Journal of Applied Horticulture, 8(2): 121-124, July-December, 2006

Agronomic attributes of saffron yield at agroecosystems scale in Iran

A. Koocheki[1], M.A. Behdani[2]* and M. Nassiri[1]

*[1]Center of Excellence for Special Crops, Ferdowsi University of Mashhad, Mashhad, Iran; [2]Faculty of Agriculture, The University of Birjand, P.O.Box. 97175/ 331, Birjand, Iran; *E-mail: mabehdani@yahoo.com*

Abstract

In order to study effective factors in production of saffron, a series of studies was carried out during 2001 and 2002. In these studies, four selected location, Birjand, Qaen, Gonabad and Torbat-Haydarieh were spotted as the main saffron producing areas in Iran. Data was collected from 160 saffron farms, aged between 1 and 5 years. Results indicated that age of saffron farms, corm size, irrigation interval, and summer irrigation had positive linear relationship with yield. Age of saffron farms had the most pronounced effects on yield and was the most important component in all linear equations. Age of farms, irrigation intervals and corm size were major factors contributing to yield. The longest irrigation interval was observed for Gonabad (24 days) and the shortest was for Torbat-Haydarieh (12 days). Highest actual yield was for Torbat-Haydarieh which is an indication of better farm management in comparison with other areas. Maximum yield of 4 kg ha^{-1} was frequent but many farms produced over 7 kg ha^{-1} yield.

Key words: Saffron, irrigation interval, summer irrigation, corm size

Introduction

Saffron is an expensive spice and has been grown for a long time in many parts of the world including Spain, Italy, Greece and Iran. Today more than 95% of saffron in the world is produced in Iran and most of this production is from central and southern Khorasan (Kafi *et al.*, 2002). Saffron is an important cash crop for the small holding in Khorasan province and more than 85000 farmers are involved in its production (Kafi *et al.*, 2002). Saffron is a family based crop and most of farming practices particularly picking flowers are carried out by family members or community cooperation. Not only this crop is a cash crop for the farmers but also it has a strong tie with their social life.

Saffron is used locally and it has traditional medicinal uses (Koocheki, 2004). Recent reports on saffron as a cancer curing agent has brought more attention to this crop (Abdullaev, 2002). Saffron production does not require much water but timeliness of irrigation, particularly the first irrigation is very important for flower emergence and length of flowering period (Kafi *et al.*, 2002). Low temperature in autumn is a crucial factor for flower emergence (Molina *et al.*, 2004). There are many factors contributing to the yield of saffron. The most important factors are environmental conditions and farming practices such as age of farm, corm size, method of planting, irrigation application, irrigation interval and recent practice of summer irrigation which is not usual practice for saffron. The purpose of present study was quantitative evaluation of the magnitude of factors affecting crop yield by a comprehensive survey at farm level for two years.

Materials and methods

Saffron producing area of southern Khorasan, in which 95% saffron is produced, were investigated in four main counties namely Birjand, Qaen, Gonabad and Torbat–Haydarieh in two growing seasons 2001 and 2002. Data were collected from 160 farms with a very diverse criteria including the size (500 m^2 to 2 ha), age of saffron fields (1 to 5 year), farming practice (farmers skill) and farming background. A comprehensive survey was made during two years, associated with farming practices such as date of planting, time of first irrigation, time of first flowering period, the amount of manure used, irrigation frequency (including summer irrigation, if any), size of corm, planting method and yield, by personal reference to the farmers and direct monitoring. Climate data were collected from the nearest climate recording station. Statistical analyses were made on the relationship between yield and yield attributing factors and correlation coefficients were calculated accordingly.

Farming practices and phenological stages of plant particularly first time of flower appearance and length of flowering were correlated to the farming practices such as time of irrigation and corm size for the whole area. Analyses were made by Excel, SigmaStat and SPSS software.

Results and discussion

Date of planting: Table 1 indicates that the most frequent date of planting in the area was 1–10th of September, however in Torbat-haydarieh this practice was more frequent in 10-20th of August and in Gonabad 11- 20th of September. Date of planting varied with different geographical locations. In Spain corms are planted during mid May to early June (Behnia, 1991) and in Kashmir mid July to late August (Farooq and Koul, 1993)

Planting method: In general, two planting methods of hill and row are in practice (Table 2). In traditional systems, more tendency is towards hill planting where 1 to 15 corms are located in each hill (Mollafilabi, 2004). In general, 14 % of farms are planted through this method (Table 2). In row planting, corms are planted in rows which are 20cm apart from each other.

