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Effect of irrigation levels and weed control methods on dry matter accumulation, growth dynamics and yield of fenugreek

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ABSTRACT

A field experiment was conducted during 2006-07 and 2007-08 at Sardarkrushinagar to find out optimum level of irrigation and suitable weed control method. The experiment consisting of three levels of irrigation (0.6, 0.8 and 1.0 IW/CPE ratio) in main plot and six weed control methods (weedy check, weed-free, hand weeding at 20 and 40 DAS, HW at 20 + interculturing at 40 DAS, application of pendimethalin@0.75 kg ha^{-1}(PE) and pendimethalin @ 0.75 kg ha^{-1} (PE) + interculturing at 40 DAS) in subplots was laid out in split plot design with four replications. Results revealed that irrigation at 1.0 IW/CPE ratio resulted in significantly higher dry matter/plant, crop growth rate, relative growth rate and net assimilation rate except CGR at 0-30 DAS which was at par with irrigation at 0.8 IW / CPE ratio. Length of pod, number of pods per plant, number of seeds per pod and test weight of seeds as well as seed, straw and biological yields were recorded the highest with irrigation at 1.0 IW/CPE ratio. Besides, weed-free treatment, the highest dry matter accumulation per plant, CGR, RGR, NAR and yield attributes as well as seed, straw and biological yield were recorded with pre-emergence application of pendimethalin @ 0.75 kg per ha + IC at 40 DAS followed by hand weeding (HW) at 20 and 40 DAS which were statistically at par with weed free treatments and significantly superior over rest of the treatments. Thus, pendimethalin @ 0.75 kg /ha+ IC at 40 DAS was found most effective weed control method in fenugreek.

Key words: Fenugreek, IW/CPE ratio, weed control, dry matter accumulation.

INTRODUCTION

Fenugreek (*Trigonella foenumgraecum* L.) is an important major seed spice crop which occupies 32.6 thousand ha area with annual production of 35.8 thousand metric tonnes having productivity of 1,093 kg /ha in India (Anon, 1). The seeds of fenugreek are used as a condiment and seasoning agent for garnishing and flavourings dishes. Fenugreek requires 300 mm water for successful crop production. At present the irrigation scheduling is done based on arbitrary intervals without any scientific rationale resulting in wastage of water. Its Initial slow growth makes it susceptible to weed problem hence simultaneous emergence and rapid growth of weed leads to severe weed crop competition for light, moisture, space and nutrients. In agriculture, weed causes more damage as compared to insect pests and diseases due to hidden losses caused by weed in crop production. It has been observed that out of the total losses of agricultural produce from various pests in India, weed accounts of 45 per cent, insect 30 per cent, disease 20 per cent and other pests 5 per cent (Rao,10). Similarly, in a study in India, it has been reported that 33 per cent of the total losses in agriculture produce due to pests is attributed to weeds alone (Joshi, 4). Raghvani *et al*. (9), in an experiment at Junagadh, reported appreciable yield losses in cumin to the extent of 30 to 80 per cent which was caused by weeds. Presently, weed management in fenugreek is by hand weeding. Mali and Suwalka (1987) reported that two hand weedings at 20 and 35 DAS were found significantly superior over herbicidal treatments in fenugreek but increasing cost of hired manpower resulting in higher cost of production. Therefore, precise information on water and weed management in fenugreek is essential and inevitable for realising higher yield of fenugreek. Hence, the study was carried out to find out appropriate irrigation levels and weed management techniques for better growth and yield of fenugreek.

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MATERIALS AND METHODS

The field experiment was conducted at Sardarkrushinagar during *rabi* season of 2006-07 and 2007-08. The experiment was laid out at different sites during both the years. The soil of the experimental field was loamy sand in texture having neural pH (7.75 and 7.73) and electrical modirate conductivity (0.12 and 0.11 dSm^{-1}), respectively during 2006-07 and 2007-08. The soil of the experimental field of both the sites were low in organic carbon (0.17 & 0.22%), available

