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Weed dynamics and yield of fenugreek (*Trigonella foenum-graecum*) as influenced with irrigation levels and weed management practices

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ABSTRACT

A field experiment was conducted during 2006–08 at Sardarkrushinagar to find out optimum irrigation level and weed management practices for getting higher yield of fenugreek (*Trigonella foenum-graecum* L.). Monocot weed at 40 days after sowing and at maturity as well as dicot and sedges weed population and dry weight of weeds at 40 days after sowing and at maturity and yield of fenugreek were exhibited significantly higher with irrigation at 1.0 irrigation water/cumulative pan evaporation ratio, followed by 0.8 ratio. Besides weedy check, the highest dry weight and population of weeds at 20 days after sowing was recorded by hand weeding at 20 and 40 days after sowing and hand weeding at 20 days after sowing + inter-culturing at 40 days after sowing but at 40 days after sowing the highest weed population and dry weight was recorded with pre-emergence application of pendimethalin 0.75 kg/ha and pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing and at maturity the lowest dicot and sedge population was recorded by pre-emergence application of pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing but lowest monocot weed population and dry weight of weed was recorded with hand weeding at 20 and 40 days after sowing. Besides, weedy check, the highest weed control efficiency at 20 days after sowing was recorded with pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing but at 40 days after sowing and maturity the highest weed control efficiency was observed with hand weeding at 20 and 40 days after sowing.

Key words: Irrigation, Weed competition, Weed-control efficiency, Weed index, Yield

Fenugreek (*Trigonella feonum-graecum* L.) is mainly grown in Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Haryana, Punjab, Bihar and Andhra Pradesh. Water is the key natural resource for successful crop production and considered as an important role in increasing yield and productivity of crops. Higher water-use efficiency can be realized by applying irrigation at appropriate schedule based on irrigation water/cumulative pan evaporation ratio. Dutta and Chatarjee (2006) found highest gross returns, net returns and benefit : cost ratio with application of irrigation at irrigation water/cumulative pan evaporation ratio, followed by 0.8. Simultaneous emergence and rapid growth of weed leads to severe weed-crop competition for light, moisture, space and nutrients hence fenugreek field should be weed free at initial stage of crop establishment by employing available weed control system. Manual weeding is commonly employed but availability of labour is becoming problem besides high cost. In a weedy check reduction in seed yield of fenugreek was 56.2% as compared to weed-free situation (Ramana *et al*.1994). Hence, 30 days crop stage is the most critical period for crop weed competition in fenugreek. Therefore, the present study was conducted to find suitable weed control method and appropriate level of irrigation for realizing higher yield of fenugreek.

MATERIALS AND METHODS

The field experiment was conducted at Sardarkrushinagar during winter (*rabi)* season of 2006–08. The experiment was laid out in different fields during the both the years. The soil was loamy sand in texture having *p*H 7.75 and 7.73 and electrical conductivity 0.12 and 0.11 dS/m, respectively, during 2006–07 and 2007–08. The soil of the both the sites were low in organic carbon (0.17 and 0.22) and available N (152.75 and 165.25 kg/ha), medium in available P_2O_5 (40.75 and 47.6 kg/ha) and good in available K_2O (260.25 and 264.7 kg/ha). The experiment was laid out in split-plot design with 4 replications, keeping 3 levels of irrigation (0.6, 0.8 and 1.0 irrigation water/cumulative pan evaporation ratio) in main

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plot and 6 weed control treatments (weedy check, weed free, hand weeding at 20 and 40 days after sowing, hand weeding at 20 +interculturing at 40 days after sowing, pre-emergence application of pendimethalin 0.75 kg/ha and application of pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing) in sub-plot. The 'GM 2' fenugreek (*Trigonella foenium-graecum* L.) was sown in second week of November during both the years at 30 cm row-to-row spacing using 20 kg seed/ha. Full dose of N and P was drilled manually through diammonium phosphate and urea at the time of sowing. 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 was done on 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 litres/ha. In manual weed control treatments, weeds were uprooted and removed at 20 and 40 days after sowing and inter-culturing was done as per treatments at 40 days after sowing. In weed-free plots, the weeds were removed manually after every 7 days for ensuring complete weed-free condition. Weed population was recorded using 0.25 quadrate and then converted into number of weeds/m^2. Two representative spots in each plot were selected randomly. The monocot, dicot and sedges weeds were separately counted at 20 and 40 days after sowing as well as at maturity of fenugreek. The data were subjected to square root transformation $\sqrt{(x+0.5)}$ to normalize their distribution (Gomez and Gomez 1984). After uprooting of weeds, the weeds were sun-dried completely till reached to constant weight and finally the dry weight was recorded for each treatment and expressed as g/m^2. Weed control efficiency and weed index were calculated by the formulae suggested by Kondap and Upadhya (1985).