Age of farm: In Fig. 1, relationships between yield and age of

Table 1. Distribution frequency of planting date in different areas (%)

Counties	10-20 August	21-31 August	1-10 September	11-20 September	21-30 September	1-10 October	11-20 October
Brijand	12.5	20.0	25.0	10.0	10.0	10.0	12.5
Qaen	20.0	27.5	42.5	5.0	5.0	0	0
Gonabad	0.0	0.0	10.0	40.0	15.0	22.5	12.5
Torbat- haydarieh	37.5	22.5	22.5	7.5	5.0	0.0	0.0
Total area	17.5	17.5	25.0	15.6	8.7	8.1	6.2

Table 2. Frequency(%) and yield (kg ha^{-1}) of saffron under different planting methods in different areas

Counties		Planting method	
		Row	Hill
Brijand	Percentage	35.00	65.00
	Yield	2.70	4.06
Qaen	Percentage	27.50	72.50
	Yield	3.74	4.52
Gonabad	Percentage	30.00	70.00
	Yield	2.60	2.82
Torbat-Haydarieh	Percentage	12.50	87.50
	Yield	5.36	5.26
Total area	Percentage	26.25	73.76
	Yield	3.60	4.18

farms up to 5 years are presented. Yield in the first year was low and the maximum yield was obtained in 5th years, but usually saffron farms are kept up to 10 years (Behnia, 1991; Kafi *et al.*, 2002; Negbi, 1999). With increasing age of farm from 1 to 5, yield was increased (Fig. 1). This trend is most pronounced for Torbat–Haydarieh followed by Birjand. Higher yield in Torbat–Haydarieh and Birjand is associated with more suitable farming practices. Age of farms in Iran, which at present are more than 8 years, has been recommended to be reduced to 4 or 5 years, because yield can be improved by shortening the average age of saffron farms from 8 -10 to 4 or 5 years.

Size of corm: The correlation between size of corm and yield is shown in Fig. 2. With increasing size of the corm, yield also increased, and there was a good correlation between these two variables. Big corms cause earlier and vigorous flower emergence and therefore higher yield is obtained. This type of corm produces bigger daughter corms for next seasonal growth (DeMasstro and Ruta, 1993; McGimpsey *et al.*, 1997). In Table 3 proportion of corms with different size is shown. As it is seen in Torbat–Haydarieh small size corm was not used and the proportion of small size corm was less than 5 % for other counties. Medium size corm 7 to 10 g was used more than other types in different counties. There are references (Sadeghi, 1998), indicating that corms with less than 7 g have a low flowering potential and corms with 9 g are the most frequent with optimum flowering potential and corms with 15 g (not frequently used), yield more flower and a saffron yield of 7 kg ha^{-1} in first year (Kafi *et al.*, 2002).

Table 3. Distribution (%) of corm size in different counties

Counties	Corm size (g)		
	8	10	12
Brigand	5.0	60.0	35.0
Qaen	5.0	50.0	45.0
Gonabad	2.5	72.5	25.0
Torbat-Haydarieh	0.0	62.5	37.5
Total area	4.2	61.2	35.6

