Indian J. Hort. 67(4), December 2010: 518-524

Effect of date of sowing and nitrogen levels on growth, yield and quality of fennel

Sanjeet Bagari, P.P. Singh*, I.S. Naruka, S.S. Rathore and R.P.S. Shaktawat
Department of Plantation and Spice Crops, College of Horticulture,
Mandsaur 458 001, Madhya Pradesh

ABSTRACT

An experiment was conducted during *rabi* season of 2008-09 to study the effect of date of sowing and nitrogen on the productivity and quality of fennel. The experiment consisting of 3 dates of sowing (15th September, 30th September and 15th October) and 4 levels of nitrogen (0, 60, 80 and 100 kg N ha^{-1}) was laid in factorial randomize block design. Early sowing *i.e.,* 15th September recorded significantly highest seed yield and yield attributes of fennel compared with late sown conditions. Similarly, application of 100 kg N/ha significantly increased the growth, yield attributes and yield of fennel compared with lower nitrogen levels. Sowing on 15th September + 100 kg N/ha (D_1N_4) resulted in the maximum net profit of Rs. 86,369 ha^{-1} with a B:C ratio of 7.14:1.

Key words: Fennel, growth, nitrogen, spacing, quality, yield.

INTRODUCTION

Fennel is cultivated in India in about 41.02 thousand ha area with the production of 61.49 thousand tonnes and productivity of 1,499 kg/ ha. India exports around 5,250 tonnes of fennel (worth Rs. 2,850 lakhs 2007-2008, Spices Board). Fennel seed is small, oblong or cylindrical, 6-8 mm. long straight or slightly curved yellowish brown. It possesses an agreeable, aromatic and sweet aroma. It is mainly valued for the aroma the aromatic, volatile oil *viz.,* anethole (50.03%) and fenchone (2.67%). The seed contains about 0.7 to 1.2 % volatile oil. The oil is widely used as flavouring agent in culinary preparations of confectioneries, cordials and liquors. Fennel oil is also used as important ingredients in several Allopathic as well as Ayurvedic medicines which are used in diseases *viz.,* cholera, bile disturbances, nervous disorder, constipation, dysentery and diorohoea. Fennel seeds are also used for pickles, meat dishes, sauces, pastries etc.

Date of sowing is an important non-monitory input which play important role in deciding growth and yield of crop. All the physiological processes in the plants other than photochemical depend on temperature modifications in environment by sowing dates, gave a great opportunity of getting optimum temperature at the time of germination and at subsequent growth stages to maximize the production. Fennel thrives well on drained loamy clay soil, which is rich in plant nutrients and lime. However, heavy soils are more desirable than light soils. Evidences show that out of all the major plant nutrients found in various Indian soils, nitrogen is the most deficient element especially in light black loamy soil. Availability of nitrogen is of prime importance for growing plants, as it is a major and indispensable constituent of proteins and nucleic acid molecules. It is an integral part of chlorophyll molecules, which are responsible for photosynthesis. An adequate supply of nitrogen is associated with vigorous vegetative and more efficient use of available inputs finally leading to higher productivity. Keeping in view this, an experiment has been undertaken.

*Corresponding author's E-mail: drppsingh21@rediffmail.com

MATERIALS AND METHODS

The experiment was undertaken to study effect of date of sowing and nitrogen on productivity and quality of fennel at the experimental Farm, College of Horticulture, Mandsaur, Madhya Pradesh using fennel cultivar NRCSS-AF-1 during *rabi* season of 2008-09. Treatment consisting of three dates of sowing *i.e.,* 15 September, 30 September and 15 October with four levels nitrogen *i.e.*, 0, 60, 80 and 100 kg N/ha. The experiment was conducted in split plot design keeping date of sowing in main plot and nitrogen level in subplot, replicated four times and recommended practices were undertaken. The experimental soil was light black loamy in texture with 7.1 pH and 0.24 dS/m EC having low available of nitrogen (140.0 kgha^{-1}), medium in available phosphorus (21.0 kgha^{-1}) and low in available potassium (144.0 kgha^{-1}). The crop was sown on 16 September, 2008 and harvested on 25 February, 2009. Economics of various treatments was calculated using the prevailing market prices of the fennel crop.

