

## IMPACT OF CLIMATE FACTORS ON THE HONEY-BEARING QUALITY OF SAFFRON CROCUS (*Crocus sativus*)

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### Abstract

The saffron crocus (*Crocus sativus*) is a flowering plant of the Iridaceae family. A spice called saffron is obtained from the dried red stigmas of the flower and is used in the pharmaceutical, cosmetic, perfumery and textile industries. It has been grown in our country for a short time, but the areas with this culture are rapidly increasing. To date, no scientific research has been conducted on this type of plant in our country. In the present article, we summarize scientific observations on the influence of climatic factors, temperature, and air humidity on the honey qualities of the saffron crocus. We determined the amount of nectar and its sugar content, the amount of individual pollen from one flower, and the size and shape of the pollen grains in the pollen. We tracked the flowering period and the number of flowers against the age of the planted bulbs.

**Key words:** climatic factors, *Crocus sativus*, flowers, honey qualities, nectar, pollen.

### INTRODUCTION

The crocus is a perennial plant from the Iridaceae family, distributed from the Eastern Mediterranean to Central Asia.

About 40 species exist, most of which are cultivated. There are nine of them in Bulgaria. Crocus has sharp, grass-like dark green leaves that are slightly hairy, usually 4 to 8 in number. It reaches up to 10 cm in height. They are most often pollinated by bees, but also by other insects. If the stamen pollen lands on the pistil after the plant has finished flowering, the fruit also appears. Because they are sterile, saffron crocus flowers do not produce viable seeds. (McGee, 2004)

Saffron crocus (*Crocus sativus* L.) is an autumn-flowering geophyte that reproduces exclusively vegetatively (Mzabri et al., 2017). It is cultivated for its red stigmas, which after drying are the most expensive and valuable spice in the world (Zhang et al., 2019).

More recently, the demand for stigmas has increased dramatically, amid the discovery of new-to-science pharmacological applications, especially those based on cytotoxic and antitumor properties (Cavusoglu, 2017; Mzabri et al., 2019). Saffron adapts extremely well to different environmental conditions, it grows well in arid and semi-arid regions (Gresta et al.,

2008), but it can also adapt to temperate and subtropical climates.

The saffron crocus (*Crocus sativus* L.) is a sterile geophyte with autumnal flowering, which reproduces exclusively by vegetative means (Mzabri et al., 2017). It is cultivated for its red stigmas which, after drying, are the most expensive and valuable spice in the world (Zhang et al., 2019). More recently, the demand for stigmas has increased dramatically, especially with the discovery of new pharmacological applications, especially those based on cytotoxic and antitumor properties (Cavusoglu, 2017; Mzabri et al., 2019). Saffron is adapted to various environmental conditions, it grows well in arid and semi-arid areas (Gresta et al., 2008) but it can also adapt to temperate and subtropical climates.

Among all environmental factors, the temperature is considered one of the key elements that control the growth and development of saffron.

The plant tolerates cold winters, withstands frosts down to  $-10^{\circ}\text{C}$  and snow cover. Despite the long period during which it has been cultivated, the scientific literature on flowering in this species is far from complete (Plessner et al., 1989).

The beginning of flowering begins in mid-autumn when the average air temperature is below 15-17°C. These temperatures appear to be close to optimal for flower emergence (Plessner et al., 1989; Molina et al., 2005).

Saffron flowers are set 3-4 months earlier, from early spring to mid-summer depending on location (Koul, 1984; Azizbekova, 1999; Negbi, 1999; Molina et al, 2005), soon after bud release in rest. The optimum temperature for initiation of flowering is in the range of 23–27°C, but long exposure to these temperatures results in delayed flowering (Molina et al., 2005).

Their colour can vary from light to dark purple with or without stripes. When flowering, the saffron crocus reaches an average height of 30 cm. Each flower is triple-branched, ending in three dark orange-red licks. They can be between 25 and 30 mm in length.

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Pollen from flowers is necessary for germination, fertilization, and seed formation. Because the crocus flowers are brightly coloured, pollination is done by insects (entomophilia).

The flowers are hermaphroditic, releasing a lot of pollen and nectar to attract insects. Pollination begins when the flowers open. In most spring flowering crocuses, the flowers open when the temperature is around 15°C, but in highland species the flowers open earlier when the temperature is between 5°C and 10°C.

Flower opening in sunny, dry weather results in rapid maturation of the pollen sac and microspores (Grilli & Canini, 2010). Pollen sacs open longitudinally by an adhesion mechanism and release the pollen.

Crocus flowers are allogamous. This is the normal case of pollination and seed development. *C. sativus* is triploid and sterile, therefore triploid saffron results in abnormal chromosome pairing, chromosome misdistribution and sterile gametes (Chichiricco & Grilli, 1987, Rudall, 1984).

