Saffron (*Crocus sativus* L.) growth and yield as influenced by organic farming practices

R Kumar & OC Sharma

Journal of Agriculture and Ecology

ISSN: 2456-9410

Volume: 4

Journal of Agriculture and Ecology (2017) 4: 25-32
<http://doi.org/10.53911/JAE.2017.4203>

Research Article

Open Access

Saffron (*Crocus sativus* L.) growth and yield as influenced by organic farming practices

R Kumar✉ & OC Sharma

Central Institute of Temperate Horticulture, Srinagar-190 007, Jammu and Kashmir, India

✉ Corresponding author: R Kumar, E-mail: rameshflori@gmail.com

Article Info	Abstract
<p><i>Article history</i> Received: 05 August, 2017 Accepted: 16 October, 2017 Available online: 30 November 2017</p> <p>Key Words: <i>Crocus sativus</i>, organic saffron, pistil, corm yield</p>	<p>The present investigation was carried out to study effect of organic manures on growth, yield and corm production of saffron (<i>Crocus sativus</i> L.) under Karewa condition of Kashmir Himalaya. The different organic manures and their combinations significantly affected vegetative, floral and yield attributes of saffron. Floral attributes of saffron were also significantly affected by different organic manure treatments and recorded maximum value for pistil length (4.19 and 4.13 cm), pistil fresh weight (40.21 and 42.00 mg) and pistil dry weight (8.01 and 8.05 mg) in T₁₃ (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) during both years. Flowers number/m² (48.27 and 55.21) and saffron yield (3.84 and 4.44 kg/ha) was observed highest in treatment T₁₃ (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) followed by T₁₁ (25% FYM+ 25% vermicompost + 50% poultry manure) with flowers number/m² (45.27 and 50.55) and saffron yield (3.60 and 4.09 kg/ha) as against lowest in T₁₄ control. Highest total saffron yield and corm yield (8.28 kg/ha and 10.05 t/ha) was found in T₁₃ (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) which was statistically at par (7.69 kg/ha and 9.64 t/ha) with T₁₁ (25% FYM+ 25% vermicompost + 50% poultry manure) and lowest was recorded (2.92 kg/ha 7.12 t/ha) in T₁₄ control, respectively. Treatment T₁₃ (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) produced highest B:C ratio 4.24 followed by 3.98 in T₁₁ (25% FYM+ 25% vermicompost + 50% poultry manure) and lowest 2.63 in T₁₄ control.</p>

Copyright ©2017 Kumar & Sharma, This is an open access article published under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Preferred citation: Kumar R & Sharma OC. 2017. Saffron (*Crocus sativus* L.) growth and yield as influenced by organic farming practices. *Journal of Agriculture and Ecology*, 4: 25-32, <http://doi.org/10.53911/JAE.2017.4203>.

Introduction

Saffron (*Crocus sativus* L.) is the world's most prized spice, well-known for its flavouring and medicinal properties. It is sterile triploid (2n=3x=24) derived from *C.*

cartwrightianus by autotriploidy and grown for its stigma production (Mathew 1982). It contains crocin responsible for its colouring strength, picrocrocin for bitter taste and safranal for aroma (Carmona et al. 2006)

which are very important ingredients in food, medicinal and pharmaceutical industries. Iran and Spain are the major producer accounting more than 80% world production with production of 300 MT annually (Emam et al. 2012). Though, India occupies the 2nd largest area of 3,785 ha but the production is only 9.46 MT with an average productivity of 2.50 kg/ha (Nehvi, 2010). The Kashmiri saffron has high crocin content and rich in aroma which has particular significance in Indian foods and beverages like Kashmiri kahwa, saffron tea, saffron milk, saffron rice, saffron fish, Kashmiri wazwan and biryani, variety of sweets and bakery products (Kumar et al. 2012). It is also used to treat a wide range of ailments including stomach upsets, as an anticancer and anti-aging agent (Hasan et al. 2011). In the world; Iran, Greece, Spain and India are the major saffron producing countries along with Greece, Azerbaijan, Morocco, and Italy. It is a legendary crop produced on Karewa's of Pulwama, Budgam, Srinagar, Doda and Kishtwar districts where ideal climatic conditions are available for good growth and flower production characterized by water scarcity, cold winter and warm dry summer. Saffron of Kashmir was also recognized by the FAO, Rome, Italy as globally important agricultural heritage system for present and future generation.

