

Development of fertilizer recommendation for Fennel in the Grey Terrace soil of Level Barind Tract

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ABSTRACT

A field experiment was conducted to find out an optimum dose of N, P, K and S for yield maximization of fennel during the rabi season of 2011-2012 and 2012-2013 at Spices Research Center (SRC), Bangladesh Agricultural Research Institute, Shibganj, Bogra. Treatments comprising four levels of N (0, 30, 60, 90 kg ha⁻¹), P (0, 10, 20, 30 kg ha⁻¹), K (0, 25, 50, 75 kg ha⁻¹) and S (0, 5, 10, 15 kg ha⁻¹) was arranged in a randomized complete block design with three replications. The combined effect of NPKS significantly increased yield and yield attributes of fennel. The highest seed yield of 1804 kg ha⁻¹ during 2011-2012 and 1569 kg ha⁻¹ during 2012-2013 was obtained from T₃ (N₆₀ P₃₀ K₅₀ S₁₀ kg ha⁻¹). From the regression analysis, it can be concluded that around 50 kg nitrogen, 15 kg phosphorous, 50 kg potassium and 10 kg sulphur per hectare of land was found optimum for fennel production in terrace soil of level Barind tract, Bogra.

Introduction

Fennel (*Foeniculume vulgare*) is a minor spices crop in Bangladesh and is cultivated throughout the country in winter season. The plants are pleasantly aromatic; leaves are used in fish sauce and garnishing; leaf stalks are used in salad. Dried fruits of fennel have a fragrant odour and a pleasant aromatic taste. In Bangladesh and neighboring country seeds are used for flavoring soaps, meat dishes and sauces, bread rolls, pastries and confectionery, liquors and in the manufacture of pickles. It is the important part of three-spices-mix 'Thuna paha' in Srilanka and five-spices-mix 'Panch phoron' in India-Bangladesh (Takeda et. al., 2008). It has some medicinal value. The fruits are aromatic, stimulant and carminative. It is used in the pharmacopoeias of all countries and is considered useful in disease of the chest, spleen and kidney. In Bangladesh, fruits are used as medicine to increase lacteal secretion. The leaves are reported to have diuretic properties and roots are regarded as purgative.

Due to diverse ways of using fennel as well as increase in population lead to increases demand for fennel. But farmers of Bangladesh are not interested of its commercial cultivation because of

lower yield and less profitability. It is cultivated as non-commercial basis mostly as mixed crop with chili, radish and onion etc and in few cases as sole crop. For food securities and policy support for rice culture, the areas under spices crop gradually decreasing (Alam, 2005). So, chance of fennel cultivation is becoming fewer. To make fennel cultivation more profitable and competitive with other crops, more research is needed for various aspect of its production. Since there is no fertilizer package for its cultivation in Bangladesh, therefore the present investigation was undertaken to determine the effect of nutrients on growth and yield of fennel and as well to develop a fertilizer recommendation for fennel.

Materials and Methods

Experimental site

A field experiment was conducted in the Terrace Soil of Level Barind Tract (Agro-Ecological Zone - 25) at SRC, Bangladesh Agricultural Research Institute, Shibganj, Bogra during the rabi season of 2011-2012 and 2012-2013. The land was medium high land and well drained. The initial soil samples of 2011-2012 of the experimental fields were collected and analyzed (Table 1).

Table 1. Fertility status of initial soils of the experimental field.

Station	pH	OM %	Ca	Mg	K	Total N %	P	S	B	Cu	Fe	Mn	Zn
			(meq 100 g ⁻¹)				(µg g ⁻¹)						
SRC, Bogra	6.2	1.10	3.2	4.1	0.16	0.11	15	14	0.2	3.1	109	29	3.88
Critical level	-	-	2.0	0.50	0.12	-	7	10	0.2	0.2	4.0	1.0	0.6

Land preparation

Land was prepared by 4-5 ploughing followed by laddering. Then plots of 3.0 m × 2.0 m were made according to the design. In between the blocks 1 m and plots 50 cm space were maintained for irrigation and drainage.

Seed sowing

Seeds of fennel of high yielding local variety were collected from SRC, Bangladesh Agricultural Research Institute, Shibganj, Bogra. Seed sowing was done in the last week of September in plots at 50 cm × 30 cm spacing.

