Indian Journal of Agronomy **52**(4) : 321–324 (December 2007)

Weed dynamics, productivity and economics of maize (*Zea mays*) as affected by integrated weed management under rainfed condition

ALOK MALVIYA* AND BHAGWAN SINGH

Department of Agronomy, N.D. University of Agriculture and Technology, Faizabad, Uttar Pradesh 224 229

Received: December 2007

ABSTRACT

A field experiment was conducted during rainy season of 2005 and 2006 under rainfed condition at Faizabad on a silty-loam soil to find out the most effective weed control measure in maize (*Zea mays* L.). Pre-emergence application of alachlor (2.0 kg/ha), pendimethalin (1.0 kg/ha) and atrazine (1.0 kg/ha) alone and in combination with one hand-weeding (30 DAS), two hand-weedings (20 and 40 DAS), smother crop (blackgram and *Dhaincha*) and earthing-up were compared with weed-free and weedy check treatments. Two hand-weedings at 20 and 40 DAS proved most effective (weed-control efficiency, WCE 60.74 and 71.78%) followed by alachlor 2.0 kg/ha + hand-weeding at 30 DAS (WCE 55.86 and 68.31%) and they reduced the weed density and weed biomass significantly, which in turn increased yield compared with weedy check. The highest grain yield of 3.70 and 3.63 t/ha was recorded under weed-free treatment during 2005 and 2006 respectively, which was on a par with two hand-weedings at 20 and 40 DAS. The highest net returns were obtained under weed-free treatment, but highest benefit : cost ratio was recorded under earthing-up and two hand-weedings.

Key words: Economics, Herbicides, Integrated weed management, Maize, Yield

The erratic rainfall pattern in rainfed areas leads to heavy infestation of weeds, which account for major yield losses. Yield loss due to weeds in maize (*Zea mays* L.) varies from 28–93%, depending on the type of weed flora and the intensity and duration of crop-weed competition (Sharma and Thakur, 1998). Initial slow growth of maize, wider spacing and adequate moisture during rainy season favour the growth of weeds. Manual weeding is difficult due to inadequate availability of labour and lack of workable field conditions at critical stages of crop-weed competition. In such a situation use of herbicides become essential. However, application of single herbicide does not provide satisfactory weed control for the desired period. Moreover, continuous use of single herbicide is known to result in the evolution of herbicide-resistance in weed species and shift in weed flora (Thakur and Sharma, 1996). Intercropping of short-duration crops like cowpea, blackgram, greengram or *Sesbania* between maize rows has been found quiet effective in weed suppression. Under such circumstances, to get effective control of composite weed flora, a logical combination of several weed-control methods is likely to prove the most effective approach. Since the information on best approach of integrated weed management in maize grown under rainfed condition is meage, the present investigation was made.

***Corresponding author** (Email: dralokmalvi@rediffmail.com)

MATERIALS AND METHODS

A field experiment was conducted under rainfed conditions during rainy (*kharif*) season of 2005 and 2006 at Agronomy Research Farm, NDUA & T, Faizabad in Uttar Pradesh (26.47° N, 82.12° E, altitude 113 m above mean sea-level). The soil was silty-loam and alkaline (pH 8.5) with 165.5, 15.68 and 269.04 kg/ha available N, P and K respectively. Maize variety 'Naveen' was sown in lines 45 cm apart using seed rate of 25 kg/ha on 5 July 2005 and 7 July 2006. The crop was fertilized with 30 kg N, 40 kg P and 30 K/ha as basal dose and the remaining 30 kg N/ha was top-dressed at 30 days after sowing (DAS). The N, P and K were supplied through urea, single superphosphate and muriate of potash respectively. Thinning was done 15 DAS to maintain plant-to-plant distance 25 cm. The experiment was laid out in randomized block design with three replications. The gross plot size was 4.5 × 5.0 m and net plot size was 3.6 × 4.0 m. The treatments comprised alachlor at 2.0 kg/ha, atrazine and pendimethalin each at 1.0 kg/ha alone and in combination with one hand-weeding at 30 DAS, intercropping of blackgram and *dhaincha* as smother crop, two hand-weedings at 20 and 40 DAS

