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Influence of organic and inorganic sources of fertilizers on growth, yield and economics of fennel (*Foeniculum vulgare* Mill.) cultivation under semi arid conditions

A S Godara*, U S Gupta, G Lal¹ & R Singh¹

Adaptive Trial Centre, Department of Agriculture, Govt. of Rajasthan,
Tabiji-305 206, Ajmer, Rajasthan.

*E-mail: godara_as@yahoo.com

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Abstract

The experiment was conducted with eight treatments (absolute control and varying proportions of organic and inorganic sources of nutrients *viz.*, 100% recommended dose of nitrogen (RDN) through fertilizers (90:45:0), 100% RDN through farm yard manure, 100% RDN through poultry manure, 100% RDN through vermicompost, 50% RDN through fertilizers + 50% RDN through farm yard manure, 50% RDN through fertilizers + 50% RDN through poultry manure and 50% RDN through fertilizers + 50% RDN through vermicompost). Results revealed that RDN through fertilizers and combinations of different organic and inorganic sources produced significantly higher grain yield over absolute control. RDN (100%) applied through fertilizers exhibited highest vegetative growth and yield attributes with maximum yield (2325 kg ha⁻¹), net returns (Rs. 62,091 ha⁻¹) and benefit cost ratio (3.01), closely followed by 50% RDN through fertilizers + 50% RDN through vermicompost.

Keywords: economics, fennel, growth, inorganic, organic, yield

Introduction

Fennel (*Foeniculum vulgare* Mill.) is an important seed spice crop mainly grown in *rabi* season and belongs to family *Apiaceae*, vernacularly called *Saunf*. This crop occupies major acreage in Gujarat, Rajasthan and Uttar Pradesh. Presently, fennel is cultivated in 61,680 ha, with 105320 t production and productivity of 1707 kg ha⁻¹ in India (DGCI & S, Calcutta, 2010–11). Fennel being a long duration crop extracts lot of the nutrients from the soil. Inadequate and imbalanced application of nutrients are the

major factors for low yield and poor quality. Exclusive application of inorganic fertilizers creates deleterious effect on soil fertility due to limitation of one or more nutrients including micro nutrients and poor soil health leading to decline in productivity. No single source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. The conjunctive (integrated) application of organics with inorganic sources of nutrients reduces the dependence on chemical inputs and also provides micro nutrients as well as

¹National Research Centre on Seed Spices, Tabiji-305 206, Ajmer, Rajasthan.

modifies the soil physical behavior and increases the efficiency of applied nutrients (Pandey *et al.* 2007). Judicious combination of manures and chemical fertilizers not only maximizes the crop production and improves the quality of agricultural produce but also helps in maintaining the soil fertility (Parihar *et al.* 2010). The overall strategy for increasing crop yields and sustaining them at a high level must include an integrated approach to the management of soil nutrient, along with other complimentary measures. Keeping these facts in view, the present study was undertaken to evaluate the effect of organic and inorganic sources of nutrients on growth, yield and economics of fennel cultivation.

Materials and methods

A field investigation was carried out to study the influence of organic and inorganic sources of fertilizers on growth, yield and economics of fennel during *rabi* season of 2010–11 at Research Farm of Adaptive Trial Centre, Tabiji, Ajmer (Rajasthan), India. The soil of the experimental field was sandy loam which was low in organic C (0.28%), low in available N (142 kg ha⁻¹), high in available P (21 kg ha⁻¹) and medium in available K₂O (178 kg ha⁻¹) with pH of 8.2 and EC of 0.32 dSm⁻¹.

The investigation comprising of eight treatments (T₁- Absolute control- No nutrition, T₂- 100% recommended dose of nitrogen (RDN) through fertilizers (90:45:0 kg NPK ha⁻¹), T₃- 100% RDN through farm yard manure, T₄- 100% RDN through poultry manure, T₅- 100% RDN through vermicompost, T₆- 50% RDN through fertilizers + 50% RDN through farm yard manure, T₇- 50% RDN through fertilizers + 50% RDN through poultry manure and T₈- 50% RDN through fertilizers + 50% RDN through vermicompost was laid in randomized block design with three replications. Full dose of N and P and organic manures as per treatments were applied manually through DAP, urea, FYM, poultry manure and vermicompost at the time of sowing. The fennel variety RF-101 was sown manually on 20th October, 2010 at 45 cm row to row and 30 cm plant to plant spacing using 10 kg seed ha⁻¹.

