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Effect of integrated nutrient management in saffron

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ABSTRACT

A field experiment was conducted on upland soils during the years 2006- 2008 at K.D. Research Station, Old Airport, Srinagar to study the effect of integrated nitrogen management on saffron yield, nutrient content and soil fertility under rainfed conditions. Saffron responded well to organic manure when used in integration with inorganic fertilizers and gave additional yield. The highest saffron yield (2.98 and 4.13 kg ha^{-1}) was recorded with the application of 90 kg N ha^{-1} in conjunction with 60 t FYM ha^{-1} which was found at par with 90 kg N ha^{-1} in conjunction with 30 t FYM ha^{-1} in 2007-08 while the minimum saffron yield (1.89 and 1.93 kg ha^{-1}) was obtained from control plots during 2006-07 and 2007-08, respectively. The combined application of nitrogenous fertilizer and FYM sustained the productivity even at lower rate of fertilizer N application. The highest N, P and K content was also recorded with the application of 90 kg N ha^{-1} along with 60 t FYM ha^{-1}. The soil organic carbon, available N, P and K content increased with the application of nitrogenous fertilizer alone or in conjunction with organics (FYM) compared with control.

Key words: Integrated nitrogen management, saffron, yield, soil fertility, organic fertilizers.

INTRODUCTION

Saffron (*Crocus sativus*) is one of the unique crops grown in Kashmir region and offers remunerative price to the farmers and is used in pharmaceutical, cosmetic and food industry. The crop is grown from time immemorial in Pampore belt of Kashmir with blanket fertilizer application not taking into account integrated nutrient management and balanced supply of nutrients. Injudicious use of high analysis chemical fertilizer results in deficiency of micronutrients and decline in organic carbon (Singh *et al.*, 9). However, when manures and biofertilizers are applied in conjunction with chemical fertilizers for efficient growth of crop, decline of crop yield was arrested and gap between actual and potential yield was bridged to a large extent (Singh *et al.*, 10).

Growing concern about the sustainability of saffron coupled with increasing price of chemical fertilizers had led to renewed interest in organic manures. Mineralizable N plays an important role in nutrition of crops. Incorporation of organic manure along with fertilizer affects the amount and distribution of organic N fraction considerably in soil (Santhy *et al.*, 11). As saffron is usually grown under rainfed conditions, maximum loss of N occurs through volatilization and nitrogen use efficiency is less. The problem is further accentuated with less water availability during its active stage which diminishes the yield potential. The present study was undertaken to mitigate this problem and to study the integrated effect of FYM and chemical fertilizer on yield of saffron and uptake of nutrient as well as soil chemical properties.

MATERIALS AND METHODS

A field experiment was conducted at the K.D. Research Station, SKUAST- K, Old Airport, Srinagar (J&K) during 2006-07 and 2007-08 to study the effect of integrated nitrogen management on saffron crop. The experimental soil was clayey loam with high plasticity and slightly acidic reaction with pH 6.2, organic carbon 0.4%, available nitrogen 161.7 kg ha^{-1}, available phosphorus 10.15 kg ha^{-1} and available potassium 145.2 kg ha^{-1}. The soil belongs to low class of fertility rating. The treatments consisted of three levels of nitrogen (0, 45 and 90 kg N ha^{-1}) and three levels of FYM (0, 30 and 60 t ha^{-1}). The trial was laid out in randomized block design with three replications. The farmyard manure contained 0.5% nitrogen, 0.25% phosphorus and 0.30% potassium. Nitrogen was applied as per treatments through urea, while phosphorus and potassium were given as per the recommendation of saffron crop. The pH (soil: water suspension) was measured using a glass electrode pH meter as described by Jackson (5) organic carbon by the wet digestion method of Walkley and Black (13). The available nitrogen content was determined by alkaline-$KMnO_4$ method (Subbiah and Asija, 12), available phosphorus content was determined as per Olsen *et al.* (8) and the available potassium content was estimated by flame photometry.

