality parameters showed a significant improvement, particularly, its color and aroma which represent two key traits of saffron added value chains. The foliar treatments significantly increased the value of the a* and Chroma color parameters and enhanced the content of crocin and picrococin confirming this growing technique can be considered as an appropriate strategy for restoring corm growth before the spring dormancy, by increasing its reserves. Therefore, foliar application of nutrients during vegetative growth of saffron, will support the stigma quality during the next flowering season.

Keywords*:* Color, Aroma, Crocin, Medicinal plant, *S*tigma.

1. INTRODUCTION

Saffron (*Crocus sativus* L.) is grown in Mediterranean areas, from Spain in west to Kashmir in east, with high cultivated areas and stigma production in Iran, which includes near 90% of its world production (Koocheki et al., 2019). It is a small bulbous plant with a growing season during rainy seasons from mid-fall to mid-spring, which makes it appropriate for areas with lower water resources (Behdani and Fallahi, 2015). Saffron is an autumn-flowering species in Iridaceae family, which propagates vagetatively by corm. The main commercial part of saffron is stigma which is used in food, medical and perfumery industries (Branca and Argento, 2010; Behdani et al., 2016), but petals are also useful for all aims (Argento et al., 2010).

Nutritional management is an important factor which affects the qualitative and quantitative parameters of saffron. Behdani et al., (2016) concluded that different nutritional organic systems had a stimulatory effect on saffron replacement corms growth. Fallahi et al., (2017) also reported that soil amendment using materials such as cow manure improves the vegetative and reproductive growth of saffron. In another studies the positive effect of nutrition management particularly using organic manure has been proved on saffron flowering, growth criteria and biomass allocation (Fallahi and Mahmoodi, 2018a, 2018b). Similar results have been observed by Koocheki et al., (2016) using humic acid and Rezvani-Moghaddam et al., (2014) using chemical and organic fertilizers.

Besides soil application of nutrients, some other researchers reported the increasing role of corm dipping (Khayyat et al., 2018) and foliar application (Jabbari et al., 2018) of potassium nitrate on growth and yield of saffron. Although most studies have proved the positive role of foliar application of nutrients on saffron (Rezvani-Moghaddam et al., 2013), but the results of previous studies are some different or sometimes even contradictory. In addition, there are low studies on the role of nutrients spraying on stigma quality (Behdani and Fallahi, 2015). Our hypothesis was that nutrient foliar application had a positive effect on enrichment of produced corms and thereby on the quality of produced flowers. Therefore, this experiment aimed to evaluate the impact of foliar spraying of nutrients on saffron stigma quality.

2. MATERIALS AND METHODS

This study was performed during 2016-18 based on a randomized complete block design, with three replications, in Sarayan agriculture faculty, (University of Birjand), Iran. Sarayan is located at 33 °N and 58 °E, with 1450 masl, ~130 mm annual long-term precipitation and 17°C annual mean air temperature.

The treatments were application (FAN) and no-application of nutrients (no-FAN). A chemical fertilizer, containing 12% N, 8% P_2O_5, 4% K_2O, 2000 ppm Fe, 1000 ppm Zn, 1000 ppm Mn and 500 ppm Cu, provided by ©Dalfard Company (Rezvani-Moghaddam et al., 2013), was used in FAN treatment.

Corm planting was done in October 2016 (using corms with ~ 8g weight, density of 100 corms per m^2 and planting depth of 15 cm) and nutritional spraying was done two times during March 2017 and also March 2018, when field was one- and two-years-old, respectively in order to evaluate its effects on stigma quality in flowers produced during November 2018. Irrigation was done 6 times during each growing season with about 3600 m^3 ha^{-1} annually.

Flowers were harvested daily by hand during the second flowering season. After that, stigmas were separated from the other flower parts and were dried at room with ~ 25 ºC temperature and in shade to be used for measurement of qualitative parameters. Iranian standard (No 259-2) which is similar to ISO 3632, was used for determination of safranal, crocin and picrocrocin content using UV–vis spectrometric in 330, 440 and 257 nm, respectively. Their content was expressed as direct readings of the absorbance of 1% aqueous solution of dried stigma (INSO, 2013).