Standard agronomic and plant protection practices were adopted for raising healthy crop. Data on growth and yield attributes were taken from 10 tagged plants. Biological and economic yields were taken from net plot. Economics of the study was determined by calculating parameters like cost of cultivation, gross returns, net returns and benefit cost ratio using the prevailing price of inputs and output in the local market. Statistical analysis was performed as per methods suggested by Panse & Sukhatme (1985).

Results and discussion

Effect on growth and yield attributes

The higher values of growth and yield attributes *viz.*, plant height, number of primary and secondary branches, umbels plant⁻¹, umbellates umbel⁻¹, seeds umbel⁻¹ and test weight of fennel seeds were recorded with the application of recommended dose of N (RDN) through fertilizers *i.e.*, 90 kg N and 45 kg P₂O₅ ha⁻¹ (Table 1). Application of RDN through fertilizers increased plant height, number of primary and secondary branches, umbels plant⁻¹, umbellates umbel⁻¹, seeds umbel⁻¹, 1000-seed weight and yield plant⁻¹ to the magnitude of 38.81%, 59.90%, 80.72%, 72.30%, 30.94%, 52.28%, 37.42% and 57.69%, respectively compared to absolute control. However, performance of this treatment (T₂) was at par with T₈ (50% RDN through fertilizers and 50% through vermicompost), T₇ (50% RDN through fertilizers and 50% through poultry manure) and T₆ (50% RDN through fertilizers and 50% through FYM). Application of recommended dose of N and P through inorganic fertilizers enhanced the availability of nutrients, which resulted in increased photosynthetic activity and translocation of photosynthates from source to sink and this might be the cause of higher growth and yield attributes. Adequate supply of N and P plays a vital role in various metabolic processes which resulted in increased flowering and fruiting thereby improving umbels plant⁻¹. Seed yield of a crop is a function of yield attributes such as umbels plant⁻¹, umbellates umbel⁻¹, number of seeds umbellate⁻¹, test weight and seed yield

plant⁻¹. Increase in yield attributes due to increasing levels of N and P had direct and positive effect on seed, straw and biological yields of fennel. Patel *et al.* (2003) also recorded higher yield attributes when RDN was applied through inorganic fertilizers in fennel, while Sherin & Ahuja (2009) recorded maximum yield and yield attributes of cluster bean with vermicompost @ 2.5 t ha⁻¹ + 75% NPK.

Effect on yield and harvest index

Results (Tables 1 & 2) revealed that application of RDN through inorganic sources had direct positive effect on seed yield, biological yield and harvest index. Seed yield plant⁻¹ as well as seed and biological yields and harvest index were significantly higher with the application of RDN through chemical fertilizers. Application of 100% RDN through inorganic fertilizers increased seed yield, biological yield and harvest index by 83.07%, 32.10% and 38.58%, respectively over absolute control and it was found that seed and biological yield for T₂ (100% RDN through inorganic fertilizers) were at par with T₈ (application of 50% RDN through fertilizers and 50% through vermicompost), T₇ (50% RDN through fertilizers and 50% through poultry manure), T₆ (50% RDN through fertilizers and 50% through FYM), T₅ (100% RDN through vermicompost) and T₄ (100% RDN through poultry manure). Balanced supply of nutrients plays a vital role in various metabolic processes, which resulted in increased flowering and fruiting thereby improving yield. Bhati *et al.* (1988) recorded similar findings at higher level of N, P and K in fennel. Patel *et al.* (2000) also reported higher yield with RDN applied through fertilizers in fennel while, Jat & Choudhary (2004) reported highest fenugreek seed yield with 100% inorganic N. Mohamed & Abdu (2004) observed higher yield of fennel from poultry manure than FYM. Singh (2011) recorded maximum biomass, seed and oil yield of coriander with the application of 7.5 t vermicompost + 25% recommended dose of NPK fertilizers.

