Package of Practices for Shalimar Saffron-1 (SD 1-13)

Heritage Crop

ADVANCED RESEARCH STATION FOR SAFFRON AND SEED SPICES

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Saffron (*Crocus sativus* L.) is the most expensive spice of the world because of its qualitative worth. It predominantly contains chemical constituents such as crocin, picrocrocin and safranal which are responsible for colour, flavour and aroma, respectively and is highly valued for flavouring foods, dying textiles, medicinal applications etc. Low yield of this spice is attributed partly to the primitive non- scientific agronomic practices and partly to the genetically uniform planting material both of which call for immediate refinement. In order to ensure the future of the saffron crop, it is indispensable to improve cultivation techniques, planting material and quality evaluation methodology. Shalimar Saffron-1 is a composite cultivar developed through mutation breeding having corms identical to gladiolus corms with respect to visual appearance. The shape of Shalimar saffron-1 corms varies from flattened to ovoid or sub-globose. Newly formed corm has 1 or 2 apical buds from which new leaves, floral axis and 3 or 4 daughter corms are produced and 4 to 7 secondary buds, placed irregularly in a spiral form in the lower portion. Its roots are adventitious, growing from the bottom of the corm, leaves are radical, long, slender grass like, channeled with curved and fringed margins and grey green in colour. Each corm has tendency to produces 7–18 leaves with 1–3 flowers having three inner tepals and three outer tepals. Stigmas are extended and protrude from the perianth; tubular, reddish in colour and their length varies from 2.3 to 3.5 cm forming a tube narrower on the base. One stigma of saffron weighs around 2.0-2.3 mg, each flower has three stigmata and to produce 1.0 kg of dry saffron it requires about 140000 – 145000 flowers.

Soil and Climate

Saffron grows best in friable, loose, low-density and well-drained clay, calcareous soils having high organic content with pH of 7-8. Alkaline soil is supposed to be desirable for giving better stand of the crop. Temperature is

the most important environmental factor controlling growth and flowering in *Crocus* species. The influence of a constant temperature regime on flower formation of saffron is quite important. Optimum temperature for flower initiation and development of the corms falls in the range of 23–27°C with 23°C being marginally better for formation of maximum number of flowers. The optimum temperature for flower emergence is 15-18 °C below and above which results in decline in number of flowers. Cloud cover overnight encourages maximum production of flowers in the following morning. Rainfall or irrigation during August to September is helpful in boosting early flowering for higher production.

Land preparation

Scientific preparation of land is necessary to create friable and loose texture of soil for saffron cultivation. The field is ploughed 4–5 times to a depth of 30 – 35 cm to bring the soil into fine tilth. This is followed by planking and leveling as needed. The field should be cleared off from all the weed growth, penetrating roots and stubble stones. For ease in weeding, hoeing and irrigation, raised beds of convenient size preferably of 1.5 – 2.0 m width and 20–25 cm height with desired length preferably 5.0 m should be made. Bed to bed distance should be kept 25- 30 cms which would serve as drainage channels during rainy season. This prevents undesirable high moisture content in the top 15–20 cm of the beds and ensures hygiene with respect to corm rot incidence.

Planting time

Strong emphasis should be laid on timely planting of corms. Delay in planting of corms results in poor establishment of corms and subsequent low flower yield during 1st year of planting. It is desirable to complete planting operation from 15th to 30th of July. Placement and position of the corms at proper depth ensures better flower and corm yields as corm continues to remain undisturbed in the soil for prescribed crop cycle period. Hand sowing of corms is a good practice as sowing at proper depth of 15 cm not only

ensures good flowering in the 1st year itself but also favours contractile root formation that favours better daughter corm formation.