Fertilizer application

Fertilizers were applied in plots according to the treatments. The sources of N, P, K and S were urea, triple super phosphate, muriate of potash and gypsum, respectively. A blanket dose of 3 kg Zn, 1 kg B and 5 t cowdung per ha was applied. The whole amount of cowdung, triple super phosphate, muriate of potash, gypsum and one third of urea fertilizers were incorporated in soil during final land preparation. The rest of urea was applied in two

equal installments at 30 and 50 days after transplanting (DAT). Nutrient compositions of cowdung used in the experimental field were determined as shown below (Table 2).

Irrigations and drainage

Flood irrigation was done for two times just after top dressing of urea. Excess water was allowed to drain out from the plots.

Intercultural operations

The field was intensively kept free from weed. No diseases and insects infestation was observed during the cultivation period.

Treatments

The fourteen treatments in combination with four levels of N (0, 30, 60, 90 kg ha⁻¹); four levels of P (0, 10, 20, 30 kg ha⁻¹); four levels of K (0, 25, 50, 75 kg ha⁻¹) and four levels of S (0, 5, 10, 15 kg ha⁻¹) were used in the present investigations (Table 3).

Table 2. Nutrient status of cowdung used in the experimental field.

Manure	pH	OM %	Ca %	Mg %	K %	Total N %	P %	S %	B %	Zn %
Cow dung	7.2	8.5	1.75	0.53	0.56	0.56	0.8	0.2	0.012	0.16

Table 3. Nutrients compositions among the treatments for the production of fennel.

Treatment	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	S (kg ha ⁻¹)
T ₁	0	20	50	10
T ₂	30	20	50	10
T ₃	60	20	50	10
T ₄	90	20	50	10
T ₅	60	0	50	10
T ₆	60	10	50	10
T ₇	60	30	50	10
T ₈	60	20	0	10
T ₉	60	20	25	10
T ₁₀	60	20	75	10
T ₁₁	60	20	50	0
T ₁₂	60	20	50	5
T ₁₃	60	20	50	15
T ₁₄	Native fertility			

Methods of chemical analyses

Soil pH was measured by a combined glass calomel electrode (Jackson, 1973). Organic carbon determination was done by wet oxidation method (Walkley & Black, 1935). Total N was determined by modified Kjeldahl method. Ca and Mg were determined by KCl extractable method. K, Cu, Fe,

Mn and Zn were determined by NaHCO₃ extraction followed by atomic absorption spectrophotometer reading. Boron was determined by CaCl₂ extraction method. Phosphorus was determined by Bray and Kurtz method while S by turbidimetric method with BaCl₂.

Data collections

Plant height was measured after harvest. The umbels were harvested several times from late February to March. Data was recorded from 10 randomly selected plants. The yield per plot was recorded and based on that per hectare yield was calculated.

Statistical analysis

The data were analyzed by computer using MSTAT-C Package while the mean separation was done by Duncan's Multiple Range Test (Steel & Torrie, 1960).

Results and Discussion

The yield of fennel increased significantly due to different combinations of N, P, K and S fertilizers at SRC, Bogra (Table 4). The highest seed yield (1804 kg ha⁻¹ during 2011-2012 and 1569 kg ha⁻¹ during 2012-2013) was obtained from T₃ that received N₆₀ P₂₀ K₅₀ S₁₀ kg ha⁻¹ which was significantly higher over all other treatments. It might be due to the higher dose of all nutrients. These findings are similar with the findings of Ahmed *et al.* (2012) where they used fertilizers at the rate of 60-20-38 kg ha⁻¹ NPK for sole production of fennel where as Bhati (1990) produced maximum seed yield of

fennel by applying N @ 90 kg ha⁻¹. On the other hand, Moosavi (2012) recorded highest seed yield of fennel up to 120 kg N ha⁻¹ along with 24 kg P ha⁻¹ and 40 kg K ha⁻¹. Singh *et al.* (1997) also obtained higher seed weight, straw and seed yield of another similar minor spice crop coriander by applying of N up to 60 kg N ha⁻¹. The second highest yield (1672 kg ha⁻¹ during 2011-2012 and 1455 kg ha⁻¹ during 2012-2013) was obtained from T₂ that received N₃₀ P₂₀ K₅₀ S₁₀ kg ha⁻¹. The lowest seed yield (1083 kg ha⁻¹ during 2011-2012 and 942 during 2012-2013) was recorded from absolute control treatment (T₁₄). The yield contributing characters like number of umbel plant⁻¹, number of umbel let umbel⁻¹, number of seed umbel let⁻¹ and 1000 seed weight showed almost similar trend of results as like the seed yield in both year.

