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Effect of different levels of irrigation and weed management on growth, yield and WUE of hybrid maize on new alluvial zone of West Bengal.

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ABSTRACT

To study the most critical physiologically water need stage of hybrid maize, effect of scheduling of irrigation at different physiological growth stages and different methods of weed control measures on growth, yield and WUE of hybrid maize under new alluvial zone of West Bengal, a field experiment was conducted at the Viswavidyalaya farm during pre-kharif season in 2007. The experiment was conducted in a sandy loam soil with 20 treatment combinations (4 irrigation levels in main plot and 5 weed control methods in sub-plot) in a split plot design replicated thrice. The study revealed that irrigation did not significantly influence the growth attributes, number (m^{-2} area) and dry weight (g m^{-2} area) of grassy, sedge and broadleaved weeds but significantly influenced the grain yield(t ha^{-1}). Irrigation applied at knee height stage and tasselling stage recorded an increase in grain yield to the tune of 76.1% and 36.72% over control, respectively. Weed control methods significantly influenced all the characters in most of the cases. The highest growth attributes and grain yield were recorded under pre-emergence application of metribuzin @ 600 g ha^{-1} and minimum number(m^{-2} area) and dry weight(g m^{-2} area) of grassy, sedge and broadleaved weeds were recorded under pre-emergence application of Metribuzin @ 600 g ha^{-1} (W_1).. The lowest CU (210.9 mm), depletion of soil moisture (%) and highest WUE (18.87 kg ha^{-1} mm^{-1}) were recorded under irrigation applied at knee height stage and these were just reverse incase of irrigation applied at silking stage.

***Key words*:** Hybrid maize, herbicide, irrigation and water use efficiency

Weed infestation is one of the major constraints of low productivity of hybrids maize. The average yield loss due to weed in hybrid maize in India is 30-70%. The unavailable and costly human labour along with unfavourable weather condition for intercultural operations make the chemical weed control methods a suitable option to farmers. Another major constraint for higher productivity of maize is improved water management practice though the maize crop can survive under stress condition due to its deep root behaviour. However, optimum supply of water at critical physiological growth stages may produce higher production of the crop that should be taken into consideration because in pre-kharif season, irrigation water is very much scarce particularly during the month of March- April. Only 20% of the maize area is irrigated and rest 80% remains rainfed during kharif season. These facts necessitate the use of herbicide in conjunction with irrigation management for higher productivity of the crop. The present study was, therefore, undertaken to study the performance of hybrid maize towards irrigation and herbicide on growth, yield attributes, yield and WUE under new alluvial zone of West Bengal.

MATERIALS AND METHODS

A field experiment was carried out at Jaguli Instructional Farm, West Bengal during 2007 in pre-kharif season. The experimental field was a medium land with new alluvial inceptisol and sandy loam in texture. The pH of soil was 6.87, organic carbon 0.59%, total nitrogen 0.07%, available P_2O_5 and K_2O_5 were 26.66 kg ha^{-1} and 179.29 kg ha^{-1}, respectively. During the cropping period, rainfall was 655.8 mm and the number of effective days of rainfall was 22. The experiment was laid out in split plot design having 4 levels of irrigation in main plots and 5 methods of weed control treatments in sub-plot and replicated thrice. The cultivar was Pac – 775. The 4 different levels of irrigation were . I_1 –at silking stage at 60 DAS ; I_2 - at knee high stage at 35 DAS; I_3 –at tasselling stage at 45 DAS; I_4 – no irrigation and 5 different methods of weed control were W_1 – pre-emergence application of metribuzin @ 600 g ha^{-1}; W_2 - pre-emergence application of bispyrebac sodium 10% SC @ 800 g ha^{-1}, W_3 – post emergence application of tragasuper 5 EC @ 50 ml ha^{-1}; W_4 – two hand weeding at 20 DAS and 40 DAS and W_5 – unweeded control.

Seed was sown on 25th April, 2007 at a spacing of 50 × 25 cm with seed rate of 60 kg ha^{-1} in experimental plot of 4 × 3 m size. The crop was harvested on 24th July, 2007. The recommended dose of fertilizer was 80:40:40 kg ha^{-1} N, P_2O_5 and K_2O, respectively. 1/4th N and full of P_2O_5 and K_2O applied as basal. Rest N applied in two splits – ½ at tasselling stage and 1/4th N at silking stage. The statistical analysis was done using the method of Panse and Sukhatme (1976).

