RESEARCH PAPER International Journal of Agricultural Sciences, June to December, 2009, Vol. 5 Issue 2 : 485-489

Influence of irrigation schedules based on IW:CPE ratios and herbicidal weed control in isabgul (*Plantago ovata* Forsk)

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ABSTRACT

Application of isoproturon was most effective for the control of all weeds, which resulted in 99.32%.weed control efficiency and 49.00 % higher mean seed yield over unweeded control. The higher WUE (3.606 kg ha^{-1} mm^{-1}) was observed under 0.4 IW:CPE ratio and higher net return (Rs ha^{-1} 28904) were obtained under the treatment combination (0.4 IW:CPE ratio and application of isoproturon @ 0.5 kg ha^{-1} as pre-emergence). The interaction effect of irrigation schedule and herbicidal weed control practices was found non-significant in some cases.

Key words : Isabgul, *Plantago ovata*, *Blonde psyllium*, Irrigation, IW:CPE ratio, Herbicide

INTRODUCTION

Blonde psyllium (*Plantago ovata* Forsk) is an important medicinal crop of Gujarat. Due to low cost of production and higher return from the crop. Gujarat commands near monopoly in the production and export of isabgul seed and seed husk to the world market. It is cultivated in India about 1.3 lakh ha with production 77000 MT seed. (Desai and Devra, 2008). Earning about 130 crores rupees from the isabgul seed and 150 crores rupees from husk were exported valued together Rs.280 crores. Isabgul is raised as a *rabi* season crop and grown in all type of soil under irrigated conditions but does best on loamy soils. Water is scare commodity, which if used judiciously along with suitable agrotechniques would substantially increase both plant growth, yield and yield attributes. With the introduction of high yielding varieties coupled with increased use of fertilizers and irrigation on weed problem have increased manifolds. Application of irrigation in proper amount and in proper time will go a long way in arresting the problem created by weeds. The predominant method of weed control by mechanical hoeing and manual weeding is found to be laborious and time consuming not only this but in peak period of crop growth. Labour is not easily available. Under these situations the chemical control of weeds is found to be effective and economical. Establishing proper herbicidal weed control and irrigation scheduling can enhance the productivity of isabgul. With these dual purpose agronomic aspects in mind, an attempt has been made to conduct an experiment on “Influence of irrigation schedules based on IW:CPE ratios and herbicidal weed control in isabgul (*Plantago ovata* Forsk).

MATERIALS AND METHODS

A field experiment was conducted during winter seasons of 2006-07 at College Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand. The soil was sandy loam in texture. Low in organic carbon, available potassium with pH 7.8. The treatment consisted of four irrigation schedules based on IW:CPE ratios and four herbicidal weed control practices. The experiment was laid out in split plot design with allocation of irrigation schedule in main plots and herbicidal weed control in sub-plots. The treatments were replicated four times. Isoproturon and oxadiargyl were applied @ 0.5 kg ha^{-1} as pre-emergence and post-emergence, respectively, in 500 liter ha^{-1} of water. Isabgul variety GI-2 was sown by broadcasting the seeds on November 15, 2006, at 4.0 kg seed ha^{-1} and fertilized with 30+15 kg NP ha^{-1}.

RESULTS AND DISCUSSION

The results obtained from the present investigation are present below:

Effect on weeds:

The major weeds observed in the experimental field were *Chenopodium album* (32.1%) *Chenopodium murale* (18.8 %), *Argemone mexicana* (8.0%), *Tribulus terrestris* (10.6%), *Cyperus rotundus* (14.0%), other weeds with low density (16.5%) were *Eragrotis major Rome and Sch.*, *Dactyloc tenium aegyptium*, *Eleusine indica*, *phyllanthus niruri*, *Argemone mexicana* and *Cynodon dactylon*. Weed density at 15 DAS was not influenced by different irrigation schedules. Irrigation at 0.4 IW:CPE ratio accounted for the significantly lowest weeds while, significantly lower total weed count was noticed under irrigation schedule I_1 (0.4 IW:CPE ratio) at 30 DAS. At 60 DAS both (I_4) and (I_1) contributed lower total weed counts. The irrigation schedule I_1 (0.4 IW:CPE

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ratio) accounted for the significantly the lowest number of dicot and total weed count at harvest, though the weed dry weight was not-significantly influenced by the number of irrigations at 30 DAS and at harvest but, at 60 DAS significantly lower dry weight of weeds was observed with irrigation schedule I_1 (0.4 IW:CPE ratio) and I_4 (flood irrigation-one month interval between two irrigation), respectively. Isoproturon @ 0.5 kg ha^{-1} caused lower weed density and weed dry weight than oxadiaryl @ 0.5 kg ha^{-1} (Table 1).

