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Growth analysis of fenugreek (*Trigonella foenum-graecum* L.) under various levels of farmyard manure and phosphorus

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Abstract

Field investigations were carried out during winter (*rabi*) season of 1996-97 and 1997-98 to study the effect of different levels of farmyard manure and phosphorus on growth of two fenugreek genotypes in sandy loam soils. The results indicated that genotype NLM was significantly superior to HM-65 in terms of plant height, LAI, LAD CGR and dry matter accumulation at all stages of crop growth, except at 30 DAS. These growth parameters in the genotype NLM resulted in higher seed yield. Plant height, LAI, LAD, CGR and dry matter accumulation were significantly higher with increase of FYM upto 15 t ha^{-1} at all stages of crop growth, except at 30 DAS. Seed yield was also enhanced significantly with the FYM up to 15 t ha^{-1}. Increasing levels of phosphorus upto 40 kg ha^{-1} significantly increased the growth parameters and yield of fenugreek.

Key words: Crop growth rate, dry matter accumulation, fenugreek, Leaf area duration, Leaf area index, phosphorus, *Trigonella foenum-graecum.*

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an important condiment crop grown during winter (*rabi*) season in northern India. It is also grown for green fodder and vegetable purposes. The seeds have medicinal value, particularly against digestive disorders whereas its leaves are rich source of protein, minerals and vitamin C (Kirtikar & Basu 1975). The growth and yield of fenugreek are strongly influenced by the application farmyard manure (FYM) and phosphatic fertilizers. Therefore, the present experiment was conducted to study the effect of different levels of FYM and phosphorus on growth parameters and yield of two fenugreek genotypes.

Materials and methods

A field experiment was conducted at Chaudhary Charan Singh Haryana Agricultural University, Hisar during winter (*rabi*) season of 1996-97 and 1997-98, to study the effect of four levels of farmyard manure (0, 5, 10 and 15 t ha^{-1}) and four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5 ha^{-1}) on two fenugreek genotypes (HM-65 and NLM). Thirty two treatment combinations, keeping genotypes and farmyard manure in main plots and levels of phosphorus in sub-plots, were replicated thrice in a split-plot

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design. The soil of the experiment field was sandy loam in texture, low in organic carbon (0.35%), available nitrogen (116.2 kg ha^{-1}) and phosphorus (21.45 kg ha^{-1}), high in potash (522.7 kg ha^{-1}) and slightly alkaline in reaction (pH 7.8). The meteorological observations recorded at Meteorological Observatory of Chaudhary Charan Singh Haryana Agricultural University, Hisar during both the crop seasons are presented in Table 1. Sowing was done in lines (30 cm apart) using a seed rate of 20 kg ha^{-1} for both the varieties under test. Full dose of farmyard manure was incorporated into the soil as per treatments, 21 days before sowing and full dose of phosphorus through single superphosphate was applied as per treatments prior to sowing. All the other recommended package of practices were followed. Observations on dry matter accumulation were recorded from five randomly selected plants from each treatment at 30, 60, 90, 120 days after sowing (DAS) and at harvest. Leaf area index (LAI) (Sestak *et al.* 1971), leaf area duration (LAD) (Anonymous 1993) and crop growth rate (CGR) (Hunt 1978) were computed for various treatments.

Results and discussion

Effect of genotypes

A perusal of data given in Tables 2, 3 and 4 indicate that with the advancement of the crop age, a corresponding increase in growth parameters namely, plant height, LAI, LAD, CGR, dry matter accumulation, upto 120 DAS was observed. Both the genotypes remained statistically at par for these characters particularly in the early stages of crop growth. But in later stages, genotype NLM was found significantly superior to HM-65 for these parameters which resulted in better harvesting of radiant energy for longer period and also better distribution in the crop canopy. Genotype NLM gave higher

Table 1. Meteorological data during crop growing season (weekly means)