However, we rarely observe sexual reproduction and seed formation. In his experiments, Molina (2005) tracked the

environmental temperature and phenological stages of crocus (*Crocus sativus* L.) The optimum temperature for flower formation was in the range of 23 to 27°C, with a temperature of 23°C slightly better. To ensure the formation of the maximum number of flowers, incubation at these temperatures should exceed 50 days.

The appearance of flowers requires moving the bulbs to a lower temperature (17°C). Various factors influence saffron cultivation, including climate, crop density, irrigation, and other agricultural methods (Madini et al., 2019; Rezvani-Moghaddam, 2020), but balanced and timely fertilization is a prerequisite for obtaining optimal yield and potential for quality of saffron (Ghanbari & Khajoei-Nejad, 2021). Despite the low fertilization requirements of saffron, studies confirm that most changes in saffron flower yield depend on fertilizers and soil amendments (Kamili et al., 2007).

## MATERIALS AND METHODS

The study was conducted in 2022 at the Educational Experimental Field of the Forestry University in Sofia. According to the scientific project No. B -1217/27.04.2022 "Comparative study of technologies for growing vegetables and spices in urban conditions", we set up a Polish experience with saffron crocus. In several consecutive scientific articles, we followed its development in the conditions of the urban environment under the climatic conditions and on alluvial soils. The bulbs were planted in two parallel furrows 40 m long. The intra-row distance was 10 cm, and the inter-row distance was 30 cm.

## RESULTS AND DISCUSSIONS

Although saffron grows well in temperate and dry climates, its vegetative growth coincides with cold weather and freezing conditions in our country. In October 2022, the temperatures are close to the norm and with precipitation below the average for the month.

Temperatures are slightly higher than usual for the season, maximum temperatures between 16 and 24 degrees. Mostly sunny with temporary overcast and high clouds.

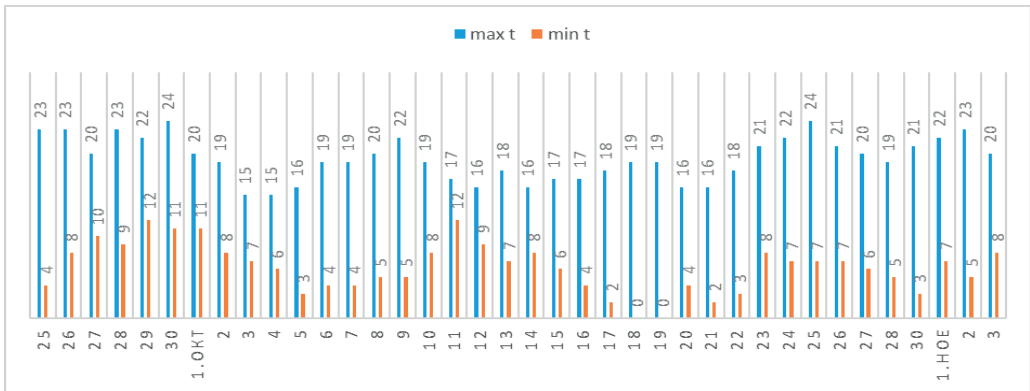


Figure 1. Air temperature, °C

Figure 1 shows the results of the temperature during the flowering period of the crocus. The temperature is favourable for normal plant development and pollinator visitation due to the

warm autumn. Of all environmental factors, temperature is considered one of the key elements that control saffron growth and development and flower production.

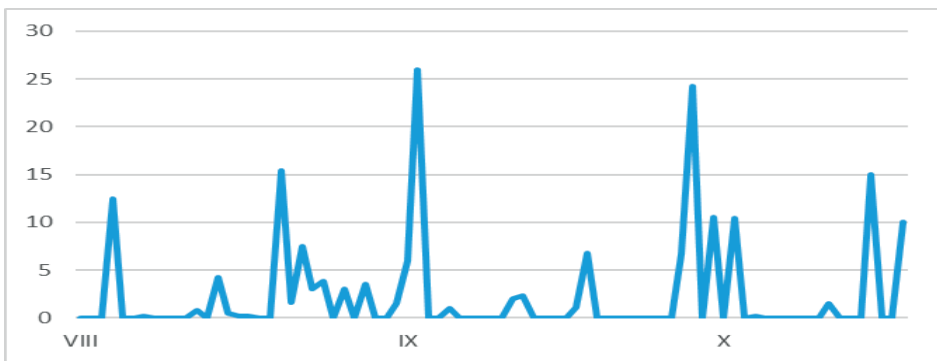


Figure 2. Average amount of precipitation during the flowering period

Figure 2 shows average rainfall data. Despite the relatively small amount of precipitation, in the period after planting the bulbs, it is evenly distributed throughout the period.

Rainfall in the initial stages of development is sufficient to meet the water needs of saffron, even in non-irrigated growing conditions.

The results in Figure 3 show that a larger number of bulbs on the plant produced an average of 2-3 and less often four flowers.

Figure 4 shows the average flowering duration of one flower in days. The duration of

flowering of each flower varies within 4 to 6 days in the large bulbs of the plants. The flowering period is strongly dependent on the temperature during the period.

