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Response of Fenugreek (*Trigonella foenum-graecum* L.) to Different Levels of Nitrogen, Phosphorus and Potassium

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Authors' contributions

This work was carried out in collaboration between all authors. Author ND designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JKH, SM and TS managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out with the aim to standardize the dose of NPK of fenugreek cv. Hissar Sonali in gangetic alluvial zone of West Bengal. The experiment was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during the year 2013-14 and 2014-15. The variety 'Hissar Sonali' was used under the study. Three levels of each nitrogen (40, 60 and 80 kg/ha), phosphorus (60, 80 and 100 kg/ha) and two levels of potassium (20 and 40 kg/ha) were included in this investigation. There were altogether 18 treatments. The experiment was laid out in Factorial Randomized Block Design with three replications. Among different treatment combination maximum plant height of 75.74 cm at 75 DAS

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were recorded with $N_{80}P_{80}K_{40}$. Plants grown under $N_{60}P_{80}K_{40}$ combination, exhibited the maximum number of secondary branches (15.94) per plant. The minimum days required for 50% flowering was noticed in $N_{40}P_{60}K_{20}$ (49.36 days) and test weight (15.24 g) was observed in $N_{60}P_{80}K_{40}$ combination. Maximum projected yield (17.20 q/ha) was recorded in $N_{60}P_{80}K_{40}$ followed by $N_{40}P_{80}K_{40}$ (16.31 q/ha) and $N_{60}P_{100}K_{40}$ (15.80 q/ha) as compared to lowest yield of 11.70 q/ha under $N_{40}P_{60}K_{20}$ combination. From yield maximization point of view, the most effective treatment was NPK @ 60:80:40 kg/ha followed by NPK @ 40:80:40 kg/ha and NPK @ 60:100:40 kg/ha under alluvial plains of West Bengal.

Keywords: Fenugreek; nitrogen; phosphorous; potassium; fertilizer.

1. INTRODUCTION

Fenugreek commonly known as *methi*, is the multipurpose crop who's every part is utilized as leafy vegetables, spice, condiments, green fodder and green manuring [1]. Green leaves are good source of protein (18.6-20.90% on dry weight basis), carbohydrate, minerals (iron and calcium) and vitamin C. Fenugreek seeds are rich in essential amino acid and trigonelline for which fenugreek is so well known over 2500 years for their medicinal uses [2]. It is used in Ayurvedic system of medicine as carminative anti-pyretic and anti-helminthic. Though India is the main producer and exporter of fenugreek in the world, however, the productivity of the crop is low. In spite of great utility of fenugreek, a little attention has been paid to evolve suitable package of practice for profitable cultivation. To boost up the yield potential, management practice for growing of a crop are of prime importance and in this regard application of nutrients through different sources is most important.

However information on the use of different levels of NPK on growth and yield of fenugreek is meager. Therefore, the present investigation was carried out to standardize the levels of nitrogen, phosphorus and potassium for getting higher seed yield of fenugreek.

2. MATERIALS AND METHODS

The experiment was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during the year 2013-14 and 2014-15. The variety 'Hissar Sonali' was taken under the study. The soil at the experimental field was gangetic alluvial with sandy clay loam texture, good water holding capacity, well drained with moderate soil fertility status and soil pH of 6.9. the organic carbon, total nitrogen, available phosphorous and potassium contents are 0.63%, 0.084%, 18.07 kg ha^{-1} and 194.80 kg ha^{-1} respectively. The seeds were sown during 1st week of November in 2.0 m x 1.5 m plot at 30 x 10 cm spacing during both the years accommodating 100 plants per plot. Standard package and practices were followed during the growing period of this crop.

Three levels of each nitrogen (40, 60 and 80 kg/ha), phosphorus (60, 80 and 100 kg/ha) and two levels of potassium (20 and 40 kg/ha) were included in this investigation. The doses of fertilizer were adjusted with the application of urea, single super phosphate and muriate of potash. There were altogether 18 treatments. Three factors involved are namely nitrogen, phosphorous and potassium. The experiment was laid out in Factorial Randomized Block Design with three replications. All experimental plots received a uniform dose of FYM at 15 tonnes/ha. FYM, ½ dose of nitrogen, full dose of phosphorus and full dose of potash were applied as basal and the remaining ½ dose of nitrogen was applied 30 days after sowing (DAS) as topdressing. FYM is added as per the general recommendation for fenugreek. It contain all the three major nutrients as it is fixed for the all treatments so there is no problem to standardized the dose of N,P and K. Harvesting was done during end of March.

