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Saffron production technology in Kashmir -North India

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Abstract
Saffron (Crocus sativus L.) is the most expensive spice of the world, and it is one of the 85 members of the genus Crocus. A native of Asia minor, and presently it is cultivated in Mediterranean countries. It is one of the most decorated crops of Kashmir valley since its introduction. Saffron predominantly contains certain chemical constituents that are responsible for imparting color, flavor, and aroma. Some of its components have cytotoxic, anti-carcinogenic and anti-tumor properties.it is propagated through corms. The growing area for saffron is limited, although its demand in the international market is increasing. The Good Agronomic Practices GAP can improve the yield to 5 Kg/ha. Research activities have been initiated to develop new production technologies of this spice in many countries. Saffron grows best in friable, loose, low-density, well-watered, and well-drained clay calcareous soils. Besides, climate and soil, planting time, seed/corm rate, planting depth, corm size/weight, crop density, nutrient management, weed management, growth regulators, harvest, and post-harvest management also influence saffron quality and quality. The other aspects of drying and marketing of the product, whereas at the same time stringent laws to check the adulteration and smuggled produces are needed. Here, an attempt has been made to compile the recent agronomic research on saffron for commercial flower and corm production, and a need to meet the target of doubling the saffron production.

Keywords: Antimycotic activity, minimum inhibitory concentration, *Argemone mexicana* L.

Introduction

Fig 1: Purple coloured bloom of saffron flowers

Saffron (Zafraan) is produced from golden colored stigmas (male part of a flower and pollen-bearing stems) of autumn Crocus *(Crocus sativus)* L. The flower blooms during mid-October to early November in northern India. Saffron threads are used as a spice after drying and used as food flavors and as a food coloring dye, etc. Saffron has a peculiar aroma and tastes bitter [1, 7]. Saffron, is the European name for this spice, *(Crocus sativus* L.) eventually derives from the Arabic word *jafran* /*Zafraan* meaning 'yellow' [2, 8]. Hindi and Sanskrit names from Kashmir, reported to produce the old saffron [9, 14]. By the name of Krakos, the spice is known to the Greeks, but the origin of the name is pre-Greek and not clear. Hebrew may be related to Karkom, which is the name of saffron in the Old Testament and behind many contemporary names of turmeric (karkuma). Its secrets stem from the dried red stigmas which accumulate large amounts of three glucosylated apocarotenoids, namely crocin, picrocrocin and safranal among the more than 150 volatile and aroma yielding compounds [3]. Saffron also has miraculous biological properties like antioxidant, anticancer, and antimutagenic [4].

Hence a result, saffron is the highest price as a spice in the world, at approx.US$ 1100–11,000/kg (http://en.wikipedia.org/wiki/Saffron), depending upon the country of its production [5]. The aim to review is to club all available agronomic aspects at one place [18-21].

History and Importance

Fig 2: Kashmir pampore and saffron flowers

The history of saffron is 3000 years back in Egypt [12, 23]. Scientists believe that saffron was first cultivated in the 7th century B.C., Arabs brought saffron to Spain and Romans introduced saffron into Great Britain [15, 24] has since been used as a spice and as an ingredient in the Mediterranean, extending its use and cultivation to other Eurasia as well as America and Africa [6, 25]. Saffron cultivation has spread to Oceania over the past decade. Thousands of devotees are anointed with saffron every 12 years as part of the 17.8 meter monolithic *Mahamastakabhisheka* festival *of Jain preist Bhagwan Gomateshwara Bahubali*, carved between 978-993 AD and located in *Sravanabelagola*, India [11]. Later, the saffron growing in the wild was used for their remedies and magic drinks.Essay on Saffron Long-distance Trade Before the 2nd Millennium BC Peak of Minoan Palace Culture. Saffron was also named in the Solomon Hebrew Song. The ancient Persians cultivated Persian saffron (Crocus sativus 'housekneihati') in Derbena. In these places, threads of saffron were used in garments, rituals were offered to the divine, and used in paints, perfumes, etc. Saffron threads are also scattered in beds and mixed with tea as a cure. Non-Persians fear saffron as a drug agent too. In his Asian programs, Alexander the Great used saffron as a cure for war wounds in his infusions, rice and baths. Kashmiri and Chinese people dates saffron back 900-2500 years ago. Meanwhile, historians studying ancient Persian records arrived shortly before 500 BC [13], attributing the Persian exchange of saffron worms to the storage of new gardens and gardens, or the Persian invasion and the colonization of Kashmir [16, 28]. The Phoenicians sold Kashmiri saffron as a color and a cure. The use of saffron in foods and colors spread throughout South Asia. For example, in India Buddhist monks adopted saffron robes after the death of Buddha Siddhartha Gautama. People believe that saffron first came to China through Persia. Saffron is also mentioned in ancient Chinese medical texts, which dates back to 200-300 BC. Traditionally attributed to the Yan ("Fire") Emperor Shenang, it records 252 phytochemical-based medical treatments for various disorders. In the 3rd century AD, the Chinese refer to saffron as a proof of Kashmir. For example. Chinese medical expert Wang Zhen reported that "Saffron is home to Kashmir, where people raise it mainly to offer it to the Buddha." Van also reflected on how saffron was used at the time. Saffron is specially cultivated in Jammu and Kashmir with new reports from Himachal Pradesh and Uttaranchal in India [17, 29]. Saffron cultivation is around Padampur (now Pampore) in the Kashmir Valley.