Effect on crop:

Irrigation schedules (0.4 IW:CPE ratio) and (Flood irrigation-one month interval between two irrigation) significantly influenced the growth attributes of isabgul. Weight of 1000 seed was found non-significant by irrigation schedules (Table 2).

Herbicidal weed control practices significantly affected the yield attributes of isabgul. Maximum values of all the yield attributes were recorded under isoproturon application and minimum under unweeded control. Reduced crop-weed competition due to isoproturon created a favorable condition for better crop growth and development (Table 2).

Seed yield, straw yield and harvest index of isabgul were influenced by irrigation schedules. Significantly higher seed yield, straw yield and harvest index were recorded when irrigations were done at 0.4 IW:CPE ratio. All the weed control treatments produced

Table 1 : Influence of irrigation schedules based on IW:CPE ratios and herbicidal weed control on weed counts and dry weight of weeds

Treatments	Weed count(m^{-2}) at 30 DAS			Weed count(m^{-2}) at 60 DAS			Weed count(m^{-2}) at harvest			Dry weight of weeds		
	Monocot	Dicot	Total	Monocot	Dicot	Total	Monocot	Dicot	Total	30 DAS	60 DAS	At harvest
	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]	Log [X+1]
Irrigation (I)												
I_1(0.4 IW:CPE ratio)	10.10	104.74	114.84	8.27	67.77	76.04	9.79	74.00	83.79	2063.97	502.29	2993.59
	*(0.82)	(1.27)	(1.39)	(0.80)	(1.06)	(1.36)	(0.84)	(1.14)	(1.30)	(2.13)	(1.71)	(2.00)
I_2(0.6 IW:CPE ratio)	14.89	160.05	174.93	12.95	134.97	147.91	9.85	158.49	168.34	3077.53	1345.25	4896.16
	(0.98)	(1.48)	(1.61)	(0.93)	(1.48)	(1.59)	(0.86)	(1.33)	(1.57)	(2.18)	(2.09)	(2.11)
I_3(0.8 IW:CPE ratio)	16.03	240.73	256.76	19.17	210.47	229.64	10.66	171.43	182.09	3732.76	1561.37	8950.73
	(1.01)	(1.50)	(1.68)	(1.04)	(1.72)	(1.76)	(0.87)	(1.40)	(1.57)	(2.20)	(2.10)	(2.29)
I_4 (flood irrigation-one month	14.01	145.22	159.23	10.04	203.80	213.83	9.62	100.31	109.93	2163.74	568.80	4646.62
interval between two irrigation)	(0.97)	(1.42)	(1.59)	(0.86)	(1.48)	(1.62)	(0.84)	(1.25)	(1.42)	(2.13)	(1.83)	(2.08)
S.E.±	0.030	0.044	0.040	0.030	0.054	0.052	0.030	0.029	0.025	0.060	0.051	0.101
C.D. (P=0.05)	0.095	0.142	0.127	0.096	0.172	0.166	NS	0.094	0.081	NS	0.164	NS
C.V.%	12.52	12.52	10.10	13.22	14.98	13.15	13.95	9.14	6.91	11.11	10.59	18.97
Herbicidal weed control (W)												
W_1 (H.W. at 20 and 40 DAS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	*(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
W_2 (Unweeded control)	20.22	325.88	346.10	19.96	309.89	329.85	14.16	308.70	322.85	7883.16	2068.69	12052.31
	(1.32)	(2.50)	(2.53)	(1.25)	(2.38)	(2.41)	(1.16)	(2.48)	(2.46)	(3.84)	(3.15)	(3.95)
W_3 (Iso.@ 0.5 kg ha^{-1} as pre-	16.62	5.24	21.86	14.71	84.58	99.29	12.49	1.53	14.02	26.48	33.75	5.23
emergence)	(1.19)	(0.77)	(1.31)	(1.18)	(1.05)	(1.55)	(1.11)	(0.35)	(1.10)	(1.38)	(1.45)	(0.79)
W_4 (Oxa.@ 0.5 kg ha^{-1} as post-	18.19	319.62	337.80	15.75	222.53	238.29	13.27	194.01	207.28	3128.36	1875.27	9429.56
emergence at 15 DAS)	(1.27)	(2.40)	(2.44)	(1.21)	(2.32)	(2.36)	(1.14)	(2.28)	(2.30)	(3.42)	(3.12)	(3.74)
S.E.±	0.017	0.030	0.029	0.020	0.035	0.034	0.018	0.026	0.019	0.048	0.045	0.069
C.D.(P=0.05)	0.048	0.086	0.083	0.058	0.099	0.096	0.051	0.076	0.055	0.137	0.128	0.197
Interaction(I×W)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	NS
C.V.%	7.04	8.46	7.34	8.89	9.62	8.48	8.28	8.27	5.23	8.81	9.24	12.94