Water use efficiency (WUE) was computed using the following formulae:

$$\text{WUE (kg ha}^{-1}\text{ cm}^{-1}) = \frac{\text{Yield (kg ha}^{-}}{\text{ET or CU value}}$$

ET = Evapotranspiration, CU = Consumptive Use

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RESULTS AND DISCUSSION

Weed flora

The predominant weed flora associated with crop were *cynodon dactylon, Echinochloa colonum, Eleusine indica, Sorghum halepense, Cyperus rotundus, Amaranthus spinosus* etc.

Effect of irrigation

The levels of irrigation did not significantly influence the growth attributes and number (m^{-2} area) and dry weight (g m^{-2} area) of grassy, sedge and broadleaved weeds except at harvest in case of number and dry weight of grassy weeds and number of sedge weeds at 60 DAS but significantly influenced the grain yield(t ha^{-1}). Plant height, LAI, dry matter production and CGR were maximum under irrigation at knee height stage (I_2) followed by irrigation at tasseling stage at 45 DAS (I_3) except plant height at 40 DAS and at harvest (Table 1and 2)**.** However, lowest plant height, dry matter production and CGR were recorded under no irrigation (I_4) treatment except 40 and 60 DAS in case of plant height and the lowest LAI was recorded under irrigation at silking stage at 60 DAS (I_1).

The lowest number and value of dry weight of grassy, sedge and broad leaved weeds per unit area were recorded under irrigation applied at knee height stage at 35 DAS (I_2) which was followed by irrigation at tasselling stage at 45 DAS (I_3) and they were statistically at per at harvest in case of grasses and at 60 DAS in case of number of sedge weeds (Table 3, 4 & 5). However, the highest number and value of dry weight of grassy, sedge and broad leaved weeds per unit area were recorded under no irrigation treatment (I_4) irrespective of date of observations.The highest grain yield (3.9 t ha^{-1}) (Table 6) was recorded under irrigation applied at knee height stage (I_2) followed by irrigation at tasselling stage (I_3). Both the treatments produced 76.1% and 36.72% increased yield over control, respectively. Irrigation applied at critical physiological growth stages favoured yield components which inturn yielded the highest grain yield of the crop. Similar findings were also observed by Majidain and Ghadiri (2002).

Effect of weed management practices

Growth attributes, grain yield (t ha^{-1}), and number (m^{-2} area) and dry weight (g m^{-2} area) of grassy, sedge and broadleaved weeds were significantly influenced by methods of weed control except plant height at 20 DAS, number and dry weight of sedges at 20 DAS and number and dry weight of broadleaved weeds at 60 DAS. Maximum plant height, highest LAI, maximum dry matter production and CGR were produced at 60 DAS and harvest (Table 1& 2) under treatment of pre-emergence application of Metribuzin @ 600 g ha^{-1} (W_1) followed by hand weeding twice at 20 and 40 DAS (W_4). These two treatments were statistically at per irrespective of dates of observations in case of plant height, dry matter production (except 20 DAS) and CGR (except 20 DAS). However, the lowest plant height, LAI, dry matter production and CGR were recorded under unweeded (W_5) treatment irrespective of date of observations.

Minimum number and dry weight of grassy, sedge and broad leaved weeds per unit area were recorded under treatment of pre-emergence application of metribuzin @ 600 g ha^{-1} (W_1) which was closely followed by hand weeding twice at 20 and 40 DAS (W_4) except at harvest in case of grassy weeds and they were significantly superior over other weed control methods (Table 3, 4 and 5). However, the highest number and dry weight of grassy, sedge and broad leaved weeds per unit area was observed under unweeded control (W_5) irrespective of date of observations during the experimentation.Highest grain yield (5.45 t ha^{-1}) (Table 6) was recorded under pre-emergence application of metribuzin @ 600 g ha^{-1} (w_1) followed by hand weeding twice at 20 DAS and 40 DAS (W_4). This could be attributed to the intensity of weed infestation. Heavier the weed infestation, less was the manifestation of yield component of the crop and that finally reflected the grain yield of the crop. Jat *et al.* (1998) observed the similar findings.

