

Response of fenugreek (*Trigonella foenum-graecum* L.) to irrigation scheduling based on IW/CPE ratio and method of sowing

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Fenugreek (*Trigonella foenum-graecum* L.) commonly known as *methi* is an important seed spices grown in arid and semiarid region of India during *rabi* season and cultivated in an area of 82,900 hectares with production of 1.25 lakh tonnes of seed in the country (Anonymous, 2012). In India, it is mainly grown in Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Haryana, Punjab and Karnataka. Water is a major factor for every metabolic activity of plant and limited quantity of water is available for irrigation, which calls for scheduling of irrigation to improve water productivity of fenugreek. Recently irrigation is being scheduled on the basis of climatological approach which is now considered as most scientific, since it indicates all whether parameters in a given climate, plant continuum giving them natural weightage (Parihar *et al.*, 1976). Maintenance of optimum plant population is essential for interception of solar radiation without exerting competition for nutrient and water in plants.

Precise information regarding appropriate scheduling of irrigation based on IW/CPE ratio and method of sowing for fenugreek is meagre. Keeping in view the above considerations this research programme was planned to study the judicious use of irrigation water which may provide information not only on water use by crop but also when to irrigate and to find suitable method of sowing for fenugreek. Hence there is an urgent need to generate precise information on irrigation requirement and method of sowing.

A field experiment was conducted at Instructional Farm, College of Agriculture, JAU, Junagadh (Gujarat) during *rabi* season of 2011-12. The soil of the experimental field was clayey in texture having field capacity moisture of 28.88 % and PWP of 12.86 % and soil moisture before sowing was 22.15 %, pH 7.9 E_c 0.33 dS m^{-1} . The soil in experimental site was medium in available nitrogen (267.0 kg ha^{-1}), P_2O_5 (38.3 kg ha^{-1}), high in available K_2O (232.0 kg ha^{-1}) and rich in organic carbon (0.83 %). The experiment was laid out in split plot design with four replications. Keeping four levels of irrigation [0.4, 0.6, 0.8 and 1.0 irrigation water (IW) cumulative pan evaporation (CPE) ratio] in main plot and two sowing methods [M_1 = line sowing at 30 cm and M_2 = broadcasting] in sub plots. Fenugreek (GM-2) was sown in first week of November-2011 as per treatments using a seed rate of 15 kg ha^{-1} . A full dose of 20 kg nitrogen and 40 kg phosphorus per hectare was drilled manually through DAP and urea as a basal at sowing. Two common irrigations each of 50 mm depth were applied, first immediately after sowing and second at 5 DAS for better germination and establishment of seedlings. Rest of the irrigations were applied as per treatments. A total of 1400 mm water was measured by parshall flume, installed in the field channel and total of 5, 6, 8 and 9 irrigations of 5.0 cm each at IW/CPE ratio of 0.4, 0.6, 0.8 and 1.0, respectively were provided. Cumulative pan evaporation was taken as the sum of the daily pan evaporation from USWB class-A evaporimeter. The soil samples collected from five different depths viz., 0-15, 15-30, 30-45, 45-60 and 60-75 cm before irrigation and 48 hours after irrigation and sample were used for estimation of moisture content. Other packages of practices were followed as per recommendation made for the crop in the region. The crop was harvested on 5th March, 2012.

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Table 1. Effect of irrigation levels and sowing method on growth, yield attributes and yields of fenugreek

Treatments	Plant height (cm)	Branches/ plant	Dry matter/ plant (g)	Pods/ plant	Pod length (cm)	Seeds/ pod	Test weight (g)	Yield (kg ha ⁻¹)	
								Seed	Straw
Irrigation (IW/CPE ratio)									
I ₁ : 0.4	42.6	5.9	14.1	18.1	6.2	10.9	12.3	1615	2777
I ₂ : 0.6	45.1	6.7	15.7	19.9	7.0	11.2	12.8	1740	2892
I ₃ : 0.8	50.5	7.2	21.6	23.1	7.8	12.8	15.2	1981	3517
I ₄ : 1.0	52.9	7.8	22.9	24.9	8.4	13.4	15.3	2031	3551
S. Em ±	1.54	0.22	0.84	0.66	0.20	0.23	0.20	83.0	174.5
C.D. at 5%	4.95	0.71	2.6	2.11	0.66	0.76	0.65	265.7	558.2
C.V. %	9.1	9.1	12.8	8.7	8.0	5.6	4.1	12.7	15.5
Sowing method									
M ₁ : 30cm Line sowing	50.1	7.2	19.5	22.6	7.8	12.4	14.1	1996	3331
M ₂ : Broadcasting	45.5	6.6	17.6	20.4	6.9	11.8	13.7	1688	3037
S. Em ±	0.82	0.13	0.45	0.30	0.11	0.14	0.09	42.2	51.7
C.D. at 5%	2.54	0.41	1.3	0.93	0.35	0.44	0.28	130.1	159.6
C.V. %	6.9	7.8	9.8	5.6	6.3	4.7	2.6	9.1	6.5
Interaction (I x M)	NS	Sig.	NS	NS	NS	Sig.	Sig.	Sig.	Sig.