In case of response function, from the average value of two years results, the positive but quadratic relationship was observed between seed yield of fennel and added nutrients (Fig. 1). From the regression equation, the optimum dose of nitrogen was appeared as 48.57 kg ha⁻¹ for SRC, Bogra (Table 5). Similarly, the optimum dose was calculated for phosphorus 16.41 kg ha⁻¹; for potassium 51.71 kg ha⁻¹ and sulphur 9.17 kg ha⁻¹ for Bogra. Beyond the said optimum dose, there was a possibility of losing certain amount of yield of higher level of nutrients were applied.

Table 4. Yield and yield component of fennel as influenced by NPKS at the field of SRC, Bogra.

Treatments ^a	Plant height (cm)	No of umbel plant ⁻¹	No of umbel let umbel ⁻¹	No. of seed umbel let ⁻¹	Seed weight plant (g)	1000 Seed weight (g)	Yield (kg ha ⁻¹)	
							2011-2012	2012-2013
T ₁	99.5 b	41.7 bcd	17.0 bc	16.7 cd	20.2 ef	5.22 c	1243 f	1081 i
T ₂	99.7 b	45.3 a-d	17.0 bc	19.0 abc	22.1 de	5.95 bc	1672 b	1455 b
T ₃	125.4 a	59.0 a	23.3 a	20.3 a	30.0 a	7.59 a	1804 a	1569 a
T ₄	111.1 ab	49.7abc	20.0 abc	18.3 a-d	28.4 ab	6.55 b	1369 ef	1191 ef
T ₅	103.7 ab	39.3 bcd	17.0 bc	18.0 a-d	23.6 cd	6.31 b	1294 ef	1126 h
T ₆	101.4 b	41.3 bcd	18.0 bc	17.3bcd	27.8 ab	6.73 ab	1519 c	1322 c
T ₇	114.5 ab	53.7 ab	20.3 ab	18.3 a-d	28.7 ab	6.69 ab	1357 ef	1181 efg
T ₈	108.7 ab	42.7 bcd	19.0 abc	18.3 a-d	22.7 cde	6.60 b	1293 ef	1125 h
T ₉	105.7 ab	47.7 a-d	19.3 abc	18.7 a-d	26.1 bc	6.42 b	1346 ef	1171 fg
T ₁₀	116.3 ab	51.0 abc	20.0 abc	19.0 abc	27.7 ab	6.69 ab	1489 cd	1295 d
T ₁₁	106.3 ab	39.0 cd	19.7 abc	18.0 a-d	25.6 bc	6.33 b	1250 ef	1088 i
T ₁₂	104.7 ab	43.0 bcd	18.0 bc	18.0 a-d	27.6 ab	6.31 b	1334 ef	1161 g
T ₁₃	111.9 ab	49.7 abc	21.3 ab	19.7 ab	28.8 ab	6.93 ab	1378 de	1199 e
T ₁₄	97.5 b	34.3 d	15.0 c	16.3 d	17.7 f	5.05 c	1083 g	942 j
CV (%)	10.72	16.64	14.10	6.58	7.13	8.02	15.39	11.19

^aDetails of the treatments were explained in the Table 3.

Means having same letter(s) do not differ significantly at 5% level of significance.

