

Growth and yield of fenugreek (*Trigonella foenum-graecum* L.) as influenced by irrigation levels and weed management practices

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Abstract

A field experiment on effect of irrigation levels and weed management practices on growth and yield of fenugreek (*Trigonella foenum-graecum*) was conducted at Sardarkrushinagar (Gujarat). The study indicated that irrigation at IW/CPE ratio 1.0 gave significantly higher plant height, dry matter accumulation plant⁻¹, leaf area plant⁻¹ and leaf area index at all the growth stages and seed, haulm and biological yields over IW/CPE ratios 0.8 and 0.6. Number of branches, number of nodules and their dry weight plant⁻¹ were also highest with irrigation at IW/CPE ratio 1.0. Days to 50% flowering and maturity significantly increased with increasing levels of irrigation from IW/CPE ratio 0.6 to 1.0. Besides weed free treatment, higher plant height, dry matter accumulation plant⁻¹, number of nodules and their weight plant⁻¹, number of branches plant⁻¹, days to 50% flowering and maturity were recorded with weed control by pre-emergence application of Pendimethalin @ 0.75 kg ha⁻¹ + Inter-culturing at 40 days after sowing (DAS) and hand weeding at 20 and 40 DAS which were significantly superior over rest of treatments. Application of irrigation at IW/CPE ratio 1.0 along with weed control by pre-emergence application of Pendimethalin @ 0.75 kg ha⁻¹ + Inter culturing at 40 DAS is beneficial for realising better growth and productivity of fenugreek.

Keywords: fenugreek, irrigation, *Trigonella foenum-graecum*, weed management.

Introduction

Information on irrigation requirement and weed management in fenugreek (*Trigonella foenum-graecum* L.) is limited. Irrigation at IW/CPE ratio of 1.0 at Nadia in West Bengal resulted in highest seed yield (Dutta & Chatterjee 2006). Weeds are also known to reduce growth and yield as high as 91.4% in

fenugreek (Mali & Suwalka 1987). Hence, a study was carried out to find the optimum irrigation schedule and weed control method for realising higher productivity of fenugreek.

Materials and methods

The field experiment was conducted at Agronomy Research Farm of S D Agricultural

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University, Sardarkrushinagar (Gujarat) during *rabi* season of 2006-07 and 2007-08. The experiment was laid out in different fields on different sites during the both the years. The experimental field was loamy sand in texture having pH 7.75 and 7.73 and electrical conductivity 0.12 and 0.11 dSm⁻¹, respectively during 2006-07 and 2007-08. The sites had low organic carbon (0.17% and 0.22%) available nitrogen (152.75 and 165.25 kg ha⁻¹), medium in available P₂O₅ (40.75 and 47.6 kg ha⁻¹) and good with respect to available K₂O (260.25 and 264.70 kg ha⁻¹). The experiment was laid out in split plot design with four replications with three levels of irrigation (based on IW/CPE ratios of 0.6, 0.8 and 1.0) in main plot and six weed control treatments (weedy check, weed-free, hand weeding at 20 and 40 days after sowing (DAS), hand weeding at 20 DAS + Inter-culturing (IC) at 40 DAS, application of Pendimethalin @ 0.75 kg ha⁻¹ (pre-emergence) (PE) and application of Pendimethalin @ 0.75 kg ha⁻¹ (PE) + Inter-culturing at 40 DAS in sub plots. The fenugreek variety GM-2 was sown in second week of November during both the years at 30 cm row to row spacing keeping a seed rate of 20 kg ha⁻¹. Full dose of nitrogen and phosphorus was drilled manually through DAP and urea at the time of sowing. Two common irrigations each at 50 mm depth were applied at sowing and at 5 DAS for good germination and establishment of the crop and afterwards the irrigations were applied as per treatments. Cumulative pan evaporation was taken as the sum of the daily pan evaporation from USWB class-A evaporimeter. Irrigation water was measured by Parshall flume installed in the field channel. Pre-emergence application of Pendimethalin @ 0.75 kg ha⁻¹ was done on the second day after irrigation which was applied immediately after sowing with the help of a knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 ha⁻¹.

