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Effect of Row Spacing and Level of NPK on Growth and Yield of Fennel (*Foeniculum vulgare*)

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ABSTRACT

An experiment was conducted at the Horticulture Research Farm, College of Horticulture, Mandsaur during the rabi season of 2013-2014 to study the effect of row spacing and NPK levels on the growth and yield of fennel. The experiment consisted of 3 levels of row spacing (30 cm, 45 cm and 60 cm) and 4 levels of NPK (0+0+0, 30+20+20, 60+40+40 and 120+60+60 kg/ha) and were evaluated under split plot design with four replications. Among various levels of row spacing tried, 45 cm row spacing exhibited significant higher growth and yield attributes and recorded significant higher seed yield (11.06 q/ha) as compared to 30 cm row spacing. Among the various NPK levels tried, 60+40+40 kg ha-1exhibited significant maximum growth, yield attributes, yield and quality of fennel. Further treatment observed significant higher seed yield 12.29 q/ha with B: C ratio of 3.45 in comparison to lower NPK levels.

Key Words: Fennel, Growth, Nitrogen, Phosphorus, Potassium, Spacing, Yield.

INTRODUCTION

Fennel (*Foeniculum vulgare* Mill.) is one of the important cash crops of family Apiaceae. The fennel seed is used in the food and flavour industry. The essential oils are used in condiments, soaps, creams perfumes and liquors. Fennel is cultivated in India about 100 thousand hectares area with the production of 143 thousand MT and productivity 1.4 MT/ha (NHB, 2013). Looking to the importance of the crop, its average productivity is less, so the efforts have made to enhance the productivity of the fennel by the management of cultural practices and fertilizer. Macro nutrients such as N, P and K are essential to all crops. Nitrogen is the element that most limits crop yields. Most of the N in plants is in organic form: nucleic acid, some vitamins, hormones, membrane component, coenzymes and pigment. P is an essential component of the energy transfer compounds (ATP and other nuclei-proteins), the genetic information system, cell membranes and phospho-proteins. K is serving as an enzyme activator or cofactor for some enzymes. It also aided in the maintenance of osmotic potential and water uptake. Plant spacing is an important factor in determining the micro environment in the fennel field. The optimization of this factor can lead to a higher yield in the crop by favourably affecting the absorption of nutrients and exposure of the plant to the light (Khorshidi *et al*, 2009). Keeping the above fact in view, the experiment was conducted for knowing the optimum row spacing with the N P K fertilization for achieving the higher growth and yield of fennel.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Research Farm, College of Horticulture, Mandsaur during the year 2013-2014. The soil of the experimental field was light black loamy in texture with low nitrogen (140.0 kg/ha), medium in phosphorus (21.0 kg/ha) and low in potassium (144.0 kg/ha) and alkaline in reaction (pH 7.1). The experiment consisted of 3 levels of row spacing 30 cm (S1), 45 cm (S2) and 60 cm (S3) and 4 levels

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of NPK 0+0+0 kg/ha (F1), 30+20+20 kg/ha (F2), 60+40+40 kg/ha (F3), and 120+60+60 kg/ha (F4). These treatments were evaluated in split plot design with four replications. The sowing of crop was done on 10th November, 2013 and harvested on 29th April, 2014. The seeds were treated with carbendezim @ 3 g/kg seed and then sown at a depth of 5 cm in row spaced as per treatment and 30 cm plant to plant using cultivar NRCSS AF - 1.

RESULTS AND DISCUSSION

Effect of row spacing

It was observed that fennel crop under row spacing 45 cm attained significant higher plant height, number of primary, secondary and tertiary branches, fresh and dry weight of plant as compared to other row spacing. These significant variations may be attributed to vigorous vegetative growth, which resulted from favourable climatic conditions. Thus greater inputs under wider spacing (45cm and 60cm) resulted in profuse branching which in turn might have helped in larger canopy development and delayed plants to attain reproductive phase. Significant improvement in growth with increase in spacing was in close conformity with the findings of Yadav *et al* (2002).