Two grams soil sample was taken in a distillation flask and added 2 ml of distilled water, 20 ml of 0.32% $KMnO_4$ solution, 20 ml of 2.5% sodium hydroxide solution and immediately fit it up in the distillation apparatus then pipetted out 20 ml of 0.02 N boric acid in a conical flask and one drop of methyl red indicator and dip the end of the delivery tube in it. Distillate solutions, titrated with 0.1N HCl. Two grams soil sample was taken in flask with 20 ml of 0.5N $NaHCO_3$ and a pinch of Darco-G.60, shake the mixture for 10 min. and filtered. Five ml of ammonium molybdate solution and 1 ml $SnCl_2$ solution were added. The blue colour was read with spectrophotometer at 640 nm and calculated P in the soil from the standard curve.

Two grams soil sample was taken in a test tube and 10 ml Morgan's reagent was added in it, shake it for 5 min. and filtered with filter paper. Filtrate solution was taken in 100 ml of conical flask to the volume of 100 ml. K concentration was estimated in the filtrate using flame photometer.

RESUTS AND DISCUSSION

The maximum plant height, fresh and dry weight, number of primary, secondary and tertiary branches per plant were recorded under 15 September sowing and minimum in 15 October sown crop. However, the plant height at 30 September and 15 October sown crop were at par. This may be due to the fact that delay sowing could not have sufficient time for vegetative growth, resulted in poor plant canopy which adversely affected the plant height, fresh and dry weight, number of primary, secondary and tertiary branches. These results are in the agreement with Mohan *et al.* (9), and Baruah (3).

The maximum days taken to 50% flowering, number of primary, secondary and tertiary umbels, number of umbellets per umbel were recorded in 15 September sowing and minimum days taken to 50% flowering in 15 October sown crop. However, the days taken to 50% flowering per plant at 30 September and 15 October sown crop were at par. These variation in occurrence of flowering may be ascribed to the weather conditions particularly temperature within different date of sowing. Similar findings were also mode by Mohan e*t al.* (9), and Singh and Randhawa (15). Batra *et al.* (4) also reported that minimum number of umbellets per umbel in the late sown crop may be due to of less time available for growth and development. Similarly, dry weight of umbel, number of seeds per umbel and 1000-seed weight of fennel were higher in case of 15 September sown crop and minimum in 15 October sowing. The maximum umbel dry weight, Number of seed per umbels were observed during 15 September sowing which was at par with 30 September sown crop but significantly reduced as sowing was delayed.

The maximum seed yield and straw yield were recorded in 15 September sown crop followed by 30 September sowing. The lowest yield was recorded 15 October sown crop. The yield was reduced during the later sowing dates as the plants did not have sufficient time for vegetative growth and entered the reproductive phase thus forcing maturity due to high temperature during seed development. The present results are in close agreement with the findings of Baruah (3), Batra *et al.* (4), and Mohan *et al.* (9).

The maximum chlorophyll, carotenoids contents in leaves, volatile oil in seed, nitrogen, phosphorus and potassium content seed and stover were recorded in 15th September sowing and minimum in 15 October sown crop. However, the chlorophyll, carotenoids contents in leaves, volatile oil in seed, nitrogen, phosphorus and potassium content seed and stover at 30th September and 15th October sown crop were at par. This may be due to fact that delay in sowing could not have sufficient time for vegetative growth and development resulted in poor plant canopy which adversely affected all the quality parameters.

The maximum plant height, fresh and dry weight of plant, number of primary, secondary and tertiary branches per plant was recorded in 100 kg N ha^{-1} and minimum in control. However, plant height, fresh and dry weight of plant, number of primary, secondary and tertiary branches per plant were at par with each other at lower levels. An adequate supply of nitrogen is associated with higher photosynthetic activity leading to vigorous vegetative growth and physiologically more stout and healthy plant morphology. The results of the present investigations are in close agreement with the findings of Rai *et al.* (11), Randhawa *et al.* (14), and Hans Raj and Thakral (12).

The maximum number of days taken to 50% flowering was recorded in application of 100 kg N/ ha treatment to fennel. The maximum number of primary, secondary and tertiary umbels per plant, number of umbellets per umbel, umbel dry weight, number of seeds per primary umbel and 1000-seed weight was recorded in 100 kg N/ha and minimum number of primary, secondary and tertiary umbels per plant, number of umbellets per umbels in control. However, the number of primary, secondary and tertiary umbel per plant, umbel dry weight, number seeds per primary umbel and 1000-seed weight at 80 and 60 kg N/ha were at par. An adequate supply of nitrogen is associated with higher photosynthetic activity and vigorous vegetative growth is found as a result, the plant turn into dark green colour with early growth delayed maturity of plant. The results of the present investigations are in close agreement with the findings of Raj and Thakral (12), Bhati (5), and Patel *et al.* (10).