Introduction in Jammu & Kashmir Valley

The world's total production annualy is estimated at 300 t / yr with Iran contributing 80% to an area of 50,000 hectares. Spain beimg the second largest producer and contributes about 10-12% of global output followed by India (3.3%), Greece (2.0%) and Morocco (0.3%).

Saffron is usually cultivated in Iran but grows also in Spain, France, and India. A heavy labor plant, the three stigma are taken from each flower, distributed in trays and then dried in charcoal. A pound of saffron represents 75,000 flowers Saffron contains about 1 percent essential oil, the main ingredient is picrocrocin and coloring by crocin.().Saffron has been worth much more than its weight in gold; it is still the most expensive spice in the world [3, 31, 34].

Saffron cultivation in the Kashmir valley dates back to 500 BC. The state of Jammu & Kashmir (Kashmir) lies in the great NW between 32 ° 17 'and 36 ° 58' N latitude and 37 ° 26 'and 80O30' E longitude. Himalayas and the North End of India. The average height of the valley is 1850 meters above the MSL, but the surrounding mountains, which are constantly covered with ice, rise 3,000–4,000 meters above the MSL saffron, with Persian migrants entering the Kashmir Valley, along with the introduction of saffron, many other plant species, especially the maple tree Locally known as chinar or boun and carpet making, Embroidery and Papier-mâché products [22]. Such as the arts and crafts. With traditional methods of saffron production in the state over the past three centuries, the Kashmir region has low exposure to new technologies, which may be one reason why they are reluctant to use new agricultural practices. The introduction of drip and fertigation technologies has the potential to increase the production of this high cost crop [32-33].

Saffron is currently grown as a traditional crop on rained karawas, with two cultural practices being adopted in June and September to facilitate germination. This has led to lower productivity levels compared to other countries in the world where saffron is grown. The long history of saffron cultivation on the Karevas of Pulwama, Budgam, Srinagar, Kishtwar, with no nutritional support and rotting of saffron with linseed, maize, wheat and oat generally made the soil as nutritious and almost as productive as the farmers practiced. Therefore, fertility of these soils should be improved by adopting integrated nutrient supply, drip irrigation and management practices (INSAM) that help restore and sustain soil fertility and crop productivity. Since the fields were left unattended until the flowering stage (November), the weeds and rats were exposed to saffron mites by more than 60 percent, resulting in low plant populations and the availability of carp for existing saffron areas and replantation.

Acreage, production and productivity

In India, 5,707 hectares of land comes under cultivation. Its annual production is sixteen thousand pounds. The state of Jammu and Kashmir leads the list of saffron-growing countries in India. It can be estimated that 5,707 hectares of land under cultivation is 4,496 hectares lying in Jammu and Kashmir [77].

