

Effect of phosphorus and plant growth regulators on growth and yield of fenugreek (*Trigonella foenum-graecum* L.)

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Abstract

A field experiment was conducted at Mandsaur (Madhya Pradesh) to find out the effect of phosphorus and plant growth regulators on growth and yield of fenugreek (*Trigonella foenum-graecum*). The results indicated that significantly higher growth and yield (17.62 q ha⁻¹) were observed with application of 60 kg phosphorus ha⁻¹. Foliar spray of naphthalene acetic acid (NAA) 20 ppm at 25 days after sowing (DAS) and 55 DAS resulted in significantly higher growth and seed yield (17.41 q ha⁻¹). The highest benefit : cost ratio (4.20:1) was observed for the treatment, 60 kg phosphorus ha⁻¹ + NAA 20 ppm.

Keywords: fenugreek, growth, growth regulator, *Trigonella foenum-graecum*, yield.

The Malwa plateau in Madhya Pradesh contributes a major share of fenugreek production (*Trigonella foenum-graecum* L.) in the state. Plant growth and seed yield increased in fenugreek when phosphorus was applied @ 60 kg ha⁻¹ and sprayed with naphthalene acetic acid (NAA) @ 20 ppm (Purbey & Sen 2005). Spraying of plant growth regulators in other seed spice crops such as NAA in coriander (Pareek 1996), and gibberellic acid (GA₃) in cumin (Omer *et. al.* 1997) have been reported to improve growth and seed yield. The present investigation was carried out to study the effect of phosphorus and plant growth regulators on growth and yield of fenugreek.

The experiment was conducted at Bahaduri Farm, College of Horticulture, Mandsaur, (Madhya Pradesh) (23°45' to 24°13' N latitude and 74°44' to 75°18' E longitude at an elevation of 435 m above MSL) during the *rabi* season of 2007-08. The climate of this zone is sub-tropical and average rainfall per year is 544 mm of which 90% is received during July to September. The maximum and minimum temperature during the study period was 34.24°C and 5.27°C, respectively. The mean daily maximum and minimum relative humidity varied between 65.7% to 75.9%. The soil of the experimental site was loamy in texture, with low in available nitrogen and phosphorus and high in potassium status. The experiment was laid out in a factorial randomized block design

consisting of 12 treatment combinations with 3 replications. The 12 treatment combinations consisted 3 levels of phosphorus (20, 40 and 60 kg P₂O₅ ha⁻¹) and foliar application of 4 plant growth regulators namely, NAA 20 ppm, GA₃ 50 ppm, ethrel 75 ppm and distilled water spray. All the plant growth regulator treatments were sprayed at 25 and 55 days after sowing (DAS).

The seed was sown manually on 11th October 2007 in rows at a spacing of 30 cm, and the plants were thinned to 10 cm, 20 DAS and the crop was harvested on 6th March 2008. The variety RMt-1 was used for study. A uniform dose of 30 kg nitrogen ha⁻¹ was applied as urea and 25 kg potassium ha⁻¹ applied as muriate of potash at the time of field preparation and the different levels of phosphorus (20, 40 and 60 kg ha⁻¹) was given as di-ammonium phosphate (DAP). The plant growth regulators prepared in desired stock solution were sprayed twice (at 25 DAS and 55 DAS). Observations were recorded on growth parameters namely, plant height, number of branches, fresh and dry weight of plant and yield and yield attributes.

Effect of phosphorus

The plant growth attributes of fenugreek were highly influenced by the application of different levels of phosphorus (Table 1). Application of 60 kg phosphorus ha⁻¹ resulted in significantly higher plant height (14.09, 43.28 and 77.42 cm), number of branches (4.17, 7.38 and 7.38), fresh weight of plant (88.63, 1129.07 and 3173.22 g per m²) and dry weight of plant (13.69, 202.28 and 967.70 g per m²) at 30 and 60 DAS and at harvest, respectively. The yield and yield attributes were also influenced significantly as a result of phosphorus application @ 60 kg ha⁻¹ (Table 2). The application of phosphorus @ 60 kg ha⁻¹ resulted in minimum number of days to complete 50% flowering (53.17 days). This treatment also resulted in maximum pods plant⁻¹ (29.96), number of seeds pod⁻¹ (17.47), test weight (14.99 g), biological yield (66.22