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RESULTS AND DISCUSSION

Application of FYM significantly influenced the saffron yield in both seasons (Table 1) and higher saffron yield, *i.e.*, 2.73 and 3.50 kg ha^{-1} was observed with application of FYM @ 60 t ha^{-1} in 2006-07 and 2007-08, respectively as compared to FYM @ 30 t ha^{-1} and control. The reason for enhanced yield in saffron may be attributed to enhanced microbial activity, which must have provided favourable conditions for the uptake of plant nutrients. The nitrogen levels caused significant differences in saffron yield during both the crop seasons. Application of nitrogen @ 90 kg ha^{-1} recorded significantly higher saffron yield (2.67 and 3.50 kg ha^{-1}) as compared to other nitrogen treatments. The lowest saffron yield, *i.e.*, 2.15 and 2.30 kg ha^{-1} was recorded in control (without nitrogen). The interaction effect between FYM and nitrogen levels had a non significant effect on saffron yield during 2006-07, but it was significant during crop season 2007-08. The maximum saffron yield (2.98 and 4.13 kg ha^{-1}) was observed when FYM @ 60 t ha^{-1} and nitrogen @ 90 kg ha^{-1} was applied. Application of nitrogen @ 90 kg ha^{-1} proved better as compared to control and 45 kg ha^{-1} of nitrogen at FYM @ 30 and 60 t ha^{-1}. This could be due to the beneficial effect of combined use of organic manure and fertilizers, which increased the nutrient availability through enhanced microbial activity, conversion from unavailable to available forms and also due to improved physical, chemical and bio-chemical conditions. Further, soil organic N is the largest source of available plant N for the crops , (Eagle *et al.*, *3*). The combined application of inorganic and organic sources produced higher yield than inorganic N alone. These results are in conformity with the findings of Bullitta *et al*. (2). Amiri *et al*. (1) also reported that stigma dry weight (yield) was higher in combined application of N + P + manure. Thus, the use of FYM with inorganic N helped in sustaining the saffron yield.

The nutrient content in saffron (stigma) with respect to N, P and K (Table 2) at varying treatment combinations varied between 0.68-1.18 and 0.62-1.30, 0.17-0.34 and 0.28-0.70, and 0.29-0.92 and 0.47-1.02% during 2006-07 and 2007-08, respectively. The nitrogen content was greatly influenced by inorganic and organic nitrogen sources either singly or in combination. The highest N content was recorded with treatment combination of 90 kg of N ha^{-1} and 60 t FYM ha$^{-1.}$ This treatment produced the highest saffron yield compared with the highest N content. This might be due to the improved physical conditions of soil with better N availability to the crop.

Table 1. Effect of nitrogen management (inorganic and organic) on saffron yield and soil organic carbon.

N (kg/ ha)	2006-07				2007-08			
	FYM (t/ha)							
	0	30	60	Mean	0	30	60	Mean
	Yield (kg/ ha)							
0	1.89	2.23	2.34	2.15	1.93	2.32	2.67	2.30
45	2.05	2.31	2.87	2.41	2.56	2.77	3.71	3.01
90	2.24	2.79	2.98	2.67	2.86	3.92	4.13	3.64
Mean	2.06	2.44	2.73			2.45	3.00	3.50
CD (P = 0.05)		FYM = 0.24				FYM = 0.28		
		N = 0.24				N = 0.28		
		FYM × N = 0.43				FYM × N = 0.50		
	Organic carbon (%)							
0	0.40	0.62	0.81	0.61	0.61	0.80	1.18	0.86
45	0.43	0.65	0.90	0.66	0.92	1.29	1.36	1.19
90	0.44	0.70	0.96	0.70	0.96	1.45	1.87	1.42
Mean	0.42	0.65	0.89		0.83	1.18	1.47	
CD (P = 0.05)		FYM = 0.03				FYM = 0.05		
		N = 0.03				N = 0.05		
		FYM × N = 0.06				FYM × N = 0.08		

Table 2. Nitrogen, phosphorus and potassium content in saffron corm as influenced by inorganic and organic fertilizers.

N (kg/ ha)	2006-07				2007-08			
	FYM (t/ ha)							
	0	30	60	Mean	0	30	60	Mean
				Nitrogen content (%)				
0	0.68	0.71	0.87	0.75	0.62	0.81	1.17	0.87
45	0.86	0.94	1.07	0.95	0.80	0.98	1.23	0.96
90	0.91	0.98	1.18	1.02	0.95	1.12	1.30	1.00
Mean	0.81	0.88	1.04		0.76	0.89	1.18	3.50
CD (P = 0.05)		FYM = 0.03				FYM = 0.02		
		N = 0.03				N = 0.02		
		FYM × N = 0.06				FYM × N = 0.04		
				Phosphorous content (%)				
0	0.17	0.20	0.22	0.20	0.24	0.32	0.36	0.30
45	0.22	0.24	0.26	0.24	0.30	0.39	0.43	0.37
90	0.23	0.30	0.34	0.29	0.38	0.45	0.50	0.44
Mean	0.21	0.25	0.27		0.31	0.39	0.43	
CD (P = 0.05)		FYM = 0.01				FYM = 0.03		
		N = 0.01				N = 0.03		
		FYM × N = 0.02				FYM × N = 0.05		
				Potassium content (%)				
0	0.29	0.42	0.50	0.40	0.47	0.67	0.72	0.62
45	0.35	0.47	0.71	0.51	0.65	0.74	0.86	0.75
90	0.59	0.85	0.92	0.78	0.70	0.94	1.02	0.88
Mean	0.41	0.58	0.71		0.60	0.78	0.86	
CD (P = 0.05)		FYM = 0.01				FYM = 0.02		
		N = 0.01				N = 0.02		
		FYM × N = 0.02				FYM × N = 0.04		

In case of P and K contents, the highest P and K concentration was also observed with the application of 90 kg N ha^{-1} + 60 t FYM ha^{-1} which was significantly superior over control. The combined treatments of inorganic and organic showed increase in P and K contents than the treatments of organic sources alone. Similar findings were also reported by Lajtha (6).