In manual weed control treatments, weeds were uprooted and removed at 20 and 40 DAS and inter-culturing was done as per treatments at 40 DAS. In weed-free plots, the weeds were removed manually after every seven days for ensuring complete weed-free condition. Plant height was measured from the ground level to the tip of the last leaf and five plants were randomly selected from adjoining inner lines of both the sides of the plot and cut to the ground level at 30, 60 and 90 DAS as well as at maturity. The samples were first dried under shade for 48 h and then in oven at 70°C till constant weights were obtained and dry matter was recorded. Soil around five randomly selected plants from adjoining inner lines of both the sides of the plot, was moistened and dug-out carefully from each plot, washed and used to count the total nodules from the roots of each plant. The number of effective nodules which were pinkish in colour, round and oval in shape with size ranging from 1.0 to 2.5 mm in diameter was counted and the weight of dried nodules was also recorded. The mean value of leaf area plant⁻¹ was computed to work out leaf area index by using the formula suggested by Watson (1947). Two border rows from each side and 50 cm on both sides across the direction of sowing was removed and harvesting of each net plot was done separately and sun dried for recording biological yield in each plot. Statistical analysis was done as per the procedure prescribed by Panse & Sukhamte (1985).

Results and discussion

Effect of irrigation levels

Application of irrigation at varying IW/CPE ratios significantly influenced plant height, dry matter accumulation plant⁻¹, number of branches plant⁻¹, days to 50% flowering and maturity. Higher plant height and dry matter accumulation at 30, 60, 90 DAS and at

maturity was recorded with irrigation at IW/CPE ratio 1.0 followed by IW/CPE ratio 0.8. Number of effective nodules plant⁻¹ and their dry weight, number of branches, days to 50% flowering and maturity were also higher with application of irrigation at IW/CPE ratio 1.0. The lowest values of all these parameters were recorded with IW/CPE ratio 0.6. Significantly taller plants, higher dry matter accumulation, leaf area and leaf area index were obtained with irrigation at IW/CPE ratio 1.0 which was due to availability of adequate soil moisture to the plants thorough out the crop growth period (Tables 1 and 2).

Higher seed, haulm and biological yields were obtained with irrigation at IW/CPE ratio 1.0 followed by IW/CPE ratio 0.8 (Table 4). Application of irrigation at IW/CPE ratio 1.0 resulted in 10% and 38% higher seed yield over IW/CPE ratio 0.8 and 0.6, respectively. The increase in seed and biological yields with 1.0 IW/CPE ratio could be explained by the fact that frequent irrigations under this treatment facilitated maintenance of optimum moisture level in soil as well as in plants during the entire growth period which resulted in better translocation of photosynthates from source to sink and higher yield attributes and yield of fenugreek. These findings are in close agreement with studies of Dutta & Chatterjee (2006) in fenugreek.

Effect of weed management practices

Growth parameters like plant height, dry matter accumulation, leaf area, LAI and number of branches plant⁻¹ at maturity were significantly influenced by weed management practices. Besides weed-free treatment, higher plant height, dry matter accumulation, leaf area, LAI at all the growth stages and number of branches plant⁻¹ at maturity

recorded with application of Pendimethalin @ 0.75 kg ha⁻¹ (PE) + IC at 40 DAS followed by hand weeding at 20 and 40 DAS which were statistically at par with each other as well as with weed-free and superior over rest of the weed management treatments (Tables 1 and 2). The lowest values of all these parameters were recorded in weedy check followed by application of Pendimethalin @ 0.75 kg ha⁻¹ (PE). These results are in conformity with that reported by Kamboj *et al.* (2005) in fenugreek in which application of Pendimethalin @ 0.75 kg ha⁻¹ with one hand weeding gave the highest growth parameters like branches plant⁻¹ while Patel *et al.* (2007) reported that highest growth parameters were recorded under weed-free treatment. Number of nodules plant⁻¹ and their dry weight were higher in weed-free treatment and were at par with application of Pendimethalin @ 0.75 kg ha⁻¹ (PE) + IC at 40 DAS and hand weeding at 20 and 40 DAS which were significantly superior over rest of the weed management treatments. Days to 50% flowering and maturity was reduced with the application of Pendimethalin @ 0.75 kg ha⁻¹ (PE) and significantly lesser number of days followed by weed free treatment. Similar results were reported by Dungarwal *et al.* (2002) in fenugreek. Pre-emergence application of pendimethalin @ 0.75 kg ha⁻¹ + IC 40 DAS and hand weeding at 20 and 40 DAS were found as effective as weed free treatments in respect to yields (Table 3). The higher seed yield of fenugreek is probably due to effective control of weeds which reduced competition for light, nutrients and water thereby enabling the crop to absorb more nutrients and water under these treatments. Thus favourable water and nutrient balance was maintained in plants resulting in higher dry matter accumulation, and more photosynthesis and hence higher seed, straw and biological yields

