Variability in saffron (*Crocus sativus* L.)[1]

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Summary. The discovery of new variants of saffron with increased number of stigmas has been reported, and the different possibilities underlying these variations are discussed. Due to sexual sterility of saffron, it is suggested that if the observed variations prove to be genetically determined, the clones which may be developed could increase yield and reduce the cost of saffron production in the future.

Saffron, the world's most expensive spice[2], is the dry style and the 3 stigmas of the flower of saffron (*Crocus sativus* L.), grown commercially in several countries, such as Spain, France, Italy, Iran and India. Work on the breeding of saffron for better quality and higher yield are non-existent, basically due to the triploid nature of this crop, which fails to produce seeds upon selfing or crossing because of its sterility[3-6]. Almost 180,000 flowers are needed for 1 kg of dried saffron, which must be harvested by hand[4,5]. Since the separation of the style and the stigmas from the flower must also be done manually, the cost of saffron production is naturally very high. Therefore, it was thought that the development of new saffron plants with more than 3 stigmas may not only increase the yield but it may also reduce the cost of saffron production. The present paper describes the discovery of plants having more than 3 stigmas which may provide the means of increasing yield in this crop.

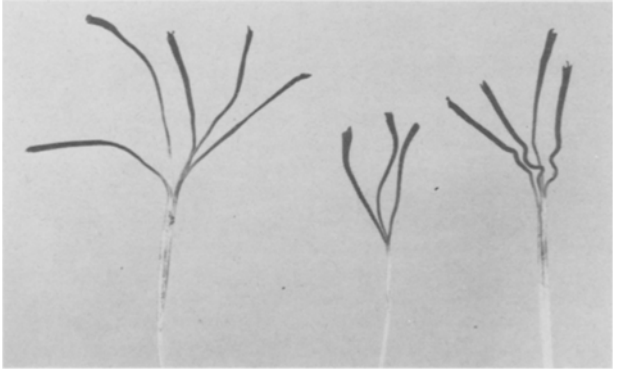
Materials and methods. About 5 ha of saffron fields in Khorassan Province were visited in 2 subsequent years at blooming time in November. The screening procedure was laborious at first, requiring a counting of the number of stigmas of each flower. Since the increase in the number of stigmas was accompanied by an increase in the number of other floral parts, the variant flower appeared to have a larger size. The screening was, therefore, simplified and based on the identification of flowers which were either smaller or larger than normal. Root tips of some of the rare plants were fixed in the field and were used for chromosome count by the methods described previously[7]. The plants were then transferred to pots and were brought to a greenhouse in Tehran for further studies.

Results. From an estimated 36 million flowers, 43 plants screened had abnormal numbers of stigmas. Therefore, the frequency of the rare types taken all together is only 1.2×10^{-6} flowers. The table shows the floral characteristics of these rare plants indicating a symmetrical change in the floral parts in both directions. Morphological comparison of the style and the stigmas of 2 rare plants with a normal plant is presented in the figure. The stigmas of the rare types are larger and their styles are thicker. On the basis of this observation, it is reasonable to assume that their yield may be higher than the normal saffron. The chromosome number of only 4 rare plants (table) was studied from their root tips. These, like the normal saffron, had 2 n = 24 chromosomes.

Flower characteristics of the rare plants

No. Plants found	No. flower parts Stigma*	Anthers	Perianth
3	2	2	4
26**	4	4	8
5	5	5	10
1	5	5	11
3**	6	6	12
2	7	7	12
1**	8	8	12
1	9	9	14
1	10	10	14

* Normal flower has 3 stigmas, 3 anthers and 6 perianth parts; ** Chromosome number of 2 n = 24 chromosomes was found for these plants. Only 2 plants with 4 stigmas and 1 plant with 6 stigmas were studied.



Comparison of the stigmas and the style of the normal saffron with those of 2 rare types with 4 and 5 stigmas.

Discussion. The observed floral variability may be due to developmental abnormalities, chromosomal variation or rare gene mutation. The first possibility would be ruled out if the rare plants repeated their characteristics in successive years. This possibility can not be discarded at this stage, pending the results of the experiments to reproduce the rare types in their original localities. Although 4 rare plants studied had 2 n = 24 chromosomes as observed in their root tips, the possibility of chromosomal variation still remains because the rare flowers may have been derived from cells differing in chromosome number from those which gave rise to their roots. The evaluation of the possibility of gene mutation being the primary cause of variation observed requires hybridization between the rare types per se, and between the rare types and normal plants. Due to the sexual sterility of saffron mentioned earlier our hybridization attempts have not been successful. If the sterility barrier can not be overcome, the genetical analysis of this variation by standard hybridization will be impossible and improvement in yield by increased stigma number will depend on clonal reproduction.

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