Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 2, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

THE DEVELOPMENT OF *Crocus sativus* L. IN THE AREA OF THE CITY OF SOFIA

Tsvetelina NIKOLOVA, Vera PETROVA

University of Forestry - Sofia, Faculty of Agronomy, Department of "Perennials and gardening", 10, Kliment Ochridsky Blvd, 1756, Sofia, Bulgaria

Corresponding author email: c.alipieva@abv.bg.

Abstract

Saffron (Crocus sativus L.) is a geophytic plant which is one of the most commonly known medicinal and aromatic plant species in the world. The stigma of saffron is used for dye, food, or beverages additive and in the pharmacology industries. The saffron crocus has been cultivated in our country quite recently, but the areas with this crop are rapidly increasing. Saffron (Crocus sativus L.) is the most expensive spice in the world. This plant species is propagated vegetatively through the formation of daughter corms from the mother one. The field experiment was conducted to determine the most suitable bulb size for saffron cultivation. In the present article, we summarize scientific observations on the influence of air factors on the development of saffron and the size of the bulbs, their mass and also the number of daughter bulbs. One of the most important organs for plant development.

Key words: *corms, Crocus sativus, reproduction, Saffron, vegetatively.*

INTRODUCTION

Globally, saffron is grown primarily in Iran, Pakistan, India, Azerbaijan, Greece, Spain, and Turkey in areas with low labor costs and small family farms under non-irrigated conditions. Saffron has the potential to be used in fields on small family farms, according to Hassan-Beygy (2010). Iran is the largest producer of saffron in the world, with more than 90% of the world's production, and 300 tons of dried product. The saffron crocus is a sterile plant that does not produce seeds and propagates from bulbs. Bulb selection is an important factor in saffron production. According to Basker & Negbi (1983) and Kafi (2002), the plant is the most valuable in the world. The unique characteristics of the saffron crocus, such as its aroma, taste, and yellow dyeing properties, have reserved a special place for this plant in the pharmaceutical, food, and textile industries. Because saffron crocus flowers are completely sterile, they do not produce viable seeds. Therefore, its reproduction depends entirely on human activity: the bulbs are removed by hand, divided, and replanted in the soil.

The mother bulb survives only one season and reproduces by division; from one bulb, about 10 daughter bulbs are formed. The resulting new bulbs subsequently grow as individual plants. The color of the bulbs is brown, the sizes are up to 4.5 cm in diameter, and they are covered with fibers.

According to Hassan-Beygy (2010), the mass and size of bulbs are of great importance when designing and developing equipment for planting, harvesting, sorting, and processing. Because until now, all processes were manual.

The yield and quality of stigmas and flowers are affected by bulb size (Andabjadid et al., 2015). Determining the most appropriate bulb size would contribute to the implementation of cultivation practices and, ultimately, yield and quality.

According to research conducted by Rechinger (1975) and Wendelbo (1977), it is a perennial plant with dimensions of about 20–30 cm. The bulbs are spherical and flat at the base, up to 5 cm in diameter and 50 g in weight, and covered with a sheath that extends upwards about 5 cm above the neck of the plant. Under variable conditions, it is possible to form roots (Negbi, 1999). After blooming, the crocus continues to take nutrients from the soil and accumulate

reserve substances needed for development and flowering the following year.
After flowering, the crocus does not stop feeding on the soil and again accumulates reserve substances, thanks to which it will grow and flower again the next year.
Under favourable conditions, they bloom for only a few weeks. During this very short period, they accumulate nutrients in their root (bulb), tuber bulb, or rhizome. During the long, unfavourable period, the plant hides underground and lives only on the reserves in its bulb.
In traditional cultivation practices, many factors influence saffron propagation. Fungal infections lead to low productivity in daughter bulbs. Conventional propagation methods do not meet the high demand for planting material. In the reproduction of this plant species, the in vitro method is of great importance, as it has many advantages.
According to authors such as Ascough (2009) and Karaoglu (2007), a very good alternative to producing quality planting material is micropropagation, which also reduces the incidence of diseases.
According to Deo (2003), domesticated crocus (*Crocus sativus*) is an autumn flowering perennial plant. According to the author, it is a sterile triploid mutant of the eastern Mediterranean autumn-flowering (*Crocus cartwrightianus*)
Dried stigmas are used medicinally as spices and food colorants. The plant has been considered the most expensive spice for centuries. This plant contains more than 150 volatile and aromatic compounds. In addition, there are many non-volatile active components, such as carotenoids, including zeaxanthin, lycopene, and various α- and β-carotenes.
According to Abdullaev (2002), the yellow-orange color of the stigmas is mainly due to the α-crocin substance. However, saffron's golden yellow-orange color is primarily the result of α-crocin (Abdullaev, 2002).