Table 1. Influence of irrigation levels and weed management practices on plant height and dry matter accumulation in fenugreek (Pooled mean of 2006-07 and 2007-08)

Treatment	Plant height (cm)			Dry matter accumulation plant ⁻¹ (g)				
	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity
Irrigation level								
I ₁ : 0.6 IW:CPE	7.3	33.9	42.4	45.8	0.35	2.71	8.45	9.81
I ₂ : 0.8 IW:CPE	7.7	38.4	51.5	57.9	0.41	3.54	11.45	13.92
I ₃ : 1.0 IW:CPE	8.3	41.9	56.0	63.1	0.42	3.79	12.90	16.58
CD (P=0.05)	0.4	1.6	2.2	2.5	0.02	0.14	0.47	0.59
Weed management								
W ₁ : Weedy check	5.7	28.0	36.8	41.0	0.29	2.47	7.78	9.52
W ₂ : Weed-free	8.8	43.0	56.6	62.9	0.44	3.79	12.54	15.47
W ₃ : HW at 20 and 40 DAS	8.5	41.8	54.9	61.0	0.43	3.69	12.10	14.88
W ₄ : HW at 20 DAS + IC at 40 DAS	7.6	37.3	49.1	54.6	0.39	3.31	10.83	13.32
W ₅ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE)	7.3	35.7	46.9	52.1	0.36	3.08	10.09	12.38
W ₆ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE) + IC at 40 DAS	8.7	42.4	55.7	61.9	0.44	3.72	12.23	15.04
CD (P=0.05)	0.3	1.5	2.0	2.4	0.02	0.14	0.45	0.54
Interaction (I x W)	NS	NS	NS	NS	NS	S	S	S

DAS = Days after-sowing; HW = Hand weeding; IC = Inter culturing; PE = Pre-emergence

Table 2. Influence of irrigation levels and weed management practices on leaf area plant⁻¹ and leaf area index of fenugreek (Pooled mean of 2006-07 and 2007-08)

Treatment	Leaf area plant ⁻¹ (dm ²)						Leaf area index		
	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity	
Irrigation level									
I ₁ : 0.6 IW:CPE	0.324	1.340	3.065	1.290	0.108	0.447	1.022	0.430	
I ₂ : 0.8 IW:CPE	0.395	1.650	3.780	1.580	0.132	0.550	1.260	0.527	
I ₃ : 1.0 IW:CPE	0.405	1.680	3.950	1.635	0.135	0.560	1.317	0.545	
CD (P=0.05)	0.015	0.060	0.148	0.060	0.005	0.020	0.049	0.020	
Weed management									
W ₁ : Weedy check	0.288	1.198	2.595	1.084	0.10	0.399	0.865	0.361	
W ₂ : Weed-free	0.421	1.751	4.106	1.713	0.14	0.584	1.369	0.571	
W ₃ : HW at 20 and 40 DAS	0.411	1.707	3.978	1.660	0.14	0.569	1.326	0.553	
W ₄ : HW at 20 DAS + IC at 40 DAS	0.367	1.527	3.568	1.489	0.12	0.509	1.189	0.496	
W ₅ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE)	0.345	1.435	3.329	1.390	0.12	0.478	1.110	0.463	
W ₆ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE) + IC at 40 DAS	0.415	1.723	4.013	1.675	0.14	0.574	1.338	0.558	
CD (P=0.05)	0.016	0.065	0.151	0.064	0.0052	0.022	0.050	0.021	
Interaction (I x W)	NS	NS	S	S	NS	NS	S	S	

DAS = Days after sowing; HW = Hand weeding; IC = Inter-culturing; PE = Pre-emergence

Table 3. Influence of irrigation levels and weed management practices on nodules plant⁻¹, branches plant⁻¹, days to 50% flowering and maturity, seed, haulm and biological yields in fenugreek (Pooled mean of 2006-07 and 2007-08)