Table 1. Effect of phosphorus and plant growth regulators on growth and yield of fenugreek

Treatment	Growth parameters											
	Plant height (cm)			No. of branches plant ⁻¹			Fresh weight (g per m ²)			Dry weight (g per m ²)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
<i>Phosphorus (kg ha⁻¹)</i>												
20	12.34	36.83	69.24	3.49	5.71	5.71	67.27	1008.49	2859.70	8.85	150.23	763.09
40	13.59	41.92	75.27	4.07	6.77	6.77	80.80	1092.31	3047.52	11.37	183.56	826.16
60	14.09	43.28	77.42	4.17	7.38	7.38	88.63	1129.07	3173.22	13.69	202.28	967.70
SEm±	0.081	0.249	0.594	0.033	0.061	0.061	0.582	06.322	08.793	0.120	1.947	4.498
CD (P=0.05)	0.237	0.730	1.743	0.099	0.181	0.181	1.769	18.543	25.790	0.352	5.713	13.182
<i>Growth regulator</i>												
Water spray (Control)	13.07	38.34	71.69	3.70	6.23	6.23	75.63	1070.87	2972.01	10.43	165.15	844.03
20 ppm NAA	13.36	42.14	74.78	4.08	7.08	7.08	80.56	1097.37	3070.40	11.98	191.37	864.94
50 ppm GA ³	13.96	42.97	76.75	3.99	6.62	6.62	80.17	1069.78	3054.50	11.69	187.36	852.05
75 ppm Ethrel	13.08	39.27	72.68	3.88	6.54	6.54	79.76	1068.48	3010.34	11.12	170.88	847.37
SEm±	0.093	0.287	0.686	0.039	0.071	0.071	0.671	07.300	10.154	0.138	2.249	5.193
CD (P=0.05)	0.274	0.834	2.013	0.114	0.209	0.209	1.969	21.411	29.780	0.406	6.597	15.233

DAS=Days after sowing; NAA=Naphthalene acetic acid; GA₃=Gibberellic acid

Table 2. Effect of phosphorus and plant growth regulators on growth and yield of fenugreek

Treatment	Yield parameters							
	Days to 50% flowering	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	Test weight (g)	Seed yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest index (%)
<i>Phosphorus (kg ha⁻¹)</i>								
20	53.07	28.37	15.40	12.97	14.90	45.52	60.42	24.87
40	53.48	29.53	16.51	14.02	16.65	47.73	64.88	25.71
60	53.17	29.96	14.47	14.99	17.62	48.60	66.22	26.68
SEm±	0.107	0.218	0.073	0.188	0.082	0.146	0.367	0.219
CD (P=0.05)	0.314	0.639	0.215	0.260	0.240	0.428	1.077	0.643
<i>Growth regulator</i>								
Water spray (Control)	56.46	24.87	15.18	13.11	15.17	42.54	57.71	26.52
20 ppm NAA	51.51	32.69	17.87	13.98	17.41	50.47	68.55	25.38
50 ppm GA ³	49.41	29.81	17.36	14.96	16.57	48.28	64.81	25.62
75 ppm Ethrel	55.58	29.77	15.42	13.90	16.40	47.88	64.28	25.49
SEm±	0.123	0.251	0.084	0.102	0.094	0.168	0.424	0.253
CD (P=0.05)	0.363	0.738	0.248	0.301	0.277	0.494	1.244	0.743

DAS=Days after sowing; NAA=Naphthalene acetic acid; GA₃=Gibberellic acid

q ha⁻¹), seed yield (17.62 q ha⁻¹), straw yield (48.60 q ha⁻¹) and harvest index (26.68%). The findings of the present investigation are in conformity with those of Pareek & Gupta (1981) and Mandal & Maiti (1992) in fenugreek, who reported that plant height, number of branches plant⁻¹, fresh weight of plant and dry weight of plant increased significantly with phosphorus fertilization.