Unfortunately, from the last few years, both area and production in Jammu & Kashmir has come down from 5,707 ha in 1996-97 to 3,785 ha during 2009-10 and the production from 15.95 MT to just 9.46 MT, mainly because of lack of irrigation and quality corm production (Ahmed et al. 2011).

Water Scarcity during active growth stage adversely affects saffron yield and corm multiplication (Nehvi et al. 2004). The leading saffron growing countries like Iran, Spain with intensive production technologies are able to achieve higher production and productivity (4-8 kg/ha) which is much higher than our productivity. Application of chemical fertilizers and pesticides causes contamination of food, destroy non-target species and gradual increase in the immunity of target organisms to these chemicals and disruption of natural balance of ecosystem. Further, these chemical fertilizers and pesticides are not biodegradable and persist in soil, plant and animal bodies. Saffron is costliest spice and presence of chemical residue in its stigma and corm may reject their supply to industries and export to other countries. In saffron growing, mostly chemicals are used in the form of fertilizer to supply nutrients and as fungicides for corm rot management. The ecological, environmental and food safety benefits of organic farming systems along with the fact of growing demand for organic food shows that organic farming systems can be an appropriate alternative to conventional chemical based farming systems (Poudel et al. 2002). Therefore, the present investigation was carried out to study the effect of organic manures namely FYM, vermicompost, poultry manure and their combinations on growth, yield and corm production of saffron (*Crocus sativus* L.) under Karewa condition of Kashmir Himalaya. The aim of this investigation is to standardize organic saffron cultivation technique for quality stigma and corm production to avoid use of

agrochemicals which have harmful effects on human health and environment.

Materials and Methods

The study was conducted at experimental farm of Central Institute of Temperate Horticulture, Srinagar during 2011-2013. The experimental field is situated at about 33°59' N latitude and 74°46' E longitude and 1674.88 m elevation above mean sea level. The soil characteristics of experimental field were clay loam to silt clay, pH 6.81 and EC 0.37 dsm⁻¹ with adequate drainage and water holding capacity. The experiment was laid out in randomized block design with three replications. Healthy and uniform corms (>8-10 g) were planted at the density of 5 lakh corms/ha on raised beds of 1.5x4 m² size with 20 cm height during 2011-12 using organic inputs under irrigated condition. The corms were treated with *Trichoderma viride* @ 5g/kg for corms rot management.

The chemical composition of organic manures utilized in the study is presented in Table 1 and average of monthly weather data are depicted in Fig.1. Recommended dose of fertilizers (RDF) in saffron was FYM 25 tonnes and N:P:K 90:100:120 kg/ha (Kumar et al. 2013). Recommended dose of N:P:K were

applied through different organic manures namely FYM, vermicompost and poultry manure in alone and different combinations. There were fourteen treatments i.e. T₁-50% RDF in form of FYM, T₂-75% RDF in form of FYM, T₃-100 % RDF in form of FYM, T₄-50% RDF in form of vermicompost, T₅-75% RDF in form of vermicompost, T₆-100% RDF in form of vermicompost, T₇-50% RDF in form of poultry manure, T₈-75% RDF in form of poultry manure, T₉-100% RDF in form of poultry manure, T₁₀-RDF as 25% FYM+25% vermicompost+50% poultry manure, T₁₁- RDF as 25% FYM+50% vermicompost+25% poultry manure, T₁₂-RDF as 50% FYM+25% vermicompost+25% poultry manure, T₁₃- RDF as 33.33% FYM+33.33% vermicompost+33.33% poultry manure and T₁₄- Control (without any manure). Uniform intercultural operations were carried out to grow the crop. These organic manures were spread uniformly in the respective bed and incorporated in the soil up to a depth of 25 cm during bed preparation in July. The data recorded on different parameters pertaining to growth, pistil yield and corms attributes of saffron and were analyzed statistically as per the methods suggested by Gomez and Gomez (1984).

