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Indoor Saffron Production - How and Why

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Abstract

Due to its exceptional commercial worth and relatively small production volume, saffron is also known as the "golden crop," and the extensive cultivation of saffron is referred to as the "Golden Zest" in Indian agriculture. Indoor farming has gained attention in the agricultural industry due to its ability to optimize resource utilization. It enables reduced water and chemical usage, provides greater control over environmental conditions, and minimizes the vulnerability of crops to extreme weather conditions. These advantages make indoor farming an appealing option for cultivating delicate crops like saffron.

Introduction

Saffron, scientifically known as Crocus sativus L., is a perennial herbaceous plant belonging to the Iridaceae family. It is a sterile geophyte and is commonly propagated using mother corms. The spice known as saffron is derived from the dried stigmas of the Crocus sativus L. plant. Widely recognized as "the red gold" (Poggi, 2009), saffron gets its name from the Arabic word "Zafran," meaning yellow (Winterhalter and Straubinger, 2000). In India, this prized aromatic spice is referred to as Kum Kumin in Sanskrit, Kesar in Hindi, and Koung in Kashmiri (Fig. 1). Presently, saffron is cultivated across a wide area, from the Western Mediterranean (Spain) to India (Kashmir) (Kumar, 2008).

Saffron is primarily cultivated in Iran, which accounts for over 90% of the world's production. Other significant saffron-producing countries include Kashmir in India, Spain, Morocco, Greece, and Italy (Babaei*et al.*, 2014; Shokrpour, 2019). The global saffron production is estimated to be around 418 tons per year, cultivated on an area of approximately 121,338 hectares. Saffron cultivation in Iran has a long history, dating back more than 750 years in the southern and central regions of Khorasan (Kafi*et al.*, 2018).Iran is the largest saffron producer worldwide, with an annual production of 200 tons of dry saffron from over 60,000 hectares of cultivated land. The maximum yield productivity of saffron in

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Iran is about 7.5 kg per hectare, with an average of 3.96 kg per hectare. This productivity differs significantly from countries like Spain, where it reaches 15 kg per hectare (Feli*et al.*, 2018).In the Jammu and Kashmir region, the total area under saffron cultivation is 3,715 hectares, with a production of 16 metric tons and a productivity ranging from 3.0 to 4.0 kg per hectare (Source: CSIR-IIIM).

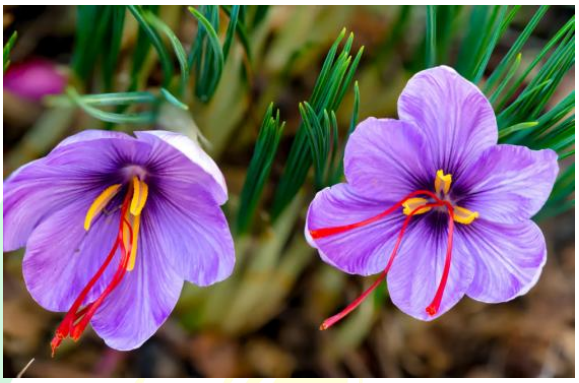

Figure1: Kashmiri Saffron (Koung)

Soil and climatic suitability of saffron

The growth and development of saffron are influenced by various environmental and topographic conditions, which can vary between different countries and regions. In India, saffron is primarily grown in temperate climate conditions with loose and well-drained soils. Clay calcareous soil, silty-clay soil, sandy soil, and sandy-loam soil are generally considered suitable for saffron cultivation. The pH value of the soil plays a significant role in yield, with higher pH values associated with higher saffron production. In Jammu and Kashmir, the soil pH for saffron cultivation ranges from 6.3 to 8.3, and the soil electrical conductivity ranges from 0.09 to 0.30 dS/m.

