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Effect of Integrated Nutrient Management on Growth Parameters of Fennel (*Foeniculum vulgare* Mill.) in Inceptisol

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ABSTRACT

Keywords

STCR-IPNM, Fennel, Plant height, Number of branches, Fresh weight and dry weight (gm) etc.

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Studies on soil test crop response based on integrated plant nutrient management system (STCR-IPNM) were conducted for the growth parameters of fennel on Inceptisol of agricultural research farm, Banaras Hindu University, Varanasi during Rabi 2017-18. Objective is to study the effect of integrated nutrient management on growth parameters of Fennel in Inceptisol. Integrated application of N.P.K 120-60-45 kg ha⁻¹ with F.Y.M 10 t ha⁻¹ in strip IIIrd showed higher values of all the growth parameters attributes, viz., - plant height, number of branches/plant, fresh weight and dry weight of following strip IInd and strip Ist.

Introduction

Fennel (*Foeniculum vulgare* Mill.) is one of popular seed spice in India mainly grown in rabi season, locally known as saunf belongs to the family Apiaceae (Umbelliferae). Fennel is native to Southern Europe and Mediterranean region. It is a perennial, but is grown as annual or biannual. It is cultivated throughout the temperate and subtropical regions of the world for its aromatic seeds which are used for culinary purpose. Plants have dark green or bronze wispy leaves with the yellow flowers on compound umbels and are cross pollinated. It is tall, hardy and erect growing herb and

grows from 90-150 cm. Among the aromatic plants, we consider the fennel, in which its seeds have several uses (culinary, pharmaceutical, etc).

Fennel is also highly recommended for diabetes, bronchitis and chronic coughs, treatment of kidney stones, and is considered to have diuretic, stomachic and galactagogue properties. 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. In India, area under fennel was 41368 ha with production of 58265 t and productivity of 1.40 t ha⁻¹ in

2010-11 (SBI, 2011). The farm yard manure (FYM) seems to be directly responsible in increasing crop yields either by accelerating the respiratory process by increasing cell permeability by hormone growth action or by combination of all these processes.

It supplies nitrogen, phosphorus and potassium in available forms to the plants through biological decomposition. Indirectly it improves physical properties of soil such as aggregation of soil, permeability and water holding capacity. It is prepared from the dung of farm animals and contains all the essential elements.

Materials and Methods

To assess the validation of fertilizer equation for fennel developed by Soil test Crop Response based on Integrated Plant Nutrient Management (STCR - IPNM) were conducted for the growth parameters of Fennel, on Inceptisol of Agricultural Research Farm, Banaras Hindu University, Varanasi during Rabi 2017-18.

Physico-chemical properties of experimental soil

The soil of the experimental site was sandy loam in texture with predominance of kiolinite type of clay minerals which taxonomically categorized under the great group *Typic Haplustepts* (old alluvium).

Soil of experimental field had 166 kg ha⁻¹ alkaline permanganate oxidizable N (Subbiah and Asija, 1956), 14 kg ha⁻¹ 0.5 N sodium bicarbonate extractable P (Olsen *et al.*, 1954), 146 kg ha⁻¹ neutral 1N ammonium acetate exchangeable K (Hanway and Heidel, 1952) as described by (Jackson, 1973). 0.43% organic carbon (Walkley and Black, 1934), pH of 7.50 and electrical conductivity of 0.43 dSm⁻¹ in 1:2.5 soil to water (Jackson, 1973).

Fertility gradient experiment

Prior to test crop experimentation, fertility gradient experiment was conducted to create soil fertility gradient using 'inductive methodology' developed by Rama Moorthy *et al.*, (1967).

For this purpose, field was divided into three equal rectangular strips and graded doses of fertilizer N, P and K were applied as N₀N₁P₁K₁ (0-40-20-15), N₀N₂P₂K₂ (0-80-40-35) and N₀N₃P₃K₃ (0-120-60-45) in strip I, strip II and strip III, respectively. Soil fertility gradient with respect to farmyard manure (FYM) was developed by applying FYM @ 0, 5 and 10 tonnes ha⁻¹ in three strips across the fertilizer applied strips. This created distinct nine blocks (3 in each strip) in field receiving different nutrient doses. During winter 2017-18, preliminary exhaustive aromatic funnel crop (variety: African tall) was grown to stabilize soil fertility. Twenty-four soil samples (0-15 cm) from each strip were collected before sowing of exhaustive aromatic crop and analyzed for available nitrogen, by the alkaline permanganate method (Subbiah and Asija, 1956); available phosphorus, by Olsen *et al.*, (1954) and available potassium, by the ammonium acetate method (Hanway and Heidel, 1952) as described by Jackson (1973).

Growth parameters

Plant height (cm), number of branches, fresh weight and dry weight (gm) were taken 35, 75 and 110 days after sowing and five randomly selected plants in each plot and the means were recorded.

The data were statistically analyzed according to a randomized block design and three replications. Mean, SD, Sem± and CV were calculated for significance amongst the treatments.