The observations were recorded on five randomly selected plants from each plot on different growth and yield parameters. The observations on plant height were recorded at 75 after sowing. The projected yield per hectare was calculated on plot yield basis after deducting 25% area utilized for channel, ridges etc. Data recorded on different parameters of fenugreek for both the years were pooled together and analyzed statistically through statistical software SPSS16.0 to express the result as there was difference between the two year in some treatments.

3. RESULTS AND DISCUSSION

3.1 Plant Height

Plant height recorded at 75 days after sowing revealed the significant variation in both sole and interaction effects of three nutrients (Tables 1 and 2).

The plant height was increased from 55.04 cm to 64.24 cm by increasing the level from N_{40} to N_{80}, from 55.98 cm to 63.11 cm with increasing level of phosphorus from P_{60} to P_{100} and from 56.90 cm to 63.95 cm with increasing level of potassium from K_{20} to K_{40}. Hence significant variations were observed in the interactions of N x P, P x K, N x K and N x P x K during both the years and in pooled analysis. Maximum plant height of 75.74 cm was obtained with $N_{80}P_{80}K_{40}$ fertilization followed by $N_{60}P_{100}K_{40}$ (74.26 cm), $N_{80}P_{100}K_{40}$ (68.42 cm) and $N_{60}P_{80}K_{40}$ (66.34 cm) as compared to minimum plant height of 48.56 cm under $N_{60}P_{60}K_{20}$ combination.

Plant height increased with increasing nitrogen doses. A positive response to nitrogen application was also reported by [3,4]. This might be due to early and abundant availability of nitrogen leading to better nutritional environment in the root zone for growth and development of plant.

Plant height increased with increasing nitrogen doses. A positive response to nitrogen application was also reported by [5,6,3]. This might be due to early and abundant availability of nitrogen leading to better nutritional environment in the root zone for growth and development of plant. In addition to its role in the formation of protein, nitrogen is an integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis. Under the present investigation, profound influence of increased N fertilization on crop growth seems to be due to maintaining congenial nutritional environment of plant system on account of their greater availability from soil media.

The findings of this investigation are in close conformity with those of [7,6] who also recorded higher plant heights in fenugreek from higher phosphorus doses (75 and 90 kg P/ha respectively). It is the main constituent of energy rich phosphate molecules like ATP. Thus, phosphorus influences photosynthesis, biosynthesis of protein and phospholipids, nucleic acid synthesis, membrane transport and cytoplasm streaming. Increased availability of phosphorus, owing to its application in the soil, improved nutrient availability. The applied phosphorus increased nitrogenous activity of roots, which enhanced the root nodulation and created congenial environment for plant rhizosphere that resulted increasing physiological growth parameters. Increase in plant height due to application of 30 to 90 Kg P_2O_5 / ha in fenugreek have been reported by [3].

Table 1. Individual effect of nitrogen, phosphorus and potassium on plant height, number of secondary branches and days to 50% flowering of fenugreek

Treatments	Plant height at 75 days after sowing			Number of secondary branches per plant			Days to 50% flowering		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Nitrogen (kg/ha)									
N_{40}	52.25	57.91	55.04	10.60	10.61	10.03	64.89	56.42	55.65
N_{60}	60.23	63.76	61.99	12.76	13.18	12.97	60.46	60.76	59.82
N_{80}	64.06	64.42	64.24	13.11	13.93	13.38	61.06	63.96	62.51
S. Em (±)	0.189	0.236	0.711	0.128	0.143	0.098	0.343	0.214	0.201
CD (P=0.05)	0.545	0.679	2.047	0.370	0.411	0.282	0.988	0.616	0.580
Phosphorus (kg/ha)									
P_{60}	56.63	55.32	55.98	10.46	11.19	11.09	53.48	56.02	54.75
P_{80}	60.35	64.03	62.19	12.74	12.96	12.85	59.73	53.39	60.72
P_{100}	59.56	66.65	63.11	13.27	13.56	13.16	53.20	61.76	62.46
S. Em (±)	0.406	0.368	0.257	0.128	0.143	0.098	0.343	0.214	0.201
CD (P=0.05)	1.169	1.060	0.742	0.370	0.411	0.282	0.988	0.616	0.580
Potassium (kg/ha)									
K_{20}	57.02	56.78	56.90	11.50	11.78	11.87	56.83	59.20	58.01
K_{40}	60.67	67.22	63.95	12.81	13.37	12.71	60.78	61.55	61.16
S. Em (±)	0.155	0.192	1.231	0.105	0.116	0.080	0.280	0.175	0.164
CD (P=0.05)	0.445	0.554	3.545	0.302	0.336	0.230	0.807	0.503	0.474

