

Effect of chemical fertilizers on growth, yield and quality of fennel (*Foeniculum vulgare* Miller)

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Abstract

A field experiment was conducted to study the effect of nitrogen (N), phosphorus (P) and potash (K) on growth, seed yield and quality of fennel at the vegetable research farm, Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar during 2002-2003 and 2003-2004. The experiment consisted of 16 treatment combinations with four levels each of N (25, 50, 75&100 kg ha⁻¹), P (25&50 kg ha⁻¹) and K (25&50 kg ha⁻¹). The experiment was laid out in randomized block design with three replications. The results revealed significant differences in growth and yield parameters among the treatments. Application of N at 100 kg ha⁻¹, P at 50 kg ha⁻¹ and K at 50 kg ha⁻¹ recorded the maximum values of plant height, flowering, umbels per plant and umbellets per umbel, while seeds per umbel, seed yield (q ha⁻¹) and harvest index was found maximum at 75 kg nitrogen, 50 kg phosphorus and 50 kg potash per hectare. However a dose of 75 kg N, 50 kg P₂O₅ and 25 kg K₂O per hectare was found economical.

Keywords: Fennel, *Foeniculum vulgare*, nitrogen, phosphorus, potash.

Introduction

Fennel (*Foeniculum vulgare* Miller) is one of the four most important seed spice cultivated throughout the temperate and sub-tropical regions of the world for its aromatic seeds which are used for culinary purpose. In India, it is mainly cultivated in the states of Gujarat and Rajasthan and to some extent in Uttar Pradesh, Bihar, Madhya Pradesh, Punjab and Haryana. It is cultivated in an area of 19.81 thousand hectare with a production of 28.20 thousand tonnes in 2000-2001 (Tiwari and Agarwal 2004). Although this crop has a number of industrial and medicinal uses, it is not grown commercially, but is mostly raised in kitchen- gardens to

meet the domestic needs. This restricted cultivation is possibly due to the lack of information on the cultural requirements for this crop coupled with poor marketing facilities. Fennel responds well to fertilizers but very little information is available on the use of fertilizers specially under Haryana conditions. Therefore, keeping in view, the importance of this crop, an experiment was conducted to study the effect of fertilizers on growth, yield and quality of fennel.

Material and methods

The experiment was conducted to study the effect of nitrogen (N), phosphorus (P) and potash (K) on growth, yield and quality of fennel at the Vegetable Research Farm,

Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar during 2002-2003 and 2003-2004. The soil of experimental field was uniform in fertility, sandy loam in texture, low in organic carbon, medium in available P and high in K with slightly alkaline reaction. The experiment consisted of 16 treatment combinations with four levels each of N (25, 50, 75&100 kg ha⁻¹), P (25&50 kg ha⁻¹) and K (25&50 kg ha⁻¹). The experiment was laid out in randomized block design with three replications. The N was applied in the form of calcium ammonium nitrate, P in the form of single super phosphate and K in the form of muriate of potash. Fennel variety HF-33 (Hisar Swarup) was sown on 15th October at spacing of 30x20 cm during both the years. Other cultural operations and plant protection measures were applied as per package of practices. Observations were recorded on plant height, branches per plant, days taken to flowering, umbels per plant, umbellets per umbel, seeds per umbellet, seeds per umbel, biological and seed yield. The Harvest index was calculated using the following formula:

Economic yield

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Results and discussion

Growth Parameters

The data on plant height upto main umbel, number of primary branches and days taken to 50 per cent and complete flowering are presented in Table-1. Plant height and number of primary branches increased linearly with increasing levels of N and P. However, the increase was more pronounced in case of N than in case of P. maximum plant height was recorded with 100 kg N/ha and smallest plants were found with the application of 25 kg N/ha. The highest N dose i.e., 100 kg/ha produced significantly more number of branches per plant but was at par with 75 kg N/ha during both the years. In case of P, 50 kg P₂O₅/ha proved superior to 25 kg P₂O₅/ha, while K had no effect on plant height and number of branches during any of the years. An adequate supply of nitrogen is associated with high photosynthetic