RESULTS AND DISCUSSION

Effect of irrigation levels

The monocot, dicot and sedge weed population as well as dry weight of weed at 40 days after sowing and maturity increased significantly with application of irrigation at increasing irrigation water/cumulative pan evaporation ratio from 0.6 to 1.0 but at 20 days after sowing no significant was observed as irrigation treatments were imposed after application of common irrigation at 5 days after sowing which provided more or less similar moisture status (Tables 1, 2). The reduction in infestation of weed at lower moisture regimes appeared to be due to moisture stress condition in the soil, which restricts the emergence of weed species. Higher dry weight of weeds with increase in number of irrigation was also reported by Patel *et al*. (2005).Weed control efficiency was not significantly influenced at all the growth stages with application of irrigation at varying levels but weed index was significantly affected and the lowest weed index was recorded with irrigation at 0.6 irrigation water/cumulative pan evaporation ratio. This might be due to the fact that as moisture level increased the proportionate reduction in yield was also higher on account of weed resulting in higher weed index.

The highest seed, straw and biological yields were obtained with application of irrigation at 1.0 irrigation water/ cumulative pan evaporation ratio, followed by with 0.8.

Table 1 Periodical monocot, dicot and sedges weed population as influenced by irrigation levels and weed management practices (pooled data for 2006–07 and 2007–08)

Treatment	Monocot weed/m^2			Dicot weed /m^2			Sedges weed /m^2		
	20 DAS	40 DAS	Maturity	20 DAS	40 DAS	Maturity	20 DAS	40 DAS	Maturity
Irrigation levels									
I_1: 0.6 IW:CPE	3.68 (15.4)	3.51 (13.7)	4.27 (20.8)	3.76 (16.2)	3.76 (15.8)	4.41 (23.4)	2.37(5.9)	2.58 (7.0)	2.73 (8.3)
I_2: 0.8 IW:CPE	3.71 (15.7)	3.71 (15.5)	4.48 (22.9)	3.78 (16.3)	3.86 (16.8)	4.60 (25.7)	2.39 (6.0)	2.61(7.2)	2.86 (9.3)
I_3: 1.0 IW:CPE	3.76 (16.2)	3.83 (16.5)	4.61 (24.3)	3.82 (16.8)	4.00 (18.1)	4.70 (26.8)	2.40 (6.1)	2.74 (8.0)	2.91 (9.7)
CD (*P*=0.05)	NS	0.15	0.15	0.12	0.12	0.14	0.08	0.08	0.09
Weed management practices									
W_1: Weedy check	5.19 (26.5)	5.39 (28.6)	6.56 (42.0)	5.29 (27.6)	5.64 (31.4)	7.82 (60.7)	3.25 (10.1)	3.77 (13.8)	4.73(21.9)
W_2: Weed free	0.71 (0.0))	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)
W_3: HW at 20 and 40 DAS	4.92 (23.8)	3.72 (13.4)	4.51 (19.9)	5.02 (24.8)	3.91 (14.8)	4.09 (16.3)	3.08 (9.0)	2.64 (6.5)	2.52 (5.9)
W_4: HW at 20 DAS and IC at 40 DAS	4.87 (23.3)	3.79 (13.9)	4.60 (20.7)	4.97(24.9)	3.98 (15.4)	4.54 (20.1)	3.05 (8.9)	2.69 (6.7)	2.78 (7.3)
W_5: Pendimethalin @ 0.75 kg/ha (PE)	3.34 (10.6)	4.35 (18.5)	5.28 (27.5)	3.40 (11.1)	4.57 (20.4)	6.32 (39.6)	2.13(4.0)	3.08 (8.9)	3.84 (14.3)
W_6: Pendimethalin @ 0.75 kg/ha + IC at 40 DAS (PE)	3.28 (10.3)	4.16 (16.9)	5.05 (25.2)	3.35 (10.7)	4.43 (19.2)	3.94 (15.1)	2.10 (3.9)	2.98 (8.4)	2.43 (5.4)
CD (*P*=0.05)	0.11	0.11	0.14	0.11	0.11	0.13	0.07	0.08	0.08

Square root transformation = $\sqrt{(X+0.5)}$; figures in parentheses are original values