Table 2. Interaction effect of nitrogen, phosphorus and potassium on plant height, number of secondary branches and days to 50% flowering of fenugreek

Treatments	Plant height at 75 days after sowing			Number of secondary branches per plant			Days to 50% flowering		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
$N_{40}P_{60}K_{20}$	53.46	49.02	51.24	7.94	8.54	8.54	51.24	47.48	49.36
$N_{40}P_{80}K_{20}$	56.24	59.28	57.76	9.21	9.63	9.42	50.63	55.21	52.92
$N_{40}P_{100}K_{20}$	51.06	60.78	55.92	11.75	11.31	11.53	56.25	62.03	59.14
$N_{60}P_{60}K_{20}$	51.65	45.47	48.56	10.72	10.58	10.65	51.36	57.10	54.23
$N_{60}P_{80}K_{20}$	57.36	61.14	59.25	14.06	13.50	13.78	58.41	64.43	61.42
$N_{60}P_{100}K_{20}$	59.62	64.70	62.16	12.18	12.86	12.52	61.50	55.22	58.36
$N_{80}P_{60}K_{20}$	58.35	53.91	56.13	11.45	11.27	11.36	57.26	61.38	59.32
$N_{80}P_{80}K_{20}$	64.16	59.70	61.93	12.44	13.36	13.15	60.67	67.65	64.16
$N_{80}P_{100}K_{20}$	61.32	57.04	59.18	13.62	14.94	14.28	64.16	62.34	63.25
$N_{40}P_{60}K_{40}$	55.64	53.32	54.48	9.35	10.17	9.76	55.62	50.90	53.26
$N_{40}P_{80}K_{40}$	49.38	54.90	52.14	11.76	11.08	11.42	53.74	58.56	56.15
$N_{40}P_{100}K_{40}$	47.76	69.68	58.72	13.58	12.94	13.26	61.85	64.31	63.08
$N_{60}P_{60}K_{40}$	58.77	64.05	61.41	10.82	12.56	11.69	54.03	60.29	57.16
$N_{60}P_{80}K_{40}$	62.48	70.20	66.34	15.16	16.72	15.94	67.82	62.94	65.38
$N_{60}P_{100}K_{40}$	71.50	77.02	64.26	13.62	14.84	14.23	69.64	64.60	67.12
$N_{80}P_{60}K_{40}$	61.92	66.20	64.06	12.48	14.04	13.26	51.35	58.99	55.17
$N_{80}P_{80}K_{40}$	72.48	79.00	75.74	13.70	14.46	14.08	67.12	71.52	69.32
$N_{80}P_{100}K_{40}$	66.15	70.69	68.42	14.84	15.48	15.16	65.82	61.86	63.84
N X P									
S. Em (±)	0.328	0.408	1.231	0.222	0.247	0.169	0.594	0.370	0.349
CD (P=0.05)	0.945	1.176	3.545	0.641	0.712	0.488	1.711	1.067	1.005
P X K									
S. Em (±)	0.268	0.333	1.005	0.182	0.202	0.138	0.485	0.302	0.285
CD (P=0.05)	0.771	0.960	N.S.	N.S.	0.581	N.S.	1.397	N.S.	0.820
N X K									
S. Em (±)	0.268	0.333	1.005	0.182	0.202	0.138	0.485	0.302	0.285
CD (P=0.05)	0.577	0.960	2.895	0.523	N.S.	N.S.	N.S.	0.871	0.820
N X P X K									
S. Em (±)	0.464	0.577	1.741	0.314	0.349	0.240	0.840	0.524	0.493
CD (P=0.05)	1.336	1.663	5.014	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

