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Influence of nitrogen, phosphorus and potassium levels on growth, seed yield and essential oil content in anise (*Pimpinella anisum* L.)

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Abstract

A field experiment was conducted to study the influence of three levels, each of nitrogen (0, 40 and 80 kg ha^{-1}), phosphorus and potassium (each at 0, 30 and 60 kg ha^{-1}) on growth, seed yield and essential oil content in anise at Horticultural Research Station, University of Agricultural Sciences, Bangalore. The results of the study revealed significant differences among the treatments with respect to growth, seed yield and essential oil content. The interaction of nitrogen at 80 kg ha^{-1}, phosphorus and potassium each at 60 kg ha^{-1} was found to be significant, recording highest values for growth characters like plant height (62.47 cm), number of leaves (33.33) and total leaf area (653.27 cm^2) per plant and yield parameters such as number of fruits per umbel (595.17), size of the umbel (38.93 cm^2) and also seed yield (698 kg ha^{-1}) compared to control (189 kg ha^{-1}). This treatment also gave the highest essential oil yield of 24.41 kg ha^{-1}.

Key words: nitrogen, phosphorus, *Pimpinella anisum*, potassium, crop yield, essential oils.

Anise (*Pimpinella anisum* L.) belonging to the family Apiaceae is one of the most ancient species which was cultivated by the Egyptians, Greeks and Romans. The crop is native of East Mediteranean region and is extensively grown in Central, South and South-East European countries. It was introduced into India during early seventies and grows well as a cold weather annual of 160 to 180 days duration. In India, it is cultivated mainly at Lucknow, Delhi and Indore. Pareek *et al.* (1981) have recommended its commercial cultivation in Malwa tract of Madhya Pradesh. Anise seeds are natural breath sweetners. The seeds are largely employed in the preparation of cordial liquors. The essential oil obtained from the seeds is used in perfumery, soaps and other toilet articles, in perfuming sachets, dental preparations and mouth washes. Medicinally anise can be used as a treatment for cough, bronchitis and *asthma*.

There is a growing demand for the seed and its oil which necessitates its cultivation on a commercial scale. Hence, the present investigation was conducted with a view to determine the optimum fertilizer requirement for maximum productivity of anise.

The field experiment was conducted at the Aromatic Crops Garden of the Horticultural Research Station, Gandhi Krishi Vigyana Kendra, Bangalore during the winter season of 2000-2001. The soil of the experimental site was red sandy loam having pH 6.12, EC 0.05 m mhos cm^{-1} and 0.35 per cent organic carbon. The soil had 190, 149 and 26 kg ha^{-1} available

nitrogen, phosphorus and potassium, respectively. The treatments consisted of three levels each of N (0, 40 and 80 kg ha^{-1}), P_2O_5 and K_2O (0, 30 and 60 kg ha^{-1} each) and the experiment was laid out in a factorial Randomized Complete Block Design with three replications. Nitrogen was supplied in the form of urea in two split doses (50 per cent each at 20 and 90 days after sowing). The seeds were sown in rows at 45 cm apart and with a plant to plant spacing of 20 cm. Observations were recorded on different growth and yield attributes and the seed and essential oil yields per hectare were also determined. The data were subjected to statistical analysis.

The different levels of nitrogen, phosphorus, potassium and their combinations significantly increased the plant height, number of branches, number of leaves and leaf area per

Table 1. Main and interaction effects of nitrogen, phosphorus and potassium on plant growth characteristics (120 DAS) in anise

Treatment	Plant height (cm)	Number of leaves $plant^{-1}$	Leaf area (cm^2)
Nitrogen (kg ha^{-1})			
0 (N)	51.14	27.19	496.10
40 (N^0)	53.01	28.43	552.23
80 (N^1)	54.72	30.56	577.65
F-test	*	*	*
SEm±	0.431	0.452	13.209
C.D at 5%	1.222	1.281	37.430
Phosphorus (kg ha^{-1})			
0 (P)	51.33	27.30	527.33
30 (P^0)	53.96	29.02	576.07
60 (P^1)	53.58	27.86	577.65
F-test	*	*	*
SEm±	0.431	0.452	13.209
C.D at 5%	1.222	1.281	37.430
Potassium (kg ha^{-1})			
0 (K)	53.06	27.10	536.75
30 (K^0)	53.06	28.62	534.02
60 (K^1)	52.74	29.46	555.21
F-test	NS	*	NS
SEm±	0.431	0.452	13.209
C.D at 5%	-	1.281	-