In Kashmir, Pampore, 15 miles [15 km] from Srinagar, is famous for its high-quality saffron. Saffron is also grown, though small, in Kishtwar of Jammu. Pampore and its surrounding areas produce an average of 2,128 pounds of saffron each year.(http://agropedia.iitk.ac.in/content/saffron-cultivation-jammu-kashmir) [78]. The other districts of Pulwama, Budgam, Srinagar and Doda. In Pulwama district Khrew, Ladoo, Dussu, Lathipora, Sambora, Awantipora and

Koil are the major saffron growing areas, accounting for about 75 per cent of the total area under saffron in the stateinclude Nagam, Sarwin, Hapatnar, Goplapora, Hyathpora, Chrawani and Chirar-i-Sharief that account for 16.13 per cent of the total area, while in district Srinagar Zeewan, Khunmoo, Balhama, Samporaand Yachnambal are the major pockets accounting for 6.68 per cent. In Jammu province of the State, saffron is grown only in district Doda in Poochal, Namil, Cherrad, Hullar, Blasia, Gatha, Bandakoota, and Sangrambatta areas, accounting for only 2.5 percent of the total area in the whole state.

More than 16,000 farm families are engaged in saffron cultivation located in 226 villages with 61 per cent of holdings below 0.5 ha, 26 per cent size of holdings between 0.5 -1.0 and 13% having holding size above 1.0ha [78].

A mission to double the from 17 to 34 tonne of saffron in the Kashmir Valley, which is likely to change the fate of thousands of farmers engaged in the cultivation of this expensive spice, said agriculture scientists adding that one hectare of saffron cultivation can earn a farmer up to Rs 24-Rs 27 lakhs. It sells at Rs 5 lakh per kilogram in the international market. Saffron is produced 2-4.5 kg per hectare. But it can be doubled to8-9 kg per hectare. About 32,000 farmers are directly associated with saffron production in Kashmir. Vikramaditya Pandey, a scientist at the Indian Council of Agricultural Research, PUSA, said the "national saffron mission was launched to bring about a saffron revolution in which the Indian Institute of Horticultural Research is playing a big role. The institute has adopted an integrated system to encourage and promote cultivation of saffron among farmers using drip irrigation [77].

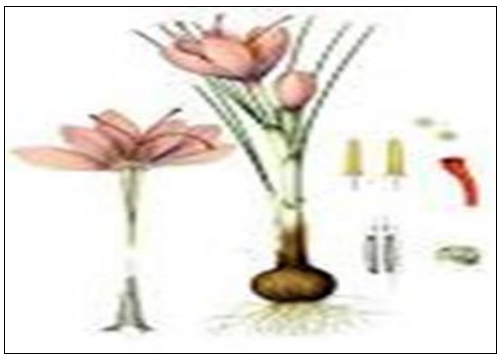

Fig 3: Typical saffron plant

The nomenclature of Saffron

Saffron (*Crocus sativus* L.) has a spherical corm from 0.5 to 5.0 cm. in diameter, depressed, globose, flattened at base, tunics fibrous, fibers very numerous and finely reticulated, extending into neck about 5 cm long at the apex of the corm. Cataphylls 3-5, white, membranous cormes 6 to 15 narrow, needle like 10-cm long channeled leaves; Around 4 to 5 scales in attractive or ciliate bottom area of 1.5-2.5 mm wide. The vegetative phase lasts from November to May. The Flowers solitary or two or three of 7 to 8 cm funnel shaped. Perianthyx [36-37] is made up of six segments in two series, violet or Reddish purple. Perianth tube 4-5 cm long, segments subequal 3.5-5 cm long, 1-2 cm wide. Bract and bracteole present, very uneven, white and laminated with long tape rather than fluffy tips. The anthers have three stamens to the throat of the perianth. Flowers arise from mid-October to early November along with aerial shoots [41-42].

Saffron multiplies by corms, and man chooses the best ones for cultivation. The saffron plant has a long life cycle in the whole summer and an active growth cycle in autumn, and the plant loses its leaves from the summer and stays dormant. The summer plant then grows vegetative again with the emission of leaves and the emergence of the flower axis wrapped in white sheaths. The commercial saffron is about 35-50mm long, along with the wonderful orange red stains (20-30mm long). One kg of dried saffron is obtained from 5.0-5.5 kg fresh stigmas + styles, which are separated from about 45-50 kg of fresh flowers, corresponding to approximately 1.15-1.50 lakh flowers. In commercial saffron, water (14.5-15.5%), protein (12.5-13.5%), total N-free extract (54.5-57.5%), starch and sugars (12.0-13.5%), fixed oil (4.7-8.5%), Volatile oil (0.7-0.8%), crude fiber (4.0-5.0%), ash (4.0-4.5%) and traces of potassium, phosphorus and boron.