Table 1. Effect of date of sowing and nitrogen levels on vegetative growth of fennel.

Treatment	Plant height (cm)			Fresh weight (g / plant)			Dry weight (g / plant)			Branches / plant			Days to 50% flowering
	60 DAS	90 DAS	Harvest	60 DAS	90 DAS	Harvest	60 DAS	90 DAS	Harvest	Primary	Secondary	Tertiary	
Date of sowing													
15 September	38.53	107.90	201.67	30.68	127.13	216.06	3.72	17.66	110.56	3.15	13.90	14.78	99.93
30 September	34.64	97.92	192.98	27.68	118.16	209.66	3.17	15.54	107.06	2.76	12.48	12.53	96.25
15 October	32.48	94.10	187.22	25.90	113.78	200.06	2.81	14.11	104.47	2.50	11.19	11.57	92.81
CD (P = 0.01)	2.091	2.554	4.922	0.568	2.963	2.162	0.299	0.411	2.287	0.173	0.571	0.955	1.146
Nitrogen (N kg/ha)													
Control	32.30	93.86	186.33	24.51	111.76	201.50	2.45	13.26	101.70	2.39	10.83	11.22	95.83
60	34.33	97.81	192.48	26.96	117.98	205.67	2.90	15.61	105.33	2.60	12.13	12.42	96.08
80	35.85	101.75	196.40	29.11	121.63	211.38	3.57	16.53	109.75	2.95	13.12	13.60	96.41
100	38.38	106.75	200.40	31.75	127.38	215.88	4.03	17.68	112.67	3.27	14.02	14.58	97.00
CD (P = 0.05)	1.81	2.01	3.70	1.94	3.57	3.97	0.38	0.89	2.23	0.28	0.87	0.87	NS

Table 2. Effect of date of sowing and nitrogen levels on yield and yield attributes of fennel.

Treatment	No of umbels/plant			No of umblets / umbel			Umbel dry weight (g)	No of seeds per primary umbel	1000-seed weight (g)	Seed yield (kg/ha)	Straw yield (kg/ ha)	Harvest index (%)
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary						
Date of sowing												
15 September	3.48	14.44	12.48	39.59	30.63	13.46	8.68	931.36	8.70	1867	2978	38.88
30 September	3.11	13.19	11.13	36.30	28.49	12.67	7.48	889.67	8.08	1767	2747	37.60
15 October	2.80	12.78	10.32	34.23	27.12	11.96	6.67	845.50	7.52	1455	2324	35.47
CD (P = 0.05)	0.30	1.29	0.81	1.42	0.77	0.62	1.03	35.21	0.41	30.4	96.6	1.44
Nitrogen (N kg/ha)												
Control	2.58	11.28	8.70	32.72	26.30	10.76	5.60	827.13	7.12	1573	2243	39.96
60	3.05	12.84	10.64	35.11	27.67	11.73	6.60	871.70	7.80	1674	2499	38.09
80	3.38	14.19	12.24	38.42	29.13	13.45	8.27	909.66	8.48	1727	2870	36.34
100	3.51	15.00	13.65	40.58	31.89	14.86	9.93	946.89	9.00	1798	3119	34.87
CD (P = 0.05)	0.33	1.22	1.05	1.20	1.17	0.85	1.01	36.28	0.45	0.38	1.42	1.31

Table 3. Effect of date of sowing and nitrogen levels on growth, oil content and nutrient uptake in fennel.

