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SHORT COMMUNICATION ARTICLE

# A preliminary study on the effects of pre-planting heating o saffron corms germination speed and number of sprouts in greenhouse conditions

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## Abstract

Saffron (*Crocus sativus* L.) is a prospective niche crop for modern climate smart and resource saving agriculture. Notwithstanding the fact of growing importance of saffron in food and pharmaceutical branches of economy, the crop remains insufficiently studied in terms of its rational cultivation technology. Pre-planting treatment of corms is on the list of unresolved and at the same time very important constituents of saffron cultivation. The study on the effects of pre-planting heating at the temperature +25…27°C during 30 days was caried out in the greenhouse conditions in four replications to understand the reaction of saffron corms on such treatment in the initial period of growth. As a result, it was established that heated corms provided significantly higher number of sprouts at germination (2.25 more sprouts per each planted corm), while the time from planting to first sprouts appearance was longer by 2.50 days (at the confidence interval 95%). Therefore, pre-planting heating is supposed to be an efficient measure for saffron yield increment through the increased number of flowers. Further detailed studies, both greenhouse and in-field, are required to accept or deny this hypothesis.

**Keywords:** *Crocus sativus* L., pre-planting treatment, controlled environment, cultivation technology.

## Introduction

Saffron (Crocus sativus L.) is a niche crop, mainly known for its use as a spice. It has also been used as a dye-staff. Currently its use has spread to the field of medicine, where it is successfully used to treat mental disorders (Lykhovyd, 2022), ophthalmological disorders (Broadhead et al., 2019), is a promising agent for amelioration of cardiac complications (Hatziagapiou & Lambrou, 2018), as well as an adjuvant and augmentation agent in treatment of viral and bacterial diseases owing to its antioxidative, anti-inflammatory, antimicrobial, and antinociceptive actions (Qadir et al., 2020). The demand for saffron on the international market is gradually growing each year, therefore, the question of the crop effective production is on the table of modern agronomy as the yields of saffron remain extremely modest up to date and fluctuate within 2-28 kg of stigma per ha with the gross international production of 418 t per year (Cardone et al., 2020).

Saffron cultivation, notwithstanding the mentioned above fact of increasing economic value of the crop, is still limited. The total world area under saffron is just about 121,338 ha (Cardone et al., 2020) with the greatest concentration in the countries like India, Iran, Greece, Spain (Mzabri et al., 2021). Mainly it is because of high labor-cost for its production, and limitations that arise from climate and soil properties of particular regions of the Earth, as well as lack of scientifically grounded guidelines for crop cultivation technology (Mzabri et al., 2021).

Apart from economic benefits, connected with rational cultivation and marketing, saffron is suitable for low-input and sustainable cropping systems within the framework of climate smart and digital agriculture that makes this crop incredibly prospective for modern farm holders. This fact pushed the scientists to renovate the investigations on saffron cultivation. Most modern studies are focused on the improvement of stigma yield and quality with optimal cultivation methods, as well as lowering labor costs and expenditures through the enhancement of mechanization of the crop production (Cardone et al., 2020). Besides, climate change requires to adopt cultivation approaches to current unstable and often extreme weather conditions. As the crop is growing more and more popular among the farmers, one of the most interesting topics of scientific research, which currently remains untouched with just a few studies covering the subject, is the possibility of its cultivation in greenhouse conditions, as greenhouse cultivation can improve productivity, decrease climate-related hazards, and broaden the geography of the crop cultivation in the world (Askari-Khorasgani & Pessarakli, 2019; Asil et al., 2022).