Effect of levels of irrigation on moisture depletion, CU and WUE

Moisture depletion pattern of hybrid maize crop was influenced by irrigation levels. The data presented in the (Table 7) show that an increase in depth of soil, gradually decreased the soil moisture depletion pattern at all the levels of irrigation till the last depth of observation recorded except 45 to 60 cm depth. Soil moisture depletion was maximum under irrigation applied at silking stage at 60 DAS (I_1) particularly at 0-15 cm soil depth. The lowest depletion of soil moisture at different depths was found in under irrigation applied at knee height stage at 35 Das (I_2) except 1st and 4th layer. Similar results were observed by Gowranga and Verma (2005). The highest WUE (18.87 kg ha^{-1} mm^{-1}) and lowest CU (210.9 mm) (Table 7) were recorded under irrigation applied at knee height stage (I_2) and these were just reverse incase of irrigation applied at silking stage (I_1). Devi and Rao (2004) observed the similar findings.

Thus, it could be concluded that irrigation applied at knee height stage in combination with pre-emergence application of metribuzin @ 600 g ha^{-1} gave the best result.

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Table 1: Effect of levels of irrigation and methods of weed control on height and LAI plant

Irrigation Treatments	Height (cm)			LAI		
	20 DAS	60 DAS	At harvest	20 DAS	60 DAS	At harvest
I_1	36.39	170.96	193.43	1.96	3.397	3.24
I_2	39.16	179.91	196.89	1.98	3.40	3.245
I_3	37.76	177.8	192.87	1.97	3.399	3.242
I_4	34.92	170.94	189.09	1.95	3.395	3.23
SEm(±)	**3.32**	**10.64**	**5.76**	**0.009**	**0.004**	**0.005**
LSD (P=0.05)	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**
Weed control Treatments						
W_1	39.49	194.41	210.68	2.08	3.53	3.42
W_2	36.73	178.83	192.66	1.95	3.45	3.28
W_3	36.25	167.62	191.85	1.94	3.33	3.17
W_4	37.07	194.35	204.88	2.00	3.46	3.31
W_5	35.76	139.30	165.27	1.85	3.21	3.02
SEm(±)	**1.47**	**8.73**	**5.73**	**0.007**	**0.0048**	**0.006**
LSD (P=0.05)	**N.S.**	**25.05**	**16.44**	**0.02**	**0.013**	**0.017**

Table 2: Effect of levels of irrigation and methods of weed control on dry matter accumulation of crop plant

Irrigation Treatments	Dry matter accumulation (g m^{-1} length)			Crop growth rate (g day^{-1} m^{-1} length)		
	20 DAS	60 DAS	At Harvest	0 to 20 DAS	40 to 60 DAS	60 DAS to Harvest
I_1	3.08	270.67	179.25	0.15	12.36	6.17
I_2	4.0	336.62	192.96	0.2	15.67	7.44
I_3	3.36	276.06	187.66	0.16	12.37	7.23
I_4	2.56	267.23	170.60	0.12	12.1	5.41
SEm(±)	**0.36**	**20.13**	**15.76**	**0.018**	**1.07**	**0.90**
LSD (P=0.05)	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**
Weed control Treatments						
W_1	4.28	395.13	254.06	0.21	18.24	9.59
W_2	3.19	267.63	179.85	0.16	12.12	6.68
W_3	2.85	226.93	167.07	0.14	10.35	4.12
W_4	3.37	375.08	207.46	0.169	17.19	8.99
W_5	2.56	173.44	104.62	0.12	7.71	3.44
SEm(±)	**0.22**	**18.79**	**22.82**	**0.01**	**0.95**	**1.22**
LSD (P=0.05)	**0.64**	**53.9**	**65.49**	**0.03**	**2.7**	**3.5**

Table 3: Effect of levels of irrigation and methods of weed control on number and dry weight of grassy weeds of hybrid maize field

Irrigation Treatments	Number of grassy weeds (m^{-2} area)			Dry weight of grassy weeds (g m^{-2} areas)		
	20 DAS	60 DAS	At harvest	20 DAS	60 DAS	At harvest
I_1	173.60	158.93	203.46	13.20	123.65	190.12
I_2	124.00	159.66	141.06	8.79	120.12	129.94
I_3	125.06	149.73	172.13	13.07	114.19	159.09
I_4	234.20	155.6	208.86	14.43	131.60	192.53
SEm(±)	**26.78**	**11.29**	**11.42**	**2.47**	**9.13**	**10.54**
LSD (P=0.05)	**N.S.**	**N.S.**	**39.50**	**N.S.**	**N.S.**	**36.46**
Weed control Treatments						
W_1	0	103.75	85.16	0	81.77	78.9
W_2	34.08	180.16	169.58	2.40	142.42	156.91
W_3	360.33	215.33	256.33	25.75	168.68	237.33
W_4	0	56.33	136.66	0	44.22	126.53
W_5	426.66	224.33	259.16	33.73	174.85	239.92
SEm(±)	**28.67**	**7.95**	**8.54**	**2.61**	**6.31**	**7.90**
LSD (P=0.05)	**82.28**	**22.80**	**24.50**	**7.49**	**18.08**	**22.60**