Test crop experimentation

After fertility gradient experiment, each strip was divided into 24 plots to accommodate 24 treatments (21 treatments + 3 controls) making total of 72 plots. Three blocks (comprising 8 treatments) were made within each strip. The experiment was laid out in fractional factorial randomized block design. The treatments comprised of selected combinations of four levels of nitrogen (0, 40, 80 and 120 kg N ha⁻¹), phosphorus (0, 20, 40 and 60 kg P₂O₅ ha⁻¹) and potassium (0, 15, 30 and 45 kg K₂O ha⁻¹) and three levels of FYM (0, 5, 10 tonnes FYM ha⁻¹) (Table 1). Treatments were randomized in each strip and replicated thrice. N was applied in three equal splits as basal and two top dressings at crown root initiation and maximum tillering; however, full basal dose of P and K was applied at the time of sowing. Test crop 'fennel' was grown during 2017-18. Twenty-four soil samples (0-15 cm) were collected from each strip before sowing of test crop fennel and analyzed for alkaline KMnO₄-N, Olsen's-P and K the ammonium acetate method.

Results and Discussion

Establishment of fertility gradient

Descriptive statistics of pre-sowing available soil nutrients in surface soil is presented in Table 2. Mean alkaline KMnO₄-N of 221.02, 232.42 and 242.47 kg ha⁻¹ were observed in strip I, II and III, respectively. Mean Olsen's-P values in strip I, strip II and strip III were 14.34, 16.10 and 23.48, respectively. The ammonium acetate method extractable-K of 206.67, 220.92 and 228.04 kg ha⁻¹ were recorded in strip I, II and III, respectively. From the data, it is obvious that mean value of the alkaline KMnO₄-N, Olsen's-P and the ammonium acetate method extractable-K was highest in strip III, followed by strip II and it was lowest in strip I. Within strip variation

with respect to soil available nutrients can be explained by coefficient of variation. A marked fertility gradient was built up by application of graded levels of fertilizer and FYM. This indicates that, adequate variability with respect to soil available N, P and K was developed before start of test crop experiment.

Growth parameter attributes

Plant height and number of branches

The data showed that integrated nutrient management significantly affected different growth parameters attributes of fennel viz., plant height (cm) and number of branches of fennel viz., 35, 75, and 110 day after sowing. These result descriptive statistics of funnel growth parameters are presented in Table 3. During experimentation, the highest growth parameters were obtain strip III being fertile strip followed by strip II and the lowest in unfertilized strip I. Mean growth parameters of overall plots were viz., plant height (cm), number of branches per plant, during all stages of growth of fennel viz., 35, 75, and 110 day after sowing. The mean value of strip I-height (cm) (10.14, 56.10, 109.03), number of branches (2.69, 3.64, 4.81), strip II – height (cm) (12.07, 67.13, 117.05), number of branches (3.11, 4.72, 5.65) and strip III – height (cm) (14.56, 76.35, 132.19), number of branches (4.88, 5.75, 7.41). Growth parameters of funnel increased with the increase in application of fertilizer N, P and K and FYM. Increased Plant height(cm), number of branches, fresh weight and dry weight (gm) with application of 100 % NPK (recommended dose) of fertilizers or combined use of farm yard manure with nitrogen might have been resulted because of higher content of nutrients sufficient level that in turn gave higher yields. The findings are in agreement with those of Patashetti *et al.*, (2002), Sankhyan *et al.*, (2003) and Hattab *et al.*, (2000).

Table.1 Detailed N, P and K treatment combinations used for test crop experimentation

Treatment Combinations					Amount of nutrients			
S.N.	N	P	K	FYM	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	FYM (t ha ⁻¹)
1	0	0	0	2	0	0	0	10
2	3	3	1	2	120	60	15	10
3	0	2	2	2	0	40	30	10
4	3	2	2	2	120	40	30	10
5	2	1	2	2	120	20	30	10
6	2	2	3	2	80	40	45	10
7	1	1	2	2	40	20	30	10
8	3	3	3	2	120	60	45	10
9	0	0	0	1	0	0	0	5
10	3	1	1	1	120	20	15	5
11	2	2	0	1	80	40	0	5
12	1	2	2	1	40	40	30	5
13	2	1	2	1	80	20	30	5
14	1	1	1	1	40	20	15	5
15	1	2	1	1	40	40	15	5
16	3	3	2	1	120	40	30	5
17	0	0	0	0	0	0	0	0
18	3	2	1	0	120	40	15	0
19	2	0	2	0	80	0	30	0
20	2	2	2	0	80	40	30	0
21	2	2	1	0	80	40	15	0
22	2	1	1	0	80	20	15	0
23	2	3	3	0	80	60	45	0
24	3	2	3	0	120	40	45	0

Table.2 Descriptive statistics of available soil (0-15 cm) nutrients after soil fertility gradient experiment