Figures in parentheses indicate original values. * This indicate transformed value (Logarithmic transformation), NS-Non- significant, Sig.- Significant

Table 2 : Influence of irrigation schedules based on IW:CPE ratios and herbicidal weed control on growth, yield and yield attributes characters

Treatments	Plant height (cm)		Total tillers per plant	Effective tillers per plant	Effective spikes per plant	Non-effective spikes per plant	Length of spikes (cm)	Test weight of 1000 seeds (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
	At tillering stage	At harvest									
Irrigation (I)											
I_1(0.4 IW:CPE ratio)	39.11	40.53	18.54	18.87	27.92	1.14	4.08	1.77	762	3978	15.73
I_2(0.6 IW:CPE ratio)	36.37	38.81	16.31	17.22	26.88	1.25	3.88	1.75	682	4042	13.77
I_3(0.8 IW:CPE ratio)	40.13	41.28	15.89	16.77	27.05	1.41	3.53	1.75	573	4396	10.98
I_4 (flood irrigation-one month interval between two irrigation)	38.83	38.41	16.66	17.96	26.79	1.32	3.68	1.77	730	3873	15.26
S.E.±	0.643	0.437	0.676	0.378	1.232	0.067	0.082	0.012	29.21	126.25	0.384
C.D. (P=0.05)	2.056	1.399	NS	1.210	NS	NS	0.261	NS	93.45	268.21	1.229
C.V.%	6.66	4.40	16.04	8.54	18.15	21.00	8.62	2.79	17.02	12.40	11.02
Herbicidal weed control (W)											
W1 (H.W. at 20 and 40 DAS)	40.01	41.18	17.28	17.68	28.67	1.28	3.85	1.77	879	4363	16.51
W_2 (Unweeded control)	35.16	37.39	15.61	16.17	24.74	1.34	3.52	1.73	347	2690	11.59
W_3 (Iso.@ 0.5 kg ha-^{1} as pre-emergence)	41.04	42.24	18.22	19.54	28.81	1.17	4.08	1.80	1004	5250	16.01
W_4 (Oxa.@ 0.5 kg ha-^{1} as post-emergence at 15 DAS)	38.22	38.22	16.29	17.43	26.42	1.33	3.73	1.75	517	3986	11.63
S.E.±	0.421	0.312	0.457	0.322	0.721	0.037	0.068	0.006	18.89	90.38	0.370
C.D.(P=0.05)	1.208	0.895	1.311	0.925	2.068	0.106	0.196	0.018	54.17	259.22	1.061
Interaction(I×W)	Sig.	Sig.	NS	NS	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.
C.V.%	4.36	3.14	10.85	7.29	10.62	11.56	7.20	1.46	11.00	8.88	10.62

significantly higher seed and straw yield except unweeded control (Table 2). Higher harvest index was observed under hand weeding at 20 and 40 DAS followed by isoproturon at 0.5 ka ha^{-1}. Isoproturon at 0.5 ka $ha^{-1}$was most effective in reducing crop-weed competition and producing higher 1000 seed weight and seed yield. The highest seed yield due to herbicide (isoproturon) in isabgul was also reported by Mehta *et al.* (1985), Patel *et al.* (1996), Parihar and Singh (2001) and Patel and Mehta (1990).

Interaction effect between irrigation schedules and herbicidal weed control practices were found significant at all stages of weed counts except weed counts at 15 DAS. The non-significant results were observed for dry weight of weeds at 30 DAS and at harvest but significant at 60 DAS. The plant height, Total tillers per plant, Length of spike, Straw yield, Seed yield and Harvest index were influenced by irrigation schedules and herbicidal weed control treatments.

The highest consumptive use of water was observed under treatment I_3 (0.8 IW:CPE ratio) followed by treatment I_2 (0.6 IW:CPE ratio). The highest water use efficiency was recorded under treatment I_1 (0.4 IW:CPE ratio) followed by treatment I_4 (Flood irrigation-one month interval between two irrigation). The maximum water expanse efficiency was noted under the I_1 (0.4 IW:CPE ratio) followed by I_4 (Flood irrigation-one month interval between two irrigation) (Table 3).