Seed (corm) rate and plant geometry

For sowing of Shalimar Saffron-1 in one hectare of land under high density with a target plant population of 12 lac corms/ha, 86.4 quintals of mixed grade corms are required. The proportion of corms weighing above 8 g to the tune of 57.6 quintal (7.20 lac corms) and proportion of corms weighing 5-8 g to the extent of 28.8 quintals (4.80 lac corms) are required. 15x10 cm^2 ditches (24 ditches/m^2) all around one hectare of land are dug in rows with inter ditch to ditch distance of 25 cm and intra ditch to ditch distance of 15 cm (Center to center of each ditch). In each ditch 5 corms are planted with 3 bigger corms (>8 g) and 2 smaller corms (5-8 g) in alternate position with centre of ditch occupied by bigger corm. For sowing of 1 kanal (500 m^2) of land, 12000 ditches are dug accommodating 4.32 quintals of mixed grade corms with a proportion of 2.88 quintals of above 8 g and 1.44 quintals of 5-8 g corms**.** For line sowing, the row to row and corm to corm spacing is kept 25 cm and 4 cm, respectively.

Corm treatment

To protect the saffron from major corm and soil borne diseases, dip the corms before sowing for 5-10 minutes in fungicidal solution prepared by dissolving (0.1%) Carbendazime 50 WP and Mancozeb (0.3%) in 100 liters of water. The saffron corms are taken out and spread on a clean cloth and then allowed to dry in shade for another 10 to 15 minutes to drain off excess moisture before sowing.

Nutrient management

Shalimar Saffron-1 is highly responsive to nutrients applied either through organic or inorganic sources. Application of nutrients depends mainly on soil nutrient status/balance and cropping system. For cost effective higher returns, the doses of applied nutrients should be matched with the soil profile properties and plant demand *per se*. However, in the absence of soil test

following fertilizer schedule may be adopted. In general, apply compost or well rotten FYM uniformly at the time of first ploughing @ 15 t/ha. This is essential for increasing water retaining capacity of the soil.

To maintain soil health under high density plantation and to ensure excellent crop growth, requirement in terms of manures and fertilizers is more than normal density plantation. Following schedule is to be followed:

Inorganic fertilizers=N: P_2O_5: K_2O - 120:90:80 kg/ha

i) Nitrogen in the form of Urea @ 186 kg/ha

ii) Phosphorous in the form of DAP @ 195 kg/ha

iii) Potassium in the form of MOP @ 133 kg/ha

Manures

i) Well decomposed farm yard manure @ 15 tons/ha (7.5 quintals /kanal)

ii) Vermicompost @ 10 quintal/ha (50 kg/kanal)

In fresh planting well rotten Farm Yard Manure/compost should be well incorporated in the soil at the time of ploughing. Full quantity of vermicompost and phosphorus, potash and 1/3rd of nitrogen through DAP, MOP and urea, respectively, should be applied before planting of the corms. Remaining dose of nitrogen should be applied as band placement in December and February when moisture is available.

Table 1: Recommended nutrient conversion in amount of fertilizers

Fertilizers (As basal application)	High density saffron		Normal density saffron	
	Per hactare	Per kanal	Per hactare	Per kanal
Urea	62 kg	3.1 kg	48 kg	2.4 kg
DAP	195 kg	9.7 kg	132 kg	6.6 kg
MOP	133 kg	6.6 kg	83 kg	4.2 kg
1st top dose of urea in Dec.	62 kg	3.1 kg	48 kg	2.4 kg
2nd top dose of urea in Feb.	62 kg	3.1 kg	48 kg	2.4 kg

Weeding and Hoeing

Weeds pose serious problem in saffron because it is a slow and low-growing crop; therefore, it faces a severe infestation from large number of weeds particularly in recapitulation stage from November to April. Therefore, timely intercultural practices are needed for achieving higher yield. Hand weeding needs to be practiced during recapitulation stage. To facilitate soil aeration during dormancy 1st hoeing should be practiced in the second fortnight of June and mechanical hoeing should be preferred over manual hoeing to reduce input cost. 2nd hoeing should be practiced in August and soil should be developed to a fine tilth to ensure emergence of sprouts.