Standard Week	Temperature (°C)				Relative humidity (%)				Evaporation (mm)		Sunshine (hrs.)		Total rainfall (mm)	
	Maximum		Minimum		Morning		Evening							
	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98	96-97	97-98
45	32.4	27.6	11.0	12.8	80.0	90.0	30.0	53.0	3.6	2.1	8.5	5.5	0.0	0.0
46	29.1	25.5	8.8	9.1	82.0	90.0	26.0	37.0	3.3	1.9	8.2	7.2	2.0	0.0
47	26.0	24.3	6.5	10.0	87.0	88.0	37.0	48.0	3.4	1.7	8.0	3.6	0.0	2.0
48	24.9	21.3	4.5	6.2	82.0	92.0	28.0	57.0	2.3	2.6	8.3	5.4	0.0	2.0
49	22.9	20.1	3.4	8.4	77.0	93.0	28.0	68.0	2.7	1.6	7.6	3.9	0.0	14.5
50	22.6	16.2	-0.5	9.4	79.0	95.0	20.0	87.0	2.3	1.1	8.3	0.4	0.0	5.0
51	24.0	13.7	1.9	5.3	84.0	95.0	29.0	74.0	1.6	1.1	7.6	1.7	0.0	0.0
52	22.8	10.6	3.9	4.4	90.0	94.0	34.0	84.0	1.9	0.8	7.0	2.1	0.0	9.5
1	22.6	19.2	2.0	2.8	95.0	92.6	40.0	43.0	1.5	1.5	5.9	6.7	0.0	0.0
2	20.5	17.9	-0.4	6.6	93.0	94.8	36.0	62.7	1.4	0.9	6.7	3.2	0.0	2.0
3	19.3	18.9	3.0	1.5	92.0	86.7	50.0	38.7	2.1	2.0	5.2	8.3	13.6	0.0
4	17.8	19.4	3.0	2.3	93.0	92.7	49.0	41.1	1.6	1.6	6.1	7.4	0.0	0.0
5	20.4	21.2	4.0	8.7	97.0	94.4	51.0	58.4	2.0	1.6	7.4	2.9	1.0	10.0
6	21.7	22.1	2.5	4.0	86.0	85.6	39.0	40.3	2.4	2.3	8.4	9.0	0.0	0.0
7	22.4	25.4	4.3	10.9	80.0	81.4	28.0	44.6	3.1	2.8	8.5	5.5	0.0	0.0
8	25.3	21.7	5.5	7.7	85.0	91.8	31.0	60.8	3.2	2.9	9.2	6.5	0.0	16.9
9	26.8	21.4	7.1	8.2	79.0	91.6	31.0	59.6	4.2	2.4	8.0	6.2	0.0	0.8
10	28.5	23.0	9.8	8.5	83.0	88.3	34.0	46.1	3.6	2.7	7.2	6.9	0.0	15.8
11	27.0	25.9	13.1	9.9	86.0	88.0	50.0	49.7	3.4	3.7	4.6	8.2	7.0	11.2
12	26.3	27.9	11.7	12.2	90.0	18.8	41.0	34.5	3.1	4.3	7.3	7.6	47.6	0.0
13	28.4	30.9	12.7	14.1	83.0	71.1	50.0	27.8	3.2	4.3	6.0	9.3	0.5	0.0
14	27.4	33.4	13.2	18.4	86.0	73.1	42.0	33.0	4.0	5.5	8.2	6.8	21.5	0.0
15	33.6	34.3	17.9	14.1	73.0	71.8	32.0	30.7	6.2	6.9	9.6	9.8	0.0	0.0
16	33.8	38.8	14.8	17.3	85.0	48.4	51.0	15.3	6.6	7.8	9.2	10.3	0.0	0.0
17	38.9	38.7	19.5	20.8	77.0	53.5	34.0	20.0	9.0	7.9	9.1	7.2	1.2	0.0

Table 2. Effect of different levels of FYM and phosphorus on plant height and seed yield of two fenugreek genotypes