Table1. Chemical composition of organic manures utilized for the experiment

Organic manure	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Organic carbon (%)
FYM	0.62	0.31	0.68	0.71	0.17	10.18
Vermicompost	2.16	0.74	1.52	0.80	0.15	15.73
Poultry manure	2.47	0.83	1.05	1.72	0.38	13.50

Fig. 1. Average monthly weather condition prevailed during experimentation

Results and Discussion

The different treatments of organic manures were significantly affected (Table 2) the vegetative, floral and yield attributes of saffron. Among all the treatments, T₁₃ treatment produced longest foliage (27.64 cm and 35.40 cm) which was statistically at par with T₁₁ (26.45 and 32.12 cm) as compared to

minimum (19.61 and 20.24 cm) in T₁₄ control during 1st and 2nd year, respectively. The maximum number of leaves/plant (15.60 and 20.12) and leaf breadth (1.23 and 1.42 mm) was obtained with T₁₃ treatment as against minimum leaves/plant (8.10 and 10.98) and leaf breadth (0.80 and 0.91mm) in T₁₄ control during 1st and 2nd year, respectively.

Table 2. Effect of different organic manures on vegetative attributes of saffron

Treatments	Foliage length (cm)		Number of leaves/plant		Leaf breadth (mm)	
	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year
T ₁	21.19	22.08	9.50	11.30	0.82	0.97
T ₂	21.18	24.11	9.30	12.25	0.81	0.93
T ₃	22.17	26.14	10.4	13.45	0.85	0.98
T ₄	23.62	25.26	12.10	14.18	0.90	1.02
T ₅	24.18	25.18	13.22	16.33	0.93	1.07
T ₆	24.32	23.12	11.90	12.11	0.91	1.03
T ₇	24.41	26.39	12.60	13.45	0.94	1.09
T ₈	25.31	25.37	13.20	15.28	0.96	1.17
T ₉	23.62	24.72	10.30	12.20	0.87	1.01
T ₁₀	24.76	28.33	14.20	18.41	1.01	1.23
T ₁₁	26.45	32.12	14.70	17.32	1.18	1.39
T ₁₂	25.70	29.18	13.80	15.00	1.07	1.31
T ₁₃	27.64	35.40	15.60	20.12	1.23	1.42
T ₁₄	19.61	20.24	8.10	10.98	0.80	0.91
LSD at 5%	3.71	3.28	1.97	2.57	0.12	0.14

Pistil length, fresh weight and dry weight are important attributes which contribute to saffron yield and were also significantly improved by different treatments of organic manures (Table 3). Maximum pistil length (4.19 and 4.13 cm) was recorded in treatment T₁₃ followed by treatment T₁₁ (4.17 and 4.12 cm). Mohammad et al. (2012) also reported increased stigma size in saffron with manure application as compared to control. Pistil fresh weight was ranged from minimum

36.28 and 38.05 mg in control T₁₄ to maximum 40.21 and 42.00 mg in treatment T₁₃ during 1st and 2nd year, respectively. Similarly, pistil dry weight was recorded minimum 7.52 and 7.72 mg in control T₁₄ and maximum 8.01 and 8.05 mg in treatment T₁₃ which was at par with T₁₁ (8.00 and 8.04 mg) during 1st and 2nd year, correspondingly. Improved stigma weight was also recorded by Koocheki et al. (2012) in saffron with cow manure over other organic treatments.

Table 3. Effect of different organic manures on floral attributes of saffron

Treatments	Pistil length (cm)		Pistil fresh weight (mg)		Pistil dry weight (mg)	
	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year
T ₁	3.62	3.87	37.20	38.12	7.63	7.81
T ₂	3.63	3.90	37.81	38.23	7.73	7.79
T ₃	3.75	3.80	38.00	38.31	7.72	7.82
T ₄	3.81	3.83	38.36	39.37	7.75	7.85
T ₅	3.90	3.91	38.63	40.12	7.80	7.82
T ₆	3.89	3.96	38.15	39.06	7.73	7.83
T ₇	3.83	3.99	38.47	38.10	7.76	7.90
T ₈	3.96	4.02	39.01	39.05	7.83	7.92
T ₉	3.75	3.86	37.62	38.67	7.72	7.96
T ₁₀	4.02	4.00	39.74	40.10	7.96	8.03
T ₁₁	4.17	4.12	40.06	40.58	8.00	8.04
T ₁₂	4.08	4.08	39.63	40.12	7.92	8.00
T ₁₃	4.19	4.13	40.21	42.00	8.01	8.05
T ₁₄	3.64	3.78	36.28	38.05	7.52	7.72
CD at 5%	0.42	0.37	2.71	2.54	0.65	0.59