MATERIALS AND METHODS

The field experiments were carried out in the Experimental Field of the University Forestry, located in the Sofia field, at an altitude of 552 m. The terrain is flat, and the vegetation is grassy. The soil is alluvial-meadow, slightly stony. It is characterized by a modern soil-forming process. Soil-forming materials are represented by clays, sandy loams, sands, and gravels. Their profile is represented by a humus horizon with a thickness of 0.10-0.40m, under which there are alluvial deposits.
The experiment was carried out under scientific project No. B-1217/27.04.2022, "Comparative study of technologies for growing vegetables and spices in urban conditions" In several scientific articles, we followed its development in an urban environment under climatic conditions and on alluvial soils. The bulbs are planted in two parallel furrows 40 m long, with the largest saffron bulbs placed in one furrow and the smaller ones in the other. The inter-row distance is 10 cm, and the inter-row distance is 30 cm. The size and mass of the bulbs before planting were measured. The size of the bulb was evaluated by a calliper and the mass by an electronic scale. No fertilizer was applied.

RESULTS AND DISCUSSIONS

According to Singletary (2020), saffron contains more than 100 biologically active compounds, the most important being crocin, crocetin, picrocrocin, and safranal.
Ghanbari & Khajoei-Nejad (2021) concluded that saffron cultivation is influenced by various factors, including climate, crop density, irrigation, and others. Fertilization is of great importance to obtaining optimal yield and quality of saffron.
According to a number of authors such as Behzad (1992a), Behnia (1999), Kafi (2002), saffron as a perennial crop is usually grown in arid and semi-arid regions in Iran.
According to Renau-Morata (2012), as the growth of the daughter bulbs increases, the mother bulbs are reduced gradually. Each mother bulb produces new daughter bulbs before it dries up. According to Bhagyalakshmi (1999), during the second growing season, each daughter bulb is considered a potential mother At the end of the growing season, the mother bulbs are brown, oval, and flat discs, with daughter bulbs attached to them (Kumar, 2009).
According to a number of authors, such as Gresta (2008), Koocheki & Seyyedi (2019),

and Renau-Morata (2012), the yield of saffron is highly dependent on the growth of daughter bulbs during the previous growing season. At the beginning of the growing season, reproduction is strongly influenced by the concentration of food reserves in the bulbs.

According to Kafi et al. (2022), plant density increases during each growing season. Accordingly, the yield of saffron in the first year is usually low, and the highest yield is recorded in the fourth to fifth year of its cultivation. In relation to the data obtained by Kumar (2009), the large number of bulbs formed in the soil, the increased density due to soil compaction, and the reduced fertility can be observed as a gradual decrease in the yield of flowers.

The field experiment was conducted in 2022 on alluvial-meadow soils. They are characterized by a gray yellow to dark gray color, with this variety depending on the amount of humus. The soils have fewer humus horizons, with certain differences among themselves in the content of coarse particle materials found in large sizes. The mechanical composition depends entirely on the composition of the river sediments on which they are formed.

Analysis of the soil

The mechanical composition of the soil (alluvial meadow) is characterized by a predominant sandy fraction of the soil substrate, both in the horizontal direction and in the depth of the soil profile up to 100-125 cm. The sandy fraction (0.25 mm) increases with depth, varying widely and having a low content of physical clay (0.01 mm) and of or (0.001 mm). These indicators are typical for the surface horizons up to 40-60 cm and cause high water permeability in the soil.