Yellow-red pigment is crocin (glycosides), which contains alpha, beta and gamma compounds. From yellow crocin released in water by saffron. The aromatic release upon heating (saffron drying) into the safranal by the enzymatic hydrolysis of picrocrocin.

Soil Conditions for Saffron

In Jammu & Kashmir, saffron cultivation is mostly spread over the Karevas, which are exposed to moderately depleted soils; 1600-1650 m.a.m.s.l. Saffron is also cultivated in the north eastern part of Jammu province (Kishtwar). The variation in color from beige to yellowish brown can be attributed to the good drainage conditions of these soils. Soil pH ranges from 6.3 to 8.3 with an average value of 7.5 and EC from 0.09 to 0.30 dsnr-1.These limits are within the safe limits of crop growth [91]. CaCO3 content ranges from 1.25 to 10.82% limestone calcareous soil The soil Organic carbon ranges from 0.06 to 0.78%.

Rains itself irrigate saffron farms in the Kashmir Valley. Farmers rely only on rain. If there is no rains, the crops will also die. The total amount of rainfall in Srinagar during the saffron season is 404 mm, but it is irregular and saffron usually suffers from some water stress. Although the need for water in saffron is low, water stress affects yield, growth and development [22]. Therefore the crop needs to be kept in drip irrigation. Relative humidity is very variable. The relative humidity of Srinagar is less than 50%.

Climatic requirements

The climate, with sunny days during this season, favors good yields. The rains in September are necessary to the timely growth of roots and flower.Areas of about 1500 to 2400 m are covered with snow during the winter, providing the coolness needed for commercial cultivation of saffron. Cold buds do not show chilling requirements and can germinate at wide temperatures. Temperatures above freezing corms can reach up to 23 ° C, much faster than 30 ° C [42]. Flower initiation takes place in early summer in the early stages of shoot growth. The ideal temperature for flower formation is in the range of 23-25C. This temperature rate of flowering is so high that it is necessary to establish the maximum number of flowers incubated for at least 50 days at this temperature. Corms incubated at 17 ° C form a flower / corm. The sequence of organ initiation at the shoot tip is as follows: [74-75]

1. Leaf initiation
2. Brack initiation
3. Stamin initiation
4. Tepal initiation

Floral abortion occurs when the corms are incubated at high temperature for a long time. The optimal temperature for

flower emergence is close to 17 ° C [44-46].

Land preparation

Similar methods as followed in Iran & Spain are used to prepare land for saffron cultivation in Kashmir. Loamy soil is well suited for saffron cultivation. With the arrival of spring, at the end of March, which lasts until April, the field is ploughed repeatedly by tractor for a period of 20 days. Subsequently, leveling and hoisting operations should be performed in August. The fields should be pulverized three to four times. It is recommended that 15-20 tons of highly decomposed farm yard manure per hectare of land should be thoroughly mixed with the soil before the last cultivation operation. The field should be cut into strips 1.5-2.0 m wide (usually 2-3 m long) with 30 cm wide on both sides and 20 cm wide. Ends in deep drainage ways [51-53]. These channels help to drain out excess water. The saffron crop requires good aeration, for which the first hoeing should be done in the second part of June with the help of a short-handle hoe, locally known as 'zunee'. The second hoeing should be done in the second week of September. The beds should be leveled properly by borrowing soil from drainage lines. Lightweight hoeing instruments to promote daughter corm production after flowering is over. Before flowering, it is necessary to break the soil crust using racks to let the flowers out. Breaking of the crust should be done to a depth of 5-10 cm [54-56].

