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Effect of nitrogen and phosphorus on growth, yield and quality of black cumin (*Nigella sativa* L.)

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ABSTRACT

A field experiment was conducted during *rabi* season of 2010-11 to find out the effect of nitrogen and phosphorus on growth, yield and quality of black cumin. Among the varieties, AN-1 recorded maximum value for number of capsules per plant (30.30), number of seeds per capsules (60.33), test weight (1.46 g), seed yield (4.88 q/ha), straw yield (12.48 q/ha), harvest index (27.89 %) and biological yield (17.36 q/ha) as compared to local cultivar of nigella. Maximum plant height at harvest (45.95 cm), number of branches per plant at harvest (17.30), fresh weight per plant at 60 DAS (13.08 g) and dry weight of shoot per plant at 60 DAS (3.21 g) were recorded with the application of fertilizer 60: 120 kg ha^{-1} N, P followed by 45: 90 kg ha^{-1} N, P and lowest in control at all the growth stages. Therefore, the application of 60 kg ha^{-1} N and 120 kg ha^{-1} P fertilizer with the variety AN-1 gave the maximum growth, yield and quality of nigella with the highest net return per hectare.

Key words : Nigella (*Nigella sativa*), Nitrogen, Phosphorus, yield, quality

INTRODUCTION

Nigella (*Nigella sativa* L.) is a minor and annual herbaceous seed spice crop belonging to the family Ranunculaceae. It is widely cultivated throughout South Europe, Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkey (Riaz *et. al.*10). In India, it is commercially cultivated in Punjab, Himachal Pradesh, Madhya Pradesh, Jharkhand, Assam, West Bengal and Andhra Pradesh (Vijay and Malhotra, 16). In India nigella seeds used as preservative in all sorts of homemade pickles. The oil of nigella seed has also demand in the pharmaceutical and perfumery industry. The main alkaloids present in nigella seeds are nigellmin, nigellidin, nigellicine and possess anticarcinogenic properties. In M.P., it is mostly cultivated in Mandsaur, Neemuch and Sajapur districts. Availability of nitrogen is of prime importance for growing plants as it is a major and indispensable constituent of protein and nucleic acid molecules (Troug, 15). An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs finally lead to higher productivity. Application of phosphorus was found to increase plant height, number of branches, fresh and dry weight and essential oil content of black cumin (Sushama and Jose, 13). Therefore, the present study was undertaken to study the effect of nitrogen, phosphorus and suitability of different cultivars on growth yield and quality of nigella.

MATERIALS AND METHOD

The field experiment was conducted during the *rabi* season of 2010-2011 at the "Bahadari farm", College of Horticulture, RVSKVV, Mandsaur (Madhya Pradesh). Mandsaur is situated in Malwa plateau in Western part of Madhya Pradesh at latitude of 23.45^{0}N to 24.13^{0}N and 74.44^{0}E to 75.18^{0}E longitudes and an altitude of 435.02 meters above mean sea level. This region falls under Agro climatic zone no.10 of the state. Ten treatment combinations comprising five doses each of nitrogen and phosphorus along with two varieties were taken in randomized block design with factorial approaches. The observations on growth and yield parameters were taken on plant height, number of branches/plant, fresh and dry weight of shoot (g), number of capsules/plant, number of seeds/capsule, days taken to 50% flowering, test weight (g), seed yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%). The quality parameters were analyzed *viz.,* N, P and K content (%) of seed, protein content (%) of seed and Volatile oil content of seed. The nitrogen content was estimated by micro kjeldhal method (Black, 3), phosphorus was estimated as the method developed by Jackson, (6), potassium content was determined by flame photo metrically (Chapman and Pratt, 5) and volatile oil content was determinate by using essential oil distillation assembly. The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by Pansey and Sukhatme (8).