nitrogen (152.75 & 165.25 kg /ha), medium in available P (18.0 and 21.0 kg /ha) and rich in respect to available K_2O (260.25 & 264.7 kg /ha). The experiment was laid out in split plot design with four replications, keeping three irrigation levels (0.6, 0.8 and 1.0 IW/CPE ratios) in main plot and six weed control treatments (weedy check, weed-free, hand weeding at 20 and 40 DAS, HW at 20 + inter-culturing at 40 DAS, application of pendimethalin @ 0.75 kg ha (PE) and application of pendimethalin @ 0.75 kg /ha (PE) + IC at 40 DAS) in sub-plots. The crop was sown in second week of November during both the years at 30 cm row to row spacing keeping seed rate of 20 kg per ha. An uniform dose 25 kg nitrogen and 40 kg P_2O_5 phosphorus were applied manually through DAP and urea at the time of sowing. Cumulative pan evaporation was taken as the sum of the daily pan evaporation from USWB class-A. The pendimethalin @ 0.75 kg per ha (PE) was applied in the second day after irrigation which was given immediately after sowing of the crop. The spray of pendimethalin was done with knapsack sprayer keeping spray volume of 600 l per ha. In manual weed control treatments, weeds were uprooted and removed at 20 and 40 DAS and interculturing was done as per treatments at 40 DAS. In weed-free plots, the weeds were removed manually at seven days interval for ensuring complete weed-free conditions. Thus, total of 10 weedings were done in the weed-free plots. Five plants were randomly selected and dried in oven at 70 ^oC for 48 h and dry weight at all growth stages was taken. The relative growth rate (RGR), crop growth rate (CGR) and net assimilation rate (NAR) was computed empirically by the use of formula suggested by Redford (8).

RESULTS AND DISCUSSION

Significantly higher dry matter accumulation, CGR, RGR, NAR at all growth stages except dry matter accumulation at 30 DAS, length of pod, number of pods per plant, seeds per pod, test weight as well as seed, straw and biological yield was obtained with irrigation at 1.0 IW/CPE ratio which might be due to optimum availability of moisture at 1.0 IW/CPE ratio without any stress resulting in higher vegetative growth, more photosynthetic area and dry matter accumulation resulting in higher CGR, RGR and NAR. The DMA at 30 DAS was recorded at par with irrigation at 1.0 and 0.8 IW/CPE ratio (Tables 1 & 2). Further, CGR increased up to 90 DAS and afterward it decreased but RGR and NAR declined with advancement of age of fenugreek crop. CGR increased up to 60-90 DAS, thereafter there was drastic reduction at maturity due to remarkable decline in leaf area at all irrigation levels. Similarly, RGR and NAR were also recorded higher during 30-60 DAS, afterwards drastic decline in both of these growth parameters was experienced at all the levels of irrigation. As growth advanced, dry matter accumulation in stem (skeleton) increased, hence RGR decreased. These findings are in close conformity with those reported by Seron (11). Similarly, dry weight of weed at harvest increased with increase in IW/CPE ratio but application of irrigation at 0.8 and 1.0 IW/CPE ratio resulted at par dry weight of weed. Weed control efficiency as well as weed index was not influenced with irrigation levels.

Application of irrigation at 1.0 IW/CPE ratio resulted significantly in higher yield attributes as well as seed, straw and biological yields over 0.6 and 0.8 IW/CPE ratio (Table 2). The increase in yield attributes and yields with application of irrigation at 1.0 IW/CPE ratio was due to frequent irrigations which facilitated maintenance of optimum moisture level in soil as well as in plant during entire growth period resulting in higher yield attributes and yields. These findings are in close agreement with Dutta and Chaterjee (3), and Nemichand *et al.* (6). Besides, weed-free treatment, the highest DMA, CGR and RGR were recorded with pre-emergence application of pendimethalin @ 0.75 kg ha^{-1} + IC at 40 DAS followed by HW at 20 and 40 DAS which were higher then rest of the weed management treatments (Table 1). The maximum values of these growth parameters under these treatments is due to better control of weeds throughout the crop growth period which resulted in better availability of moisture and nutrients to the crop resulting in favourable condition for crop, consequently crop attained luxuriant growth having smothering effect on weed. Application of pendimethalin @ 0.75 kg ha^{-1} + IC at 40 DAS and HW at 20 and 40 DAS gave at par values for these parameters with weed-free treatment. These results are in conformity with Kamboj *et al.* (5), and Patel *et al*. (7). Similarly, besides weed-free treatment, significantly the highest length of pod per plant, number of seeds per pod and test weight of seed as well as seed, straw and biological yields of fenugreek were recorded with pre-emergence application of pendimethalin @ 0.75 kg per ha + IC at 40 DAS followed by with HW at 20 and 40 DAS which were statistically at par with each other as well as with weed-free treatment. Higher seed yield of fenugreek seems to be due to cumulative effect of growth and yield attributes which were recorded significantly higher in weed-free treatment, pendimethalin @ 0.75 kg ha^{-1}(PE) + IC at 40 DAS and HW at 20 and 40 DAS. The least weed population under these treatments were also responsible for better seed yield, straw and biological yields. Tiwari *et al*. (12) and Patel *et al*. (7) reported similar results in fenugreek. Besides, weed-free treatment, highest weed control efficiency at maturity was obtained with weed control by hand weeding at

