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Participatory Crop Improvement in Spice Crops

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1. Background information

Saffron (*Crocus sativus* L.) and Kalazeera (*Bunium persicum* Bioss.) the legendary heritage spice crops are confined to seven districts of of Jammu and Kashmir state viz; Pulwama,, Budgam ,Srinagar, Kishtwar (Saffron),Bandipora, Kupwara, Kargil and Srinagar (Gurez) occupying an area of 4010 ha with an overall exchequer of Rs 235 crores generated from marketing of 15 M.T of saffron, and 29 M.T of Kalazeera. Although saffron cultivation is under regular farming system, but Kalazeera is found growing naturally in alpine and sub-alpine habitats of northwestern Himalayas at an altitude of 1800-3500m amsl. It generally grows in forests, grassy slopes,and to some extent in low alpine pastoral lands in the states of Himachal Pradesh, Uttranchal and Jammu,as well as Kashmir. The species has now been domesticated and developed for scientific production (Panwar,1992).More than 20,000 farm families are directly or indirectly associated with spice farming system from production to consumption,

1.1. **Saffron Plant:** Saffron is classified into *Magnoliophyta* Division, Class *Liliopsida* and Order *Asparagales*. It is a member of the *Iridaceae* family and the *Crocus* genus .Crocus consists of 9 species viz, *Crocus cartwrightianus* and its derivatives, *Crocus sativus*, *Crocus moabiticus, Crocus oreocreticus, Crocus pallasii, Crocus thomasii, Crocus badriaticus, Crocus asumaniae* and *Crocus mathewii* (Nehvi and Shafiq, 2008).. Saffron with subhysteranthous behaviour is a perennial herbaceous plant attaining a height of 25-40cm. Corm , foliar structure and floral organs constitute main parts of saffron plants (Nehvi and Salwee, 2010) .Corms consist of nodes and are internally made up of starch-containing parenchyma cells. These corms are 3 to 5 cm in diameter and are covered by tunics. Each corm produces five to eleven green leaves or monophylls. The leaves are 1.5 to 2.5mm wide per sprout and are called bristles and can measure upto 50cm (Dhar and Mir, 1997;Lucceno,1999).Saffron blooms in autumn It has two years plant cycle which starts from the month of July of the first year and the apical bud takes a year to acquire its maximum size, and becomes a fully grown corm, while it takes another year before it is depleted and ends up like a wrinkled black disc (recapitulation stage). In midway, the plant enters a dormant stage. During dormancy, floral and vegetative buds and roots begin to differentiate (Le Nard and Hertogh, 1993). In mid June, a progressive decrease of starch concentration is observed in the total dry matter of corms at one level (67%) .Activation stage in saffron begins from September when the day temperature reaches about 25°C with night temperature of about 15°C. Corms begin to sprout with floral and vegetative structures increasing in length inside the cataphylls. Flowering starts in the second fortnight of October and lasts up to first week of November (Nehvi and Salwee, 2010).Flowers emerge in three to four flushes with massive emission known as covering

in second flush. At the beginning of November, commencement of degradation of mother corm is visible which looks quite wrinkled and flat .Vegetative phase starts immediately in November after flowering is over with young leaves emerging from the corms.