Color parameters of stigma powder was evaluated using colorimeter and then results were expressed as Hunter color values of L, a and b. L is used to denote lightness, a redness and greenness, and b yellowness and blueness (Khayyat et al., 2018). In addition, color intensity (Chroma) and Hue angle were calculated using the equations 1 and 2 (McGuire, 1992):

$$\text{Chroma} = (a^2 + b^2)^{0.5} \qquad \text{Equation 1}$$

$$\text{Hue angle} = tg^{-1}(\frac{b}{a}) \qquad \text{Equation 2}$$

Data analysis was done using SAS, version 9.1. Means were compared using LSD test at 5% level of probability.

3. RESULTS AND DISCUSSION

Among all color parameters, foliar application of nutrients (FAN) had a significant effect on redness (a^*) and chroma (Table 1). Redness was increased by 23.8% by FAN. Also, chroma for FAN and no-FAN was 32.2 and 26.4, respectively, which shows a 21.7 enhancement by application of nutrients (Table 2).

Table 1. mean of square for the effect of foliar application of nutrients on stigma quality in saffron in a two years-old field

S.O.V	L^*	a^*	b^*	b/a	Hue
Replication	15.45^{ns}	0.90^{ns}	2.66^{ns}	0.0084^{ns}	0.0048^{ns}
Treatment	11.20^{ns}	39.16^{**}	10.56^{ns}	0.0170^{ns}	0.0416^{ns}
Error	5.25	1.13	3.95	0.0024	0.0114
C.V (%)	8.83	4.44	11.72	6.68	9.61

S.O.V	Chroma	Crocin	Picrocrocin	Safranal
Replication	20.44^{ns}	19.5^{ns}	6.51^{ns}	1.36^{ns}
Treatment	49.30^{*}	5953.5^{**}	294.0^{*}	29.04^{ns}
Error	2.65	39.5	10.5	11.19
C.V (%)	5.55	4.26	5.14	8.14

ns: no-significant. * and ** significant at 5 and 1% level of probability.

Table 2. Means comparison for the effect of foliar application of nutrients on Hunter color parameters of saffron stigma, obtained from a two years-old field

Treatment	L^*	a^*	b^*	b/a	Hue	Chroma
Foliar application of nutrients	24.57^{a}	26.55^{a}	18.30^{a}	0.69^{a}	1.19^{a}	32.20^{a}
No-foliar	27.30^{a}	21.44^{b}	15.64^{a}	0.79^{a}	1.03^{a}	26.46^{b}

In each column, means followed by the same letters aren't statistically different using LSD test at 5% level of probability.

The effect of FAN was statistically significant on the content of crocin and picrocrocin in stigma (Table 1). Crocin content increased by 54.3%, when nutrients were used. In addition, FAN improved the picrocrocin content of stigma by 24.7. Although there was no significant difference between FAN and no-FAN in terms of safranal content, but FAN showed a superiority of 11.3% (Table 3).

In a previous study, FAN during one growing season increased the content of crocin by 20.6%, while there was no significant difference between FAN and no-FAN in terms of picrocrocin and safranal (Fallahi et al., 2019). Therefore, it seems that when FAN is applied during more than one growing season, similar the present study, it's positive effects on improving the quality of the stigma appear more. It has been reported that, FAN during vegetative growth of saffron is an appropriate strategy for increasing corms reserves, for more flowering and higher stigma quality in the next flowering season (Behdani & Fallahi, 2015).

Table 3. Means comparison for the effect of foliar application of nutrients on the quality of stigma obtained from a two years-old field

Treatment	Crocin ($\lambda\frac{1\%}{1cm}$)	Picrocrocin ($\lambda\frac{1\%}{1cm}$)	Safranal ($\lambda\frac{1\%}{1cm}$)
Foliar application of nutrients	179^{a}	70.0^{a}	43.3^{a}
No-foliar	116^{b}	56.1^{b}	38.9^{a}
Iranian standard	150-220	70-85	20-50

In each column, means followed by the same letters are not statistically different using LSD test at 5% level of probability.

4. CONCLUSION

It was concluded that it is possible to improve the quality of saffron stigma by foliar application of nutrients, during the previous growing season.

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