Interactions	K_0	K_1	K_2	K_0	K_1	K_2	K_0	K_1	K_2
N_0P_0	43.37	53.27	53.67	26.27	27.33	29.00	362.23	478.00	508.44
N_0P_1	52.67	50.27	52.67	27.13	30.27	27.80	522.18	587.89	518.26
N_0P_2	50.40	56.67	47.27	30.07	21.93	26.87	605.12	392.35	490.43
N_1P_0	52.60	54.60	46.03	25.27	27.20	23.97	537.56	523.44	460.43
N_1P_1	58.80	54.53	51.93	23.80	32.27	30.33	520.36	603.09	723.59
N_1P_2	54.07	50.07	54.53	29.53	23.93	30.53	593.55	434.09	573.59
N_2P_0	55.87	51.43	51.20	32.13	30.57	27.93	725.52	613.22	536.64
N_2P_1	56.67	53.20	54.93	25.08	31.18	29.33	471.96	649.10	588.56
N_2P_2	53.13	53.60	62.47	28.60	26.90	33.33	492.63	524.98	653.27
F-test		*			*			*	
SEm±		1.294			0.1356			39.627	
C.D at 5%		3.586			3.758			109.52	

NS = Non-significant; * = Significant at 5% level

plant (Table 1). Among the different levels of nitrogen the higher doses increased the growth attributes significantly. Nitrogen at the maximum level (80 kg ha^{-1}) increased the plant height (54.72 cm), number of leaves (30.56), and total leaf area (577.65 cm^2) per plant compared to control (51.14 cm, 27.19 and 496.10 cm^2, respectively). Phosphorus also at its maximum level (60 kg ha^{-1}) significantly increased the total leaf area. However, its application at 30 kg ha^{-1} recorded maximum plant height (53.96 cm) and number of leaves per plant (29.02). Potassium at the intermediate level (30 kg ha^{-1}) recorded the maximum plant height (53.06 cm) but maximum number of leaves (29.46) and total leaf area (555.21 cm^2) per plant were noticed in plants supplied with the maximum (60 kg ha^{-1}) dose of potassium. The combination of NPK at 80:60:60 kg ha^{-1} significantly enhanced the plant height (62.47 cm), number of leaves (33.33) and total leaf area (653.27 cm^2) per plant. This increase in the growth of the plants might be due to the availability of adequate amounts of nutrients at the right time that contributed for accumulation of food reserves in plants which in turn was expressed in growth parameters. Similar results have been obtained by Afridi *et al.* (1978) in dill, Ramesh *et al.* (1989) in isabgol, Sudheendra (1993) in celery, Ramesh *et al.* (1996) in kalmegh, Sreeramu & Farooqi (1996) in roselle and Lakshmipathaiah (1998) in babchi.

The yield characters were significantly influenced by increased rates of nitrogen application (Table 2). The maximum number of umbels per plant (51.72), umblets per umbel (32.76), number of fruits per umbel (535.61), 1000 seed weight (4.26 g), and harvest index (0.17) were obtained in plots supplied with nitrogen at 80 kg ha^{-1}. Seed yield per plant (7.66 g) and per hectare (637 kg) were also highest in plots supplied with maximum dose of nitrogen (Table 3). The increase in the seed yield could be attributed to the increased plant height, number of leaves and leaf area per plant at higher levels of nitrogen. These results are in conformity with the findings of Sudheendra *et al.* (1993) and Lakshmipathaiah (1998) in celery and babchi, respectively. The maximum essential oil yield (13.48 kg ha^{-1}) was recorded in plants supplied with 80 kg ha^{-1} of nitrogen. The results are in accordance with the findings of Sethi (1985) and Singh *et al.* (1987) in anise and dill, respectively.

Application of phosphorus at 60 kg ha^{-1} resulted in the maximum number of umblets per umbel (30.36), fruits per umbel (477.55) and harvest index (0.14). Seed yield per plant (5.81 g) and per hectare (4.84 kg) were also maximum in plots supplied with phosphorus @ 60 kg ha^{-1}. Maximum essential oil content (2.79%) and essential oil yield (14.07 kg ha^{-1}) were observed at the same dose of phosphorus which might be due to the positive influence of phosphorus on growth attributes. Similar kind of results have been reported by Subramanian & Kumar (1998) in coriander. Potassium at 60 kg ha^{-1} also significantly increased the number of umbels per plant (44.86), umblets per umbel (30.20) and fruits per umbel (476.18). The maximum seed yield per plant (6.13 g) and per hectare (511 kg) as well as essential oil yield (15.03 kg ha^{-1}) were obtained with the maximum dose of potassium.

The interactions between N, P and K also had a significant effect on growth as well as yield attributes. A combination of NPK at 80:60:60 kg ha^{-1} recorded higher values for growth characters such as plant height (62.47 cm), number of leaves (33.33) and total leaf area (653.27 cm^2) per plant and yield parameters like number of fruits per umbel (595.17) and size of the umbel (38.93 cm^2). The maximum seed yield (6.98 kg ha^{-1}) and essential oil yield (24.41 kg ha^{-1}) were also found in the same combination of nutrients. Therefore, application of NPK at 80:60:60 kg ha^{-1} ($N_2P_2K_2$) is found optimum for obtaining the maximum growth, seed and essential oil yield from anise under Bangalore conditions.