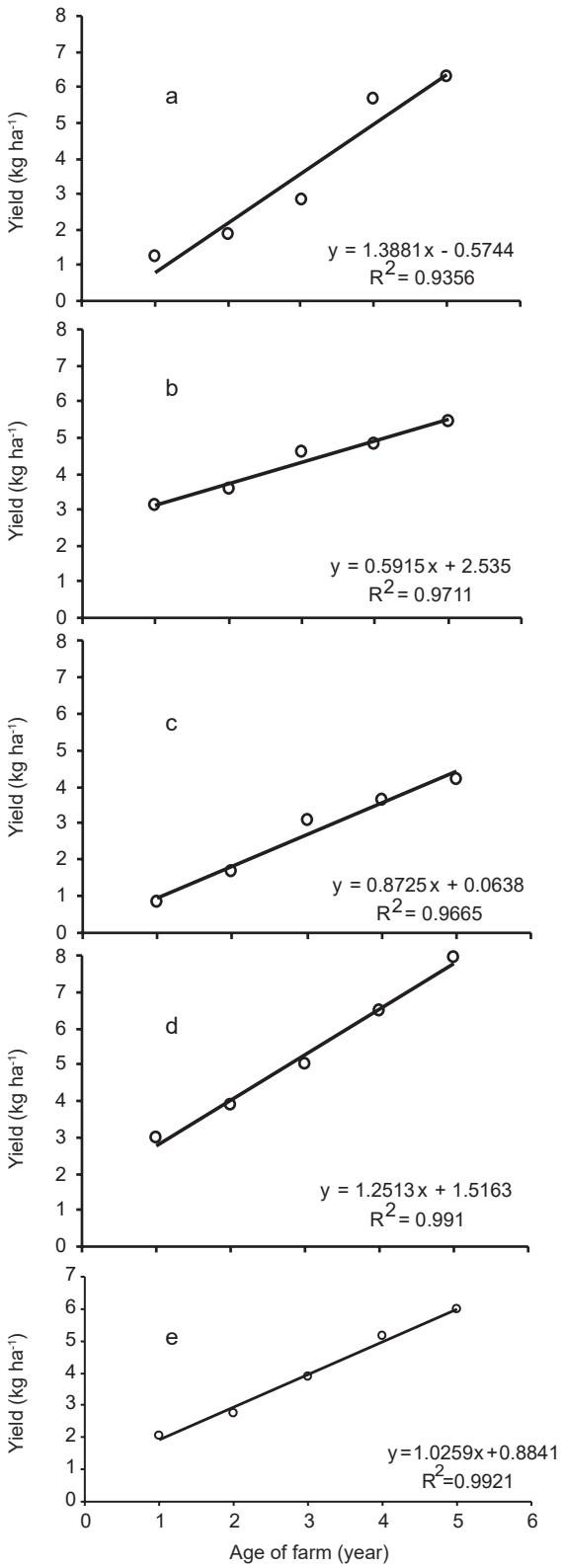

Fig 1. Relationship between yield of saffron and age of farm in Birjand (a), Qaen (b), Gonabad (c), Torbat-Heydarieh (d) and mean of whole area (e).

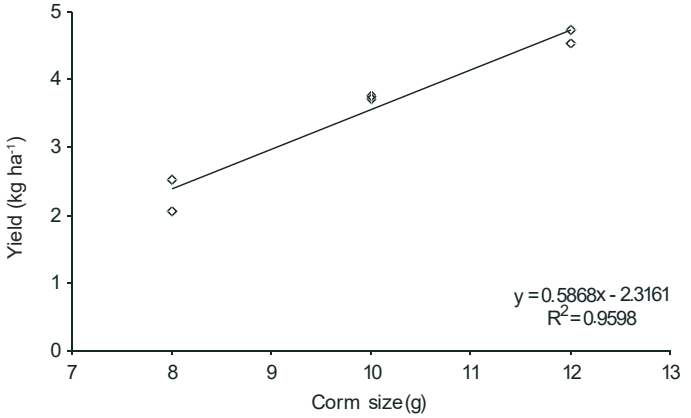

Fig. 2. Relationship between yield and corm size

Irrigation interval: There was a good correlation between irrigation intervals and yield of saffron (Fig. 3). By reducing irrigation interval, yield increased for different age groups and also for the average of all age groups. Higher yield obtained with lower irrigation interval has also been confirmed elsewhere (Mosaferi, 2001).

Three different irrigation intervals that were used for different counties are shown in Fig. 4. It is observed that irrigation with 24-days interval was most frequent in Birjand, Qaen and Gonabad and 12-days interval was most frequent in Torbat–Haydarieh, a reason for higher yield. There was no irrigation interval with 12 days in Gonabad.

Summer irrigation: Based on the physiological characteristics of saffron (growth start in early autumn with decreasing temperature of the area), first irrigation is required to stimulate flower emergence.

After flower emergence and harvesting, which normally last 30 days, vegetative growth starts and the leaves emerge. During winter days growth of leaves continue and by the end of May

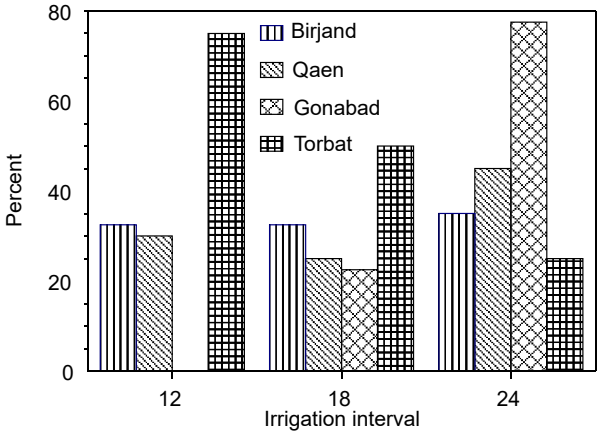

Fig 4. Percentage of farms with different irrigation intervals in different counties.

