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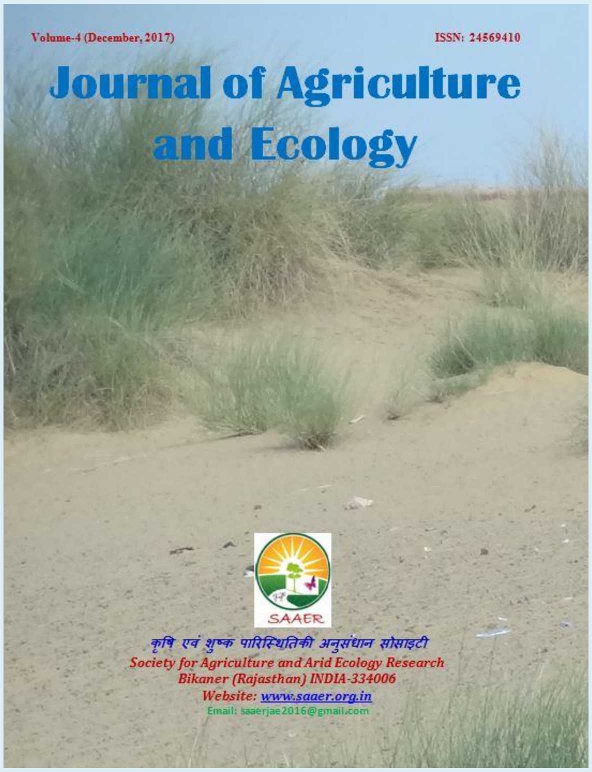

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R Kumar & OC Sharma

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

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

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Abstract

The present investigation was carried out to study effect of organic manures on growth, yield and corm production of saffron (*Crocus sativus* 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 T_{13} (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) during both years. Flowers number/m^2 (48.27 and 55.21) and saffron yield (3.84 and 4.44 kg/ha) was observed highest in treatment T_{13} (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) followed by T_{11} (25% FYM+ 25% vermicompost + 50% poultry manure) with flowers number/m^2 (45.27 and 50.55) and saffron yield (3.60 and 4.09 kg/ha) as against lowest in T_{14} control. Highest total saffron yield and corm yield (8.28 kg/ha and 10.05 t/ha) was found in T_{13} (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 T_{11} (25% FYM+ 25% vermicompost + 50% poultry manure) and lowest was recorded (2.92 kg/ha 7.12 t/ha) in T_{14} control, respectively. Treatment T_{13} (33.33% FYM+ 33.33% vermicompost+ 33.33% poultry manure) produced highest B:C ratio 4.24 followed by 3.98 in T_{11} (25% FYM+ 25% vermicompost + 50% poultry manure) and lowest 2.63 in T_{14} control.

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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 m^2 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. T_1-50% RDF in form of FYM, T_2-75% RDF in form of FYM, T_3-100 % RDF in form of FYM, T_4-50% RDF in form of vermicompost, T_5-75% RDF in form of vermicompost, T_6-100% RDF in form of vermicompost, T_7-50% RDF in form of poultry manure, T_8-75% RDF in form of poultry manure, T_9-100% RDF in form of poultry manure, T_{10}-RDF as 25% FYM+25% vermicompost+50% poultry manure, T_{11}- RDF as 25% FYM+50% vermicompost+25% poultry manure, T_{12}-RDF as 50% FYM+25% vermicompost+25% poultry manure, T_{13}- RDF as 33.33% FYM+33.33% vermicompost+33.33% poultry manure and T_{14}- 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

