



Influence of spacing and organic and inorganic sources of nitrogen on growth and yield of fennel (*Foeniculum vulgare* L.)

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ABSTRACT

To study the effect of spacing and combination of nitrogen from organic and inorganic sources on growth and yield of fennel an experiment was conducted during consecutive two winter seasons in the Anantharajupeta of Andhra Pradesh at college of Horticulture of Dr. YSR Horticulture University. The experiment was designed in Randomised Block Design with sixteen treatments and three replications. The seed of fennel was sown with different spacing i.e., 45 X 45 cm, 60 × 35 cm. The plants were manured with five different combination of nitrogen from organic and inorganic sources along with bio-fertilizer and phosphorus and potassium. The results showed that the maximum seed yield (14.2 q ha) was noticed under the treatment of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing. The minimum yield of 9.1 q ha was noticed under Control (No fertilizers) 60×45cm spacing.

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INTRODUCTION

Fennel (*Foeniculum vulgare* Mill.) belongs to the Apiaceae family and it is stout, aromatic and annual herb. The plant is pleasantly aromatic and each part of the fennel (leaves, stalks, bulbs and seeds) is edible. It is mainly used as condiment and culinary spice. In addition to its use as medicinal purpose, fennel has much health benefiting nutrient, essential compounds, anti-oxidants, dietary fiber, minerals and vitamins. Fennel seeds are composed of health benefiting volatile essential oil compounds such as anethole, limonene and fenchone. This crop occupies major acreage in Gujarat, Rajasthan and Uttar Pradesh.

Fennel being a long duration crop extracts lot of the nitrogen from the soil. Inadequate and imbalanced application of nitrogen is the major factors for low yield and poor quality. Exclusive application of inorganic fertilizers creates deleterious effect on soil fertility due to limitation of one or more nutrients including micro nutrients and poor soil health leading to decline in productivity. No single source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. The conjunctive (integrated) application of organics with inorganic sources of nutrients reduces the dependence on chemical inputs and also provides micro nutrients as well as modifies the soil physical behavior and increases the efficiency of applied nutrients (Pandey et al. 2007). Judicious combination of manures and chemical fertilizers not only maximizes the crop production and improves the quality of agricultural produce but also helps in maintaining the soil fertility (Parihar et al. 2010). Suitable planting pattern is important non-cash input avoiding intra spacing competition, cooperative interaction and competitive interaction; it is of vital importance for interception of sunlight in plant canopy. It is an established fact that there is a positive correlation between fertilizer and agricultural production (Singh et al. 2015). The overall strategy for increasing crop yields and sustaining them at a high level must include an integrated approach to the management of soil nutrient, along with other complimentary measures. Keeping these facts in view, this study was therefore made to find out optimum row spacing and level of nitrogen for obtaining the most economical grain yield.

MATERIALS AND METHODS

A field investigation was carried out to study the influence of spacing and organic and inorganic sources of nitrogen on growth, yield and economics of fennel during Rabi season of 2015-16 at college of horticulture, Anantharajupeta, Andhra Pradesh, India. The investigation comprising of eleven treatments given below (Table 1).

Table 1: Details of treatments

Notations	Treatment details	Notation	Treatment details
T ₁	100 % RDN through UREA with 45 X 45 cm	T ₈	100 % RDN through Vermicompost with 60 X 35 cm
T ₂	100 % RDN through UREA with 60 X 35 cm	T ₉	50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm
T ₃	100 % RDN through FYM with 45 X 45 cm	T ₁₀	50 % RDN through Vermicompost + 50 % RDN through Urea with 60 X 35 cm
T ₄	100 % RDN through FYM with 60 X 35 cm	T ₁₁	Control (No fertilizers) 60×45cm spacing
T ₅	50 % RDN through FYM + 50 % RDN through Urea with 45 X 45 cm		
T ₆	50 % RDN through FYM + 50 % RDN through Urea with 60 X 35 cm		
T ₇	100 % RDN through Vermicompost with 45 X 45 cm		