## Materials and Methods

The experiment was performed in the autumn 2021 in the conditions of controlled environment. Saffron corms were initially checked for the signs of infestation by pests and diseases, calibrated to avoid unevenness in size (we used the corms with a diameter of 2.5-3.5 cm), and then divided in two equal shares either to direct planting in pots or pre-planting heating. Pre-planting heating was carried out in wooden box, protected against sunlight income, at the temperature of +25…27°C during 30 days, while regular saffron corms were stored at the temperature of +18…22°C. Moisture regime was identical in both groups of saffron corms. The pots, used as the placement of soil material and substrate of saffron vegetation, were disinfected in advance with a boiled water and vapor. Universal packed soil produced by "ECOFLORA" brand was used as a substrate for the plant. The properties of the soil are as follows: nitrogen content ($NH_4$+$NO_3$) – 2-3mg/kg, phosphorus content ($P_2O_5$) – 3.0-4.5 mg/kg, potassium content ($K_2O$) – 2.5-3.5 mg/kg alongside with Fe, Mn, B, Cu, Zn, Mo; pH within 5.5-7.5 points; initial moisture content – 30-50%. Saffron corms were planted in the pots on the depth of 5 cm with a spacing of 15 cm between each corm. Watering was carried out using regular tap water at the first signs of drying of the 0-10 cm soil layer (assessed manually). The temperature in the greenhouse was kept up at the level of +16…20°C within the time span of the study (planting – germination – sprouting). Germination was fixed through visual observations, the number of sprouts per each corm was manually counted. The speed of germination was assessed in the days between planting and first sprouts appearance. The study was carried out in four replications without randomization. Statistical processing of the collected data was performed using common computational technique of analysis of variance (ANOVA), statistical significance of the effect of pre-planting heating on the crop initial growth and development was established through the least significant difference (LSD) calculation at the confidence interval of 95% (Williams & Abdi, 2010; Vozhehova et al., 2019). Standard deviation in the trial was calculated according to (Wan et al. 2014). Statistical calculations were conducted using Microsoft Excel 365 package.

## Results and Discussion

Some previously conducted studies regarding saffron germination under various environmental and agro-technological conditions determined that prolonged incubation period of corms (120 days vs. 60 days) resulted in the reduced corm size, and bigger corms are preferable because of their greater vigorousness. Besides, long-term incubation increased the time from planting to germination. Pre-planting light regimes played crucial role for flowering initiation, and as a result, determined the crop yield (Kouchaki et al., 2006). Apart from light regime, temperature in the pre-planting period is also crucial for proper initiation of flowering (Wang et al., 2021).

As a result of our own study, we have established that pre-planting heating significantly impacted the number of sprouts per corm as well as the germination speed Tab. 1. Surprisingly, the corms that were not subjected to pre-planting treatment with heat germinated much faster than those under an influence of heating, while the number of sprouts per each corm was greater in the variant with previously heating. We should admit that the latter mentioned parameter can be of a greater importance for the crop productivity as more sprouts will result in more flowers per each corm, e.g., more yield of stigma collected.

**Table 1.** Saffron corms germination speed and intensity of sprouts formation depending on pre-planting heating

| Variant | Mean number of sprouts per corm ± standard deviation | Mean number of days to germination ± standard deviation |
|---|---|---|
| No pre-planting heating | 2.50±1.29 | 15.00±2.31 |
| Pre-planting heating | 4.75±2.58 | 17.50±3.42 |
| Difference between the variants | 2.25 | 2.50 |
| Error of the experiment ($S_d$) | 1.11 | 0.96 |
| $LSD_{05}$ | 2.05 | 1.82 |

As about the speed of germination, it could be delayed in the variant with pre-heating treatment due to the fact of greater number of living buns stressed out to provide sprouts that required more time for them to appear. However, this statement is just an assumption and lacks scientific evidence in its support.

On contrary, (Zahmati et al. 2018.) claimed that pre-planting treatment with high temperature (+30°C vs. +17°C) had no significant effect on the crop growth and development. Besides, in the greenhouse cultivation practice media and pre-planting treatment with growth stimulants can play an important role in the plant development improvement and yield increase (Turhan et al., 2007; Khayyat et al., 2018).

The data in support of our results could be found in the study by Aysun (2010) where the author proved negative impact of prolonged storage of saffron corms in cold (+8°C) conditions on the crop's growth, development, and yield. Besides, (Molina et al. 2005a) had proved the possibility of delaying saffron flowering at the expense of the crop corms storage in cold conditions (at +2°C), but optimal flowering was obtained from the saffron corms stored at the temperature +25°C during 55 days (Molina et al., 2004). Prolonged (more than 50 days) incubation of saffron corms at the temperature +23…27°C results in the best flower formation, however, storage at such temperatures for more than 150 days leads to abortion of flowering in the crop (Molina et al., 2005b).

Although there is some evidence, additionally supported with our study, that pre-planting heating of saffron corms is beneficial both at the initial stages of the crop growth and at the stage of flowering, it should be admitted that there is still a great gap that must be filled to obtain a complex image on how the pre-planting temperature treatment effects saffron.

## Conclusions

To sum up, pre-planting heating of corms seems to be a prospective and effective technological measure to enhance the rate of productive saffron plants per area unit, thus, resulting in higher yields of stigma. Further studies, especially field ones conducted alongside to greenhouse ones, are required to accept or reject this cultivation element and provide practical guidelines for saffron growers. Besides, different temperature regimes are to be included in further studies to find out the best option for germination provocation under the greatest number of sprouts.

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