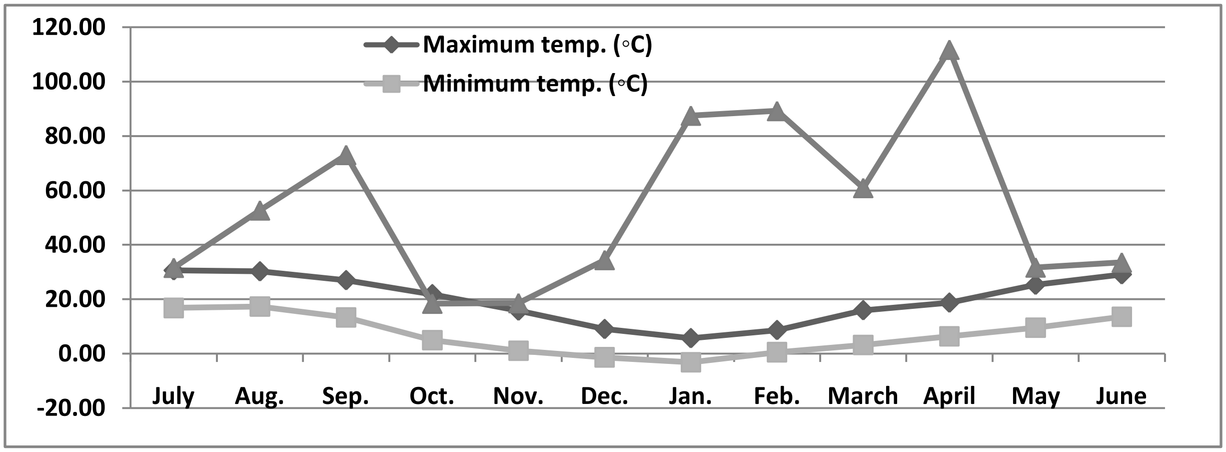

Fig. 1. Average monthly weather condition prevailed during experimentation

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, T_{13} treatment produced longest foliage (27.64 cm and 35.40 cm) which was statistically at par with T_{11} (26.45 and 32.12 cm) as compared to minimum (19.61 and 20.24 cm) in T_{14} 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 T_{13} treatment as against minimum leaves/plant (8.10 and 10.98) and leaf breadth (0.80 and 0.91mm) in T_{14} 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)	
	1st year	2nd year	1st year	2nd year	1st year	2nd 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 T_{13} followed by treatment T_{11} (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 T_{14} to maximum 40.21 and 42.00 mg in treatment T_{13} during 1st and 2nd year, respectively. Similarly, pistil dry weight was recorded minimum 7.52 and 7.72 mg in control T_{14} and maximum 8.01 and 8.05 mg in treatment T_{13} which was at par with T_{11} (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)	
	1st year	2nd year	1st year	2nd year	1st year	2nd 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/m^2; saffron pistil and corm yield were significantly affected and improved by different organic manure treatment. Maximum flower number/m^2 (48.27 and 55.21) was recorded in treatment T_{13} followed by treatment T_{11} (45.27 and 50.55) while minimum flower number/m^2 (18.46 and 20.08) was observed in T_{14} 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 T_{13} and $T_{11.}$ In second year, flower number/m^2 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 T_{13} followed by treatment T_{11} (3.60 and 4.09) while lowest saffron yield (1.35 and 1.57

kg/ha) was observed in T_{14} (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 T_{13} which was statistically at par with T_{11} (7.69 kg/ha) as compared to minimum (2.92 kg/ha) in T_{14} 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 T_{14} control to maximum 10.05 t/ha in T_{13}, which was statistically at par with T_{11}, T_{12}, T_{10}, T_7, T_8 and T_4 treatments. Highest saffron pistil and corm yield in treatments T_{13} and T_{11} 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. osysporum*) 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 T_{13} followed by T_{11} (3.98), T_{12} (3.82) and T_{10} (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)
	1st year	2nd year	1st year	2nd 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.

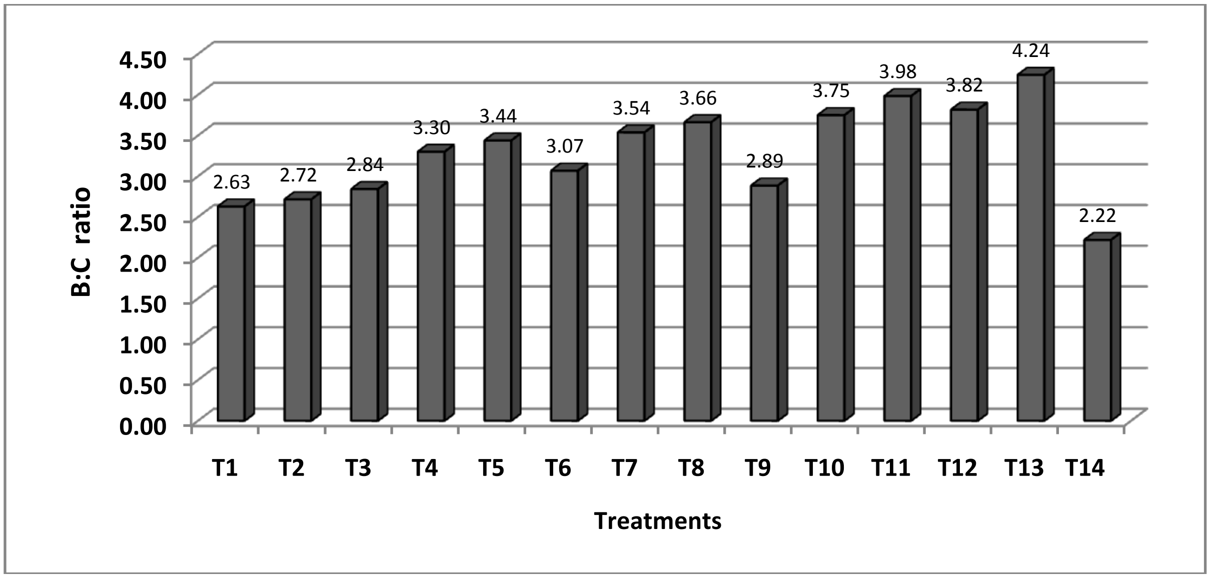

Fig. 2. Benefit cost ratio of saffron cultivation under different organic manure treatments

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