Seeds were soaked overnight and dried under shade and were sown in previously prepared plots at a depth of 2-3cm and covered with a layer of fine soil. Fennel seeds were sown in 3rd week of October in flat beds with a spacing of 60× 45 cm, 45×45 cm row to row and plant to plant. First irrigation was given immediately after planting. Then the subsequent irrigations were given at an interval of 15 days depending upon the soil moisture and weather condition. Plant is individually tied with stake by rope to protect from wind damage. Staggered harvesting was done when seeds became brownish in colour. Proper care was taken during drying and threshing of seeds. The observation on growth characters like plant height, number of primary branches, number of secondary branches per plant and -1yield attributes like number of umbels plant , number -1of umbelletes umbel , yield and test weight were recorded and were analyzed statistically. The significance of different treatment of variation was tested by Fisher & Snedecor's 'F' test at a probability of 0.05 per cent (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION:**Plant height:**

It is evident from the data presented in table- 2 that plant height varied significantly at different stages of growth at 60 and 80 and 100 days after planting among different treatments. The maximum plant height was noticed under 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing in all the four days of observation with a maximum value at 100 DAS (169.5), whereas the shortest plant (127.5) was observed under Control (No fertilizers) 60×45cm spacing. Observations showed that the application of less amount of half dose of nitrogen through Vermicompost and half dose of nitrogen through urea with lower spacing lowers the growth of the plants, as inorganic nitrogen enhances the height of the plant very rapidly.

Number of primary branches per plant:

Number of primary branches per plant varied significantly with application of different treatments. The maximum no of primary branches was recorded under the treatment of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing at 3 days of observations viz, 60 DAS (8.1) and 80 DAS (11.5); while the lowest value was obtained under treatment of Control (No fertilizers) 60×45cm spacing.

Number of secondary branches per plant:

A significant variation in secondary branches was also observed in different treatment. A similar trend of result was noted in this parameter like primary branches of plant. The combined application of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm produced maximum number of secondary branches (9.2 and 19.2) at 60 DAS and 80 DAS. Whereas the least number of secondary branches (5.7 and 11.3) under the treatment of Control (No fertilizers) 60×45cm spacing was observed at 60 DAS and 80 DAS respectively also.

Number of umbel per plant:

It is clear from Table 2 that the umbel per plant varied significantly at three stages of growth (80,100 and 120 DAS). Among different treatment combination, 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing produced the highest number of umbel at 80 DAS (4.9) , 100 DAS (57.5) and 120 DAS (108.5). But under the treatment of (No fertilizers) 60×45cm spacing the minimum number of umbel per plant was recorded at all the three stages of growth.

Table 2: Influence of spacing and organic and inorganic sources of nitrogen on growth and yield of fennel (*Foeniculum vulgare L.*)

TREATMENT	PLANT HEIGHT			PRIMARY BRANCHES		SECONDARY BRANCHES		UMBEL PER PLANT			UMBLET PER UMBEL	YIELD (KG /HA) -1	TEST WEIGHT	
	60 DAS	80 DAS	100 DAS	60 DAS	80 DAS	60 DAS	80 DAS	80 DAS	100 DAS	120 DAS				
T ₁	64	77.3	147.9	6.2	9.0	7.3	15.1	3.1	43.7	97.2	100 DAS	31.5	13.0	6.7
T ₂	62.6	73.3	146.6	6.7	9.2	7.5	16.3	3.3	48.6	101.0		31.7	13.2	5.7
T ₃	53.6	69.2	135.3	5.2	7.7	5.7	12.0	1.9	33.0	83.7		27.7	10.6	6.2
T ₄	55.6	73.2	137.2	5.3	8.7	6.6	14.0	2.7	36.7	87.0		28.5	10.1	6.0
T ₅	61	74.6	150.2	7.2	10.1	8.4	17.3	4.4	52.2	108.8		36.5	13.5	7.4
T ₆	63.6	74.5	145.8	6.4	8.9	7.2	14.1	3.1	40.3	92.5		31.7	13.0	6.5
T ₇	59.3	75.7	143.0	5.9	8.6	6.8	13.9	2.6	38.8	84.5		26.5	11.6	5.5
T ₈	62.8	77.2	147.5	6.6	9.4	7.6	15.2	3.4	46.3	97.0		36.2	13.4	7.2
T ₉	70.3	100.0	169.5	8.1	11.9	9.2	19.2	4.9	64.3	116.4		42.0	14.2	8.4
T ₁₀	68.8	87.5	153.2	7.4	11.5	8.8	18.5	4.6	57.5	108.5		38.7	13.6	7.7
T ₁₁	53.5	65.3	127.5	4.0	6.5	5.7	11.3	1.5	27.3	71.7		20.5	9.1	4.7
SEm (±)	1.38	1.48	2.76	0.18	0.39	0.23	0.40	0.15	1.36	1.34		0.59	0.05	0.19
CD (0.05)	4.06	4.37	8.14	0.53	1.14	0.68	1.18	0.44	4.02	3.95		1.75	0.13	0.57