Table 2 Dry weight of weed, weed-control efficiency at different growth stages and weed index as influenced by irrigation levels and weed management practices (pooled data of 2006–07 and 2007–08)

Treatment	Dry weight of weed (g/m^2)			Weed-control efficiency (%)			Weed
	20 DAS	40 DAS	Maturity	20 DAS	40 DAS	Maturity	index (%)
Irrigation levels							
I_1: 0.6 IW:CPE	5.50	18.30	67.45	38.87	46.99	46.87	9.92
I_2: 0.8 IW:CPE	5.62	19.48	71.30	40.28	47.08	46.91	13.20
I_3: 1.0 IW:CPE	5.71	20.62	76.95	42.46	46.15	46.14	13.17
CD (*P*=0.05)	NS	0.99	3.37	NS	NS	NS	NS
Weed management practices							
W_1: Weedy check	9.46	36.59	135.12	0.00	0.00	0.00	35.93
W_2: Weed free	0.00	0.00	0.00	100.00	100.00	100.00	0.00
W_3: HW at 20 and 40 DAS	8.43	17.13	63.26	10.54	53.10	53.01	2.98
W_4: HW at 20 DAS and IC at 40 DAS	8.30	17.83	65.84	11.93	51.31	51.12	12.99
W_5: Pend @ 0.75 kg/ha(PE)	3.79	23.63	87.26	59.71	35.13	35.01	18.58
W_6: Pend. @ 0.75 kg/ha	3.67	21.63	79.90	61.03	40.89	40.71	2.11
CD (*P*=0.05)	0.23	0.94	3.56	2.28	2.56	2.46	0.80

Table 3 Seed yield, straw yield, biological yield and harvest index of fenugreek as influenced by irrigation levels and weed management practices (pooled data of 2006–07 and 2007–08)

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Irrigation level				
I_1: 0.6 IW:CPE	1 072	2 200	3 272	32.7
I_2: 0.8 IW:CPE	1 346	2 684	4 030	33.4
I_3: 1.0 IW:CPE	1 474	2 835	4 309	34.1
CD (*P*=0.05)	63.0	123.1	185.2	NS
Weed management practices				
W_1: Weedy check	936	1 927	2 863	32.69
W_2: Weed free	1 479	2 904	4 383	33.65
W_3: HW at 20 and 40 DAS	1 434	2 835	4 269	33.51
W_4: HW at 20 DAS and IC at 40 DAS	1 287	2 552	3 839	33.42
W_5: Pendimethalin 0.75 kg/ha (PE)	1 199	2 380	3 580	33.42
W_6: Pendimethalin 0.75 kg/ha + IC at DAS (PE)	1 447	2 840	4 287	33.65
CD (*P*=0.05)	54.2	114.8	166.4	NS

HW, hand weeding

However, the harvest index was not significantly influenced with varying levels of irrigation (Table 3). Application of irrigation at 1.0 irrigation water/cumulative pan evaporation ratio resulted 10 and 38% higher seed yield over 0.8 and 0.6 irrigation water/cumulative pan evaporation ratio, respectively. The increase in seed, straw and biological yields with application of irrigation at 1.0 irrigation water/ cumulative pan evaporation 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 plant during entire growth period which resulted better translocation of photosynthates from source to sink resulting in higher yields of fenugreek. These findings are in close agreement with those of Dutta *et al*. (2006) and Nemichand *et al*. (2007).

Effect of weed management

Besides, weedy check, weed population and their dry weight at 20 days after sowing was significantly higher with hand weeding at 20 and 40 days after sowing, followed by hand weeding at 20 and interculturing 40 days after sowing and the lowest was recorded in weed free. Besides weedy check, significantly the highest population and dry weight of weed at 40 days after sowing was recorded with pre emergence application of pendimethalin 0.75 kg/ha and pendimethalin 0.75 kg/ha + inter-culturing at 40 days after sowing but the lowest weed population was recorded in hand weeding at 20 and 40 days after sowing and hand weeding at 20 days after sowing + interculturing at 40 days after sowing.The effective weed control by hand weeding at 20 days after sowing in both the treatments was responsible for