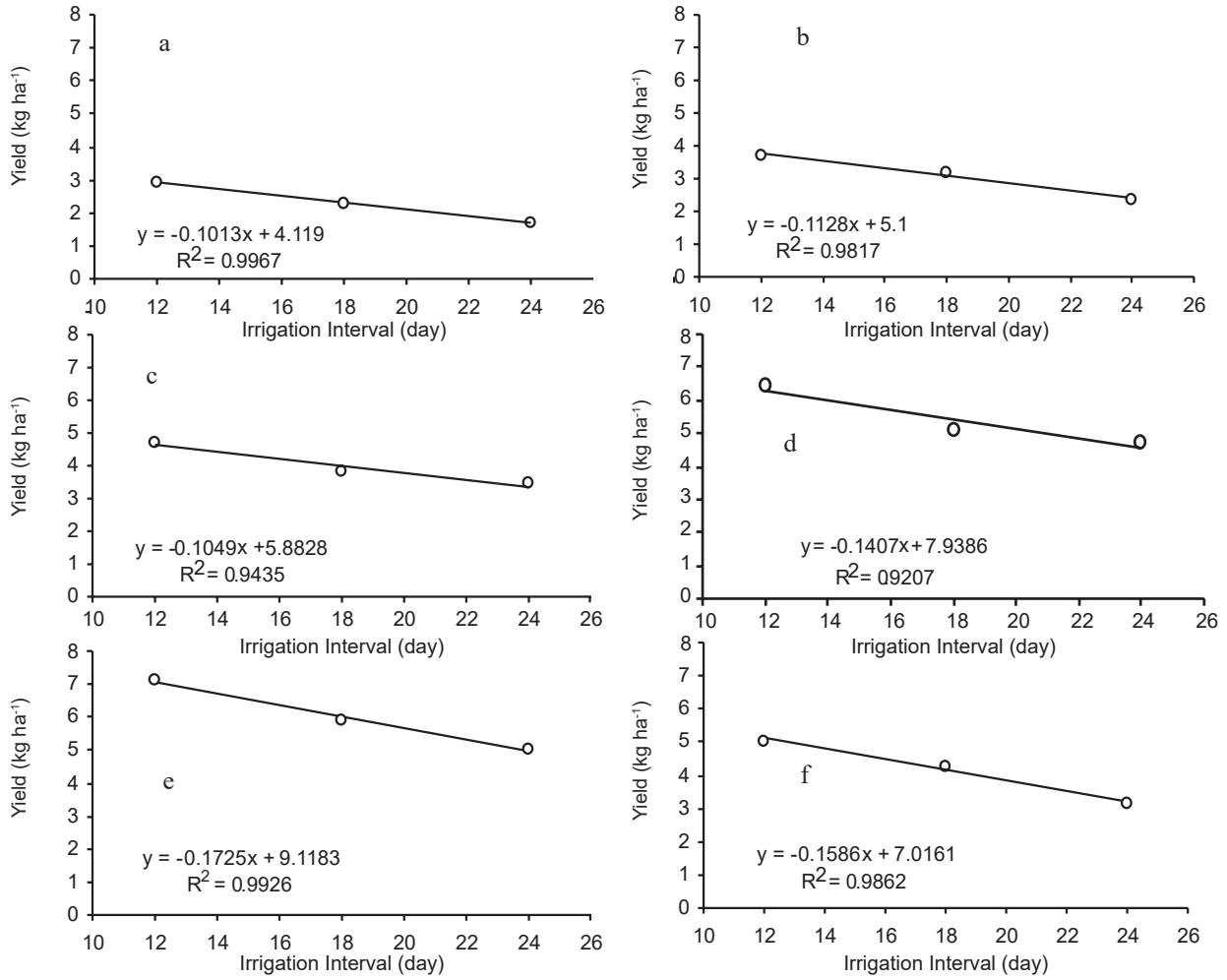

Fig 3. Relationship between irrigation intervals and yield of saffron in different aged farms. a, b, c, d, and e, represent farms with 1, 2, 3, 4, and 5 years old, respectively. f illustrate the mean of different aged farms in whole surveyed area.

leaves are dried and the plant goes under dormancy. Flower initiation start in early July (Farooq and Koul, 1983). Therefore, first irrigation is normally applied at the beginning of the fall without any summer irrigation applied. However, in recent years one summer irrigation is practiced between end of July to mid August. It is believed that application of one irrigation at the time of early flowering helps this process and results higher rate of flowering (Farooq and Koul, 1983; Sadeghi, 1993).