Effect on economics

The data (Table 2) revealed that application of 100% RDN through inorganic sources fetched

Table 1. Effect of different sources of nutrients on growth and yield attributes of fennel

Treatment	Plant height (cm)	No. of primary branches plant ⁻¹	No. of secondary branches plant ⁻¹	No. of umbels plant ⁻¹	No. of umbellates umbel ⁻¹	No. of seeds umbellate ⁻¹	Test weight (g)	Seed yield plant ⁻¹ (g)
T ₁ -Control (Absolute)	112.56	4.24	10.32	11.48	12.54	25.25	6.12	10.21
T ₂ -100% RDN through fertilizers (90:45:0)	156.25	6.78	18.65	19.78	16.42	38.45	8.41	16.10
T ₃ -100% RDN through FYM	140.54	5.85	15.23	15.98	14.68	30.42	7.84	13.45
T ₄ -100% RDN through poultry manure	143.36	5.94	15.59	16.12	14.74	31.24	7.92	13.84
T ₅ -100% RDN through vermicompost	146.75	6.04	16.22	16.54	15.23	31.95	7.98	14.05
T ₆ -50% RDN through fertilizers + 50% RDN through FYM	148.35	6.21	17.05	17.11	15.64	33.11	8.08	14.56
T ₇ -50% RDN through fertilizers + 50% RDN through poultry manure	149.25	6.36	17.48	17.56	15.78	34.87	8.14	14.84
T ₈ -50% RDN through fertilizers + 50% RDN through vermicompost	152.58	6.44	17.84	18.04	16.05	35.97	8.23	15.12
CD (P<0.05)	11.24	0.71	1.94	2.24	1.54	3.28	0.82	2.04
CV%	10.2	9.68	10.18	8.48	8.94	9.47	8.74	9.24

Table 2. Effect of different sources of nutrients on yield and economics of fennel

Treatment	Seed yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest index (%)	Gross returns (Rs)	Cost of cultivation (Rs)	Net returns (Rs)	Returns due to treatment (Rs)	B:C ratio
T ₁ -Control (Absolute)	12.70	83.33	15.24	50800	29000	21800	-	1.75
T ₂ -100% RDN through fertilizers (90:45:0)	23.25	110.08	21.12	93000	30910	62090	42200	3.01
T ₃ -100% RDN through FYM	19.21	98.77	19.45	76840	42500	34340	26040	1.81
T ₄ -100% RDN through poultry manure	19.89	100.56	19.78	79560	43200	36360	28760	1.84
T ₅ -100% RDN through vermicompost	20.56	102.59	20.04	82240	39200	43040	31440	2.10
T ₆ -50% RDN through fertilizers + 50% through FYM	21.01	104.27	20.15	84040	36700	47340	33240	2.29
T ₇ -50% RDN through fertilizers + 50% through poultry manure	21.98	108.00	20.35	87920	37050	50870	37120	2.37
T ₈ -50% RDN through fertilizers + 50% through vermicompost	22.70	111.00	20.45	90800	34200	56600	40000	2.66
CD (P<0.05)	3.76	10.32	0.82					

maximum gross returns (Rs. 93000 ha⁻¹), net returns (Rs. 62090 ha⁻¹) and B:C ratio (3.01) followed by application of 50% RDN through fertilizers and 50% through vermicompost-T₈ (B:C ratio 2.66) and 50% RDN through fertilizers and 50% through poultry manure-T₇ (B:C ratio 2.37).

It is concluded that application of 100% RDN through chemical fertilizers (T₂) gave maximum yield (23.25 q ha⁻¹) of fennel and fetched maximum net returns (Rs. 62,090 ha⁻¹) and B:C ratio (3.01). However, from sustainable production and soil health point of view we recommend combined application of 50% RDN through fertilizers + 50% RDN through organic manures (vermicompost/ poultry manure/ FYM), where the yields obtained (22.70, 21.98 and 21.01 q ha⁻¹ respectively) were at par with that of the treatment T₂.

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