

Effect of spacing and fertilizer levels on yield, quality and nutrient uptake of fennel (*Foeniculum vulgare* Mill.) under northern dry zone of Karnataka

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Abstract

An experiment was carried out on effect of spacing and fertilizer levels on yield, quality and nutrient uptake of fennel (*Foeniculum vulgare* Mill.) under northern dry zone of Karnataka. Among various spacing levels, 60 x 30 cm spacing recorded highest seed yield. The highest essential oil content and essential oil yield was obtained in 60 x 40 cm spacing. Nutrient uptake was found maximum in 60 x 30 cm spacing. The maximum seed yield, essential oil content, oil yield and total nutrient uptake was obtained by supplying 100:50:40 NPK kg ha⁻¹ and it was at par with 90:40:30 N, P₂O₅, K₂O kg ha⁻¹ respectively.

Keywords: Fennel, *Foeniculum vulgare* mill, fertilizer, yield, nutrient uptake, quality, spacing

Introduction

Spices are high value and low volume commodities of commerce in the world market. India is known as the home of spices and has consistently been the major player in production, consumption and export of spices. The fast growing food industries across the world depends largely on spices as taste and flavour makers to create variation in their product line. Spices are plant based fragrant products that are used to flavour food and beverages. They are a gold mine of natural

bioactive compounds, which can enhance the keeping quality and medicinal value of food. In India spices are grown over an area of 45,17,720 ha with production of 1,04,85,100 tonnes (Anon, 2020). Fennel (*Foeniculum vulgare* Mill.) is one of the most important seed spices cultivated throughout the temperate and sub-tropical countries like Romania, Russia, Germany, France, Italy, India, Japan, Argentina and U.S.A. In India, fennel is mainly cultivated in the states of Gujarat, Rajasthan, Bihar, Punjab, Haryana, Karnataka, Uttar Pradesh and Madhya Pradesh. In Karnataka,

fennel is mainly cultivated in districts of Bangaluru, Gadag, Mysuru, Chikkaballapura, Ramanagara and Mandya, covering an area of 35 ha with production of 79 tonnes (Anon, 2018).

The planting geometry determines the efficiency of moisture and nutrients utilized by plants as well as interception of incident solar radiation. Dense plant population may cause adverse effect on crop in terms of competition among plants for nutrient and moisture, while sparse plant population may not take full advantage of applied nutrients and allow weeds to grow resulting in low production. Thus, maintaining optimum plant population is a primary requirement to get higher yield (Dubey & Lal 1971). The major nutrients like nitrogen, phosphorous and potassium play important role in plant growth and development. Adequate supply of N promotes higher photosynthetic activity and vigorous vegetative growth and as a result, the plants turn into dark green colour. Phosphorus imparts hardness to shoot, improves grain quality, regulates photosynthesis, governs physiochemical processes and help in the enlargement of cell, develop resistance to diseases. Potassium is known to increase the resistance of plants to the moisture stress, heat, diseases caused by fungi, nematodes and other microorganisms. There is wide scope to improve and increase the fennel production and productivity by enhancing its nutritional requirement (Balasubramaniyam & Palaniappan 2005). The productivity of fennel has remained low when compared to its potential yield of 2500 kg ha⁻¹. So, efforts have been made to enhance the productivity of the fennel by adopting suitable agronomic practices *i.e* management of plant population and nutrients input. Proper fertilization and optimum spacing are the most important factors for getting higher yields. In view of the importance of these factors, present investigation was conducted to study the effect of spacing and fertilizer levels on yield, quality and nutrient uptake of fennel.

Materials and methods

The present study was conducted during Rabi 2020-2021 at College of Horticulture, University of Horticultural Sciences, Bagalkot. The experimental site was situated at 16° 10' North latitude, 74° 42' East longitudes and at an altitude of 542 m above the mean sea level (MSL). This domain falls under the northern dry zone of Karnataka (Zone-3). The experiment was delineated in a split plot design with spacing in main plot and fertilizer levels in sub plot replicated thrice with nine treatment combinations. The treatments consist of three spacing levels (S) – S₁: 60 x 20 cm, S₂: 60 x 30 cm and S₃: 60 x 40 cm and three fertilizer levels (F) – F₁: 80:30:20 N, P₂O₅, K₂O kg ha⁻¹, F₂: 90:40:30 N, P₂O₅, K₂O kg ha⁻¹ and F₃: 100:50:40 N, P₂O₅, K₂O kg ha⁻¹ with 15 t FYM ha⁻¹. Nitrogen was applied in three split doses in concerned treatments. Half dose of nitrogen and full dose of phosphorus and potassium were applied as basal dose and remaining half dose of nitrogen was applied as top dressing at 30 and 60 DAS. Variety used was Ajmer fennel-1. Five plants were selected at random and labelled in each plot for recording observations on yield and nutrient uptake. Further, statistical analysis of the data by Panse & Sukathme (1967) was carried out as per the method suggested.