1.2. **Kalazeera Plant:** *Bunium persicum* (2 N =14) is a member of Apiaceae (carrot family). The family consists of about 423 genera, mostly herbs, shrubs, trees and aromatics (4). The genus *Bunium* contains about 166 species, including *B. persicum* (Figure 1), *B. carum, B.bulbocastenum, B. copticum, B. flexuosum, B.elegans,B. cylendricum and B. chaerophyllocides* that are prevalent in Central Asia, Caucasus, Crimea, and Europe. The most distinctive feature of the Apiaceae is its inflorescence "umbel," which means "sunshade". It is a convex or flat-topped flower clusterin which all the pedicles arise from the same apex. The other distinctive feature is its fruit. *Shizocarp* consisting of two mericarps that are often attached to an entire or deeply forked central stalk (carpophore) with globular or elongated oil canals (vittae). The stem is often hollow in the internodal region with secretary canals containing ethereal oils and resins (Judd et al.,2002,). The plant type of Kala zeera varies from dwarf (30 cm) to tall (80 cm) compact or spreading, moderately to highly branched, tuberous and perennial herb (Panwar,2000).The leaves are freely, pinnate (2-3), finely dissected and filiform. The flowers are small, white in color with readily symmetrical small sepals, petals and stamens (each five in number), and are present in compact umbels. The bracts are linear, sometimes divided, and bracteoles are absent with asymmetrical rays. The gynoecium is bicarpelate with inferior ovary with two styles fused at the base. The 1,000 seed weight is around 2 g. tubers of Kala Zeera are of hypocotyls or root origin. The somatic chromosome number in *B. persicum, B.chaerophyllocides* and *B. cylendricum* has been reported to be 2N = 14, 12, and 20 respectively . The seeds of cultivated origin contained cumin aldehyde (27-34%) followed by p-mentha-1,3-dien-7-al and p-mentha-1,4-dien-7-al (29-36%),whereas the seeds from the wild mainly contained γ-terpene (25-42%) and p-cymene (24-27%) and less aldehydes. Straw of Kalazeera also contains 1-20 per cent oil that resembled the oil from seeds. Under temperate conditions of Kashmir valley Kalazeera blooms around Ist fortnight of June and flowering last for one month and by end of July the plant is ready for harvesting.

2. Propagation

Saffron with 2n=24 chromosomes, is triploid and for this reason sterile and thus allows vegetative multiplication, but not for regular sexual reproduction. This is because triploids meiosis and gamete development are irregular, resulting into many anomalies in sporogenesis and gametophyte development (Chichiricco, 1984).Saffron infertility is mainly related to the male gametophyte (Chichiricco, 1989).It does not produce viable seeds; therefore corms are indispensable for its propagation. The corm is vegetative organ of saffron. After flowering, the base of the stem enlarges producing a daughter corm that propagates the plant. In kalazeera propagation is from seed to tuber.

3. Concerns and Strategies for realizing higher yields in spice crops

Even though spice crops are high value crops, they are relatively unexploited in terms of breeding efforts aimed at seeking higher yields through genetic manipulations However, there are obvious following constraints that have limited the genetic improvement of these valuable spice crop,

i) Triploid nature of saffron and long duration of the seed to tuber cycle of kalazeera leading to lack of distinct and high yielding cultivars.

ii) Genetic erosion .

Strategies: Participatory crop improvement

For realizing high yields in both the crops following strategies are to be adopted in farmer's participatory approach to identify elite genes from existing natural population**.**

i. Collection, Conservation and Utilization of elite germplasm base for higher yield gains

Potential traditional saffron fields & Kalazeera natural habitat to be surveyed at the time of flowering and vegetative phase and elite plants with distinct superiority for floral, morphological and quality attributes to be selected and evaluated for developing a passport data with regard to variability and divergence at genetic and molecular level in collaboration mode after obtaining the full pedigree details of the selected plants from concerned farmers**.**

ii. Clonal Selection

Two principles can be applied:

a) Searching, identification and separation of superior clones in existing plantations using following method

- Collection of large sample population (2000 plants from each site)
- Grouping of plants on the basis of corm/tuber weight
- Plantation of corms/tubers in individual pits under required plant geometry
- Inspection of each pits during flowering and vegetative phase and individual pits scored on the basis of highest no of flowers. minimal number of flowers, complete absence of flowers ,multiplication index, big corm index, flower creating index.
- Labelling of elite pits and evaluation for variability at molecular and genotypic level.
- Mass propagation of elite clones through tissue culture or vegetative propagation.
- Layout of on farm trials in the target environments for stability analysis of elite clones.
- Confirmation of high yielding clones and their mass multiplication for distribution among farmers.

b) Creating new valuable forms experimentally using following methodology.

c) Exposure of natural population to Physical and chemical mutagens afte evaluating different doses and method and time of application.

e) Plantation of exposed material for identification of variants in 2 planting cycles.

f) Studying variants for variability and divergence at genetic and molecular level.

g) Mass propagation of elite variant clones through tissue culture/vegetative propagation.

h) Layout of on farm trials in the target environments for stability analysis of elite variant clones.

i) Confirmation of high yielding clones and their mass multiplication for distribution among farmers.

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