The organic carbon content of soil after harvest of saffron was higher than the initial value (before start of the experiment). Significant increase in organic carbon content was recorded in the treatment where FYM had been applied along with inorganic fertilizer (Table 1). The highest organic carbon content (0.96 and 1.87%) was recorded in the treatment of 90 kg N ha^{-1} + 60 t FYM ha-1 during 2006-07 and 2007-08, respectively. This corroborates the findings of Lee-Jaeseog *et al.* (7). Application of inorganic fertilizer N alone or in combination with FYM increased the soil organic carbon due to addition of organic matter due to FYM. However, in control plots, there was significant reduction in organic carbon content.

The available nitrogen content in soil increased significantly over control (Table 3). The initial available nitrogen status of soil for 2006-07 and 2007-08 of saffron cropping was 161.4 and 137.6 kg/ha in control, while maximum available nitrogen (247.6 and 418.2 kg/ ha respectively) was found in inorganic N in conjunction with FYM treatment. The result clearly indicates that higher dose of inorganic N along with FYM has increased the N soil content. Application of inorganic

Table 3. Available nutrients in soil after harvest of Saffron as influenced by integrated nutrient management.

N (kg/ ha)	2006-07				2007-08			
	FYM (t/ ha)							
	0	30	60	Mean	0	30	60	Mean
	Available nitrogen (kg/ ha)							
0	161.4	175.6	229.3	188.8	137.6	180.9	265.5	194.7
45	164.3	209.5	215.8	196.5	216.7	291.5	308.3	272.1
90	201.8	239.5	247.6	229.6	208.5	326.5	418.3	317.8
Mean	175.8	208.2	230.9		187.6	266.3	330.7	
CD (P = 0.05)		FYM = 13.7				FYM = 15.2		
		N = 13.7				N = 15.2		
		FYM × N = 24.5				FYM × N = 27.4		
	Available phosphorus (kg/ ha)							
0	10.1	15.1	18.9	15.0	9.16	17.3	29.1	18.5
45	11.6	16.6	22.8	17.0	18.9	23.0	31.8	24.6
90	12.9	18.5	28.7	20.1	23.2	28.1	39.4	30.2
Mean	11.5	16.7	23.4		17.1	22.8	33.4	
CD (P = 0.05)		FYM = 1.1				FYM = 3.3		
		N = 1.1				N = 3.3		
		FYM × N = 2.0				FYM × N = 5.9		
	Available potassium (kg/ ha)							
0	137.0	172.0	178.2	162.4	104.0	131.8	159.0	131.6
45	192.8	199.0	223.5	205.1	149.0	185.6	210.3	181.4
90	220.5	229.5	259.5	236.5	175.6	225.2	256.0	218.9
Mean	183.4	200.2	220.4		142.7	180.9	208.4	
CD (P = 0.05)		FYM = 16.9				FYM = 15.1		
		N = 16.9				N = 15.1		
		FYM × N = 30.3				FYM × N = 27.2		

nitrogen with or without organic sources proved superior over control. This corroborates the findings of Hegde *et al.* (4). The favourable soil conditions under these treatments might have helped in the mineralization of soil N leading to build up of available N.

Application of FYM significantly increased the available P content as compared to non application of FYM treatment. The maximum available phosphorous (28.66 and 59.37 kg/ha) was observed in the treatment receiving 90 kg N ha^{-1} in conjunction with 60 tonnes FYM ha^{-1}during 2006-07 and 2007-08 respectively and was significantly higher over rest of the treatments (Table 3). Incorporation of FYM along with inorganic N increased the availability of phosphorus, due to increased mineralization of organic P by microbial action and enhanced P mobility.

Significant increase in the available potassium content of soil over control was observed due to various nutrient management practices (Table 3). In the treatment where higher fertilizer doses were applied, available potassium content was recorded to be maximum. The increase in available potassium content might be due to higher amount of fertilizers applied. Higher build up of available K was also noticed in the treatments having both FYM and inorganic N.

It may be concluded that integration of inorganic nitrogen coupled with organics (FYM) was effective in increasing saffron yield, improving the nutrient content, and build up N, P, K and organic carbon in the soil.

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