Treatment	Plant height (cm)										Seed yield (q ha^{-1})	
	Days after sowing (1996-97)					Days after sowing (1997-98)						
	30	60	90	120	Harvest	30	60	90	120	Harvest	1996-97	1997-98
Genotype												
HM-65	1.88	14.14	48.00	85.35	97.02	1.55	10.33	32.41	62.35	75.32	20.22	17.55
NLM	1.90	14.30	50.35	90.23	102.26	1.60	10.69	34.93	67.10	80.18	22.54	20.93
SEm±	0.10	0.28	0.13	0.58	0.70	0.03	0.22	0.56	0.85	0.98	0.33	0.34
CD (P=0.05)	N.S	N.S	0.28	1.24	1.50	N.S	N.S	1.71	2.60	3.01	0.99	1.01
Farmyard manure (tonnes ha^{-1})												
F_0	1.88	12.00	39.28	75.26	89.65	1.54	7.11	25.64	56.16	67.74	17.52	15.19
F_5	1.87	13.57	46.40	87.79	98.99	1.56	10.03	32.93	62.75	77.94	20.93	18.54
F_{10}	1.91	15.00	54.04	92.77	103.19	1.60	11.74	36.25	67.95	81.15	22.57	20.73
F_{15}	1.89	16.33	56.95	95.35	106.74	1.58	12.77	39.84	71.99	84.17	24.50	22.49
SEm±	0.14	0.28	0.43	0.58	0.66	0.04	0.31	0.79	1.21	0.70	0.46	0.47
CD (P=0.05)	N.S	0.85	1.39	1.80	2.02	N.S	0.93	2.41	3.70	2.14	1.40	1.44
Phosphorus level (kg ha^{-1})												
P_0	1.86	12.10	44.70	80.00	94.00	1.52	8.71	28.10	58.22	70.96	17.55	14.96
P_{20}	1.86	14.04	48.31	87.00	99.26	1.58	10.28	32.95	64.36	77.12	21.20	19.29
P_{40}	1.91	15.32	51.83	91.91	102.27	1.60	11.23	36.54	67.75	81.02	23.29	21.30
P_{60}	1.91	15.46	51.90	92.25	103.04	1.58	11.42	37.07	68.53	81.90	23.48	21.40
SEm±	0.05	0.24	0.23	0.35	0.53	0.03	0.23	0.46	0.61	0.58	0.37	0.37
CD(P=0.05)	N.S	0.67	0.67	1.01	1.64	N.S	0.70	1.39	1.86	1.73	1.10	1.05

seed yield compared to HM-65, which was about of 11.5 and 19.3 per cent increase during 1996-97 and 1997-98, respectively. Sheoran (1997) also reported variations in the varieties for these growth parameters.

Effect of farmyard manure

Application of FYM had a beneficial effect on the growth parameters of fenugreek. Each successive increase of FYM from 0 to 15 t ha^{-1} brought significant improvement in plant height, LAI, LAD, CGR and dry matter accumulation at all stages of crop growth (Tables 2, 3 and 4). However, non-significant differences were observed in the early stage of crop growth (30 DAS). This might be due to the slow release of nutrients from FYM, because of longer time required for its mineralization in soil under low temperature conditions. The per cent increases over control in growth parameters were to the tune of 12.4, 17.1 and 21.3 for plant height and 17.3, 35.0 and 45.5 for dry matter per plant at harvest with 5, 10 and 15 t FYM ha^{-1}, respectively. Almost similar trend was also observed for LAI, LAD and CGR at 120 DAS. The significant increase in dry matter may be due to cumulative effect of improvement in all the crop growth parameters due to application of FYM. Application of FYM increased the availability of nutrients to the plants which might have enhanced the vegetative growth and resulted in higher dry matter production. These results are in line with the findings of Pareek (1983) and Singh *et al.* (1994). Similarly, each successive increase in the dose of FYM upto 15 t ha^{-1} increased the seed yield significantly during both the years.

Effect of phosphorus

The data presented in Tables 2, 3 and 4 further revealed that application phosphorus upto 40 kg ha^{-1} increased plant height, LAI, LAD, CGR and dry matter accumulation significantly over the lower doses at all stages of crop growth

Table 3. Effect of different levels of FYM and phosphorus on leaf area index and leaf area duration of two fenugreek genotypes