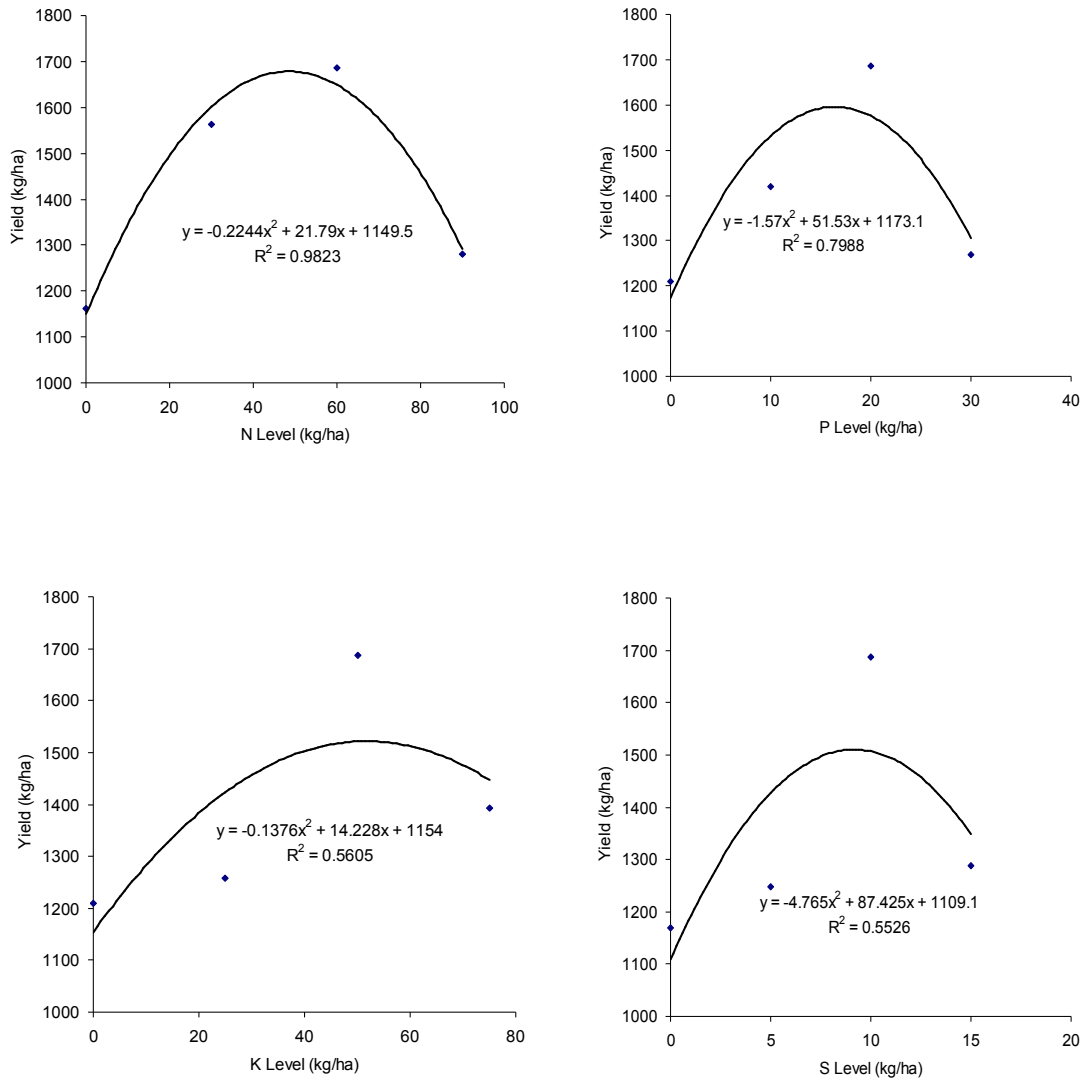


Fig. 1. Response of fennel to N, P, K and S at SRC, Bogra (Average of 2011-2012 and 2012-2013).

Table 5. Response functions of fennel to added N, P, K and S (Average of 2011-2012 and 2012-2013).

Nutrient	Regression equation	Optimum dose (kg ha ⁻¹)
N	$y = 1149.5 + 21.79x - 0.2244x^2$	48.57
P	$y = 1173.1 + 51.53x - 1.570x^2$	16.41
K	$y = 1154 + 14.228x - 0.1376x^2$	51.71
S	$y = 1109.1 + 87.425x - 4.765x^2$	9.17

Conclusion

The yield of fennel increases due to added nutrients in the soil. From the result of response function, it can be concluded that around 50 kg nitrogen, 15 kg phosphorous, 50 kg potassium and 10 kg sulphur per hectare of land was found optimum for fennel production in Terrace Soil of Level Barind Tract, Bogra. By applying this fertilizers packages, farmers can obtained higher yield of fennel. Thus, fennel cultivation will be more profitable and competitive with other crops. For fennel production at other regions of Bangladesh, more modification of this fertilizers package is needed and so, further study is needed at other areas of Bangladesh.

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