The humus content in the surface horizon of arable land varies from 1-2%. Along the depth of the profile, it either decreases gradually, or horizons or layers with higher or lower humus content alternate. These soils have a medium acid to slightly alkaline volume (pH in H_2O 5.0–6.0). The amount of total nitrogen also varies from 0.040% to 0.30%. The conditions for the mobilization of organic nitrogen are good. As a result, the phosphorus stock is highly subject to plant extraction, and phosphorus deficiency is possible. Groundwater plays an important role in the lowlands, where during the winter-spring season it is high and causes swamping. The volumetric weight of the soil for the layer 0- 100 cm is 1.46 g/cm^3, and the field capacity (FP) in percent relative to the absolute dry weight of the soil is 21.1%. The reaction of the soil in an aqueous solution is neutral to slightly alkaline, and the content of humus in the surface genetic layer defines the soil as medium humus.

Climatic characteristic

The climate in the Sofia valley, where the experiment was carried out, is moderately continental, with an average annual temperature of 9-10.5°C. Winters are cold and snowy, except for the last one. In winter, temperatures drop to -15°C or lower on the coldest winter days. The coldest month is January. At the beginning of the winter season, fog is a very characteristic phenomenon. Snow cover in winter in Sofia averages 58 days. In the last few years, snow cover has been a rare phenomenon. Summer is hot and sunny. Due to the higher altitude, it is slightly cooler in the summer than the rest of the country.

However, on the hottest summer days, most often in July and August, temperatures can exceed 35°C. Changeable and dynamic weather is characteristic of spring and autumn. The recorded average annual rainfall is within 581.8 mm, reaching its maximum in late spring and early summer. Thunderstorms are also observed during this period, which are not rare.

Figure 1 presents the data from the measured temperatures and precipitation rate after planting the bulbs.

The recorded rainfall since the beginning of the growing season for saffron is about 3.86 mm. Two of the highest rainfall amounts were recorded in early and mid-August, at 12.5 and 15.4 mm, respectively. Despite the relatively small amount of rainfall, it is very evenly distributed and is sufficient to meet the water needs of saffron in the initial stages of development. In the month of September, twice as much precipitation was reported 26 and 24.3 mm.

The rainfall is less compared to the previous month but in larger amounts, which is sufficient for the development of saffron. Total rainfall for October was 37.1 mm, which combined with the drop in average daily

temperatures provided sufficient soil moisture at the end of the saffron flowering period.
The average daily temperature during the growing season is between 24.6 and 8.9ºC. At the end of September, there is a sharp drop in temperatures. For the month of October, the temperatures are between 8.7 and 15.9ºC.

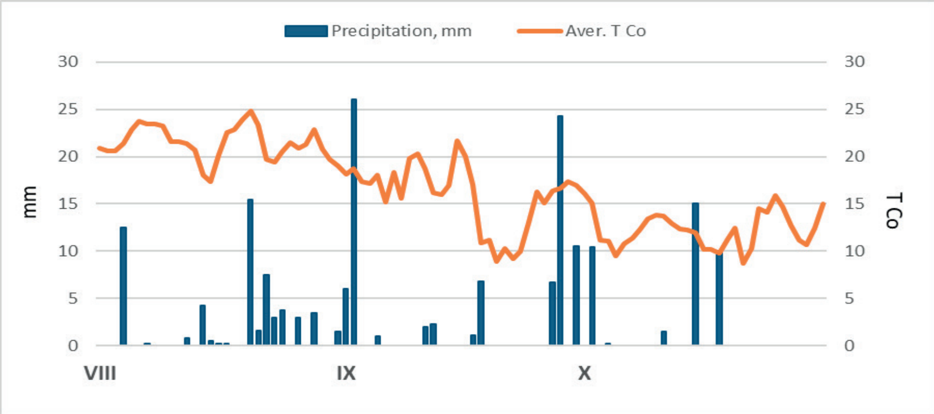

Figure 1. Precipitation and average air temperatures for 2022

.
For the production of saffron, the size of the bulb is essential. Reported sizes vary from 1 cm/small fraction/to 3 cm/large fraction/. To get the maximum yield from the production of flowering saffron, it is advisable to start with a larger bulb size, as shown in Figure 2.