Table 4: Effect of levels of irrigation and methods of weed control on number and dry weight of sedge weeds on hybrid maize field

Irrigation Treatments	Number of sedge weeds (m^{-2} area)			Dry weight of sedge weeds (g m^{-2} areas)		
	20 DAS	60 DAS	At harvest	20 DAS	60 DAS	At harvest
I_1	9.6	16	12.26	1.40	10.24	15.17
I_2	4	3.73	8	0.63	1.76	4.69
I_3	4.66	13.86	10.93	0.63	8.45	7.67
I_4	10.93	21.06	16.53	1.70	15.70	16.02
SEm(±)	**4.78**	**3.3**	**2.96**	**0.77**	**2.68**	**3.59**
LSD (P=0.05)	**N.S.**	**11.41**	**N.S.**	**N.S.**	**N.S.**	**N.S.**
Weed control Treatments						
W_1	5.41	0	0	0.91	0	0
W_2	8.41	7	11.66	1.28	4.33	8.62
W_3	10.24	9.66	19	1.29	8.83	24.12
W_4	0	6.33	3	0	4.33	1.56
W_5	12.41	45.33	26	1.98	27.7	20.15
SEm(±)	**4.56**	**5.0**	**4.35**	**0.68**	**3.15**	**4.47**
LSD (P=0.05)	**N.S.**	**14.35**	**12.48**	**N.S.**	**9.04**	**12.82**

Table 5: Effect of levels of irrigation and methods of weed control on number and dry weight of broad leaved weeds of hybrid maize field

Irrigation Treatments	Number of BL weeds (m^{-2} area)			Dry weight of BL weeds ($g\ m^{-2}$ areas)		
	20 DAS	60 DAS	At harvest	20 DAS	60 DAS	At harvest
I_1	31.2	0.8	3.73	7.39	1.46	11.15
I_2	12.53	0.26	0.8	1.98	0.96	3.04
I_3	31.2	0.53	1.33	6.38	1.2	3.75
I_4	45.06	1.86	7.2	7.57	2.13	19.25
SEm(±)	**11.26**	**1.14**	**2.06**	**1.69**	**1.66**	**5.68**
LSD (P=0.05)	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**
Weed control Treatments						
W_1	0	0	0.66	0	0	0.16
W_2	25.33	0.33	2.33	6.04	1.20	4.99
W_3	50.33	0.66	5	10.81	1.50	11.03
W_4	0	0	1	0	0	2.33
W_5	74.33	3.33	7.33	12.30	4.50	27.98
SEm(±)	**12.42**	**1.18**	**1.62**	**2.13**	**1.68**	**4.74**
LSD (P=0.05)	**35.66**	**N.S.**	**4.65**	**6.11**	**N.S.**	**13.60**

Table 6: Effect of levels of irrigation and Methods of weed control on grain yield of hybrid maize

Irrigation Treatments	Grain Yield ($t\ ha^{-1}$)	% yield increase	Methods of weed control Treatments	Grain Yield ($t\ ha^{-1}$)	% yield increase
I_1	2.49	10.17	W_1	5.45	573.68
I_2	3.98	76.10	W_2	2.84	298.94
I_3	3.09	36.72	W_3	1.88	197.89
I_4	2.26		W_4	3.64	383.15
			W_5	0.95	
SEm(±)	**0.131**		**SEm(±)**	**0.15**	
LSD (P=0.05)	**0.45**		**LSD (P=0.05)**	**0.42**	

Table 7: Effect of levels of irrigation on moisture depletion, CU and WUE of hybrid maize

Irrigation Treatments	Soil profile moisture depletion (%) Depth of soil (cm)				CU (mm)	WUE ($kg\ ha^{-1}\ mm^{-1}$)
	0 - 15	15- 30	30 - 45	45 - 60		
I_1	52.92	44.33	15.83	21.63	300.1	8.29
I_2	37.90	21.57	12.24	22.63	210.9	18.87
I_3	46.34	24.66	13.05	21.27	235.2	13.13
I_4	37.27	26.11	14.07	17.96	212.3	10.64