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RESULTS AND DISCUSSION

Effect of cultivars

The data presented in Table 1 showed that significantly higher plant height at 30, 60 DAS and at harvest (44.49 cm), number of branches per plant at 30, 60 DAS and at harvest (16.71), fresh weight of shoot (g) per plant at 30 and 60 DAS (13.01g) and dry weight of shoot (g) per plant at 30, 60 DAS and at harvest (9.69g) was recorded more with AN-1 cultivar at all the three growth stages as compared to local cultivar of nigella.

Both the varieties were significantly differ with respect number of capsules per plant, number of seeds per capsules, test weight , seed yield, straw yield, harvest index, biological yield (Table-1). Variety AN-1 recorded maximum value for number of capsules per plant (30.30), number of seeds per capsules (60.33), test weight (1.46 g), seed yield (4.88 q/ha), straw yield (12.48 q/ha), harvest index (27.89 %) and biological yield (17.36 q/ha) as compared to local cultivar of nigella. Higher photosynthetic area, more dry matter accumulation might have resulted in highest yields parameters and yield in variety AN-1. Similar findings were also reported by Ashraf *et al.* (2) and Tank *et al,* (14) in nigella crop. N, P, K and content in AN 1 was more than local cultivars (Table-2).

Effect of fertilizers

Data presented in Table 1 revealed that the application of fertilizer levels exerted significant influence on growth parameters. Maximum plant height at harvest (45.95 cm), number of branches per plant at harvest (17.30), fresh weight per plant at 60 DAS (13.08 g) and dry weight of shoot per plant at 60 DAS (3.21 g) were recorded under application of fertilizer level in F_5 (60: 120 kg/ha N, P) followed by F_4 (45: 90 kg/ha N, P) and lowest in control i.e. F_1 (0: 0 kg/ha N, P) at all the growth stages. Higher levels of nitrogen fertilization may be attributed to better nutritional environment in the root zone as well as in the plant system. The biological role of nitrogen as an essential constituent of chlorophyll in harvesting solar energy, phosphorylated compounds in energy transformations, nucleic acids in the transfer of genetic information and the regulation of cellular metabolism and of protein as structural units and biological catalysts is well known.

The data in the Table 1 revealed that increase in levels of fertilizers increases the yield and yield attributes of nigella significantly. The maximum value for number of capsules per plant (31.58), number of seeds per capsules (63.40), test weight (1.51 g), seed yield (5.90 q ha^{-1}), straw yield (13.12 q ha^{-1}), harvest index (31.00 %) and biological yield (19.02 q ha^{-1}) were observed with the F_5 (60: 120 kg/ ha N, P) level of fertilizer, followed by F_4 (45: 90 kg/ha N, P) and lowest in control. Increased yield may be due to role of fertilizer in improving uptake of nutrient by root system, increased chlorophyll content, photosynthesis activity and protein content in crop plants. These findings are also supported by Rai *et al.* (9) and Bommi *et al.* (4).

A perusal of data in Table 2 indicated that higher level of fertilizer was significantly superior to other treatment with respect to quality attributes viz., N, P, K, protein content and volatile oil content in seeds of nigella. Maximum value for N (3.71 %), P (0.037 %) and K (0.25 %), protein (23.18 %) and Volatile oil (0.93 %)content in seed were found more with F_5 (60: 120 kg ha^{-1} N, P) level of fertilizer application, followed by F_4 (45: 90 kg ha^{-1} N, P) and the lowest in F_1 (0: 0 kg ha^{-1} N, P). Similar findings were also reported by Ashraf *et al.* (1), and Sultan *et al*. (12) in nigella crop.

Interaction effect of cultivars and fertilizer levels

Table 1 reveals that combined effect of varieties and fertilizer levels exerted significant influence on growth parameters of nigella. The Maximum plant height (46.71 cm), number of branches per plant (17.61), fresh weight (13.11 g) and dry weight (10.57 g) of shoot per plant were recorded in cultivar AN-1 fertilized with F_5 (60: 120 kg.ha^{-1} N, P) level of fertilizer. Similar findings were also reported by Shah, (11) in nigella.