Treatment	Chlorophyll content (mg/g leaf)		Carotenoids content (mg/g leaf)		Volatile oil (ml/100 g seed)	Uptake by seed (kg/ha)			Uptake by stover (kg/ha)			Available nutrient in soil (kg/ha)		
	60 DAS	90 DAS	60 DAS	90 DAS		N	P	K	N	P	K	N	P	K
Date of sowing														
15 September	1.66	1.78	0.85	0.89	1.35	45.29	22.01	129.40	31.14	10.05	102.00	172.03	9.20	331.56
30 September	1.24	1.33	0.59	0.65	1.20	43.28	20.78	129.41	26.85	9.44	97.10	172.18	9.38	332.09
15 October	1.08	1.22	0.46	0.57	0.89	38.08	19.56	125.50	21.76	8.03	94.25	173.34	9.44	332.75
CD (P = 0.05)	1.07	0.11	0.04	0.02	0.20	1.26	NS	NS	2.43	NS	NS	NS	NS	NS
Nitrogen (N kg/ha)														
Control	1.07	1.28	0.44	0.57	0.98	24.73	16.43	116.80	19.38	7.82	94.08	168.37	8.94	330.16
60	1.25	1.36	0.62	0.67	1.11	42.28	20.56	116.93	25.60	8.70	96.92	171.41	9.07	331.83
80	1.43	1.53	0.69	0.74	1.22	49.60	22.36	135.85	29.60	9.60	98.93	174.37	9.66	332.88
100	1.55	1.66	0.77	0.83	1.34	52.27	23.78	142.86	31.68	10.59	101.23	175.91	9.69	333.66
CD (P = 0.05)	0.10	0.11	0.05	0.03	0.21	1.43	NS	NS	2.45	NS	NS	1.73	NS	NS

Table 4. Benefit : cost ratio of different treatment combinations on fennel.

Treatment ombination	Yield (q/ha)	Cost of cultivation (Rs./ha)	Gross return ha^{-1} @ Rs. 5000/q	Net profit (Rs./ha)	Benefit: cost ratio
D_1N_1	17.56	11,576	87,800	76,224	6.58:1
D_1N_2	18.44	11,879	92,200	80321	6.76:1
D_1N_3	19.00	11,980	95,000	83,020	6.92:1
D_1N_4	19.69	12,081	98,450	86,369	7.14:1
D_2N_1	16.92	11,576	84,600	73,024	6.30:1
D_2N_2	17.15	11,879	85,750	73,871	6.21:1
D_2N_3	17.78	11,980	88,900	76,920	6.42:1
D_2N_4	18.48	12,081	92,400	80,319	6.64:1
D_3N_1	12.73	11,576	63,650	52,074	4.49:1
D_3N_2	14.66	11,879	73,300	61,421	5.17:1
D_3N_3	15.05	11,980	75,250	63,270	5.12:1
D_3N_4	15.77	12,081	78,850	66,769	5.52:1

The maximum seed and straw yield (q ha^{-1}) were recorded in 100 kg N ha^{-1} followed by 80 kg N ha^{-1} and the lowest in control. The increase in seed yield might be due to increased availability of nitrogen accelerating the photosynthetic rate which results in more production of carbohydrates. The increase in straw yield was due to positive response of nitrogen being a major structural element of cell and helping in cell division and cell elongation, which in turn increase growth parameters and lead to higher yields attributes and yield. The resulted are in agreement with those of Bhati (5), Amin (1), and Amin *et al.* (2).

The maximum chlorophyll, carotenoids contents in leaves, volatile oil content in seed were recorded in 100 kg N ha^{-1} and minimum in control. However, the chlorophyll, carotenoids contents in leaves, volatile oil in seed increased at 80 and 60 kg N ha^{-1} which were at par with 100 kg N ha^{-1}. This may be due to the fact that application of higher dose of nitrogen researching in higher vegetative growth, development and quality improvement. The present results are in close agreements with the findings of Randhawa *et al.* (14), Khan *et al.* (2), and Ram Pratap *et al*. (13).

The maximum available nitrogen, phosphorus and potassium in soil after harvest of fennel was found in treatment 100 kg N ha^{-1} and minimum were found in control. In general, overall improvement in crop growth under balanced nutrition involving combination of nutrients *viz.,* NPK seems to be on account of their potential role in modifying soil and micro-environment conducive for plant growth and development leading to yield improvement. This finding is also in agreement with Bhunia *et al.* (6), Kumar *et al.* (8), and Ram Pratap *et al*. (13).

The highest uptake of nitrogen, phosphorus and potassium by seed and stover of fennel was recorded when application of higher dose of nitrogen and minimum uptake when lowest nitrogen of the soil. Nutrient uptake is the function of nutrient concentration and higher yield and more nutrient concentration might have resulted in increased nutrient uptake by these higher doses of nitrogen Bhunia *et al.* (6), Kumar *et al.* (8), and Ram Pratap *et al.* (13).