Figure 2. Size of the bulbs

Figure 3 shows the bulb sizes of the two fractions. Values range from 10-10.5 mm for small bulbs to 30 mm for larger bulbs. To produce daughter bulbs, a larger size may be recommended.

The results in Figure 4 show that the mean bulb mass values ranged from 2.89 to 3.57 g.
Larger bulbs develop better and accumulate more nutrients.

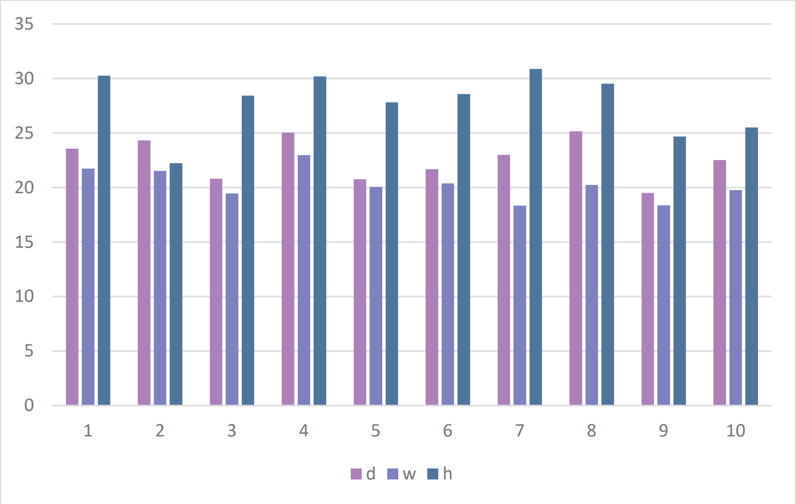

Fig. 3. Size of the bulbs depending on the diameter (mm)

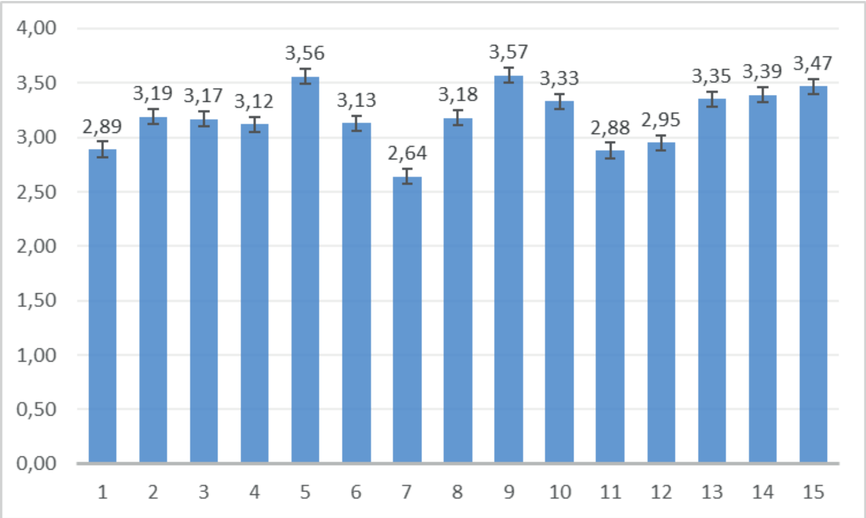

Figure 4. Mass of the bulbs

CONCLUSIONS

The climatic characterization made during the field experience, the type of soil and the growing conditions are favourable for growing saffron in the Sofia basin. Temperature and humidity during the period have a positive effect on its development. Larger bulb size results in a higher number of flowers per m^2 and a higher total yield of daughter bulbs.

ACKNOWLEDGEMENTS

Project NIS- No. B-1217: 27.04.2022 "Comparative study of technologies for growing vegetables and spices in urban conditions".