Planting of Corms

Corms are a very expensive input in saffron cultivation. A distance of 20 x 10 cm requires 5 lakhs / ha of cones. At 10 g / corm it is 5 tons per hectare. In monetary terms it comes to a market rate of Rs.50,000 / t / hectare of Rs.250000 / ha. In the traditional system of Kashmir, ungraded corms are broadcasted after plouging. Improper placement of corms in the soil can lead to massive loss of germination. The worms are mixed with different weights at a rate of 20-30 q/ seed per hectare. However, it is recommended to plant saffron corms weighing more than 10 grams on beds grown in rows at a depth of 15-20 cm. The corm base is essentially associated with the lower part of the furrow and the apical portion upwards. Usually the worms are planted in dry beds; However, before the irrigation of the field, the seeds are preferred to germinate efficiently and quickly. In Iran, plants are planted in the hills with a height of 3-15 corms / hill at a distance of 25 cm. When the corms are planted in rows, shallow pits (30-35 cm apart) are made by a furrower. Saffron farms in France are revived every three years [48]. The Italian Corms are planted in 4 rows. In each row the worms are in contact or at a distance of 1-1.5 cm.The depth of a plant is 8-10 cm. In Greece, annual planting saffron corms are placed in the fur at a depth of 15-17 cm and 11-15 cm. The distance between the rows is 20-25 cm.

Planting should be completed between mid August -mid September in the temperate climates of Jammu and Kashmir. Planting in the hot months such as June and July will cause corms to die and is not recommended. Plant breeding is practiced in Iran [50].

The following steps should be taken to prepare the plants for successful and productive saffron harvesting in Jammu and Kashmir.

Corm Lifting

Fig 4: saffron corms

Corm is an important ingredient in saffron cultivation because of its availability and high cost. This is why farmers prefer to rejuvenate saffron farms with their own corms. Sufficient time and phase productivity has become essential for lifting corms away from saffron fields, which is important for the viability and productivity of corms. Early lifting in June-July is not recommended due to high temperatures and humidity, which can lead to dehydration of the corms. Late spawning in September is also not justified because the sprouted corms can be damaged at flower primitives because they are unproductive. Therefore second half of August is ideal for corm lifting. Lifted corms should be immediately stored in cold rooms / stalls to avoid desiccation and unless weather conditions permit (3-5°C) June Lifting is recommended (about 40%) as humidity is low in Iran. Storing the cones for long periods can reduce flowering potential [50].

Sorting

Saffron only reproduces vegetatively after dormancy of May-Aug. Mother corn reproduces annually and gives birth to 2 to 6 new daughter corms.The most important factor is to regulate the proper germination.Corm size is very variable and can range from 1 to 20 grams [51-52]. In Jammu and Kashmir, traditional long planting cycles (10-15 years) produce relatively small quantities of daughter corms Frequency of large-sized flowering cones in this population <10 per cent- is the major cause of low productivity. Field age seems to be an important factor in corm size. Therefore, it is recommended that the field age should be reduced to 4 years to prevent reducing the size of the plants that have a negative potential for flowering potential [53]. Large corms with a diameter greater than 2 cm are free from wounds and diseases, and the outer loose scales are removed before planting [54]. Planting corms without sorting is the main reason for the spread of corm diseases, the germs are not eliminated during re-planting, so sorting corms before planting has two major advantages

1. Flower in the first year with high productivity.
2. Corm rot pathogen spread control

Corm Treatment

Fig 5: saffrom bloom

The annual multiplication of corm rot in the fields, the longer planting cycle and the prevailing primitive farming practices are the cause of poor saffron harvest. In the mainland saffron in Kashmir (Pampore), saffron pest incidence ranges from 11.60 to 21.60% [68-69]. The duration of the crop cycle increases the incidence of disease due to excessive buildup and inoculum spread over the years. Plant parasitic nematodes are highly infected in saffron fields in Pulwama district. The worms affected by the nematodes develop chlorosis of the radical leaves after a month of planting and then turn yellow, leading to complete corm rot Infected corms appear from brown to dark brown submerged and irregular patches under Corm standards. Pest lesions usually have increased margins to a depth of 1 mm. Pest symptoms are mostly in the root and bud areas. In extreme cases, the whole corm turns into a black powder [78]. White or yellowish white fungal mass is observed in some corms. Infected worms produce leaves that give a "die back" characteristic. Initial treatment of healthy saffron corms with Mancozeb 75 WP @ 0.3% + Carbendazim 50 WP @ 0.1% is effective in controlling corm rot. After sorting, soak the healthy-worms in the recommended fungicide suspension for 5-10 minutes. Saffron corms should be spread on a cloth and allowed to dry in the shade for 10-15 minutes [78].