Investigation shows that 45% of the farms, in the area, received one summer irrigation (Table 4) except in Gonabad. Mean yield for the farms with summer irrigation was higher than those with no summer irrigation (4.9 and 3.35 kg/ha, respectively) and as a whole, nearly 60% of yield was obtained from the farms in which summer irrigation was practiced. There are references showing that one irrigation in mid Augest led to yield increase while one irrigation in mid July resulted in 17% reduction weight of flowers (Mosaferi, 2001).

Table 4. Frequency (%) and yield of saffron farms (kg ha^{-1}) with and without summer irrigation

County	Farm/yield characters	No summer irrigation	Summer irrigation is applied
Birjand	Farms (%)	17.00	23.00
	Frequency	42.50	57.50
	Yield	3.17	3.89
	% From total yield	44.87	55.12
Qaen	Farms (%)	25.00	15.00
	Frequency	62.50	37.50
	Yield	3.96	4.88
	% From total yield	44.50	55.50
Gonabad	Farms (%)	40	0
	Frequency	100	0
	Yield	0	0
	% From total yield	0	0
Torbat Haydarieh	Farms (%)	15.00	25.00
	Frequency	37.50	62.50
	Yield	4.32	5.83
	% From total yield	42.58	57.42
Total area	Farms (%)	97.00	63.00
	Frequency	60.62	39.37
	Yield	3.35	4.90
	% From total yield	40.64	59.36

In conclusion, farm practices related to irrigation interval, summer irrigation, age of farms and corm size are the main attributes of saffron yield. Increasing irrigation intervals decrease yield however, a summer irrigation at flower differentiation stage will led to yield increase. While saffron farms are used up to 10 years after establishment, the highest yield is obtained from 5 years old farms and yield will be decreased in the following years. Large corms also have promotive effect on flower emergence, yield and also on producing bigger daughter corms.

References

Abdullaev, F.I. 2002. Cancer chemopreventive and tumoroicidal properties of saffron (*Crocus sativus* L.). *Exp. Biol. Med*., 227: 20-25.

Behnia, M.R. 1991. *Saffron cultivation.* Tehran University Press, Theran.

DeMasttro, G. and C. Ruta, 1993. Relation between corm size and saffron (*Crocus sativus* L.) flowering. *Acta Horticulturae,* 344: 512-517.

Farooq, S. and K. Koul, 1983. Changes in gibberellins like activity in corms of saffron plant (*Crocus sativus* L.) during dormancy and sprouting. *J. Plant Biochem*., 178: 685-691.

Kafi, M., M.H. Rashed, A. Koocheki and A. Mollafilabi, 2002. *Saffron* (*Crocus sativus* L.)*, production and processing*. Center of excellence for agronomy, Faculty of Agriculture Ferdowsi University of Mashhad, Iran.

Koocheki, A. 2004. Indigenous knowledge in agriculture with particular reference to saffron production in Iran. *Acta Horticulturae,* 650: 175-182.

McGimpsey, J.A., M.H. Douglas and A.R. Wallace, 1997. Evaluation of saffron (*Crocus sativus* L .) in New Zealand. *Nz. J. Crop Hort. Sci.*, 25: 159-168.

Molina, R.V., M. Valero, Y. Navaro, A. Garcia-luis and J.L. Gardiola, 2004. Temperature effects on flower formation in saffron (*Crocus sativus* L.). *Scientia Horticulturae*, 103(b): 361-379.

Mollafilabi, A. 2004. Experimental finding of production and ecophysiological aspects of saffron (*Crocus sativus* L.). *Acta Horticulturae,* 650: 195-200.

Mosaferi, H. 2001. *Effect of different regimes of irrigation on saffron yield*. M. Sc. Thesis of irrigation and drainage, Ferdowsi University of Mashhad, Iran.

Negbi, M., 1999. Saffron cultivation: past, present and future prospects. In: *Saffron* (*Crocus sativus* L.), Negbi, M. (ed.), Harwood Academic Publishers, Amsterdam, pp. 1-18.

Sadeghi, B. 1993. Effect of corm weight on saffron flowering. I.R.O.S.T. Mashhad Center, Iran.

Sadeghi, B. 1998. Effect of summer irrigation on saffron yield. I.R.O.S.T. Mashhad Center, Iran.