Benefit: cost ratio of different treatment combinations clearly reveals that 15 September sowing + 100 kg N/ha (D_1N_4) resulted in maximum net profit of Rs. 86,369 ha^{-1} with a B:C ratio of 7.14 :1. Whereas, the maximum B:C ratio (6.92:1) was recorded with the treatment combination of 15 October + control (D_1N_3) with a net profit of Rs. 83,020 ha^{-1}. Although, the maximum yield/ha was recorded under 15 September sowing +100 kg N/ha (D_1N_4) but B : C ratio was lower as compared to 15 October + control (D_3N_1) and followed by 30 September sowing + 100 Kg N/ha (D_2N_4) due to the additional cost of nitrogen. Thus, the treatment combination 15 September sowing + 100 kg N ha^{-1} (D_1N_4) was the best for fennel production.

REFERENCES

1. Amin, A.U. 2005. Response of fennel (*Foeniculum vulgare* Mill.) to irrigation and fertility levels under North Gujarat condition. *Agric. Sci. Digest*, **25**: 41-43.

2. Amin, A.U., Singh, Ajay, Patel, B.S. and Patel, J.K. 2005. Effect of various row spacings and nitrogen levels on drilled rabi fennel (*Foeniculum vulgare* Mill.). *Agric. Sci. Digest,* **25**: 44-46.

3. Baruah, G.K.S. 2001. Effect of sowing dates and plant spacing on growth and seed yield of fennel in hills of Assam. *Hort. J.* **14**: 85-89.

4. Batra, V.K., Mohan, V.P., Thakral, K.K. and Bhatia, A.K. 2002. Seed yield and quality of fennel as influenced by date of sowing and seed rate. *Haryana J. Horti Sci.* **31**: 111-13.

5. Bhati, D.S. 1990. Effect of stage of umbel picking and nitrogen fertilization on fennel (*Foeniculum vulgare* Mill.). *Indian J. Agron.* **35**: 375-79.

6. Bhunia, S.R., Chauhan, R.P.S. and Yadav, B.S. 2005. Effect of nitrogen and irrigation on water use, moisture-extraction pattern, nutrient uptake and yield of fennel (*Foeniculum vulgare*). *Indian J. Agron.* **50**: 73-76.

7. Khan, M.M.A., Samiullah, Afaq, S.H. and Afridi, M.M.R.K. 1992. Yield and quality of fennel (*Foeniculum vulgare* Mill.) in relation to basal and foliar application of nitrogen and phosphorus. *J. Plant Nutri.* **11**: 2505-15.

8. Kumar, Ashok., Singh, Ranbir and Chhillar, R.K. 2006. Nitrogen requirement of fennel (*Foeniculum vulgare*) based cropping systems. *Indian J. Agri. Sci.* **76**: 599-602.

9. Mohan, V.P., Batra, V.K. and Thakral, K.K. 2001. Response of sowing dates and seed rate on growth and yield of fennel. *Haryana J. Hort. Sci.* **30**: 271-73.

10. Patel, B.S., Patel, K.P., Patel, I.D. and Patel, M.I. 2000. Response of fennel (*Foeniculum vulgare*) to irrigation, nitrogen and phosphorus. *Indian J. Agron.* **45**: 429-32.

11. Rai, S.K., Katiyar, R.S. and Singh, S.P. 2002. Effect of nitrogen and phosphorus on the growth and yield of *Foeniculum vulgare* on the sodic soil. *J. Med. Arom. Pl. Sci.* **24**: 65-67.

12. Raj, Hans and Thakral, K.K. 2008. Effect of chemical fertilizers on growth, yield and quality of fennel (*Foeniculum vulgare* Mill). *J. Spices Arom. Crops*, **17**: 134-39.

13. Ram Pratap, Meena, N.L. and Yadav, G.L. 2004. Effect of nitrogen and sulphur on yield, quality and nutrient uptake by fennel (*Foeniculum vulgare* Mill.). *Haryana J. Hort. Sci.* **33**: 276-77.

14. Randhawa, G.S., Bains, D.S. and Mahajan, V.P. 1981. Seed and oil yield of fennel as influenced by sowing time and the levels of nitrogen. *J. Res. Punjab Agric. Uni.* **18**: 244-47.

15. Singh, A. and Randhawa, G.S. 1991. Influence of agronomical practices on yield of dill (*Anethum gravelens* L.) *J. Res. Punjab Agric. Uni.* **28**: 179-87.

16. Spices Board (2007). State/Spice wise area and production of spices, India. www. Indianspices.com.

Received: June, 2010; Revised: August, 2010;
Accecpted : September, 2010