3.2 Number of Secondary Branches per Plant

The findings obtained from Tables 1 and 2, indicated the significant variations in majority cases among the different observations in respect of sole effect and interactions effect during both the years and in pooled analysis. In case of sole effect of nitrogen, the positive responses were noticed with the increasing levels. The number of branches increased from 10.03 to 13.38 per plant with increase in nitrogen level from 40 kg/ha to 80 kg/ha. In respect of phosphorus, the similar trend also noticed. The branch number increased from 11.09 to 13.16 with the increasing level of phosphorus from 60 kg/ha to 100 kg/ha. In case of potassium increasing dose for 20 kg/ha to 40 kg/ha resulted in increasing branch number from 11.87 to 12.71. Among the interactions, the higher level of potassium with medium level of nitrogen and phosphorus generally produced more number of secondary branches per plant. The maximum number of branches was noticed with $N_{60}P_{80}K_{40}$ (15.94) followed by $N_{80}P_{100}K_{40}$ (15.16), $N_{80}P_{100}K_{20}$ (14.28) and $N_{80}P_{80}K_{40}$ (14.08) as compared to lowest number under $N_{40}P_{60}K_{20}$ (8.54) combination. The favourable effect of nitrogen and phosphorus on increasing the number of branches per plant has also been reported by [4,8].

3.3 Days to 50% Flowering

Perusal of the data presented in Tables 1 and 2, clearly demonstrated that application of higher doses of nutrients caused delayed flowering as compared to lower doses. The increasing dose of

nitrogen from 40 kg/ha to 80 kg/ha resulted in delayed flowering from 55.65 days to 62.51 days. Likewise in increasing dose of phosphorus (P_{60} to P_{100}) and potassium (K_{20} to K_{40}) caused delayed flowering from 54.75 to 62.46 days and among the interactions the minimum days (49.36) was required for 50% flowering in plants grown under $N_{40}P_{60}K_{20}$ followed by $N_{40}P_{80}K_{20}$ (52.92) and $N_{40}P_{60}K_{40}$ (53.26). The plants grown under $N_{80}P_{80}K_{40}$ required maximum days (69.32) for flowering followed by $N_{60}P_{100}K_{40}$ (67.12). The similar results in respect of nitrogen, phosphorus and potassium also reported by [9,4,10] in fenugreek. Higher levels of nutrients delayed the flowering mainly because of better growth parameters which might have passed through long span resulted to delay in flowering.

3.4 Test Weight

Thousand seed weights were not significantly affected by different doses of nitrogen, phosphorus and potassium during both the years and in pooled analysis. Maximum values of test weights were noticed with N_{60} (14.15 g), P_{100} (14.36 g) and K_{40} (14.37 g). Maximum test weight was observed with increasing level of nitrogen up to 90 kg/ha [5,6]. Favourable effect of phosphorus on test weight was reported by several workers. [11,9,12] reported that increasing phosphorus levels upto 40 kg, 60 kg and 120 kg/ha have positive influence on test weight Moreover, [13] reported that phosphorus application improved the performance of fenugreek plants in terms of 1000 seed weight. Among the interactions maximum test weight was observed under $N_{60}P_{80}K_{40}$ (15.24 g) followed by $N_{60}P_{100}K_{40}$ (14.92 g) and $N_{60}P_{100}K_{20}$ (14.66 g) as compared to lowest test weight of 12.02 g with $N_{80}P_{60}K_{20}$ combination (Tables 3 and 4).

3.5 Project Yield per Hectare

The effect of nitrogen and phosphorus at their medium level gave good response on seed yield per plot and further increase in dose *i.e.* at N_{80} and $P_{100,}$ no positive response was noticed Increase of potassium was level from K_{20} to K_{40} caused increased in yield. In sole effect the maximum yield of 14.60 q/ha was recorded with N at the rate of 60 kg/ha. In respect of phosphorus and potassium the maximum yield of 14.56 q/ha and 14.41 q/ha were observed with 80 kg P and 40 kg K per hectare respectively. Among the interactions, the maximum projected yield was recorded with $N_{60}P_{80}K_{40}$ (17.20 q/ha) followed by $N_{40}P_{80}K_{40}$ (16.31 q/ha) and $N_{60}P_{100}K_{40}$ (15.80 q/ha) as compared to lowest yield of 11.70 q/ha under $N_{40}P_{60}K_{20}$ combination. From different agro-climatic condition different researchers got responses with different levels. Like [5,6] recorded maximum plot yield with 60 kg, 50 kg and 45 kg N per hectare. Some workers reported that an increase in the seed yield of fenugreek was obtained with 60 kg and 120 kg phosphorus per hectare ([9,14]).