For optimal flower development, saffron requires temperatures ranging from 23 to 27 °C during summer, while winter temperatures should not drop below -15 to -20 °C. It is evident that environmental factors such as temperature and precipitation play a crucial role in the growth and development of saffron (Galavi*et al.*, 2008). However, while these conditions provide a basis for identifying suitable regions for cultivation, further exploration is necessary to understand the specific requirements for successful saffron growth in targeted regions. Other factors, including the availability of quality planting materials, cultivation techniques, corm production methods, and the survival rate after sowing, also play a vital role in ensuring proper growth and development of saffron.

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Why indoor saffron cultivation

The following are the reasons that we go for indoor saffron:

Reduced productivity of saffron in Kashmir: Following the vegetative stage, the saffron plant undergoes plant senescence, which occurs from 1st April to 30th April. As the first week of April approaches, prominent signs of leaf aging become evident. During this period, there is a downward movement of photosynthates from the leaves to the corms, which serve as the storage organs. Over the course of approximately 30 days, this downward translocation process takes place, leading to the development of fully mature daughter corms. These daughter corms display a reduced resemblance to the mother corms, indicating the completion of the reproductive cycle. Plant senescence marks the conclusion of the growth phase for the saffron plant as it prepares to enter a period of dormancy before the next growth cycle begins.

Some important factors that have contributed to less production of saffron are:

a) **Rainfall:** The production of saffron is closely linked to the amount of rainfall received in the cultivation areas. Ideally, regions that receive 100-150 cm of rainfall, which is well-distributed throughout the year and accompanied by snow during the winter months, are considered highly suitable for saffron cultivation. Adequate rainfall, especially in September, is crucial for fulfilling the water requirements of the corms, leading to better flower yields. However, there has been a noticeable decline in precipitation in the mountainous parts of the valley, with a significant decrease of 10.3 mm/year. In contrast, the flood plains have experienced a relatively lower decrease rate of 3.6 mm/year. The foothills and Karewas have shown a moderate rate of decline, with a decrease of 6.3 and 5.8 mm/year, respectively. These variations in rainfall patterns can have an impact on saffron production in different regions within the valley.

b) **Technological poverty and unaware farmer**s: The use of outdated technology in saffron cultivation has had detrimental effects on soil fertility and overall crop production. To address this issue, it is important to raise awareness among farmers about modern post-harvest methods and the latest techniques for storing the crop. In particular, there is a need to educate farmers about the optimal timing and stage for separating the stigma from the style, as well as promoting the use of solar dryers and

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effective branding strategies. Kashmiri saffron is known to contain a significant amount of crocin in its fresh stigmas, ranging from 14% to 17%. However, due to poor post-harvest handling practices and insufficient knowledge about preserving the quality, the crocin content tends to decrease to 9% to 11.5% after harvesting and storage. This decline can be attributed to factors such as improper handling, inadequate drying methods, and a lack of understanding about the preservation techniques. As a result of these challenges, Kashmir lags behind in terms of saffron production, with an average yield of 2.23 kg/ha. In comparison, countries like Spain achieve an average yield of 8.24 kg/ha and Italy reaches 10.0 kg/ha. Improving post-harvest practices and adopting modern techniques can contribute to enhancing the productivity and quality of saffron in Kashmir.

c) **Diseases:** The intensive cultivation and monoculture practices observed in saffron farming, coupled with the persistent use of diseased planting material, have led to frequent occurrences of corm rot diseases caused by various pathogens.

d) **Climate change:** Prolonged periods of drought have caused significant concerns among saffron farmers. Since the crop heavily relies on rainfall, insufficient precipitation has resulted in the region experiencing its lowest saffron productivity in the past three decades. During the years 1999-2003, the productivity dropped from 3.12 kg/ha to 1.57 kg/ha. However, there was a positive turnaround in 2004-05 with favourable rainfall, leading to an improved productivity of 2.96 kg/ha. Over the subsequent 13 years, the average yield reached 8.71 metric tons. In 2015, the saffron crop yielded a total of 9.6 metric tons from 3,674 hectares of land.In addition to the challenges posed by drought, the region is also facing issues related to urbanization and increasing population growth.