Combined effect of varieties and fertilizer levels showed significant influence on yield and yield attributes of nigella (Table 1). Maximum number of capsules per plant (32.25), number of seeds per capsules (65.00), test weight (1.54 g), seed yield (6.20 q.ha^{-1}), straw yield (13.47 q.ha^{-1}), biological yield (19.67 q.ha^{-1}) and harvest index (31.48 %), were found in variety AN-1 fertilized with F_5 (60: 120 kg.ha^{-1} N, P) level of fertilizer. These findings are also supported by Shah, (11) and Mollafilabi *et al.* (7) in nigella crop. Combined effect of varieties and fertilizer levels exhibited significant influence on quality attributes of nigella. Maximum value for N content (3.91 %), P content (0.039 %), Protein content (24.44 %) and Volatile oil content (0.96 %) in seed was found in variety AN-1 fertilized with F_5 (60: 120 kg ha^{-1} N, P) level of fertilizer application. However non-significant influence on K content (%) of seed was observed. These findings were also supported by Ashraf *et al.* (1) and Sultan *et al*. (12). In case of N, P, K, protein and volatile the interaction effect of varieties and fertilizer level found non significant, so results are not presented.

Benefit:cost ratio of different treatment combinations presented in Table 3 clearly reveals that V_1F_5 resulted in maximum net profit of Rs. 68367 ha^{-1} with a B: C ratio of 4.89:1 which was followed by V_1F_4 treatment combination result in net profit of Rs. 59860 with a B: C ratio of 4.71:1.

Thus, it can be concluded that higher doses of N and P have more yield and quality of AN 1 as well as highest return per hactare.

Table 1. Effect of N and P levels on growth and yield of nigella varities

Treatment	Plant height at harvest (cm)	No. of branches at harvest	Fresh wt at 60 days	Dry wt. at harvest	No. of capsule /Plant	No. of seeds/capsule	Test wt(g)	Seed yield (q/ha.)	Straw yield (q/ha.)	Biological yield (q/ha.)	Harvest index
Varieties											
V_1 (NRCSS AN-1)	44.49	16.71	13.01	9.69	30.30	60.33	1.46	4.88	12.48	17.36	27.89
V_2 (Local kalonji)	43.61	16.36	12.93	9.32	29.53	58.47	1.41	4.39	12.05	16.44	26.32
S.Em±	0.129	0.051	0.016	0.052	0.115	0.277	0.012	0.05	0.067	0.11	0.15
CD at 5%	0.383	0.152	0.048	0.153	0.341	0.823	0.035	0.16	0.20	0.34	0.45
Fertilizer level (F)											
F_1 (0: 0 kg/ha N,P)	41.27	15.42	12.77	8.37	27.48	53.52	1.29	3.21	11.03	14.24	22.42
F_2 (15: 30 kg/ha N,P)	42.76	16.02	12.93	8.98	28.78	56.65	1.40	4.11	11.72	15.83	25.99
F_3 (30: 60 kg/ha N,P)	44.84	16.85	13.03	9.83	30.61	61.06	1.47	4.70	12.60	17.30	27.18
F_4 (45: 90 kg/ha N,P)	45.45	17.09	13.06	10.07	31.15	62.35	1.49	5.25	12.87	18.12	28.95
F_5 (60: 120 kg/ha N,P)	45.95	17.30	13.08	10.27	31.58	63.40	1.51	5.90	13.12	19.02	31.00
S.Em±	0.204	0.081	0.026	0.082	0.182	0.438	0.019	0.08	0.10	0.18	0.24
CD at 5%	0.605	0.240	0.077	0.243	0.540	1.302	0.056	0.26	0.31	0.54	0.71
Interaction of Varieties (V) and Fertilizer levels (F)											
T_1 (V_1F_1)	42.12	15.76	12.90	8.73	28.21	55.29	1.38	3.69	11.48	15.17	24.34
T_2 (V_1F_2)	42.90	16.07	12.93	9.03	28.90	56.95	1.40	4.20	11.76	15.95	26.32
T_3 (V_1F_3)	44.88	16.87	13.03	9.87	30.65	61.15	1.47	4.88	12.61	17.49	27.89
T_4 (V_1F_4)	45.86	17.26	13.08	10.23	31.51	63.24	1.51	5.44	13.07	18.51	29.41
T_5 (V_1F_5)	46.71	17.61	13.11	10.57	32.25	65.00	1.54	6.20	13.47	19.67	31.48
T_6 (V_2F_1)	40.42	15.09	12.65	8.00	26.75	51.75	1.20	2.73	10.57	13.30	20.50
T_7 (V_2F_2)	42.61	15.96	12.92	8.93	28.65	56.35	1.39	4.03	11.67	15.70	25.66
T_8 (V_2F_3)	44.80	16.83	13.02	9.80	30.57	60.98	1.47	4.53	12.58	17.10	26.46
T_9 (V_2F_4)	45.03	16.93	13.03	9.90	30.78	61.47	1.48	5.05	12.68	17.73	28.48
T_{10} (V_2F_5)	45.19	16.99	13.04	9.97	30.92	61.81	1.48	5.61	12.77	18.37	30.51
S.Em±	0.288	0.114	0.036	0.115	0.257	0.620	0.027	0.12	0.15	0.25	0.34
CD at 5%	0.857	0.339	0.108	0.343	0.763	1.841	0.079	0.36	0.44	0.76	1.00