Table 2. Main and interaction effects of nitrogen, phosphorus and potassium on number of umbels per plant, number of umblets per umbel and number of fruits per umbel in anise

Treatment	No. of umbles plant^{-1}			No. of umblets umbel^{-1}			No. of fruits umbel^{-1}		
Nitrogen (kg ha^{-1})									
0 (N_0)	33.660			24.770			329.340		
40 (N_1)	46.300			31.350			513.800		
80 (N_2)	51.720			32.760			535.610		
F-test	*			*			*		
SEm±	00.454			00.333			013.514		
C.D at 5%	01.285			00.943			038.295		
Phosphorus (kg ha^{-1})									
0 (P_0)	40.730			29.140			448.300		
30 (P_1)	46.060			29.380			452.890		
60 (P_2)	45.390			30.360			477.550		
F-test	*			*			NS		
SEm±	00.454			00.333			013.514		
C.D at 5%	01.285			00.943			-		
Potassium (kg ha^{-1})									
0 (K_0)	43.220			29.120			432.520		
30 (K_1)	43.600			29.550			470.040		
60 (K_2)	44.860			30.200			476.180		
F-test	*			NS			NS		
SEm±	00.454			00.333			013.514		
C.D at 5%	01.285			-			-		
Interactions	K_0	K_1	K_2	K_0	K_1	K_2	K_0	K_1	K_2
N_0P_0	43.37	53.27	53.67	26.27	27.33	29.00	362.23	478.00	508.44
N_0P_0	25.25	30.10	31.43	18.00	24.62	28.40	218.62	293.80	436.17
N_0P_1	32.73	32.90	36.68	23.75	24.52	25.68	308.00	367.35	302.08
N_0P_2	37.32	38.00	38.48	26.27	25.45	26.25	331.80	315.95	390.25
N_1P_0	38.03	39.55	44.85	30.12	29.42	29.82	422.18	538.83	418.67
N_1P_1	43.00	53.08	56.83	31.57	32.57	30.83	545.20	550.83	418.67
N_1P_2	51.58	48.30	41.78	32.73	32.17	32.93	483.98	562.33	583.67
N_2P_0	55.20	47.92	49.77	37.83	32.22	31.83	654.67	483.18	468.58
N_2P_1	54.83	51.88	52.55	30.17	32.90	32.42	441.83	569.72	572.50
N_2P_2	51.32	50.67	51.32	31.67	32.13	32.67	486.42	548.40	595.17
F-test		*			*			*	
SEm±		1.361			0.998			40.543	
C.D at 5%		3.772			2.766			112.362	

NS = Non-significant; * = Significant at 5% level

Table 3. Main and interaction effects of nitrogen, phosphorus and potassium on the yield of seed and essential oil in anise

Treatment	Seed yield (g plant^{-1})	Seed yield (kg ha^{-1})	Essential oil yield (kg ha^{-1})
Nitrogen (kg ha^{-1})			
0 (N_0)	3.370	2.810	07.270
40 (N_1)	5.380	4.480	12.270
80 (N_2)	7.660	6.370	13.480
F-test	*	*	*
SEm±	0.063	0.051	00.064
C.D at 5%	0.180	0.144	00.181
Phosphorus (kg ha^{-1})			
0 (P_0)	5.050	4.210	10.940
30 (P_1)	5.550	4.610	13.000
60 (P_2)	5.810	4.840	14.070
F-test	*	*	NS
SEm±	0.063	0.051	00.064
C.D at 5%	0.180	0.144	-
Potassium (kg ha^{-1})			
0 (K_0)	4.930	4.110	10.880
30 (K_1)	5.320	4.430	12.100
60 (K_2)	6.130	5.110	15.030
F-test	*	*	*
SEm±	0.063	0.051	00.064
C.D at 5%	0.180	0.144	00.181

Interactions	K_0	K_1	K_2	K_0	K_1	K_2	K_0	K_1	K_2
N_0P_0	2.26	2.43	3.67	1.89	2.02	3.06	4.43	5.05	8.12
N_0P_1	3.17	3.56	3.92	2.64	2.97	3.27	6.71	7.69	8.67
N_0P_2	3.09	3.69	4.50	2.57	3.08	3.75	6.59	8.11	10.07
N_1P_0	4.75	4.76	5.88	3.96	3.97	4.90	9.78	10.39	13.26
N_1P_1	4.38	5.64	6.38	3.65	4.70	5.32	10.05	12.30	15.18
N_1P_2	5.01	5.25	6.34	4.17	4.38	5.29	11.30	12.16	15.91
N_2P_0	6.65	7.07	7.68	5.58	5.89	6.27	13.99	15.33	18.08
N_2P_1	7.12	7.36	8.20	5.93	6.13	6.87	16.88	18.00	21.56
N_2P_2	7.94	8.09	8.37	6.62	6.75	6.98	18.23	19.83	24.41
F-test		*			*			NS	
SEm±		0.190			0.152			1.181	
C.D at 5%		0.525			0.420			-	

NS = Non-significant; * = Significant at 5% level

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