Treatment	Nodules plant ⁻¹		Dry wt. of nodules plant ⁻¹ (mg)		Branches plant ⁻¹	Days to 50% flowering	Days to maturity	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)
	40 DAS	60 DAS	40 DAS	60 DAS						
Irrigation level										
I ₁ : 0.6 IW:CPE	5.04	9.24	9.86	19.55	3.69	50.67	111.18	1072	2200	3272
I ₂ : 0.8 IW:CPE	6.34	10.82	10.71	23.65	4.79	53.12	115.68	1346	2684	4030
I ₃ : 1.0 IW:CPE	6.99	12.20	12.40	25.91	5.20	55.30	120.14	1474	2835	4309
CD (P=0.05)	0.24	0.41	0.43	0.86	0.21	1.96	4.25	63.0	123.1	185.2
Weed management										
W ₁ : Weedy check	4.51	7.92	8.10	16.97	3.36	56.32	120.58	936	1927	2863
W ₂ : Weed-free	6.94	12.20	12.47	26.13	5.16	51.97	113.80	1479	2904	4383
W ₃ : HW at 20 and 40 DAS	6.73	11.82	12.08	25.32	5.01	52.49	114.95	1434	2835	4269
W ₄ : HW at 20 DAS + IC at 40 DAS	6.01	10.56	10.79	22.62	4.48	53.13	116.35	1287	2552	3839
W ₅ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE)	5.74	10.08	10.30	21.59	4.27	51.43	112.64	1199	2380	3580
W ₆ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE) + IC at 40 DAS	6.79	11.93	12.20	25.57	5.08	52.81	115.65	1447	2840	4287
CD (P=0.05)	0.25	0.45	0.46	0.93	0.19	1.86	5.36	54.2	114.8	166.4
Interaction (I x W)	NS	NS	NS	NS	NS	NS	NS	S	S	S

DAS = Days after sowing; HW = Hand weeding; IC = Inter-culturing; PE = Pre-emergence

Table 4. Leaf area plant⁻¹ and leaf area index as influenced by interaction effect between irrigation levels and weed management practices in fenugreek (Pooled mean of 2006-07 and 2007-08)

Weed management practices / Irrigation levels	Leaf area plant ⁻¹ (dm ²)			Leaf area index		
	90 DAS	Maturity	90 DAS	Maturity	90 DAS	Maturity
	0.6	0.8	1.0	0.6	0.8	1.0
	IW/CPE	IW/CPE	IW/CPE	IW/CPE	IW/CPE	IW/CPE
W ₁ : Weedy check	2.46	2.61	2.71	1.04	1.09	1.12
	0.82	0.87	0.90	0.35	0.36	0.37
W ₂ : Weed-free	3.40	4.35	4.56	1.43	1.82	1.89
	1.13	1.45	1.52	0.48	0.61	0.63
W ₃ : HW at 20 and 40 DAS	3.33	4.20	4.41	1.40	1.75	1.82
	1.11	1.40	1.47	0.47	0.58	0.61
W ₄ : HW at 20 DAS + IC at 40 DAS	2.98	3.70	4.03	1.25	1.55	1.67
	0.99	1.23	1.34	0.42	0.52	0.56
W ₅ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE)	2.85	3.61	3.53	1.20	1.51	1.46
	0.95	1.20	1.18	0.40	0.50	0.49
W ₆ : z 0.75 kg ha ⁻¹ (PE) + IC at 40 DAS	3.37	4.22	4.46	1.42	1.76	1.84
	1.12	1.41	1.49	0.47	0.59	0.61
CD (P=0.05)	0.40*	0.37**	0.17*	0.16**	0.13*	0.12**
	0.06*	0.05**				

DAS = Days after sowing; HW = Hand weeding; IC = Inter-culturing; PE= Pre-emergence

* CD for irrigation levels means at same level of weed management practices

** CD for weed management practices means at same level of irrigation mean

Table 5. Seed, haulm and biological yields as influenced by interaction effect between irrigation levels and weed management practices in fenugreek (Pooled mean of 2006-07 and 2007-08)

Weed management practices / Irrigation levels	Seed yield (kg ha ⁻¹)			Haulm yield (kg ha ⁻¹)			Biological yield (kg ha ⁻¹)		
	0.6 IW/CPE	0.8 IW/CPE	1.0 IW/CPE	0.6 IW/CPE	0.8 IW/CPE	1.0 IW/CPE	0.6 IW/CPE	0.8 IW/CPE	1.0 IW/CPE
W ₁ : Weedy check	861	929	1017	1874	1900	2007	2736	2829	3024
W ₂ : Weed-free	1189	1551	1698	2402	3059	3249	3592	4610	4947
W ₃ : HW at 20 and 40 DAS	1164	1494	1645	2363	2979	3164	3526	4473	4809
W ₄ : HW at 20 DAS + IC at 40 DAS	1041	1316	1503	2138	2624	2892	3180	3941	4395
W ₅ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE)	996	1284	1318	2046	2560	2534	3042	3844	3852
W ₆ : Pendimethalin @ 0.75 kg ha ⁻¹ (PE) + IC at 40 DAS	1177	1502	1663	2376	2979	3164	3553	4481	4827
CD (P=0.05)	106.3*	93.9**	219.1*	198.8**	321.5*	288.2**			