Metribuzin being a selective herbicide in saffron checks the emergence of most prevalent saffron associated weeds. Application of metribuzin in December followed by metribuzin in February @ 560 g/ha diluted in 300-350 litres of water is recommended for control of winter weeds in saffron.

Irrigation

Saffron is sensitive to water particularly during active stags of crop growth viz., August to November. Irrigation schedule based on 5 irrigations (700m^3 = 70mm) @ 140m^3/ irrigation / ha starting from 1st September to 10th October and 10th November to 30th November has been standardized for Shalimar Saffron-1. Water requirement is in addition to 131 mm (1310 m^3) available to saffron through rains during August to November making a total water requirement of 201 mm (2010 m^3)/ha for Shalimar saffron-1 (Table-2).

Table 2: Irrigation Schedule for Shalimar Saffron-1

(Evapo-transpiration and other system losses are taken into consideration while following the schedule)

Cycle	Date of Irrigation	Quantity of water (m^3/ha)	Interval (Days)
A) Sprouting			
First	1st Sep. to 15th Sep.	140	15 days
Second	16th Sep. to 30th Sep.	140	

Total (A)		**280**	
B) Pre Flowering			
Third	1st Oct. to 10th Oct.	140	15 days
Total (B)		**140**	
C) Post Flowering			
Fourth	10th Nov. to 20th Nov.	140	15 days
Fifth	21th Nov. to 30th Nov.	140	
Total (C)		**280**	
Total (A+B+C)		**700**	

Disease management

Shalimar Saffron-1 is moderately resistant to corm rot and leaf blight diseases. However, in case of disease symptom appearance, apply following plant protection measures

i. Corm rot of saffron caused by *Fusarium* spp. can be managed by drenching Carbendezium 12% + Mencozeb 63% WP @ 50 grams per 100 liters of water.
ii. Leaf blight caused by *Stemphyllum* sp. can be managed by applying foliar spray of Zineb 68% + Hexaconazole 4% 72 WP @ 50 grams in 100 liters of water.

Rodent Management

Rodent management is a very complicated problem in saffron. Two rodents *viz.*, Blyth's Vole, *Pitymys leucurus* and Indian crested porcupine, *Hystrix indica* are the major problem in saffron growing belts of Kashmir valley.

I. Blyth's Vole, *Pitymys leucurus* belong to Family Muridae is a common rodent species found active in saffron fields. It is active throughout vegetative phase of Saffron (Nov-April). Rodent damage is visible from patches which have withered dry foliage resembling corm rot symptoms Effective rodent pest management can be achieved through an integrated approach as given under:

Management of Blyth's Vole, *Pitymys leucurus*

i. Due to traditional longer planting cycle, corm cultivation from raised beds, mixed cropping of saffron with almond and menace of weeds, rodents have found saffron fields as breeding ground due to availability of food material during fall months (October to March) when all other agricultural fields are fallow and thus devoid of any grain to be day as there is no check through management practices being followed by farmers. Effective rodent pest management can be achieved through an integrated approach as given under:

ii. **Field sanitation:** Removal of dropped debris and grasses from field to discourage rodents from availability of food and shelter.

iii. **Reduction in bund size:** Reduce the size of bunds or boundaries around the fields up to 30 cm to force the rodents to leave the burrows which will discourage the rodents to burrows and inhibit in the bunds.

iv. **Fumigation with smoke:** Use of burrow fumigator is very effective against rodents in field. In this method recharge fuel (Cow dung + Maize straw + Local herbs) are burnt to produce smoke in the burrows.

v. Chemical control (Rodent bait schedule):