Table 2. Effect of N and P levels on qulity of nigella varities

Treatment	N (%) content in seed	P (%) content in seed	K (%) content in seed	Oil (%) content in seed	Protein (%) content in seed
Varieties					
V_1 (NRCSS AN-1)	3.32	0.033	0.177	0.87	20.77
V_2 (Local Kalonji)	3.09	0.031	0.165	0.83	19.31
S.Em±	0.034	0.0003	0.0021	0.004	0.21
CD at 5%	0.102	0.0010	0.0061	0.013	0.63
Fertilizer level (F)					
F_1 (0: 0 kg/ha N,P)	2.47	0.025	0.13	0.74	15.42
F_2 (15: 30 kg/ha N,P)	2.86	0.029	0.14	0.80	17.89
F_3 (30: 60 kg/ha N,P)	3.42	0.034	0.15	0.88	21.36
F_4 (45: 90 kg/ha N,P)	3.58	0.036	0.19	0.91	22.37
F_5 (60: 120 kg/ha N,P)	3.71	0.037	0.25	0.93	23.18
S.Em±	0.054	0.00054	0.0032	0.007	0.33
CD at 5%	0.162	0.0016	0.0096	0.021	1.00

Table 3. Benefit-cost ratio of different treatment combinations in Nigella

Treatment	Common Expenditure (Rs/ha)	Expenditure on fertilizer and variety (Rs/ha)	Cost of cultivation (Rs/ha)	Gross return/ha (Rs.)	Net profit (Rs/ha)	Cost : Benefit ratio
V_1F_1	10740	1040	11780	52605	40825	4.47
V_1F_2	10740	2490	13230	59259	46029	4.48
V_1F_3	10740	3940	14680	68442	53762	4.66
V_1F_4	10740	5390	16130	75990	59860	4.71
V_1F_5	10740	6839	17579	85946	68367	4.89
V_2F_1	10740	880	11620	34221	22601	2.95
V_2F_2	10740	2330	13070	48999	35929	3.75
V_2F_3	10740	3780	14520	54824	40304	3.78
V_2F_4	10740	5230	15970	60622	44652	3.80
V_2F_5	10740	6679	17419	66780	49361	3.83

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