The onset of flowering in the large bulbs of *Crocus sativus* began on October 10 and lasted a total of 25 days. This period is strongly influenced by weather conditions during the period. High temperatures in summer have a positive effect on flowering in autumn. The bulbs receive enough heat in the soil during the summer period.

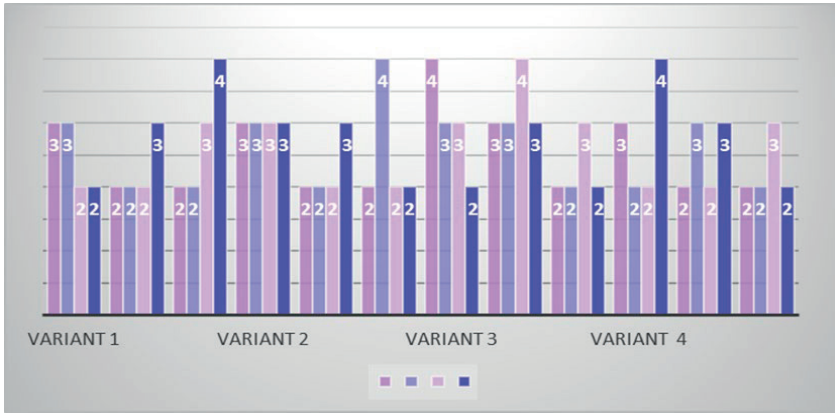


Figure 3. Number of flowers from one tuber

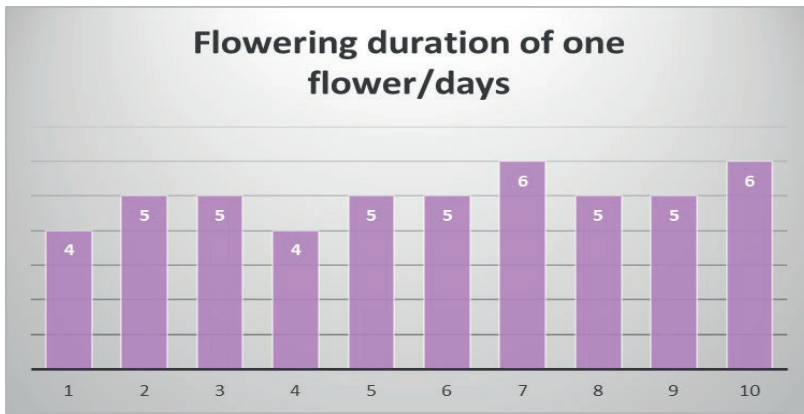


Figure 4. Flowering duration of one flower/days



Figure 5. Saffron crocus flower, stamens, and stigmas

Table 1. Flowering period

Beginning of flowering	Mass flowering	End of flowering	Flowering period in days
10.10.2022	15.10.2022	03.11.2022	25

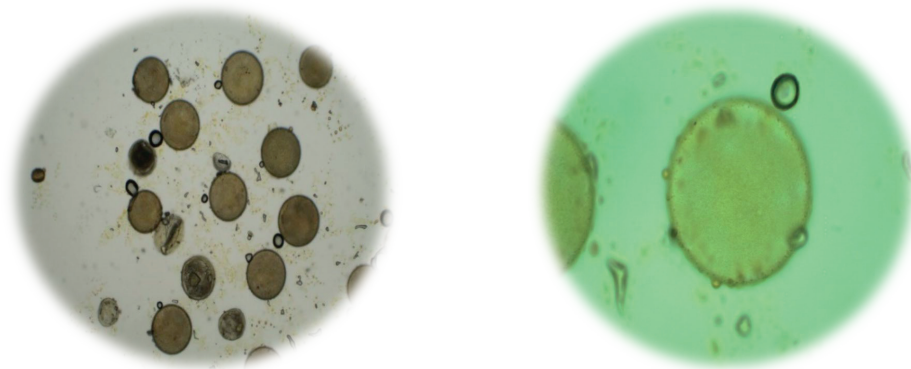


Figure 6. Pollen grains of *Crocus sativus*

Figure 6 shows the results of microscopic observation of *Crocus sativus* pollen grains. Pollen grains are of the correct shape for the species, they are viable and have no deviations. Saffron crocus pollen is heavy and sticky, but it can be collected by insect pollinators, such as honeybees and bumblebees and other insects, in areas where climatic conditions permit. Saffron produces a good amount of pollen and nectar with a nectar sugar content of 2% Brix.

## CONCLUSIONS

Larger bulb sizes result in a larger number of flowers per m<sup>2</sup>. Climatic conditions in the Sofia valley and alluvial soils have a favourable effect on the development of saffron.

The plants develop well and produce many flowers, therefore also stigmas, for this the recorded temperature and humidity during the vegetation period of the plants are favourable.

In areas where the climate allows bees to fly, the saffron crocus is a good plant as a source of food and honey.

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