Table 1. Dry matter accumulation, crop growth rate, relative growth rate and net assimilation rate as influenced by irrigation levels and weed management practices.

Treatment	Dry matter accumulation plant^{-1} (g)				Crop growth rate (g m^{-2} day^{-1})				Relative growth rate (g g^{-1} day^{-1})			Net assimilation rate (g dm^{-2} day^{-1})		
	30 DAS	60 DAS	90 DAS	Matu.	0-30 DAS	30-60 DAS	60-90 DAS	90 DAS-Maturity	30-60 DAS	60-90 DAS	90 DAS-Maturity	30-60 DAS	60-90 DAS	90 DAS - Maturity
IW/CPE ratio														
0.6	0.35	2.71	8.45	9.81	0.38	2.63	6.37	1.52	0.02985	0.01646	0.00215	0.0479	0.0399	0.0096
0.8	0.41	3.54	11.45	13.92	0.46	3.47	8.79	2.74	0.03105	0.01698	0.00282	0.0514	0.0444	0.0142
1.0	0.42	3.79	12.90	16.58	0.47	3.74	10.12	4.08	0.03183	0.01769	0.00362	0.0544	0.0494	0.0202
CD (P = 0.05)	0.02	0.14	0.47	0.59	0.02	0.19	0.45	0.14	0.00076	0.00059	0.00013	0.0027	0.0011	0.0006
Weed management														
Weedy check	0.29	2.47	7.78	9.52	0.33	2.42	5.91	1.93	0.03086	0.01659	0.00281	0.0493	0.0425	0.0133
Weed-free	0.44	3.79	12.54	15.47	0.49	3.72	9.72	3.25	0.03094	0.01725	0.00291	0.0519	0.0454	0.0155
HW at 20 and 40 DAS	0.43	3.69	12.10	14.88	0.48	3.62	9.34	3.09	0.03092	0.01710	0.00287	0.0516	0.0449	0.0149
HW at 20 DAS and IC at 40 DAS	0.39	3.31	10.83	13.32	0.43	3.25	8.359	2.76	0.03090	0.01707	0.00285	0.0516	0.0447	0.0146
Pendimethalin 0.75 kg ha^{-1} (PE)	0.36	3.08	10.09	12.38	0.40	3.02	7.79	2.54	0.03090	0.01712	0.00285	0.0513	0.0448	0.0146
Pendimethalin 0.75 kg ha^{-1} (PE) + IC at 40 DAS	0.44	3.72	12.23	15.04	0.49	3.65	9.45	3.12	0.03092	0.01713	0.00289	0.0517	0.0451	0.0151
CD (P = 0.05)	0.02	0.14	0.45	0.54	NS	0.18	0.42	0.16	NS	NS	NS	NS	0.0015	0.0008

Table 2. Dry weight of weed, weed control efficiency (WCE) and weed index (WI) at maturity attributes and yield of fenugreek as influenced by irrigation levels and weed management practices in fenugreek.

Treatment	Dry weight of weed (g)	Weed control efficiency (%)	Weed index (%)	Length of pod (cm)	No. of pods/plant	No. of seeds/pod	1000-seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
IW/CPE ratio										
0.6	67.45	46.87	9.92	9.3	20.4	10.4	10.3	1072	2200	3272
0.8	71.30	46.91	13.20	11.6	25.9	13.1	11.9	1346	2684	4030
1.0	76.95	46.14	13.17	12.9	28.0	14.8	12.9	1474	2835	4309
CD (P = 0.05)	3.37	NS	NS	0.5	1.1	0.6	0.5	63.0	123.1	185.2
Weed management										
Weedy check	135.12	0.00	35.93	8.1	17.9	9.2	8.6	936	1927	2863
Weed-free	0.00	100.00	0.00	12.9	28.2	14.5	13.2	1479	2904	4383
HW at 20 and 40 DAS	63.26	53.01	2.98	12.5	27.4	14.1	12.8	1434	2835	4269
HW at 20 DAS and IC at 40 DAS	65.84	51.12	12.99	11.2	24.6	12.6	11.4	1287	2552	3839
Pendimethalin 0.75 kg ha^{-1} (PE)	87.26	35.01	18.58	10.4	22.9	11.8	10.9	1199	2380	3580
Pendimethalin 0.75 kg ha^{-1} (PE) + IC at 40 DAS	79.90	40.71	2.11	12.6	27.6	14.2	13.0	1447	2840	4287
CD (P = 0.05)	3.56	2.46	0.80	0.4	1.0	0.5	0.5	54.2	114.8	166.4
I × W interaction	NS	0.00	35.93	NS	Sig.	Sig.	NS	Sig.	Sig.	Sig.