Nutrients	Strip I			Strip II			Strip III		
	Range	Mean Sem±	SD CV	Range	Mean Sem±	SD CV	Range	Mean Sem±	SD CV
Alkaline KMnO ₄ -N	210 - 230	221.02 1.72	8.44 3.82	215.86 - 250.50	232.42 2.18	10.67 4.59	225.40- 265.44	242.47 6.71	31.71 13.08
Olsen's-P (kg/ha)	13.44- 15.12	14.34 0.11	0.56 3.99	14.00 - 17.88	16.10 0.30	1.46 9.09	21.44 - 25.56	23.48 0.27	1.32 5.60
Ammonium acetate K (kg/ha)	192.48 - 214.17	206.67 1.66	7.99 3.87	201.48 - 237.84	220.92 2.37	11.59 5.24	213.89 - 240.43	228.04 1.58	7.75 3.40

Table.3 Descriptive statistics of funnel growth parameters

Parameters	Strip I			Strip II			Strip III		
Plant height(cm)	Range	Mean, Sem±	SD CV	Range	Mean Sem±	SD CV	Range	Mean Sem±	SD CV
35 DAS	9.20 - 11.30	10.14 0.186	0.91 9.01	10.25 - 13.70	12.07 0.19	0.95 4.51	12.60 - 16.70	14.56 0.26	1.29 8.86
75 DAS	55.40 - 65.30	56.10 2.87	14.09 25.13	60.35 - 72.40	67.13 0.81	3.98 5.93	67.65 - 84.20	76.35 0.78	3.81 4.99
110 DAS	100.40 -115.30	109.03 1.00	4.91 4.51	108.15 - 125.50	117.05 .99	4.870 4.16	120.35 -145.20	132.19 1.47	7.19 5.44
Number of branches									
35 DAS	2.20 - 3.15	2.69 0.06	0.31 11.54	2.85 - 3.95	3.11 0.09	0.43 13.96	4.30 - 5.45	4.88 0.08	0.40 8.18
75 DAS	3.10 - 4.35	3.64 0.69	0.44 12.13	4.10 - 5.25	4.72 0.08	0.38 7.99	5.20 - 6.70	5.75 0.13	0.66 11.46
110 DAS	4.20 - 5.50	4.81 0.09	0.42 8.86	5.00 - 6.90	5.65 0.13	0.63 11.18	6.50 - 8.15	7.41 0.10	0.49 0.56
Fresh weight (gm)									
35 DAS	20.70 - 28.30	23.72 0.42	2.04 8.58	26.40 - 34.30	30.40 0.55	2.69 8.86	30.6 - 42.70	34.08 0.70	3.80 11.15
75 DAS	57.35 - 65.60	60.16 0.47	2.28 3.79	60.20 - 68.40	63.38 0.50	2.43 3.83	67.65 - 84.20	75.85 1.04	5.08 6.70
110 DAS	100.30- 109.35	105.08 0.67	3.30 3.14	105.15- 114.50	109.05 0.61	2.99 2.74	113.35 -140.20	126.61 1.65	8.10 6.40
Dry weight (gm)									
35 DAS	8.20 - 12.40	9.98 0.27	1.33 3.31	10.40 - 13.15	11.24 0.15	0.73 6.54	12.70 - 16.40	14.70 0.29	1.43 9.73
75 DAS	22.40 - 25.15	23.81 0.90	0.93 3.91	23.25 - 26.30	24.39 0.23	1.15 4.71	25.10 - 29.40	27.79 0.24	1.16 4.16
110 DAS	36.45 - 40.30	38.39 0.22	1.10 2.86	37.15 - 42.20	39.36 0.26	1.27 3.22	40.20 - 47.35	43.35 0.51	2.49 5.74

Note: DAS-Day after sowing, SD - Standard Deviation and CV – Coefficient of variation (Standard Deviation/Mean*100) in%

Fresh and dry weight/plant (gm)

The data showed that integrated nutrient management significantly affected different growth parameters attributes of fennel viz., plant fresh weight and dry weight(gm) of fennel viz., 35, 75, and 110 day after sowing. These result descriptive statistics of funnel growth parameters are presented in Table 3. During experimentation, the highest growth parameters were obtain strip III being fertile strip followed by strip II and the lowest in unfertilized strip I.

Mean growth parameters of overall plots were viz. plant fresh weight (gm) and plant fresh weight (gm), during all stages of growth of fennel viz., 35, 75, and 110 DAS. The mean value of strip I-fresh weight(gm)/plant (23.72, 60.16, 105.08) and dry weight(gm)/plant- (9.98, 23.81, 38.39) strip II - fresh weight(gm) (30.40, 63.38, 109.05) and dry weight(gm) (11.24, 24.39, 39.36) and strip III - fresh weight(gm) (34.08, 75.85, 126.61) and dry weight (gm) (14.70, 27.79, 43.35). Growth parameters of funnel increased with the increase in application

of fertilizer N, P and K and FYM. Similar results were observed by (Singh and Verma, 1999) and (Baboo *et al.*, 1995)

It was observed that the recorded the higher Plant height, number of branches, fresh weight and dry weight increased with the increasing application of fertilizer N, P and K and FYM. So we can suggest STCR treatments with farm yard manure for eastern plain zone of Uttar Pradesh for improvement of soil health and sustainable production.

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