lower weed population and weed biomass at 40 days after sowing. At maturity, besides weed free, the lowest, dicot and sedges weed population was recorded with pre-emergence application of pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing, followed by hand weeding at 20 and 40 days after sowing and hand weeding at 20 and interculturing at 40 days after sowing but lowest monocot weed population and dry weight of weed was obtained with hand weeding at 20 and 40 days after sowing. The lowest weed population at maturity in pendimethalin 0.75 kg/ha + interculturing might be due to inter-culturing operation at 40 days after sowing which resulted effective weed control at maturity (Tables 1, 2). The highest weed control efficiency at 20 days after sowing was recorded with pre- emergence application of pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing, followed by pendimethalin @ 0.75 kg/ha but at 40 days after sowing and maturity, the highest weed control efficiency was obtained by hand weeding at 20 and 40 days after sowing (Table 2). The highest weed control efficiency with these treatments might be due to effective weed control resulting in lower weed biomass which resulted better weed control efficiency. At maturity, beside weed-free treatment, the pre-emergence application of pendimethalin @ 0.75 kg/ha + interculturing at 40 days after sowing resulted significantly higher weed-control efficiency, followed by hand weeding at 20 and 40 days after sowing which were at par with weed-free treatment. Tiwari *et al*.(2006) reported reduced weed population and weed biomass with application of pendimethalin @ 1.0 kg/ha + hand weeding at 25 days after sowing Significantly higher weed index was recorded in weedy check and the lowest in weed-free treatment and the second lowest weed index was found with pre emergence application of pendimethalin 0.75 kg/ha + interculturing being at par with hand weeding at 20 and 40 days after sowing.

Pre-emergence application of pendimethalin @ 0.75 kg/ha with interculturing at 40 days after sowing and hand weeding at 20 and 40 days after sowing were found as effective as weed-free treatments in respect to yield (Table 3). The higher seed yield of fenugreek seems to be due to effective control of weeds, which reduced competition for light, nutrients and water, thereby enabling fenugreek 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 hence higher seed, straw and biological yields were obtained. With pre-emergence application of pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing and hand weeding at 20 and 40 days after sowing 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

Seed, straw and biological yields were significantly influenced with interaction effect between irrigation levels and weed management practices. Besides combination of weed-free treatment, the highest seed, straw and biological yields were obtained by application of irrigation at 1.0 irrigation water/cumulative pan evaporation ratio with pre-emergence application pendimethalin 0.75 kg/ha + interculturing at 40 days after sowing being at par combined application of irrigation at 1.0 irrigation water/cumulative pan evaporation ratio and with hand weeding at 20 and 40 days after sowing. The lowest seed, straw and biological yields were obtained by irrigation at 0.6 irrigation water/cumulative pan evaporation ratio with weedy check, followed by irrigation at 0.6 irrigation water/cumulative pan evaporation ratio along with pre-emergence application pendimethalin (Table 4). Effective weed control with pre-emergence application of pendimethalin @ 0.75 kg/ha + interculturing at 40 days after sowing and hand weeding at 20 and 40 days after sowing along with adequate availability of moisture at 1.0 irrigation water/cumulative pan evaporation ratio gave higher seed, straw and biological yields. Mustafee

Table 4 Seed, straw and biological yields (kg/ha) as influenced by interaction effect between irrigation levels and weed management practices (pooled data of 2006–07 and 2007–08)

Weed management practices/ irrigation levels	Seed yield (kg/ha)			Straw yield (kg/ha)			Biological yield (kg/ha)		
	0.6 I W/CPE	0.8 I W/CPE	1.0 I W/CPE	0.6 I W/CPE	0.8 I W/CPE	1.0 I W/CPE	0.6 I W/CPE	0.8 I W/CPE	1.0 I W/CPE
W_1: Weedy check	861	929	1 017	1 874	1 900	2 007	2 736	2 829	3 024
W_2: Weed free	1 189	1 551	1 698	2 402	3 059	3 249	3 592	4 610	4 947
W_3: HW at 20 and 40 DAS	1 164	1 494	1 645	2 363	2 979	3 164	3 526	4 473	4 809
W_4: HW at 20 DAS and IC at AS	1 041	1 316	1 503	2 138	2 624	2 892	3 180	3 941	4 395
W_5: Pendimethalin 0.75 kg/ha (PE)	996	1 284	1 318	2 046	2 560	2 534	3 042	3 844	3 852
W_6: Pendimethalin 0.75 kg/ha + IC at 40 DAS (PE)	1 177	1 502	1 663	2 376	2 979	3 164	3 553	4 481	4 827
CD (P =0.05)	106.3*		93.9**	219.1*		198.8**	321.5*		288.2**

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

(1990) observed best weed control with application of pendimethalin 0.75 kg/ha + irrigation at 2 days after sowing resulting the highest yield of cumin.

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