Data presented in Table 4 showed that saffron yield attributes *i.e.* flower number/m²; saffron pistil and corm yield were significantly affected and improved by different organic manure treatment. Maximum flower number/m² (48.27 and 55.21) was recorded in treatment T₁₃ followed by treatment T₁₁ (45.27 and 50.55) while minimum flower number/m² (18.46 and 20.08) was observed in T₁₄ control during 1st and 2nd year, correspondingly. Enhanced flower numbers were also reported by Rani

(2010) in litchi with organic manure application. That may be owing to improved nutrients supply by the combination of different organic manures in treatments T₁₃ and T₁₁. In second year, flower number/m² were increased from 1st year that is possible due to improved corm size in second year; which resulted in increased number of flower buds on the corms. Highest saffron yield (3.84 and 4.44 kg/ha) was recorded in treatment T₁₃ followed by treatment T₁₁ (3.60 and 4.09) while lowest saffron yield (1.35 and 1.57

kg/ha) was observed in T₁₄ (control) treatment during 1st and 2nd year, respectively. Similar results were also obtained by Rani (2010) in litchi by application of organic manures.

Total saffron yield was registered maximum 8.28 kg/ha in T₁₃ which was statistically at par with T₁₁ (7.69 kg/ha) as compared to minimum (2.92 kg/ha) in T₁₄ control. Saffron corm with improved quality and yield are essential in sustainable saffron growing, particularly under organic saffron production system. This may be due to combined application of organic manures not only provides nutrients but also improve soil structure, which results in enhanced saffron pistil and corm yield. Saffron corms were harvested after second year to record data on corm characteristics. Corm yield was ranged from minimum 7.12 t/ha in T₁₄ control to maximum 10.05 t/ha in T₁₃, which was statistically at par with T₁₁, T₁₂, T₁₀, T₇, T₈ and

T₄ treatments. Highest saffron pistil and corm yield in treatments T₁₃ and T₁₁ may be due to supply of high amount of nutrients particularly N, P, K, Ca, Mg and organic carbon as compared to control. Under Karewa condition of Kashmir Himalaya low multiplication coefficient and corm rot caused by *Fusarium oxysporum* f.sp. *gladioli* (Verma et al. 2012) are major problem. Application of organic manures enhanced *T. viride* population and reduced the population of pathogenic fungi (*F. oxysporum*) with maximum effect due to FYM, vermicompost and poultry manure amendments, which reduced corm rot incidence and maximized corm growth and yield. Similar results were also obtained by Wani (2004) in saffron. Benefit cost ratio after two year was ranged from 2.22 to 4.24 under different treatments and noticed highest 4.24 in treatment T₁₃ followed by T₁₁ (3.98), T₁₂ (3.82) and T₁₀ (3.72).

Table 4. Effect of different organic manures on yield attributes of saffron

Treatments	Number of flowers /m ²		Saffron yield (kg/ha)		Total saffron yield (kg/ha)	Corm yield (t/ha)
	1 st year	2 nd year	1 st year	2 nd year		
T ₁	22.12	25.10	1.67	1.96	3.63	8.51
T ₂	23.52	27.29	1.78	2.13	3.91	8.60
T ₃	26.13	30.16	2.00	2.36	4.36	8.63
T ₄	35.84	37.48	2.71	2.94	5.65	9.01
T ₅	38.45	40.05	2.96	3.13	6.09	9.22
T ₆	30.62	36.13	2.31	2.83	5.14	8.87
T ₇	37.07	41.33	2.87	3.27	6.17	9.31
T ₈	40.84	44.65	3.13	3.54	6.65	9.30
T ₉	25.96	30.24	1.92	2.41	4.33	8.92
T ₁₀	42.33	45.49	3.34	3.65	6.98	9.42
T ₁₁	45.27	50.55	3.60	4.09	7.69	9.64
T ₁₂	42.51	47.94	3.32	3.84	7.16	9.50
T ₁₃	48.27	55.21	3.84	4.44	8.28	10.05
T ₁₄	18.46	20.08	1.35	1.57	2.92	7.12
CD at 5%	6.02	5.32	0.96	1.02	0.67	1.05

Higher growth and yield of saffron under combined application of different manures may be attributed to improvement of physical properties of the soil including aeration, water holding capacity and balance

between nutrients in the soil solution with slow release of nutrients during growth period and low leaching of the nutrients.