Table 3. No. of pods/plant, No. of seeds/pod, seed, straw and biological yields (kg ha^{-1}) as influenced by interaction between irrigation levels and weed management practices in fenugreek.

Weed management	No. of pods/plant			No. of seeds/pod			Seed yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biological yield (kg ha^{-1})		
	0.6	0.8	1.0	0.6	0.8	1.0	0.6	0.8	1.0	0.6	0.8	1.0	0.6	0.8	1.0
Weedy check	16.40	17.85	19.34	8.36	9.01	10.19	861	929	1,017	1,874	1,900	2,007	2,736	2,829	3,024
Weed-free	22.64	29.80	32.30	11.54	15.05	17.02	1,189	1,551	1,698	2,402	3,059	3,249	3,592	4,610	4,947
HW at 20 and 40 DAS	22.15	28.71	31.29	11.29	14.50	16.49	1,164	1,494	1,645	2,363	2,979	3,164	3,526	4,473	4,809
HW at 20 DAS and IC at 40 DAS	19.83	25.30	28.60	10.10	12.77	15.07	1,041	1,316	1,503	2,138	2,624	2,892	3,180	3,941	4,395
Pendimethalin @ 0.75 kg ha^{-1} (PE)	18.97	24.68	25.06	9.67	12.46	13.21	996	1,284	1,318	2,046	2,560	2,534	3,042	3,844	3,852
Pendimethalin @ 0.75 kg ha^{-1} + IC at 40 DAS (PE)	22.40	28.87	31.62	11.41	14.57	16.67	1,177	1,502	1,663	2,376	2,979	3,164	3,553	4,481	4,827
CD (P = 0.05)	1.96*		1.77**	1.00*		0.91**	106.3*		93.9**	219.1*		198.8**	330.5*		288.2**

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

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

20 and 40 DAS but lowest weed index was recorded with application of pendimethalin @ 0.75 kg ha^{-1}+ IC at 40 DAS .

Significantly the highest number of pods per plant, number of seeds per pod , seed yield, straw yield and biological yield were recorded with application of irrigation at 1.0 IW/CPE ratio with weed-free treatment (I_3W_2) being at par to irrigation at 1.0 IW/CPE ratio with pendimethalin@0.75 kg/ha + IC at 40 DAS (I_3W_6) and irrigation at 1.0 IW/CPE ratio with hand weeding at 20 and 40 DAS (I_3W_3) which were significantly higher over rest of the treatment combinations (Table 3). This was due to effective control of weeds with application of pendimethalin @ 0.75 kg ha^{-1} (PE) + IC at 40 DAS and HW at 20 and 40 DAS coupled with sufficient availability of moisture at 1.0 IW/CPE ratio increased growth of crop and enhanced photosynthetic efficiency resulting in higher dry matter accumulation under these treatment combinations. Application of irrigation at 1.0 IW /CPE ratio along with weed-free treatment resulted significantly in highest seed, straw and biological yield which being at par with irrigation at 1.0 IW/CPE ratio + pre-emergence application of pendimethalin @ 0.75 kg per ha and irrigation at 1.0 IW/CPE + HW at 20 and 40 DAS. Further, it was observed that irrespective to weed management practices, increase in IW/CPE ratio significantly increased number of pods per plant, number of seeds per pod, seed yield, straw yield and biological yield of fenugreek. The results are in close conformity with those reported by Bhimani (2) in mustard.

Thus, application of irrigation at 1.0 IW/CPE ratio along with weed control by pre-emergence application of pendimethalin @ 0.75 kg h^{-1} was found most effective for getting higher yield of fenugreek.

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