Field management is an important factor in the success of the saffron crop. Jammu and Kashmir saffron growers are reluctant to invest in this sector because they are ignorant or low income. All parameters that lead to low yields should be considered for a successful saffron crop.

The planting cycle

The age of saffron fields is an important feature of high saffron yield. Studies have shown that higher plant populations of 4-year-olds yield maximum saffron yield (14.0 kg / ha), whereas maximum saffron yield is maintained at around six years of age (13.0 kg / ha) in low plant populations. With declining yields (less than 3 kg per hectare) at 13 years of age, the average age of saffron farms in Kashmir is over 15 years and corms are less populated, therefore, an important factor of low productivity (<2.0 kg / ha).

Nutritional Management

Saffron has long been cultivated without reclaiming deficiency of soil nutrients. Therefore, the stability of saffron yield is endangered. The average yield of saffron is clearly reflecting which has decreased from 3.13 kg / ha to 2.28 kg / ha, which is a concern for the crop in one way or another. The biggest obstacle in the horizontal expansion of the area under saffron is the lack of adequate and quality rich planting material [58-60]. The proportion of well-developed corms in Kashmir (about 2.5 cm or 10 g weight) is less than 10% compared to 30-35% in European and other saffron growing countries. This is mainly due to the short planting cycle of 3-5 years and high nutrient management. With high quality experiments on integrated plant nutrient supply (IPNS) results suggest that the application of organic fertilizer (FYM) has a significant impact on increasing the yields of corm and saffron in good quality, and also in the use of inorganic fertilizers; However, the response level to organic fertilizer application is high. FYM @ 175 q / ha combined with inorganic fertilizer for quality saffron corms planted at a density of 5 lakhs per hectare. If in addition to saffron flowers leaves are also harvested,every ton of leaves mine 10.2 kg of nitrogen (N), 3.2 kg of phosphorus (P), and 22.8 kg of potassium (K) from the soil [57]. Fertilizer or manure alone does not meet the nutritional needs of saffron. However, the combination of N, P, and K (NPK) and organic fertilizers improves flower production / yield and quality [65].

At a yield of 165.0 q per hectare showing an increase of 103.70 over the control plots. The proportion of quality saffron corms with average corm weight over l0g is 52.63%. Through this combination a sum of Rs. 53,800 at plurional planting cycles. As a result of integrated plant nutrient supply, saffron yield was 4.667 kg / ha, an increase of 55.53% after the plurional planting cycle, an additional benefit of Rs 137360 over the fair use of fertilizers and fertilizers). Significant saffron yield increases were associated with quality improvement in terms of increased crocin content. Azotobacter + vermicompost is valuable

Weed Management

Weeding and interculture operation works are the important labor cost component (35% of total labor cost) in saffron cultivation. Currently, Jammu and Kashmir saffron growers do not adopt weed management practices. Saffron farms were infected with weed cover from December to May as farmers believed that saffron crops should not be disturbed during the vegetative phase.The poor hygiene of the fields is usually observed during the critical period of growth (November - May), responsible for loss of planting material due to rodent attack. Fresh and old burrows are evident on saffron farms. Agricultural farm women undergo intercultural/hoeing in saffron fields in May to prepare the fields followed by hoeing operations in June. *Gallinsoga parviflora, crusgalli, Poa annua, Equisetum sp., Cyperus aristatus, Malva rotundifolia, Malva verticillata, Portulaca oleracea, Chenopodium album, Chenopodium amranticolor, Stellaria media, Echinochloa, Anagalis arvensis, Avena fatua, Digitaria sanguinalis, Allium wallichi,* and *Medicago falcata* are reported to be present in saffron fields [61-62] he control of weeds by intercultural operations also effectively control rodents. Effective planting of corms in furrow for weeding is essential. In Iran, a study by showed that when weeding the saffron crops after the saffron crop, Loxynil (750 g a.i./ ha) [63] and Tribenonormethyl (18.75 g ai / ha) were used when spraying weeds in the autumn tests. Weed control by Trifloralin (960 g ai / ha) is optimistic for early emergence and before saffron flowering. Metribuzin (560 g ai / ha ") controls weeds with no saffron injury, whether in spring autumn or autumn.. Studies conducted at Sangla in Himachal Pradesh (India), revealed paraquat @ 0.6 kg/ha or hand weeding followed by pendimethalin @1.5 kg/ha or metolachlor @ 1.5 kg/ha or fluchloralin @ 1.0 kg/ha helped in effectively managing the weeds in saffron [63-63].