e) **Urbanization and increasing population:** The rapid urbanization and population growth in Kashmir pose a significant threat to saffron cultivation. The renowned saffron fields of Pampore, located near the capital city of Srinagar, have become highly appealing for conversion into residential areas. However, it is crucial to prevent and discourage these detrimental attempts by individuals who seek to transform the valuable saffron land into settlement townships. Preserving the saffron

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fields and their cultural significance should be prioritized to ensure their continued existence and flourishing.

f) **Less availability of Land:** Saffron growers encounter numerous challenges, and one significant issue is the presence of small land holdings. Furthermore, a considerable portion of land that was previously dedicated to saffron cultivation has been converted into horticulture land. This conversion has had an impact on the availability of suitable land for saffron production. Additionally, many individuals involved in the saffron sector have transitioned to alternative livelihoods, leaving their land behind and further contributing to the decline in saffron cultivation. These factors have collectively affected the sustainability and continuity of saffron farming in the region. The continuous decline in saffron production is a cause for concern as it not only impacts the livelihood of the local communities but also jeopardizes the reputation of the Kashmir Valley as a renowned saffron-producing region. The growing commercialization of peri-urban areas, particularly Pampore, calls for innovative measures to sustain and expand saffron cultivation. Exploring non-traditional areas for saffron cultivation and adopting novel techniques such as indoor farming can offer potential solutions.

Basic Requirements and procedure of Growing Indoor Saffron

The world's most expensive spice saffron grows extremely well in an indoor, vertical system and has the potential to inspire great business models.

The requirements for indoor saffron cultivation are as given below:

a) **Hall:** Indoor saffron cultivation in enclosed spaces allows for maximized density. Using a 60-meter long hall, it is possible to grow 4 metric tons of saffron bulbs. With a conversion rate of 70 kg of flowers to 1 kg of dried saffron, each tonne of saffron bulbs can produce approximately 2 kg of dried saffron. This means that indoor cultivation on just 100 square meters can yield the same amount as outdoor cultivation on a 1-hectare land area. However, successful indoor cultivation requires proper planning, infrastructure, and management. Factors like lighting, temperature control, and nutrient supply must be carefully regulated for optimal growth and yield.

b) **Trays and Racks:** Saffron cultivation indoors involves the use of plastic trays (Fig. 2) and specially selected perennial seeds that have the ability to grow consistently

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over multiple years. The materials are carefully placed in racks within a dark room to create an environment with stable temperatures, which contributes to improved outcomes. The entire cultivation process, from planting to the emergence of flowers, typically takes around three months. Following the harvest, the saffron buds are preserved in open fields or kitchen gardens to be used for future seasons, ensuring a continuous and sustainable production cycle.

c) **Bulbs:** Healthy and diseases free corms of medium size is used for indoor cultivation of saffron.

Fig.2: Cultivation of saffron in plastic trays

V. How indoor saffron cultivation (Procedure)

i. **Corm disinfection:** The corms are treated with fungicide to prevent rotting and ensure their health and viability.

ii. **Sorting of corms:** The corms are sorted based on their size to ensure uniformity and optimal growth.

iii. **Placing corms in plastic trays:** The corms are placed in plastic trays, providing a suitable environment for their growth and development.

iv. **Transferring trays onto racks:** The trays with corms are then transferred onto racks, allowing for better organization and management of the cultivation process.

v. **Dark phase:** The racks with the trays of corms are placed in a dark environment for a period of 120 days. This extended dark phase is necessary for the corms to undergo the required physiological changes and prepare for sprouting and flowering.

Conclusion

By embracing indoor farming techniques, saffron cultivation can be extended beyond its traditional geographic boundaries, thereby diversifying production and mitigating the risks

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associated with unpredictable climate patterns. This approach has the potential to enhance the reliability and stability of saffron yields, ensuring a consistent supply of this prized spice.However, it is important to carefully assess the feasibility and suitability of indoor farming for saffron cultivation, considering factors such as cost-effectiveness, infrastructure requirements, and adherence to quality standards.

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