Treatment W_3 (Isoproturon @ 0.5 kg ha^{-1} as pre-emergence) and W_2 (Unweeded control) had registered higher consumptive use of water. The highest water use efficiency was observed under W_1 followed by W_3. The highest WEE was observed under the treatment W_3 followed by W_1 (Table 3). Maximum WUE was observed under the treatment hand weeding at 20 and 40 DAS and isoproturon @ 0.5 kg ha^{-1} as pre-emergence. This might be due to minimum transpiration loss of water through weeds. This was effectively controlled by isoproturon @ 0.5 kg ha^{-1} as pre-emergence.

Economics:

The treatment combination I_4W_3 (flood irrigation-one month interval between two irrigation and isoproturon @ 0.5 kg ha^{-1} as pre-

Table 3 : Consumptive use (CU), water use efficiency (WUE) and water expense efficiency (WEE) by isabgul crop as influenced by varying levels of irrigation and herbicidal weed control practices

Treatments	CU (mm)	WUE (kg ha^{-1} mm^{-1})	WEE (kg ha^{-1} mm^{-1})
Irrigation (I)			
I_1 (0.4 IW:CPE ratio)	141.80	5.374	3.810
I_2 (0.6 IW:CPE ratio)	180.02	3.791	2.728
I_3 (0.8 IW:CPE ratio)	298.62	1.917	1.910
I_4 (flood irrigation-one month interval between two irrigation)	142.70	5.113	3.650
Herbicidal weed control (W)			
W_1 (H.W. at 20 & 40 DAS)	142.70	6.157	3.701
W_2 (Unweeded control)	181.27	1.915	1.461
W_3 (Iso.@ 0.5 kgha-^{1} as pre-emergence)	278.40	3.670	4.227
W_4 (Oxa.@ 0.5 kgha-^{1} as post-emergence at 15 DAS)	140.90	3.606	2.177

Table 4 : Gross realization, net realization and incremental cost benefit ratio (ICBR) and net incremental cost benefit ratio for varying irrigation schedules and herbicidal weed control practices

Treatment combinations	Seed yield (kgha^{-1})	Gross realization (Rs.ha^{-1})	Total cost of production (Rs.ha^{-1})	Net realization Rsha^{-1}	ICBR	NET ICBR
I_1W_1	950	33237	7304	25933	1:19.43	1:18.43
I_1W_2	465	16275	6194	10081	1:E	1:E
I_1W_3	1018	35625	6721	28904	1:45.42	1:44.42
I_1W_4	616	21550	11836	9714	1:1.75	1:0.75
I_2W_1	915	32025	7581	24444	1:15.03	1:14.03
I_2W_2	328	11463	6471	4991	1:-Ve	1:-Ve
I_2W_3	1010	35341	6999	28343	1:30.68	1:29.68
I_2W_4	478	16713	12114	4599	1:0.86	1:-Ve
I_3W_1	678	23713	7859	15854	1:8.34	1:7.34
I_3W_2	262	9175	6749	2426	1:-Ve	1:-Ve
I_3W_3	959	33575	7276	26299	1:25.46	1:24.46
I_3W_4	391	13687	12391	1296	1:0.34	1:-Ve
I_4W_1	973	34038	7304	26734	1:20.15	1:19.15
I_4W_2	334	11675	6194	5481	-	-
I_4W_3	1029	36000	6721	29279	1:46.14	1:45.14
I_4W_4	584	20438	11836	8601	1:1.55	1:0.55

Selling price: Seeds @ Rs. 35.00 kg^{-1} Note: E= Infinity -Ve= Negative

emergence) had given the highest net returns, ICBR and net ICBR (29279, 1:46.14, 1:45.14, respectively). The second best treatment combination was I_1W_3 (0.4 IW:CPE ratio and isoproturon @ 0.5 kg ha^{-1} as pre-emergence) with net realization (28904), ICBR (1:45.42) and net ICBR (1:44.42) (Table 4).

Conclusion:

Thus, from the point of view of productivity and economics, the isabgul crop should be irrigated either on the basis of (0.4 IW:CPE ratio) or (Flood irrigation-one month interval between two irrigation) to obtain higher yield and net returns. Maintaining a weed free plot with the application of isoproturon @ 0.5 kg ha^{-1} as pre-emergence could preferred for Gujarat soil for achieving highest yield and remuneration.

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Received : March, 2009; Accepted : April, 2009