Table 3. Individual effect of nitrogen, phosphorus and potassium on test weight and seed yield of fenugreek

Treatments	Test weight			Seed yield per plot (g/3m^2)			Projected yield (q/ha)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Nitrogen (kg/ha)									
N_{40}	13.47	14.23	13.85	535.07	553.65	544.36	13.37	13.84	13.61
N_{60}	13.74	14.57	14.15	543.33	625.35	584.34	13.58	15.63	14.61
N_{80}	13.66	14.34	14.00	474.38	543.80	509.09	11.85	13.59	12.72
S. Em (±)	0.059	0.051	0.039	0.410	0.410	0.303	0.122	0.143	0.098
CD (P=0.05)	N.S.	N.S.	N.S.	1.180	1.182	0.872	0.350	0.412	0.283
Phosphorus (kg/ha									
P_{60}	13.13	13.61	13.37	450.18	525.79	487.99	11.25	13.14	12.19
P_{80}	13.77	14.75	14.26	547.33	618.32	582.83	13.68	15.45	14.57
P_{100}	13.96	14.77	14.36	555.27	578.69	566.98	13.88	14.46	14.17
S. Em (±)	0.059	0.051	0.039	0.410	0.410	0.303	0.122	0.143	0.098
CD (P=0.05)	N.S.	N.S.	N.S.	1.180	1.182	0.872	0.350	0.412	0.283
Potassium (kg/ha)									
K_{20}	13.47	13.78	13.63	493.14	537.63	515.38	12.32	13.44	12.88
K_{40}	13.77	14.97	14.37	542.05	610.91	576.48	13.55	15.27	14.41
S. Em (±)	0.048	0.042	0.032	0.335	0.335	0.247	0.099	0.117	0.080
CD (P=0.05)	N.S.	N.S.	N.S.	0.964	0.965	0.712	0.284	0.336	0.231

Table 4. Interaction effect of nitrogen, phosphorus and potassium on test weight and seed yield of fenugreek

Treatments	Test weight			Seed yield per plot (g/3m^2)			Projected yield (q/ha)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
$N_{40}P_{60}K_{20}$	12.65	13.05	12.85	418.35	517.89	468.12	10.45	12.95	11.70
$N_{40}P_{80}K_{20}$	13.16	13.68	13.42	496.23	551.87	524.05	12.46	13.74	13.10
$N_{40}P_{100}K_{20}$	14.17	13.35	13.76	582.05	522.31	552.18	14.55	13.05	13.80
$N_{60}P_{60}K_{20}$	12.86	13.54	13.20	407.16	439.36	423.26	10.18	10.98	10.58
$N_{60}P_{80}K_{20}$	13.98	14.32	14.15	558.27	615.13	586.70	13.95	15.37	14.66
$N_{60}P_{100}K_{20}$	14.28	15.04	14.66	563.15	661.55	612.35	14.07	16.53	15.30
$N_{80}P_{60}K_{20}$	11.76	12.28	12.02	418.35	445.95	432.15	10.46	11.14	10.80
$N_{80}P_{80}K_{20}$	12.65	13.91	13.28	524.12	582.68	553.40	13.10	14.56	13.83
$N_{80}P_{100}K_{20}$	13.24	12.88	13.06	470.56	501.92	486.24	11.76	12.54	12.15
$N_{40}P_{60}K_{40}$	13.62	14.06	13.84	492.03	561.61	526.82	12.30	14.04	13.17
$N_{40}P_{80}K_{40}$	14.39	13.85	14.12	687.18	617.94	652.56	17.17	15.45	16.31
$N_{40}P_{100}K_{40}$	13.78	15.68	14.43	634.55	550.29	592.42	15.87	13.75	14.81
$N_{60}P_{60}K_{40}$	13.42	14.08	13.75	521.64	604.84	563.24	13.04	15.12	14.08
$N_{60}P_{80}K_{40}$	14.94	15.54	15.24	642.71	733.57	688.14	16.07	18.33	17.20
$N_{60}P_{100}K_{40}$	14.65	15.19	14.92	567.04	697.66	632.35	14.17	17.43	15.80
$N_{80}P_{60}K_{40}$	12.65	13.31	12.98	443.56	585.08	514.32	11.08	14.62	12.85
$N_{80}P_{80}K_{40}$	13.21	14.05	13.63	475.46	608.74	542.10	11.86	15.24	13.55
$N_{80}P_{100}K_{40}$	12.43	13.09	12.76	514.25	538.43	526.34	12.84	13.46	13.15
N X P									
S. Em (±)	0.102	0.089	0.067	0.710	0.711	0.524	0.211	0.247	0.170
CD (P=0.05)	N.S.	N.S.	N.S.	2.044	2.047	1.511	0.607	0.713	0.491
P X K	0.083	0.027	0.055	0.579	0.580	0.428	0.172	0.202	0.139
S. Em (±)									
CD (P=0.05)	N.S.	N.S.	N.S.	1.669	N.S.	1.234	0.495	N.S.	0.401
N X K	0.083	0.027	0.055	0.579	0.580	0.428	0.172	0.202	0.139
S. Em (±)									
CD (P=0.05)	N.S.	N.S.	N.S.	1.669	1.672	1.234	N.S.	0.582	0.401
N X P X K	0.144	0.125	0.095	1.004	1.005	0.742	0.298	0.350	0.241
S. Em (±)									
CD (P=0.05)	N.S.	N.S.	N.S.	N.S.	2.896	2.137	N.S.	1.008	0.694