Number of umbelletes per umbel:

Combination of different spacing in fennel plants treated with inorganic and bio-fertilizers were influenced significantly in respect of number of umbelletes per umbel. The maximum number of umbelletes per umbel at 100 DAS was (42.0) noticed under the combined inoculation of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing whereas the lowest (20.5) was noticed at the combination of Control (No fertilizers) 60×45cm spacing.

Yield (kg /ha) -1:

The highest seed yield of 14.2 q ha was noticed under the treatment of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing. However, the minimum yield of 9.1 q ha was noticed under Control (No fertilizers) 60×45cm spacing.

Test weight:

A significant difference in thousand seed weight was witnessed among different treatments. The highest test weight of 8.40g was noticed under the treatment of 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing. However, the minimum weight of 4.70 g was noticed under Control (No fertilizers) 60×45cm spacing.

The experiment was conducted with Nitrogen sources FYM and Vermicompost in combination with inorganic nitrogen at different levels and with fixed phosphorus & potassium and sown at different spacing. Considering the yield and other parameters, the treatment combination 50 % RDN through Vermicompost + 50 % RDN through Urea with 45 X 45 cm spacing -1 produced the highest yield (14.2 q ha). Investigation also revealed that the same treatment recorded maximum plant height, number of branches, number of umbels per plant, number of umblets per umbel and testweight. The reason behind that positive role of combination of Vermicompost and urea as nitrogen source. Similar results are found Godara et al. (2014) also observed highest plant height, number of branches, number of umbels, dry weight and fruit yield per plant of coriander with the treatment combination of 50% RDF through fertilizers + 50% RDF through vermicompost. Organic fertilizers add nutrients to soil and stimulating positively on crop yield. The beneficial role of supplemented organic manures and bio-fertilizers in improving soil physical, chemical and biological role is well known, which in turn helps in better nutrient absorption by plants and resulting higher yield (Prabu et al., 2002).

Regarding spacing of the rows, the results corroborate the earlier findings of different scientists. Ahmad et al. (2004) reported that 40 cm gave the greatest plant height (114.7 cm), seed weight per 1umbel (2.2 g) and seed yield ha (369.7 kg), while the lowest plant height (78.1 cm), seed weight per umbel (1.8 g) and seed yield/ha (192.5 kg) were recorded with 70-cm spacing. The interaction of autumn sowing and 40-cm row spacing produced the highest 1seed yield (560.5 kg ha). According to Amin et al. (2005) crops

sown on 45 cm row spacing recorded significantly higher fennel seed and stover yield and yield attributes. Whereas, growth attributes increased with increase in row spacing from 30 to 60 cm.

CONCLUSION

The study revealed that the most promising treatment under the Anantharajupeta region of Andhra Pradesh for fennel production is 50%N through vermi compost +50 %N through Urea with 45×45cm spacing. Hence, there is a chance of saving 50% of nitrogen with supply of vermi compost which may also leads to reduction of environmental pollution to some extent and Vermicompost was proved to be better supplement of nitrogen.

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