Treatment	Leaf Area Index (LAI)								Leaf Area Duration (LAD)							
	Days after sowing (1996-97)				Days after sowing (1997-98)				Days after sowing (1996-97)				Days after sowing (1997-98)			
	30	60	90	120	30	60	90	120	30	60	90	120	30	60	90	120
Genotypes																
HM-65	0.049	2.52	3.15	3.85	0.034	2.20	2.66	3.39	0.609	39.53	85.17	104.91	0.523	34.73	74.15	90.76
NLM	0.042	2.64	3.61	4.39	0.035	2.42	3.15	3.94	0.623	40.65	93.96	120.06	0.519	35.54	82.31	106.32
SEm±	0.005	0.04	0.05	0.04	0.001	0.04	0.05	0.06	0.006	0.64	0.95	1.24	0.013	0.9	1.07	1.43
$CD_{0.05}$	N.S	0.11	0.17	0.12	N.S	0.13	0.16	0.24	N.S	N.S	2.89	3.78	N.S	N.S	3.26	4.35
Farmyard manure (tonnes ha^{-1})																
F_0	0.043	2.02	2.65	3.34	0.034	1.71	2.23	2.88	0.612	31.14	70.4	89.84	0.506	26.10	59.16	76.57
F_5	0.055	2.45	3.02	3.83	0.035	2.18	2.57	3.46	0.608	38.32	82.08	102.65	0.530	33.24	71.20	90.35
F_{10}	0.042	2.79	3.54	4.28	0.035	2.57	2.96	3.77	0.620	43.60	94.54	117.31	0.527	38.98	82.79	100.97
F_{15}	0.041	3.05	4.31	5.03	0.034	2.76	3.87	4.55	0.623	47.30	111.24	140.14	0.521	42.23	99.77	126.28
SEm±	0.007	0.05	0.09	0.06	0.001	0.06	0.07	0.08	0.008	0.91	1.34	1.76	0.019	0.90	1.52	2.02
$CD_{0.05}$	N.S	0.16	0.33	0.20	N.S	0.18	0.22	0.29	N.S	2.76	4.1	5.34	N.S	2.74	4.61	6.15
Phosphorus level (kg ha^{-1})																
P_0	0.038	2.01	2.64	3.33	0.033	1.74	2.13	2.72	0.559	31.64	69.85	89.55	0.510	26.52	58.25	75.85
P_{20}	0.056	2.46	3.25	3.95	0.035	2.21	2.77	3.65	0.614	39.13	86.3	108.88	0.531	33.55	74.55	93.28
P_{40}	0.043	2.89	3.76	4.53	0.034	2.70	3.31	4.04	0.642	45.1	100.72	122.95	0.514	40.88	90.04	109.50
P_{60}	0.044	2.94	3.86	4.67	0.036	2.60	3.40	4.24	0.650	44.50	101.4	128.58	0.530	39.60	90.10	115.52
SEm±	0.007	0.05	0.08	0.08	0.002	0.06	0.08	0.11	0.012	0.85	1.63	2.20	0.022	0.96	1.62	2.12
$CD_{0.05}$	N.S	0.15	0.22	0.23	N.S	0.18	0.23	0.34	N.S	2.43	4.65	6.26	N.S	2.72	4.60	6.05

Table 4. Effect of FYM and phosphorus levels on periodic crop growth rate and dry matter accumulation of fenugreek genotypes

Treatment	Crop Growth Rate (g sq.m^{-1}day^{-1})										Dry matter accumulation (g plant^{-1})									
	Days after sowing (1996-97)					Days after sowing (1997-98)					Days after sowing (1996-97)					Days after sowing (1997-98)				
	0-30	30-60	60-90	90-120	Harvest	0-30	30-60	60-90	90-120	Harvest	0-30	30-60	60-90	90-120	Harvest	0-30	30-60	60-90	90-120	Harvest
Genotypes																				
HM-65	0.135	5.82	10.28	16.37	5.11	0.111	4.95	10.02	16.43	5.25	0.06	2.65	6.99	14.15	15.99	0.050	2.18	6.54	14.15	15.05
NLM	0.132	6.55	12.81	18.07	5.82	0.112	5.56	12.83	19.21	6.30	0.06	2.95	8.62	16.10	17.30	0.050	2.46	8.22	15.69	16.50
SEm±	0.006	0.12	0.24	0.46	0.17	0.004	0.11	0.36	0.65	0.21	0.01	0.05	0.14	0.24	0.26	0.002	0.05	0.16	0.32	0.32
$CD_{0.05}$	N.S	0.35	0.73	1.39	0.54	N.S	0.33	1.10	1.99	0.66	N.S	0.15	0.41	0.75	0.81	N.S	0.15	0.50	0.96	1.00
Farmyard manure (tonnes ha^{-1})																				
F0	0.132	4.25	7.96	13.73	4.71	0.108	4.00	8.10	11.30	3.73	0.06	2.12	5.97	11.98	13.33	0.050	1.44	5.52	11.26	12.72
F5	0.140	6.15	10.41	16.27	5.15	0.116	5.10	10.70	16.70	5.23	0.06	2.78	7.50	14.16	15.76	0.050	2.32	6.80	13.45	14.80
F10	0.134	6.88	12.71	18.33	5.68	0.115	5.73	12.65	20.00	6.38	0.06	3.01	8.43	16.33	18.17	0.050	2.62	7.90	16.45	17.01
F15	0.130	7.47	15.10	20.55	6.32	0.108	6.23	14.30	23.50	7.76	0.06	3.27	9.31	18.04	19.33	0.050	2.90	9.33	18.45	18.60
SEm±	0.008	0.16	0.34	0.65	0.21	0.005	0.15	0.51	0.931	0.24	0.01	0.07	0.20	0.35	0.38	0.003	0.07	0.23	0.45	0.39
$CD_{0.05}$	N.S	0.49	1.04	1.96	0.66	N.S	0.47	1.54	2.81	0.77	N.S	0.21	0.57	1.05	1.14	N.S	0.21	0.70	1.37	1.26
Phosphorus levels (kg ha^{-1})																				
P0	0.132	5.10	7.49	11.82	3.71	0.111	4.24	6.90	11.75	3.86	0.06	2.31	5.04	10.18	11.68	0.050	1.89	4.00	9.75	10.91
P20	0.136	6.00	10.60	16.36	5.29	0.113	5.00	11.00	17.30	5.61	0.06	2.70	7.47	14.77	17.00	0.050	2.21	7.10	14.53	15.06
P40	0.132	6.41	14.00	20.12	6.32	0.109	6.00	13.38	20.50	6.63	0.06	3.06	9.32	17.68	18.89	0.050	2.57	9.20	17.61	18.43
P60	0.134	6.43	14.11	20.58	6.54	0.113	6.00	14.50	21.75	7.00	0.06	3.11	9.39	17.87	19.02	0.050	2.61	9.23	17.80	18.71
SEm±	0.008	0.13	0.32	0.50	0.19	0.006	0.12	0.41	0.48	0.22	0.01	0.06	0.15	0.34	0.46	0.004	0.05	0.16	0.26	0.27
$CD_{0.05}$	N.S	0.38	0.91	1.43	0.58	N.S	0.34	1.15	1.37	0.68	N.S	0.16	0.43	1.08	1.46	N.S	0.15	0.50	0.74	0.83