Fig. 2. Benefit cost ratio of saffron cultivation under different organic manure treatments

Acknowledgement: Authors thanks to Director, ICAR-Central Institute of Temperate Horticulture, Srinagar for providing necessary facilities and technical support.

References

- Ahmed N, Kumar R, & Habib K. 2011. Present status and scope of saffron cultivation in India and the world. In: Intensive production technologies in saffron for higher productivity. Eds. Ahmed N. and Kumar R., Oct. 28-30th, 2011. Central Institute of Temperate Horticulture, Srinagar. pp.1-10.
- Carmona M, Zalacain A, Sanchez AM, Novella JL & Alonso GL. 2006. Crocetin esters, picrocrocin and its related compounds present in *Crocus sativus* stigmas and *Gardenia jasminoides* fruits. Tentative identification of seven new compounds by LC-ESI-MS. *Journal of Agricultural and Food Chemistry*, 54:973-979.
- Emam V, Eghbal MK, Lar MMS, Khalaj KN, Peknejad F & Rohami B. 2012. The effect of planting density and different nitrogen and phosphorus application rates on saffron yield. *Journal of Basic and Applied Scientific Research*, 2(3): 2400-2404.
- Gomez KA. & Gomez AA. 1984. Statistical procedures for agricultural research. 2nd edn., John Wiley and Sons. Inc., New York.

- Hasan I, Ansari AH, Sherwani AMK & Zulkifle M. 2011. The incredible health benefits of saffron: A Review . *Journal of Pharmacy Research*, 4(7): 2156-2158.
- Koocheki A, Tabrizi L, Ghafouri AA & Khorramdel S. 2012. Evaluation of growth characteristic and yield of saffron (*Crocus sativus* L.) by application of organic planting beds and different sowing beds. *Souvenir and Abstracts. 4th International saffron symposium*. Oct. 22-25, 2012, pp.56.
- Kumar R, Ahmed N & Lal S. 2012. Saffron-A golden spice nutritional and medicinal wonder. *Science India*, 15(10): 32-36.
- Kumar R, Ahmed N, Kumar D, Lal S & Salmani MM. 2013. Intensive production technology in saffron for higher productivity. Extension Folder, Central Institute of Temperate Horticulture, Srinagar, J&K-190 007.
- Mathew B. 1982. The *Crocus*- A revision of the genus *Crocus* (Iridaceae). Portland. Timber Press.
- Nehvi FA, Agarwal SG, Verma MK, Dar SA, Mir ZA, Nusrat N & Allie BA. 2004. Technological innovation for saffron production. Proc. National symposium on enhancing productivity and sustainability in hill and mountain agro ecosystem, 10-12 August, Dehradun, Uttranchal, pp.58-67.
- Nehvi FA. 2010. Forthcoming challenges for improving saffron farming system in Kashmir. *Acta Horticulturae*, 850:281-285.
- Poudel DD, Horwath WR, Lanin, WT, Temple SR. & Van-Bruggen AHC. 2002. Comparison of soil N availability and leaching potential, crop yields and weeds in organic, low-input and conventional farming systems in northern California. *Agriculture Ecosystems and Environment*, 90:125-137.
- Rani A. 2010. Effect of organic manures on yield, quality and post harvest life of litchi (*Litchi chinensis* Sonn.) cv. rose scented. Ph.D. Thesis Submitted to G.B. Pant University of Agriculture and Technology, Pantnagar-263145 (Uttarakhand).
- Verma R. K., Ahmed N., Kumar R., Lal S. and Andrabi M. 2012. Management of corm rot of saffron with chemical seed treatment in Kashmir valley conditions. 4th International Saffron Symposium, 22-25 October, 2012, SKUAST-K and ISHS, pp.96.
- Wani MA. 2004. Studies on corm rot of saffron (*Crocus sativus* L.). Ph.D. Thesis. Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, J&K.