Irrigation

Farmers have developed a unique method of extraction of groundwater known as "Oanat" in the local language. This method of groundwater extraction brings water to the surface. In Kashmir, saffron is cultivated as a rainfed crop on the Karewas without any irrigation resources [12]. Saffron irrigation was not considered necessary until 1999, when saffron areas were used to obtain good natural precipitation in September-October [47].

Water is the key to the success of the saffron crop. Root formation depends strictly on the availability of water [66]. Various shrinkage roots occur in harvested saffron. Fibrous contraction roots originate in early November and they appear in the fibrous root ring of the corms and sometimes contract. 8-13 fibrous shrinkage roots occur in each corn. Corm

shrinkage roots appear after flowering time in mid-November and are not produced from fibrous root rings, but originate from the edge of the corm, forming 1–2 shrinkage roots in each corm. Primordial of lateral bud shrinkage roots arise from the base of the lateral bud and continue to grow after flowering. They will then shrink during the senescence. In each corm, approximately 3-5 lateral bud contractions are produced. Terminal bud shrinkage origins Primordial appear in September-October, before flowering at the base of the apical bud. At first they appear to be of small tubular origin and are thicker than other types. Their number per carm is 1 but rarely increases to 2-3 [67]. With inception of drought period in past saffron productivity of state got drastically reduced. In Iran saffron fields are flood irrigated prior to flowering. Irrigation facilitates quick activation of buds leading to corm sprouting and flower initiation. Studies in Kashmir has revealed that saffron crop should be sprinkler irrigated @ 70m^3/ha at an interval of 7 days i.e. 25th August to 15th October (sprouting stage) followed by 3 irrigations at an interval of 7 days from 8th Nov.—30th Nov (Post flowering stage). Irrigation @ 700 M3/ha recorded the maximum saffron recovery (4.350kg/ha) showing an increase of 40.09% over the control plots. Increased saffron recovery was associated with increased number of flowers per hectare which might be due to more activation of buds (An additional income of Rs. 49,800 is generated from one hectare of land/year through the adoption of low cost sprinkler system of irrigation [76].

Irrigation Timing

The first irrigation is practiced immediately after planting in late August, when the plants show no morphological growth. The next irrigation is scheduled after a ten-day break and will continue until mid-November. Due to heavy rains in the fall of winter and early spring, the irrigation should be stopped during the flowering period and after May 20.the four irrigation is sufficient to harvest good saffron based on local knowledge of Iranian saffron yields.

1. First irrigation is necessary for the initial growth and flowering. If properly managed, irrigation will start to bloom immediately and vegetation will begin to grow, otherwise flowering and vegetation growth will begin at once, and the next many will interfere with harvesting
2. The second irrigation is delayed until the flowers and leaves are cut and reappear. After the first irrigation takes about a month.
3. After weeding and spreading the fertilizer, it is the best time for third irrigation.
4. The last irrigation is done at the end of the growing season (usually May) as summer irrigation is uncommon practice. However, required irrigation in August imrove the saffron yields of newly established and old saffron farms by 17 and 40%, respectively. The yields reduce by 17% as a result of irrigation in mid-June.

Harvesting and Drying

Three factors can hinder mechanical harvesting

I. The flower grows above the ground level.
II. Flowers comes with leaf form and / or later.
III. Quality is poorly effected if clods get mixed up.

Therefore, cuttings of flowers with machine can destroy the leaves and severely reduce the re-establishment of replacement corms. The flowers are usually picked by hand in the morning. The work is done in a bent posture. Some machines are in process to test based on the vacuum principle. Care should be taken that the quality of the product is not affected. It takes about 90 days with labor to separate saffron flower pistol from one hectare production of land. A wind tunnel with variable suction pipe that exposes the cut flowers to the air draft created by the various vortices also tried.These are required during the months of October-November when farmers are busy. Three pickings are required to collect saffron from the last part of October to a 4-day interval In the simple form the flakes are removed from the stamens by the fan and manually or by a iron screen, which is usually carried in drying shade in Kashmir, which usually takes 27 to 53 hours to dry the product. The safe humidity level is 8%. Drying slowly leads to degraded quality. Solar heated air dryers designed and fabricated in Kashmir can increase the drying time by hour and the product closely matches the pigment density found in fresh saffron [43].