Results and discussion

Yield and quality parameters of fennel

Crops grown under spacing 60 x 30 cm (S₂) produced higher seed yield (Table 1). The maximum essential oil content and essential oil yield was noticed in plants spaced at 60 x 40 cm and it was on par with 60 x 30 cm *i.e*. 0.93 per cent and 15.95 kg ha⁻¹ respectively. The maximum essential oil content of seed under wider spacing could be ascribed due to availability of large space per plant resulting in profuse vegetative growth and delay in attaining reproductive growth. Similar results have been reported by Menaria & Maliwal (2007) in fennel and Naruka *et al.* (2012) in

ajwain. The maximum seed yield, essential oil content and essential oil yield was noticed in plants supplied with 100:50:40 N, P_2O_5 , K_2O kg ha⁻¹ level of fertilizer and it was on par with 90:40:30 N, P_2O_5 , K_2O kg ha⁻¹ i.e. 0.84 per cent and 14.20 kg ha⁻¹. Potassium is described as a quality improvement element in crop production. It indirectly improves utilization of nitrogen and protein formation, fruit size, weight, oil content and colour. The significant improvement in quality parameters due to NPK were in close agreement with findings of Krishnamoorthy & Madalgari (2000); Wahab & Mohamed (2007); Naruka et al. (2012) in ajwain.

Nutrient uptake in fennel

The maximum total uptake of nitrogen, phosphorus and potassium after harvesting was recorded in plants spaced at 60 x 30 cm (S_2) and it was on par with plants spaced at 60 x 40 cm (Table 2). This might be due to higher plant density, higher seed yield which resulted in higher dry matter production and higher nutrient content in seed and stover. These observations agree with the findings of Singh et al. (2010) in isabgol, Joy et al. (2016) in *Curculigo orchoides* & Meena et al. (2017) in chandrasur.

Table 1. Effect of geometry and fertilizer levels on yield, quality parameters of fennel

Treatment	Seed yield (kg ha ⁻¹)	Essential oil content (%)	Essential oil yield (kg ha ⁻¹)
Spacing (S)			
S_1 : 60 x 20 cm	1624.63	0.50	8.12
S_2 : 60 x 30 cm	1714.06	0.93	15.95
S_3 : 60 x 40 cm	1693.91	1.00	16.96
C.D @ 5%	15.10	0.40	6.54
Fertilizer levels (F)			
F_1 : 80:30:20 N, P_2O_5 , K_2O kg ha ⁻¹	1653.32	0.61	10.14
F_2 : 90:40:30 N, P_2O_5 , K_2O kg ha ⁻¹	1683.99	0.84	14.20
F_3 : 100:50:40 N, P_2O_5 , K_2O kg ha ⁻¹	1695.29	0.98	16.69
C.D @ 5%	11.47	0.23	3.81
Interaction (S x F)			
S_1F_1	1618.01	0.40	6.46
S_1F_2	1625.79	0.53	8.66
S_1F_3	1630.09	0.57	9.23
S_2F_1	1669.86	0.67	11.13
S_2F_2	1730.12	0.95	16.43
S_2F_3	1742.21	1.17	20.29
S_3F_1	1672.10	0.77	12.82
S_3F_2	1696.06	1.03	17.51
S_3F_3	1713.56	1.20	20.56
C.D @ 5%	19.86	NS	NS

The maximum total uptake of nitrogen, phosphorus and potassium after harvest was recorded in 100:50:40 N, P₂O₅, K₂O kg ha⁻¹ and was on par with 90:40:30 N, P₂O₅, K₂O kg ha⁻¹. Since the nutrient uptake is a function of its concentration in crop plant and seed and straw yield of the crop, the increase in these parameters due to fertilization led to an increased uptake of nutrient in the present study. These observations agree with the findings of Singh *et al.* (2001), Dadheech & Sumeriya (2004) in isabgol and Anwar *et al.* (2005) in French basil and Wankhade *et al.* (2005) in musk mallow.

Conclusion

It may be concluded that fennel planted at 60 x 30 cm spacing has recorded highest seed yield and nutrient uptake. Application of 100:50:40 kg N, P₂O₅, K₂O kg ha⁻¹ and 90:40:30 kg N, P₂O₅, K₂O kg ha⁻¹ of fertilizers are at par with each other with respect to seed yield, quality and nutrient uptake.

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