Table1. Effect of fertilizers on plant height, number of branches, days taken to 50 percent and 100 percent plants to flower in fennel (mean of two years)

Treatments	Plant height(cm)	Branches per plant	50% flowering	Complete flowering
Nitrogen (kg N/ha)				
25	136.4	7.2	116.2	126.5
50	143.5	7.9	120.9	131.0
75	149.4	8.4	123.4	134.6
100	160.9	8.5	125.9	136.8
C.D. at 5%	3.3	0.6	1.4	1.6
Phosphorus (kg P ₂ O ₅ /ha)				
25	146.3	7.6	120.3	131.3
50	148.8	8.4	123.0	133.2
C.D. at 5%	2.1	0.4	1.0	1.2
Potash (kg K ₂ O /ha)				
25	147.0	7.8	121.3	131.9
50	148.1	8.1	121.9	132.6
Mean difference	NS	NS	NS	NS

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 Randhawa *et al.* (1978) who reported increased plant height and number of branches with increasing dose of N in seed crop of fennel. However, Ughreja and Chundawat (1992) recorded maximum plant height and branches with higher N and P levels in coriander. Days taken to bloom is decided by C: N ratio. The plants tend to bloom earlier with higher C: N ratio. The data in Table-1 indicated that each N increment from 25 to 100 kg N/ha significantly delayed flowering in fennel. It took 125.9 & 136.8 days for 50 and 100 per cent flowering in the treatment of 100 kg N/ha respectively. Delayed flowering was also found with increase in dose of P from 25 to 50 kg P₂O₅/ha. However, K did not influence the days taken to flowering during both the years.

Yield Parameters

N, P and K have been reported to have great impact on the seed yield and seed production

in fennel (Bhat and Sulikeri 1992; Tomar *et al.* 1994). The number of umbels per plant and umbellets per umbel as affected by fertilizers are presented in Table-2. N at the rate of 100 kg/ha produced significantly higher number of primary, secondary and tertiary umbels per plant as well as umbellets per umbel in main, primary and secondary umbels which were found statistically at par with 75 kg N/ha. Increase in dose of P from 25 to 50 kg/ha significantly improved the number of primary, secondary & tertiary umbels per plant and number of umbellets in main, primary as well as secondary umbels. K had no effect on the number of umbels and umbellets per umbel during any of the year. As regard the number of seeds per umbellet and seeds per umbel, N at 75 kg/ha produced significant more number of seeds per umbellet and number of seeds per umbel in main, primary & secondary umbel as compared to the remaining three doses of N in all the umbel order (Table-3). The plots which received 50 kg P₂O₅/ha produced more seeds per umbellet as well as seeds per umbel than 25 kg P₂O₅/

Table 2. Effect of fertilizers on number of umbels per plant and umbellets per umbel in fennel (mean of two years)

Treatments	Umbels per plant			Umbellets per umbel		
	Primary umbel	Secondary umbel	Tertiary umbel	Primary umbel	Secondary umbel	Tertiary umbel
Nitrogen (kg N/ha)						
25	6.6	17.2	6.5	24.9	22.7	21.5
50	7.1	18.0	7.5	25.1	23.5	22.2
75	7.7	18.8	8.3	26.7	25.7	23.6
100	7.8	18.8	8.3	26.8	25.9	24.0
C.D. at 5%	0.6	0.7	0.7	1.4	2.2	2.4
Phosphorus (kg P ₂ O ₅ /ha)						
25	7.1	17.1	7.0	24.6	22.7	21.5
50	7.6	19.3	8.3	27.2	26.1	24.1
C.D. at 5%	0.4	0.5	0.5	1.1	1.5	1.6
Potash (kg K ₂ O /ha)						
25	7.2	18.0	7.5	25.4	23.8	22.5
50	7.4	18.4	7.8	26.3	25.1	23.1
Mean Difference	NS	NS	NS	NS	NS	NS