and earthing-up at 30 DAS, along with weed-free and weedy checks. Under weed-free treatment four hand-weedings at 25 days interval were done for maintaining weed free condition. All the herbicides were sprayed a day after sowing with a manually operated knapsak sprayer fitted with flat-fan nozzle at spray volume of 600 litres/ha. As per treatment the maize crop was also intercropped with smother crop in 1:1 alternate rows 22.5 cm apart in additive series, and at 30 DAS it was incorporated *in situ*. Density and biomass of weeds were recorded at 90 DAS in 50 cm^2 quadrate by throwing randomly at four places in each plot. Weed data were subjected to square-root transformation ($\sqrt{x+1}$) before statistical analysis. Nitrogen content in plant material was determined by Kjeldahl digestion and distillation process.

RESULTS AND DISCUSSION

Weed flora

The predominant weed species infesting the experimental field were: *Cyperus rotundus* L., *Cynodon dactylon* (L). Pers., *Eclipta alba* L., *Solanum nigrum* L., *Digera arvensis* L., *Phyllanthus niruri* L., *Echinochloa colonum* (L.) Link. and *Commelina benghalensis* L.. However, after 90 DAS the weed species found were: *Cyperus rotundus* (55.08% and 54.99%), *Cynodon dactylon* (36.91% and 37.05%), *Echinochloa colonum* L. Link. (3.91% and 4.05%) and *Commelina benghalensis* L. (3.91% and 4.05%) (Table 1).

Effect on weeds

Weed population and dry weight were significantly reduced due to all weed-control treatments compared with the weedy check during both the years except *dhaincha* as smother crop during 2005 (Table 2). Among pre-emergence herbicides, the lowest weed population and dry weight were recorded under alachlor, followed by pendimethalin and atrazine. Similar trend was also observed when these herbicides were integrated with one hand-weeding at 30 DAS. Pandey *et al.* (2001) also reported similar results. Weed-control efficiency (WCE) of different treatments varied from 26.37–60.74%, and 47.03–71.78% during 2005 and 2006, respectively. Among all the treatments, two hand-weedings treatment was the most effective in controlling the weeds (WCE 60.74 and 71.78%), followed by alachlor + hand-weeding (HW) at 30 DAS (WCE 55.86 and 68.31%). Among pre-emergence herbicides, alachlor was the most effective in controling the weeds (WCE 45.12 and 60.49%), followed by pendimethalin (WCE 37.11 and 54.85%) and atrazine (WCE 30.07 and 49.78%). Pandey *et al.* (2002) also reported similar results.

Effect on crop

Plant growth, yield attributes and grain yield were significantly influenced due to weed-control measures (Table 3). Maximum dry weight of plants, number of cobs/plant, test weight and grain yield were recorded under weed-free treatment, and they were significantly superior to that under weedy check. Among all the treatments alachlor + HW 30 DAS, two HW at 20 and 40 DAS and earthing-up at 30 DAS gave similar dry weight, number of cobs/plant and test weight as obtained under weed-free treatment.

The season-long crop-weed competition reduced the grain yield of maize by 70.27 and 70.24% compared with the weed-free conditions during 2005 and 2006 respectively. All the weed-control treatments resulted in significantly higher grain yield than weedy-check in both the years (Table 2). Among herbicides, pre-emergence application of alachlor resulted in significantly higher grain yield over pendimethalin and atrazine. Pandey *et al.* (2002) reported similar results. Earthing-up at 30 DAS

Table 1. Effect of weed-control treatments on weed flora at 90 days after sowing

Treatment	*Cyperus rotundus*		*Commelina benghalensis*		*Echinochloa colonum*		*Cynodon dactylon*		Total	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Alachlor 2.0 kg/ha pre-em.	155	150	11	11	8	8	107	104	281	273
Alachlor 2.0 kg/ha pre-em. + HW	124	121	9	9	7	7	86	83	226	219
Atrazine 1.0 kg/ha pre-em.	197	191	14	14	14	14	132	128	358	347
Atrazine 1.0 kg/ha pre-em. + HW	168	163	12	12	12	12	113	110	306	297
Pendimethalin 1.0 kg/ha pre-em.	177	172	13	12	10	9	122	119	322	312
Pendimethalin 1.0 kg/ha pre-em. + HW	146	11	11	8	8	104	101	273	265	150
Blackgram as smother crop	160	155	12	11	12	11	107	104	290	281
Dhaincha as smother crop	207	201	15	15	15	15	139	135	377	366
2 hand-weedings (20 and 40 DAS)	111	107	8	8	8	8	74	72	201	195
Earthing-up	170	165	12	12	12	12	114	111	309	300
Weed-free	0	0	0	0	0	0	0	0	0	0
Weedy-check	282	380	20	28	20	28	189	256	512	691