The better growth response at medium rate of nitrogen application might be due to the fenugreek being a leguminous crop, the roots of which have capability to fix nitrogen which make up a part of its requirement [14]. [15] observed that performance in combination with all the nitrogen levels, but the best result was observed with lower dose of nitrogen. It is because fenugreek being a legume crop requires low dose of nitrogen and high phosphorus. Further, the phosphorus also improved nodulation of the plant roots [16] in which nitrogen fixation took place which reduced the additional requirement of nitrogen. From yield maximization point of view the most effective treatment was $N_{60}P_{80}K_{40}$ (17.20 q/ha) followed by $N_{40}P_{80}K_{40}$ (16.31 q/ha) and $N_{60}P_{100}K_{40}$ (15.80 q/ha) under alluvial plains of West Bengal for fenugreek production.

The medium level of both nitrogen and phosphorus with higher level of potassium was more effective for maximization of yield. Both nitrogen and phosphorus applied beyond the lower dose delayed the flowering mainly because of better performance of growth parameters like plant height and number of branching which might have passed through long span resulted to delay in flowering [9]. Fenugreek roots have the ability to trap high levels of phosphorus and use it for growth and development of the plant [17]. But, if the is already rich in P, addition of P fertilizer will not be effective [18].

The maximum plant height (75.74 cm) was observed with highest level of nitrogen (80 kg/ha) and medium level of phosphorus (80 kg/ha) at 75 days after sowing. A positive response to phosphorus application may be due to favorable effect of phosphorus on nitrogen transformation leading to accumulation and metabolism of carbohydrates in plants [19] reported higher ratio of phosphorus application increased height of the plant. Similarly positive response of nitrogen, phosphorus and potassium upto 50 kg/ha, 90 kg/ha and 60 kg/ha were on number of branches per plant were reported by [6,3,9] respectively.

The interaction effects due to N and P application were beneficial for yield and yield attributes. The increase in seed yield was associated with a similar increase in yield attributes [14] have also shown that seed yield in fenugreek was positively correlated with the plant height, number of branches per plant, number pods per plant, number of seed per pod and test weight. These finding leads us to believe that fenugreek makes a moderate demand on nitrogen and phosphate. [14] also did not get any positive response beyond 30 kg N/ha and 60 kg P/ha.

4. CONCLUSION

It is an annual herb belonging to subfamily Papilliaceae, and family Legumonosae. In West Bengal it is mainly grown in to a limited extant as a rainfed crop. Cultivation of fenugreek in West Bengal is limited and information on the possibilities of commercial cultivation of the crop in this region is scanty.

Being a leguminous crop the root nodules enrich the soil with atmospheric nitrogen. Intensive agriculture involving use of high input for increasing production resulted in heavy removal of nutrients from the soil. However fertilizer application generally remains much below as compared to removal. Thus there is a wide gap between nutrients removed from soil and nutrient supplied; this gap can be bridged with use of chemical fertilizers along with other management practices.

Maximum plant height of 75.74 cm at 75 DAS was recorded with $N_{80}P_{80}K_{40}$. Plants grown under $N_{60}P_{80}K_{40}$ combination, exhibited the maximum number of secondary branches (15.94) per plant. The minimum days required for 50% flowering was noticed in $N_{40}P_{60}K_{20}$ (49.36 days). The yield attributing parameter like test weight (15.24 g) was observed in $N_{60}P_{80}K_{40}$ combination. From yield maximization point of view, the most effective treatment was NPK @ 60:80:40 kg/ha under alluvial plains of West Bengal.

Therefore, the present investigation was carried out to standardize the levels of nitrogen, phosphorus and potassium for getting higher seed yield of fenugreek.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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