It was observed that increase in spacing significantly improved various yield attributes of the crop. Days to 50 per cent flowering, number of umbels per plant, number of umbellets per umbel, 1000 seed weight, seed yield, straw yield and harvest index were improved due to each increase in spacing and the maximum value for these estimates were obtained at the wider row spacing 45 cm, while least under closer spacing 30 cm. Crop grown under row spacing of 45 cm produced significantly higher seed yield (11.60 q/ha) compared to other row spacing. Marked improvement in yield attributes of the crop with increase in spacing appear to be on account of flowering and adequate supply of metabolites due to the increase in biomass per plant might have helped in retention of flower thereby greater seed formation and seed growth. This was ultimately reflected in increased seed yield. Under the 45 cm row spacing improved overall growth of crop and increased crop yield due to increased biomass resulting in higher seed yield. These findings were in close conformity with Yadav and Khurana (2000) and Yadav *et al* (2002) in fennel.

It was observed that increase in row spacing from 30 cm to 60 cm significantly improved the chlorophyll content of leaves. Significantly higher chlorophyll content of leaves under wider row spacing could be ascribed due to availability of large space per plant resulted in profuse vegetative growth and delayed plants to attain reproductive growth. The similar results have also been reported by Menaria and Maliwal (2007) in fennel.

Effect of NPK

Significantly higher plant height, primary, secondary and tertiary braches per plant at harvest and fresh and dry weight per plant was recorded as a result of higher levels of NPK (60:40:40 kg/ha). Thus, increased endogenous level of N P K in plant by virtue of its increased availability in the soil medium and there after efficient absorption and translocation in various growths by way of active cell division and elongation resulting in greater plant height, number of primary and secondary branches. The improvement in morphological parameters under the influence of NPK application might have resulted in larger canopy development and presumably higher chlorophyll content of leaves as nutrient actively participate in its formation. The findings of this investigation were in close conformity with those of Rai *et al* (2002) in fennel, Krishnamoorthy and Madalgiri (2002), Nath *et al* (2008), Naruka *et al* (2012) in ajowan.

Data on yield components of the crop under influence of NPK application indicate that increasing level of NPK up to 60:40:40 kg/ha significantly improved days to 50 per cent flowering, number of umbels per plant, number of umbellets per umbel, number of seeds per umbel, test weight, seed yield. Levels of NPK application indicates that increasing level of NPK up to (120:60:60 kg/ha) significantly improved straw and biological yield. The faster

Table 1. Effect of row spacing and NPK levels on growth and quality of fennel.

Treatment	Plant height (cm)			Branches per plant			Fresh weight/ plant (g)			Dry weight/ plant (g)			Chlorophyll content (mg/g)	
	60 DAS	90 DAS	At harvest	Primary	Secondary	Tertiary	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS
Row spacing														
30 cm	46.14	136.63	152.18	3.44	11.89	14.45	25.82	116.13	206.72	2.86	14.47	106.08	1.26	1.46
45 cm	48.60	140.59	155.04	3.58	12.13	14.55	27.24	119.72	208.90	3.12	15.26	107.26	1.27	1.48
60 cm	50.80	144.68	159.68	3.64	12.14	14.64	27.80	120.66	209.63	3.33	16.07	107.91	1.29	1.50
S.Em ±	0.63	1.42	1.35	0.03	0.05	0.03	0.18	0.44	0.37	0.06	0.21	0.29	0.01	0.01
CD at 5%	2.19	4.91	4.68	0.10	0.18	0.11	0.61	1.53	1.28	0.21	0.74	1.01	0.02	0.02
Levels of NPK (Kg/ha)														
Control (0,0,0,)	45.07	130.93	145.02	3.30	11.79	14.15	25.35	116.46	206.12	2.72	14.39	105.54	1.22	1.40
30, 20, 20	45.98	136.36	150.25	3.53	11.91	14.37	26.93	117.77	207.51	2.94	14.60	105.93	1.24	1.46
60, 40, 40	48.30	143.48	158.78	3.71	12.28	14.81	27.26	119.52	209.67	3.36	15.91	108.41	1.29	1.52
120, 60, 60	54.71	151.75	161.47	3.74	12.43	14.96	28.26	121.60	210.37	3.41	16.16	108.44	1.34	1.55
S.Em ±	0.86	2.20	2.46	0.05	0.11	0.12	0.38	0.80	0.73	0.12	0.41	0.68	0.02	0.02
CD at 5%	2.50	6.38	7.14	0.13	0.32	0.36	1.09	2.33	2.13	0.36	1.19	1.98	0.05	0.04

Table 2. Effect of row spacing and NPK levels on yield attributes, yield and economics of fennel.