DAS = Days after sowing; HW = Hand weeding; IC = Inter-culturing; PE = Pre-emergence

* CD for irrigation levels means at same level of weed management practices

** CD for weed management practices means at same level of irrigation mean

were obtained with application of pendimethalin @ 0.75 kg ha⁻¹ (PE) + IC at 40 DAS and hand weeding at 20 and 40 DAS being at par with weed-free treatment. Tiwari *et al.* (2006) and Patel *et al.* (2007) also reported similar results in fenugreek.

Interaction effect of irrigation and weed management practices

Leaf area plant⁻¹ and LAI at 90 DAS and at maturity as well as seed, haulm and biological yields of fenugreek were significantly influenced with interaction effect between irrigation levels and weed management practices. The highest leaf area plant⁻¹, LAI as well as seed, haulm and biological yields were obtained with application of irrigation at IW/CPE ratio 1.0 with weed-free treatment being at par with irrigation at IW/CPE ratio 1.0 and weed control by application of Pendimethalin @ 0.75 kg ha⁻¹ + IC at 40 DAS (I₃W₆) and irrigation at IW/CPE ratio 1.0 and weed control at 20 and 40 DAS (I₃W₃) which was significantly higher over rest of the treatment combinations. The lowest values of these parameters were obtained by irrigation at IW/CPE ratio 0.6 with weedy check followed by irrigation at IW/CPE ratio 0.6 with weed control by application of Pendimethalin @ 0.75 kg ha⁻¹ (I₁W₅) (Tables 4 and 5). Effective weed control with application of Pendimethalin @ 0.75 kg ha⁻¹ + IC at 40 DAS and hand weeding at 20 and 40 DAS along with adequate availability of moisture at 1.0 IW/CPE ratio gave higher growth attributes which in turn gave higher seed, straw and biological yields.

The study thus indicated that application of irrigation at IW/CPE ratio 1.0 along with weed control by pre-emergence application of Pendimethalin @ 0.75 kg ha⁻¹ + Inter

culturing at 40 DAS is beneficial for realising better growth and productivity of fenugreek.

References

- Dungarwal H S, Chaplot P C & Nagda B L 2002 Herbicidal weed management in fenugreek (*Trigonella foenum-graecum* L.). Indian J. Weed Sci. 34: 247-250.
- Dutta S & Chatterjee R 2006 Effect of irrigation regimes on moisture extraction pattern, evaporation and yield of fenugreek (*Trigonella foenum-graecum* L.). J. Spices Arom. Crops 15: 125-129.
- Kamboj O P, Bhatia A K, Batra V K, Thakral K K & Ram M 2005 Effect of weed control treatments on weed spectrum and nutrient uptake by weeds in fenugreek. Haryana J. Hort. Sci. 35: 105-107.
- Kramer P J 1969 Plant and Soil Water Relation: A Modern Synthesis. McGraw Hill Book Company, New York.
- Mali A L & Suwalka S N 1987 Studies on weed control in fenugreek. Indian J. Agron. 32: 188-189.
- Panse V G & Sukhatme P V 1985 Statistical Methods for Agricultural Workers, 4th Edition, Indian Council of Agricultural Research. New Delhi.
- Patel J C, Patel P P & Jat G L 2007 Integrated weed management in fenugreek (*Trigonella foenum-graecum* L.) In: Malhotra S K & Vashishtha B B (eds.) Production, Development, Quality and Export of Seed Spices (pp. 284-288). National Research Centre on Seed Spices, Ajmer.
- Tiwari R C, Bairwa R C & Sharma P K 2006 Effect of phosphorus and weed control on fenugreek (*Trigonella foenum-graecum* L.). Legume Res. 29: 304-307.
- Watson D J 1947, Fearce R B & Mitchell R L 1988 Physiology of Crop Plants. Scientific Publisher, Jodhpur.