except at early stage (30 DAS) where the differences were non-significant. The overall improvement in crop growth under the influence of phosphorus application could be attributed to better development of root system and increased microbial activity in plant root nodules which might have improved the uptake of nutrients by the crop and greater nitrogen fixation. Dasora (1980) and Rathore (1980) also observed the increase in various growth parameters of fenugreek with the application of phosphorus. The increasing dose of phosphorus upto 40 kg P_2O_5 ha^{-1} significantly increased the seed yield during both the years. The mean percentage increase was 24.5 and 37.2 in seed yield with the application of 20 and 40 kg P_2O_5 ha^{-1} over control, respectively. Significant increase in yield upto 40 kg P_2O_5 ha^{-1} was also reported by Maliwal & Gupta (1989), Bhati (1993) and Jat & Sharma (1999).

References

Anonymous 1993 Agronomic Terminology (3rd edition). Indian Society of Agronomy, New Delhi.

Bhati D S 1993 Effect of irrigation and phosphorus on seed yield and its attributes of fenugreek (*Trigonella foenum-graecum* L.). Indian J. Agron. 38 : 449-452.

Dasora P 1980 Effect of dates of sowing, different levels of phosphorus with and without nitrogen on growth, yield and quality of fenugreek. M.Sc. Thesis, Sukhadia University, Udaipur, Rajasthan.

Hunt 1978 Plant Growth Analysis. Edword Amold Publishers Limited, London.

Jat & Sharma O P 1999 Effect of fertility levels and biofertilizers on growth, yield and quality of fenugreek. 4th Agricultural Science Congress Jaipur, Rajasthan.

Kirtikar K R & Basu B P 1975 Indian Medicinal Plants (2nd edition). Periodical Experts, New Delhi.

Maliwal P L & Gupta O P 1989 Study on the effect of four herbicides with and without phosphorus on weed control and seed yield of fenugreek. Trop. Pest Mgt. 35 : 307-310.

Pareek R G 1983 Effect of fertility levels and irrigation on growth and yield of fenugreek (*Trigonella foenum-graecum* L.). M.Sc. Thesis, Sukhadia University, Udaipur, Rajasthan.

Rathore P S 1980 Effect of date of sowing, nitrogen and phosphorus on growth and yield of fenugreek. M.Sc Thesis, University of Udaipur, Rajasthan.

Sestak Z J, Catskay & Jarvis P G 1971 Plant Photosynthesis Production : Manual of Methods. N.V. Publications. The Hague.

Sheoran R S 1997 Influence of phosphorus and sowing time on growth, yield and quality of fenugreek (*Trigonella foenum-graecum* L.) genotypes. Ph.D. Thesis, CCS Haryana Agricultural, University, Hisar.

Singh V, Rakesh K & Ram L 1994 Effect of applied FYM and molybdenum on yield and nutrients uptake by Egyptian clover (*Trifolium alexandrinum* L.). Indian J. Agron. 39 : 507-509.