Post-harvest management

Fig 7: kesar

In Kashmir, saffron is mostly sold in three forms [70]. *Lacha, Gucci and Mongra.* The *Lacha and Gucci* form covers the whole filament (total stigma + style), whereas the *mongra* form contains the entire stigmatic portion without any style. *Mongra* saffron has 10 percent more pigmentation compared to the corresponding lacha / Gucci [39].

Mongra saffron has 10 percent more pigmentation compared to the corresponding *Lacha and Gucci*. Harvested saffron is inherently high quality, but poor quality due to improper handling of harvesting and packaging. Delay in the separation of tainted from freshly picked flower can significantly affect saffron restoration percentage, resulting in quality and high labor cost. Crop harvesting losses due to prolonged separation of pistil, drying and packing can be attributed to lower spot prices due to higher microbial load. The pistol is separated from the flowers within 6-8 hours of removal and dried using a dryer [71-72].

Economics of production

Fig 6: sun drying of saffron

The mean production cost per hectare was Rs.24 thosand, against a input cost of Rs.35 thosand and both contributed to an BC ratio of 1: 0.69. Kharif, a research conducted on the same crop during 1998, poses BC ratio near 1: 2.49. A low BC ratio of 1: 0.69 puts saffron crop at risk and conveys warning signs to the government. This ratio indicates that 30% of the investment in saffron cultivation has been lost. Obviously they cannot sustain this for long [76]. Marketing executives capture a significant proportion of the profits and the loss of both growers and consumers.

Cost of cultivation

The cultivation of saffron per hectare in various size groups is presented in Table 2. The main factor in the cost of cultivation of saffron by growers of three sizes is the amount of money spent on human labor. Establishment expenses in the first year of cultivation amounted to 170710.96, Rs. 165737.04 an.d-Rs 153123.41, which means that 34-36 per cent of total expenses were made in the first period. Only the cultivation year. Spending on seed corms is a major part of it. It accounts for 65.60 per cent, 63.97 per cent and 62.69 per cent of the fixed cost, respectively, in the in three groups. Size group 1, then 2nd, and 3rd size groups are more cost effective for human labor. The share of family labor in total household labor consumption is 60 per cent higher in small farms (1st size group growers), 50 per cent in medium farms (2nd size group) and 39 per cent in large farms (on all farms). 3rd size group). it has been observed in the case of female labor consumption also. As the farm size increase and the family members increase in small farms compared to other farms, the number of hired workers also declined, while average human use and bull labor declined. This is reported that small farms are more labor intensive than large farms. Thus, the results indicate that as the size of the farm increases, the percentage of rented human labor increases. Costs on fertilizers, plant safety measures, bull & machine power, etc., constitute other cost components. The total cost of ranges from 34 to 37 percent over the ten-year period of the crop cycle. The tenth year also includes the costs of harvesting and cleaning the saffron worms, usually in July next year. Picking, sagging and drying of saffron is a very important operation. Total cultivation costs were more for the early growing group, followed by the latter size groups. This is also due to higher overhead charges per unit on smaller farms. Thus, the existence of economies of scale in crop cultivation is clear [73].

Conclusion

We can improve saffron production by adopting following few points:

1 Supply of seed material of good and high quality.
1. Expansion to agricultural and production areas.
2. Widespread use of sun-dried and air-dried. Financial assistance with the purchase of these equipment.
3. Proper training to pack the product.
4. Comprehensive and equitable professional cooperation and communication with saffron growers.

Marketing is one of the key issues. The humble saffron farmer finds it difficult for him to sell small quantities of his produce. Each size and packaging is not a huge benefit. The farmer has limited resources. Therefore, this is necessary for cooperative societies to be formed in order to sell saffron at leading prices. The right strategy must be established and the whole operation must be well organized so that the efficient saffron manufacturers can get the full benefits of his work.

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