Table 3. Effect of fertilizers on seeds per umbellet and seeds per umbel in fennel (mean of two years)

Treatments	Seeds per umbellet			Seeds per umbel		
	Main umbel	Primary umbel	Secondary umbel	Main umbel	Primary umbel	Secondary umbel
Nitrogen (kg N/ha)						
25	10.4	9.7	8.3	256.6	218.2	176.2
50	11.0	10.2	9.2	271.8	237.4	195.9
75	11.7	10.9	10.1	310.2	277.2	237.4
100	10.0	8.9	8.1	265.4	227.7	181.7
C.D. at 5%	0.9	0.9	1.0	27.1	34.4	26.8
Phosphorus (kg P ₂ O ₅ /ha)						
25	10.1	9.4	8.3	245.4	211.2	170.5
50	11.4	10.4	9.3	306.5	268.7	224.8
C.D. at 5%	0.6	0.7	0.7	19.2	24.3	19.0
Potash (kg K ₂ O /ha)						
25	10.5	9.7	8.6	263.7	227.4	187.2
50	11.0	10.1	9.0	288.2	253.4	208.2
Mean Difference	NS	NS	NS	19.2	24.3	19.0

ha. K had no significant effect on number of seeds per umbellet during both the years. The number of seeds obtained from main, primary and secondary umbels was significantly higher at 50 kg K₂O/ha than its lower dose of 25 kg K₂O/ha during both the years of experimentation.

The data on biological yield and seed yield (Table-4) revealed that increasing the level of N and P significantly influenced the biomass of fennel and seed yield (q/ha). The application of 100 kg N and 50 kg P₂O₅/ha recorded significantly higher biomass than their lower doses. K application did not influence the biological yield during any of the year. As regards the seed yield, N at 75 kg/ha yielded 18.2 & 19.4 q/ha during 2002-2003 and 2003-2004, respectively which was significantly higher than other three doses of N. Regarding P, 50 kg P₂O₅/ha yielded significantly higher than 25 kg P₂O₅/ha but K had no effect on seed yield. The positive influence of N and P fertilization is due to improved nutritional environment both in root zone and the plant system. A good supply

of phosphorus is associated with increased root growth and greater straw strength. Due to these reasons, higher N as well as P increased the yield attributing characters like umbels per plant, umbellets per umbel, seeds per umbellet, seeds per umbel and finally seed yield of fennel. Patel *et al.* (2000) and Kumar *et al.* (2002) also reported increase in the number of umbels per plant, umbellets per umbel, seeds per umbellet, seeds per umbel and yield with higher N and P doses.

The harvest index was found maximum with the application of 75 kg N/ha (22.3 & 22.6% during 2002-2003 and 2003-2004, respectively) and 50 kg P₂O₅/ha (21.8 and 22.7%). However, N at 75 kg/ha was found at par with 50 kg N/ha and superior to 25 and 100 kg N/ha while P at 50 kg P₂O₅/ha was superior to its lower dose of 25 kg P₂O₅/ha during both the years. K had no effect on harvest index of fennel. The harvest index of fennel increased upto 75 kg N/ha and reduced at 100 kg N/ha because of continuous increase in biological yield and reduction in seed yield during both the years.