Treatment	Umbels/plant			Umbellet/plant			Days to 50% flowering	Seeds / umbel	Test weight (g)	Seed yield (q ha-1)	Straw yield (q ha-1)	Biological yield (q ha-1)	Harvest index (%)	Gross return Rs ha-1	Net return Rs ha-1	B:C ratio
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary										
Row spacing																
30 cm	3.42	12.36	11.07	33.5	27.7	12.23	94.17	428.08	7.92	9.34	22.17	31.71	28.86	84015	60158	2.49
45 cm	3.56	12.85	11.26	33.9	28.2	12.63	93.38	506.53	8.08	11.06	22.72	33.59	31.93	99506	75769	3.10
60 cm	3.59	13.14	11.58	34.3	28.4	13.04	95.04	522.06	8.21	11.40	22.90	34.30	32.07	102611	78994	3.30
S.Em ±	0.03	0.09	0.06	0.14	0.13	0.13	0.19	7.73	0.04	0.17	0.14	0.24	0.34	1546	1546	0.07
CD at 5%	0.11	0.30	0.21	0.48	0.43	0.45	0.64	26.76	0.14	0.59	0.48	0.84	1.19	5352	5352	0.24
Levels of NPK (Kg/ha)																
Control (0,0,0,)	3.18	12.22	10.33	32.7	27.0	11.65	91.88	343.61	7.41	7.64	14.23	21.62	29.63	68722	49182	2.52
30, 20, 20	3.41	12.40	10.93	33.1	27.5	12.35	92.82	493.20	7.99	9.96	20.93	30.89	32.23	89640	67454	3.04
60, 40, 40	3.64	12.88	11.86	34.5	28.9	13.17	95.52	544.05	8.40	12.29	27.16	39.45	31.15	110610	85777	3.45
120, 60, 60	3.87	13.73	12.09	35.3	29.0	13.36	96.57	562.69	8.48	12.50	28.06	40.55	30.80	112537	84148	2.97
S.Em ±	0.06	0.19	0.15	0.35	0.33	0.23	0.81	11.81	0.12	0.26	0.25	0.36	0.54	2362	2362	0.10
CD at 5%	0.17	0.56	0.44	1.00	0.95	0.68	2.35	34.27	0.36	0.76	0.73	1.04	1.58	6854	6854	0.30

growth of plants evidenced from increased biomass per plant at successive stages of crop growth with NPK subscribe to the views that there was better availability of metabolites and nutrients, which synchronized to the demand for the growth and development of each reproductive structure of the fennel plant.

A perusal of results indicated that increasing levels of NPK increased seed yield and straw yield of the crop up to 60:40:40 kg/ha. These increased could be ascribed to its direct influence on dry matter accumulation at successive growth stages while indirect influence seems to be *viz*. improvement in various morphological and yield attributing characters. The present trend of increase in seed yield and straw yield of fennel with the application of NPK were in close conformity with the findings of Rai *et al* (2002), Bagri *et al* (2010) in fennel crop and Krishnamoorthy and Madalgari (2002), Nath *et al* (2008) and Naruka *et al* (2012).

ECONOMICS

The significantly higher gross return of Rs. 99506 and net return of Rs.75769/ ha with a B:C ratio of 3:10 was recorded with row spacing of 45 cm. Similarly significantly higher gross return of Rs. 110610 and net return of Rs. 85777/ha with a B:C ratio of 3.45 was recorded with the application of 60:40:40 Kg N P K/ ha applied to fennel.

CONCLUSION

It may be concluded that 45 cm row spacing and 60+40+40 kg NPK/ha recorded significantly higher growth attributes, yield attributes, yield and quality of fennel as compared to other row spacing and NPK levels tested, respectively.

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