REFERENCES

Andabjadid, S.S., Eslam, B.P., Bakhtavari, A.R.S., & Mohammadi, H. (2015). Effects of corm size and plant density on Saffron (*Crocus sativus* L.) yield and

its components. *International Journal of Agronomy and Agricultural Research (IJAAR),* 6(3), 20-26.
Abdullaev, F.I. (2002). Cancer chemo preventive and tumoricidal properties of saffron (*Crocus sativus* L.), *Experimental Biol. Med*., 227, 20-25.
Ascough, G.D., Erwin, J.E., & Staden, J. (2009) Micropropagation of Iridaceae-a review. *Plant Cell Tissu Org. Cult*., 97, 1–19
Basker, I. & Negbi, M. (1983). Saffron Quality: Effect of Agricultural Practices, Processing and Storage. *Production Practices and Quality Assessment of Food Crops*, 1, DOI: 10.1007/1-4020-2533-5_8.
Behzad, S., Razavi, M., & Mahajeri, M. (1992a). The effect of mineral nutrients (N.P.K.) on saffron production. *International Symposium on Medicinal and Aromatic Plants, Acta Horti*., 306, 426-430.
Behzad, S., Razavi, M., & Mahajeri, M. (1992b). The effect of various amount of ammonium phosphate and urea on saffron production. *International Symposium on Medicinal and Aromatic Plants, Acta Horti*., 306: 337-339.
Deo, B. (2003). Growing Saffron – The World's Most Expensive Spice, Crop & Food Research (New Zealand Institute for Crop & Food Research), 20. http://www.crop.cri.nz/home/productsservices/publications/broadsheets/020Saffron.pdf
Gresta, F., Gresta, G., Avola, G.M., Lombardo, L., Siracusa, G. R. (2009). Analysis of flowering, stigmas yield and qualitative traits of saffron (*Crocus sativus* L.) as affected by environmental conditions. *Sci. Hort., 119* (2009), 320-324.
Ghanbari, J. G., Khajoei-Nejad, S. M., & van Ruth, S. A. (2019). The possibility for improvement of flowering, corm properties, bioactive compounds, and antioxidant activity in saffron (*Crocus sativus* L.) by different nutritional regimes. *Industrial Crops and Products,* 135, 301-310.
Hassan-Beygy, S.R., Ghanbarıan D., Kianmehr M.H., & Farahmand, M. 2010. Some Physıcal Propertıes of Saffron Crocus Corm. *Agronomic Research in Moldova, XLIII* (141), 17-29.
Karaoglu, C., Cocu, S., Ipek, A., Parmaksiz, I., Sarihan, E., Uranbey, S., Arslan, N., Kaya, M.D., Sancak, C., Ozcan, S., Gurbuz, B., Mirici, S., & Khawar, K.M. (2007) *In vitro* micropropagation of saffron. *Acta Hortic*., 739, 223–228.
Kafi, M., Rashed, M.H., Koocheki, A., & Mollafilabi, A. (2002). *Saffron: Production Technology and Processing.* Center of Excellence for Agronomy (Special Crops). Faculty of Agriculture, Ferdowsi University of Mashhad, Iran.
Kumar, R. V. S., Devi, K., Sharma, M., Singh, M.K., Ahuja, P.S. (2009). State of art of saffron (*Crocus sativus* L.). Agronomy: a comprehensive review. *Food Rev. Int., 25* (2009), 44-85.
Negbi, M. (1999). *Saffron cukivation: past, present and future prospects.* Amsterdam, ND: Hanvood Academic Publishers.
Rechinger, K. H. (1975). Flora Iranica, Fasc. 111–162 https://www.iranicaonline.org/articles/flora-iranica-
Renau-Morata, B., Nebauer, S.G., Sánchez, M., Molina, R.V. (2012). Effect of corm size, water stress and cultivation conditions on photosynthesis and biomass partitioning during the vegetative growth of saffron (*Crocus sativus* L.). *Industrial Crops and Products*, 39, 40-46.
Singletary, K. (2020). Saffron Potential Health Benefits. *Nutrition Today, 55*(6), 294-303.
Wendelbo, P. (1977). *Tulips and Irises of Iran and Their Relatives.* Botanical Institute of Iran, Botanical Garden, Tehran.