Table 4. Effect of fertilizers on biological yield, seed yield (q/ha) and harvest Index (%) in fennel

Treatments	Biological yield q/ha)			Seed yield (q/ha)			Harvest Index (%)		
	2002-2003	2003-2004	Mean	2002-2003	2003-2004	Mean	2002-2003	2003-2004	Mean
Nitrogen (kg N/ha)									
25	70.7	75.9	73.3	15.1	16.8	16.0	21.4	22.1	21.8
50	75.8	79.8	77.8	16.8	17.9	17.3	22.1	22.4	22.3
75	81.6	85.8	83.7	18.2	19.4	18.8	22.3	22.6	22.5
100	98.4	99.9	99.2	15.4	17.1	16.3	15.6	17.1	16.4
C.D. at 5%	2.8	2.1	--	1.2	1.3	--	0.7	0.7	--
Phosphorus (kg P ₂ O ₅ /ha)									
25	80.5	84.4	82.4	14.7	16.0	15.4	18.3	19.0	18.7
50	82.8	86.3	84.5	18.1	19.6	18.8	21.8	22.7	22.3
C.D. at 5%	1.9	1.4	--	0.8	0.9	--	0.5	0.5	--
Potash (kg K ₂ O /ha)									
25	80.8	84.8	82.8	16.3	17.8	17.0	20.2	21.0	20.6
50	82.5	85.9	84.2	16.4	17.8	17.1	19.9	20.7	20.3
Mean Difference	NS	NS	--	NS	NS	--	NS	NS	--

Quality Parameters:

The data pertaining to 1000 seed weight (g) of main, primary and secondary umbels, seed germination(%) and vigour Index-I are

presented in Table-5. N, P and K did not influence the test weight of main umbel, while in case of primary umbel, highest dose of N (100 kg/ha) produced maximum test weight

Table 5. Effect of fertilizers on Test Weight (g), Seed germination (%) and Vigour Index in fennel

Treatments	Test Weight (g)			Seed germination (%)			Vigour Index		
	Main umbel	Pri. umbel	Sec. umbel	Main umbel	Pri. umbel	Sec. umbel	Main umbel	Pri. umbel	Sec. umbel
Nitrogen (kg N/ha)									
25	7.3	6.1	5.1	90.6	88.6	85.4	1096.1	999.1	818.2
50	7.4	6.9	5.3	91.0	89.1	86.5	1295.0	1060.2	884.5
75	7.6	7.0	5.5	91.6	89.4	87.1	1465.5	1202.6	1017.6
100	7.7	7.1	6.1	92.9	90.5	88.5	1530.4	1331.3	1144.3
C.D. at 5%	NS	0.3	0.3	NS	NS	NS	65.3	59.4	47.6
Phosphorus (kg P ₂ O ₅ /ha)									
25	7.5	6.3	5.1	90.6	88.8	86.6	1225.5	1048.3	846.5
50	7.6	7.3	5.9	92.4	90.0	87.1	1468.1	1248.3	1185.7
C.D. at 5%	NS	0.2	0.2	NS	NS	NS	46.0	41.8	33.5
Potash (kg K ₂ O /ha)									
25	7.4	6.5	5.3	90.7	89.0	86.3	1272.6	1090.4	925.0
50	7.7	7.0	5.7	92.4	89.9	87.4	1421.0	1206.2	1007.2
Mean Difference	NS	0.2	0.2	NS	NS	NS	46.0	41.8	33.5

which was found to be significantly higher than 25 kg N/ha and statistically at par with 50 and 75 kg N/ha, but in case of secondary umbel 100 kg N/ha produced significantly higher test weight as compared to the remaining three doses during both the years. P and K application at 50 kg/ha had also significantly higher test weight of seed than its lower dose of 25 kg/ha of primary and secondary umbel during both the years. As regards the germination percentage, none of the treatments influenced the seed germination percentage of different order umbels. Increased test weight with higher N and P has also been reported by Patel et al. (2000) in fennel. Regarding seed vigour index, the data indicated that each increment of N, P and K increased significantly seed vigour index for the umbels of all the three orders. Higher dose of N at 100 kg/ha produced significantly more vigorous seedlings which were superior to 25, 50 and 75 kg N/ha. K and K each at 50 kg/ha recorded significantly more vigour index than its lower dose of 25 kg/ha.

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