- *Day 1*: Plugging of rodent burrows
- *Day 2*: Identification of live burrows for pre-baiting (100gm) prior to poison baiting; For pre baiting with plain bait (crushed rice (48 gm) + broken wheat grain/ wheat flour (48 gm)+ jaggery or sugar (2.0 gm and 2.0 ml. mustard oil) and place 10-15gm/ live burrow
- *Day 3*: 2.0% Zinc phosphide baiting(100 gm) during late evening with (crushed rice (48 gm) + broken wheat grain/ wheat flour (48 gm) + Zinc phosphide 2.0 gm and 2.0 ml. mustard oil, all mixed together) be placed inside the live burrow @ 6-10 g bait/ live burrow) .
- *Day 4*: Collection and burying of dead rodents. Close all burrows at evening hours
- *Day 5*: Identification of live burrows.
- *Day 6*: Fumigate live reopened burrows with Aluminum phosphide pellets @ 2 pellets/burrow and cover with wet mud.

II. Indian crested porcupine, *Hystrix indica* , Family : Hystricidae

Indian crested porcupine, *Hystrix indica* is the other rodent which causes heavy damage to saffron crop. It is managed by the following practices:

i. Placement of light lamps in and around the field.
ii. Fencing is a preventive measure with 45-60 cm metallic sheet can be placed around the field.
iii. Application of 5 lt of herbolive in 45 lt water along the border bunds of the field at 7-8 days interval can control the damage caused by porcupine.

Harvesting and stigma separation

Harvesting of flowers and separation of stigmas from the flower is the most difficult operation in saffron cultivation. It is time consuming, laborious and makes saffron the expensive spice of the world. The harvesting must begin shortly after dawn and completed quickly. If left exposed to the sun, saffron quickly loses its colour and flavour and withers under the sun light. Therefore, picking of unopened flowers is advised as unopened flowers have better shelf life because respiration process is arrested till the flower opens and it take 24 hours. Separation of stigma from unopened flowers should be completed within 24 hours.

Saffron drying

Post harvesting handling of saffron particularly the drying process is critical for maintaining the quality of saffron as indicated by the levels of secondary metabolites crocin (colour), picrocrocin (taste) and safranal (aroma). A quick dehydration post harvesting treatment is necessary to convert saffron pistil into saffron spice as it prevents bio-degradation of crocin into crocitin. During the dehydration process, the stigmas loses 80% of their weight. Drying brings about the physical and biochemical changes necessary to achieve the desired attributes of Saffron. This process also play an important role in preserving this spice for longer period including transit and marketing. A lower moisture content at least 10-12% value established by International ISO

3632 (*1*), maintains the quality of products for a longer time. Drying of saffron at temperature of 60 ^{o}C in hot air, solar, electrical or vacuum dryers is recommended. Drying temperature varies because stigmas from unopened flowers have more moisture compared to stigmas from opened flowers.

Packaging and storage

Saffron in filaments, cut filaments and powder forms shall be packed in rigid, sealed, clean, and sound containers made of material which cannot affect the product quality and which protects it from environmental effects. Packing material should be waterproof and consumer friendly. The packaging should comply with any food grades materials and environmental protection.

Corm harvesting and storage

After 4 years of planting cycle, corms of Shalimar Saffron-1 are lifted manually and stored at appropriate conditions to avoid sprouting. Corms lifted in June can be stored in boxes covered with soil at 19–23°C and 65–75% relative humidity for 40-45 days. Shalimar saffron-1 has potential to yield 250-275 quintals of corms after 4th year of planting cycle under high density plantation and recommended irrigation schedule.

Saffron yield

The average stigma yield of Shalimar Saffron-1 (SD 1-13) over 4 years of planting cycle is 8-10 kg/ha which is significantly higher over farmers managed natural population (4-5 kg/ha).

Quality parameters

Shalimar Saffron-1 is high in quality parameters particularly crocin, picro-crocin and saffranal as compared to natural population found in Jammu and Kashmir. It contains 379.48 Crocin ($E^{1\%}$), 124.88 Saffranal ($E^{1\%}$) and 55.61 Picrocrocin ($E^{1\%}$) which as per ISO standards falls in Grade I category.

Note: Standards for Agro practices may vary with environments and the said information was generated at ARSSSS, SKUAST-Kashmir, Pampore