Table 2. Effect of irrigation levels and sowing method on water use, WUE and economics of fenugreek

Treatments	Total no. of irrigation applied	Total quantity of irrigation water applied (mm)	WUE (kg ha ⁻¹ mm)	Realization (₹ ha ⁻¹)		BCR
				Gross	Net	
Irrigation (IW/CPE ratio)						
I ₁ : 0.4	5	250	6.46	42571	16337	1.62
I ₂ : 0.6	6	300	5.80	45816	18972	1.71
I ₃ : 0.8	8	400	4.95	52274	24210	1.86
I ₄ : 1.0	9	450	4.51	53566	24892	1.87
Sowing method						
M ₁ : 30cm line sowing	-	-	5.85	52564	25980	1.98
M ₂ : Broadcasting	-	-	5.01	44563	16239	1.57

Significantly higher plant height, dry matter accumulation, number of branches per plant, pods per plant, pod length, number of seeds per pod, test weight, seed and straw yields were recorded at IW/CPE ratio of 1.0 than rest of the treatments but it remained at par with IW/CPE ratio of 0.8 (Table 1). While in case of water use efficiency it was maximum (6.46 kg ha⁻¹ mm) at 0.4 IW/CPE ratio (Table 2). Significantly higher seed and straw yields (2031 and 3551 kg ha⁻¹) were produced at higher IW/CPE ratio (1.0) it might be due to frequent irrigation at shorter interval under this treatment which maintain optimum moisture level in the soil during the entire growth period resulted in better translocation of photosynthates from source to sink which in turn resulted higher yield attributes and yield of fenugreek. These findings are in close agreement with studies of Dutta and Chatterjee (2006).

The higher values of growth and yield attributes; seed and straw yields were observed when crop was sown at 30cm row spacing (Table 1). Significantly the maximum seed yield (1996 kg ha⁻¹) was produced under line sown crop at 30 cm row spacing which was 18.2% higher than broadcast method of sowing. The probable reason for higher yield under line sowing might be due to intra-space competition and competitive interactions among the plant can be avoided by providing suitable stand geometry by which all the strata of leaves can get copious sunlight and carry out effective photosynthesis and consequently higher dry matter and yield (Duncan, 1977). Yadav *et al.*, (2000) also reported higher seed yield of fenugreek under 30 cm row spacing.

Data of one year revealed the presence of significant interaction of irrigation (I) and sowing method (M). Significantly for the higher no. of branches per plant, seeds per pod, test weight, seed and straw yields were recorded when crop was irrigated at 1.0 IW/CPE ratio along with 30cm row spacing (Table 3). Treatment combination I₄M₁ recorded significantly higher seed yield than rest of the combinations, but it remained at par with I₃M₁ combinations (irrigation at 0.8 IW/CPE ratio along with 30cm row spacing). Irrigating the crop at an IW/CPE ratio 1.0 and sowing the crop at 30cm row spacing significantly increased yields which might be due to the contribution of more pods, pod length and seeds per pod as evidenced by test weight and grain yield per plant resulting from more nutrition to plants. These findings are corroborating with the reports of Davut Karaaslan (2007) in sesame.

Table 3 Interaction effects of irrigation and sowing method on growth, yield attributes, seed and straw yield

Treatments	Branches/plant				Seeds/pod				Test weight(g)				Seed yield(kg ha ⁻¹)				Straw yield(kg ha ⁻¹)			
	I ₁	I ₂	I ₃	I ₄	I ₁	I ₂	I ₃	I ₄	I ₁	I ₂	I ₃	I ₄	I ₁	I ₂	I ₃	I ₄	I ₁	I ₂	I ₃	I ₄
M ₁	6.1	6.5	7.6	8.4	11.1	11.0	13.4	14.0	12.4	12.8	15.4	15.9	1729	1792	2108	2354	2913	2933	3583	3896
M ₂	5.7	6.9	6.7	7.1	10.7	11.4	12.2	12.7	12.3	12.7	15.1	14.7	1500	1688	1854	1708	2642	2850	3450	3206
C.D. at 5%	0.83				0.88				0.57				260.3				329.2			

The maximum amount of moisture was extracted from 0-15 cm soil depth irrespective of irrigation and it was decreased with soil depth (Fig. 1). About 60.91% soil moisture was extracted from the top 30 cm of soil depth under 0.4 IW/CPE ratio but in case of 1.0 IW/CPE ratio more than 65.57% soil moisture was extracted at the same depth. This indicated that irrigation levels had prominent effect on soil moisture extraction pattern.

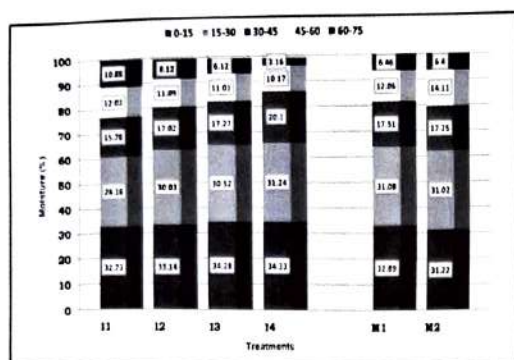


Fig. 1 Moisture extraction pattern of fenugreek under different IW/CPE ratio and sowing method

Soil moisture extraction increased from 15 cm soil depth with increasing irrigation level. The higher amount of moisture extraction from surface layer under different irrigation levels might be due to increased surface evaporation, shallow root density and higher water uptake due to availability of irrigation water. These findings are also corroborate with the findings of Dutta and Chatarjee (2006). In lower level of irrigation treatments, moisture extraction was higher from deeper (30-60 cm) soil layer. In this condition moisture stress compelled the roots to go into deeper soil layer for utilization of water for their proper growth and development. In case of sowing method maximum moisture extraction of 63.97% was noted in line sowing followed by broadcast method of sowing with 62.24%, respectively.

The results presented in Table 2 on economics of different irrigation levels indicated that an application

of irrigation water at 1.0 IW/CPE ratio recorded highest gross and net realization of Rs. 53566 and Rs. 24892/ha, respectively, due to more yield followed by 0.8 IW/CPE ratio. In case of sowing method highest gross and net realization recorded under line sowing method.

It was concluded that for getting higher yield and maximum economics of fenugreek should be irrigated at an IW/CPE ratio of 1.0 with sown at 30cm row spacing along with other recommended package of practices.

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