Effect of plant growth regulators

The application of plant growth regulators significantly improved vegetative growth of fenugreek (Table 1). Among the different plant growth regulator treatments, GA³ @ 50 ppm at 30 and 60 DAS and at harvest significantly increased plant height (13.96, 42.97 and 76.75 cm, respectively). Application of 20 ppm NAA significantly increased the number of branches at 30 and 60 DAS and at harvest (4.08, 7.08 and 7.08, respectively), fresh weight of plant (80.56, 1097.37 and 3070.40 g per m²) at 30 and 60 DAS and at harvest, respectively and dry weight of plant (11.98, 191.37 and 864.94 g per m²) at 30 and 60 DAS and at harvest, respectively. The yield and

yield attributes were also influenced significantly as a result of application of plant growth regulators (Table 2). Application of GA³ @ 50 ppm at 25 DAS resulted in minimum days to complete 50% flowering (49.41 days) and test weight (14.96 g). Foliar application of NAA @ 20 ppm resulted in maximum pods plant⁻¹ (32.69), number of seeds pod⁻¹ (17.87), biological yield (68.55 q ha⁻¹), seed yield (17.41 q ha⁻¹) and straw yield (50.47 q ha⁻¹). Significantly highest harvest index (26.52%) was recorded in water spray (control). The treatment combination 60 kg phosphorus ha⁻¹ + 20 ppm NAA resulted in the highest Benefit : Cost ratio of 4.20:1 (Table 3). El-Keltwai (2000) also reported that foliar application of GA₃ encourages plant growth and gave significantly highest plant height at all stages of growth in cumin.

The study indicated that application of 60 kg P₂O₅ ha⁻¹ and foliar spray of NAA 20 ppm at 25 DAS and 55 DAS gave significantly higher growth and yield of fenugreek under loamy soil condition of Mandsaur (Madhya Pradesh).

Table 3. Economics of application of phosphorus and plant growth regulators in fenugreek

Treatment	Common expenditure (Rs ha ⁻¹)	Extra expenditure (Rs ha ⁻¹)	Total cost of cultivation (Rs ha ⁻¹)	Seed yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Gross income (Rs ha ⁻¹)	Net income (Rs ha ⁻¹)	Benefit : Cost ratio
20 kg P ₂ O ₅ + Water spray	8692	426	9118	13.33	41.11	30160	21042	3.30:1
40 kg P ₂ O ₅ + Water spray	8692	852	9544	15.87	43.00	35016	25471	3.66:1
60 kg P ₂ O ₅ + Water spray	8692	1278	9970	16.26	43.52	35796	25825	3.59:1
20 kg P ₂ O ₅ + NAA 20 ppm	8692	456	9148	15.82	48.50	35751	26602	3.90:1
40 kg P ₂ O ₅ + NAA 20 ppm	8692	882	9574	17.38	50.89	38917	29343	4.06:1
60 kg P ₂ O ₅ + NAA 20 ppm	8692	1308	10000	19.05	52.04	42096	32095	4.20:1
20 kg P ₂ O ₅ + GA ₃ 50 ppm	8692	3126	11818	15.08	46.47	34114	22296	2.88:1
40 kg P ₂ O ₅ + GA ₃ 50 ppm	8692	3525	12217	16.99	48.55	37864	25647	3.09:1
60 kg P ₂ O ₅ + GA ₃ 50 ppm	8692	3978	12670	17.64	49.70	39207	26236	3.09:1
20 kg P ₂ O ₅ + Ethrel 75 ppm	8692	1126	9818	15.07	46.01	34063	24245	3.46:1
40 kg P ₂ O ₅ + Ethrel 75 ppm	8692	1525	10217	16.62	48.48	37188	26970	3.63:1
60 kg P ₂ O ₅ + Ethrel 75 ppm	8692	1978	10670	17.37	49.16	38640	27969	3.62:1

NAA=Naphthalene acetic acid; GA₃=Gibberellic acid

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