Table 2. Effect of weed-control treatments on weed density, weight, weed-control efficiency, and N uptake by maize

Treatment	Weed density (No./m²)		Weed dry weight (g /m²)		Weed-control efficiency (%)		N uptake (kg/ha)			
							Grain		Stover	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Alachlor 2.0 kg/ha pre-em	16.61 (281)	16.37 (273)	14.11 (202.3)	13.86 (195.2)	45.1	60.4	42.26	40.99	29.83	28.94
Alachlor 2.0 kg/ha pre-em +HW	14.99 (226)	14.76 (219)	12.73 (162.7)	12.49 (156.5)	55.8	68.3	46.15	45.32	33.26	32.66
Atrazine 1.0 kg/ha pre-em	18.86 (358)	18.56 (347)	16.01 (257.7)	15.71 (248.1)	30.0	49.7	27.81	27.40	19.99	19.69
Atrazine 1.0 kg/ha pre-em +HW	17.33 (306)	17.07 (297)	14.71 (220.3)	14.44 (212.3)	40.2	57.0	33.25	32.18	23.34	22.59
Pendimethalin 1.0 kg/ha pre-em	17.96 (322)	17.68 (312)	15.25 (231.8)	14.96 (223.0)	37.1	54.8	29.72	28.65	21.24	20.47
Pendimethalin 1.0 kg/ha pre-em+ HW	16.46 (273)	16.22 (265)	13.98 (196.5)	13.73 (189.4)	46.6	61.6	33.92	33.27	23.74	23.29
Blackgram as smother crop	17.03 (290)	16.77 (281)	14.46 (208.8)	14.19 (200.9)	43.3	59.3	33.22	32.72	22.60	22.26
Dhaincha as smother crop	19.41 (377)	19.22 (366)	16.48 (271.4)	16.18 (261.6)	26.3	47.0	34.64	33.70	24.28	23.62
2 hand-weedings (20 and 40 DAS)	14.16 (201)	13.95 (195)	12.03 (144.7)	11.81 (139.4)	60.7	71.7	47.10	46.58	34.38	34.00
Earthing-up	17.53 (309)	17.27 (300)	14.88 (222.4)	14.61 (214.5)	39.6	56.5	42.70	41.98	30.69	30.17
Weed-free	1.00 (0)	1.00 (0)	1.00 (0.0)	1.00 (0.0)	100.0	100.0	52.60	51.54	38.94	38.17
Weedy check	22.56 (512)	26.20 (691)	19.15 (368.6)	22.16 (494.0)			12.99	12.78	8.17	8.04
SEm ±	1.22	1.23	1.03	1.04			1.10	1.49	1.31	1.39
CD (P=0.05)	3.56	3.61	3.03	3.05			3.24	4.37	3.85	4.07

Figures in parentheses are original values

Table 3. Effect of weed control treatments on growth, yield attributes, yield and economics of maize

Treatment	Dry matter at 90 DAS (g/plant)		No. of cobs/ plant		Test weight (g)		Grain yield (t/ha)		Gross returns (x 10^3 Rs/ha)		Net returns (x 10^3 Rs/ha)		Benefit : cost ratio	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Alachlor 2.0 kg/ha pre-em.	211.6	199.8	1.46	1.39	263.2	250.0	3.13	3.01	20.59	19.86	12.86	12.13	1.66	1.57
Alachlor 2.0 kg/ha pre-em. + HW	216.3	209.5	1.50	1.44	274.6	263.6	3.34	3.28	22.00	21.56	13.67	13.23	1.64	1.59
Atrazine 1.0 kg/ha pre-em.	181.2	177.4	1.32	1.26	232.4	226.6	2.24	2.21	14.89	14.66	7.77	7.55	1.09	1.06
Atrazine 1.0 kg/ha pre-em. + HW	190.6	186.0	1.41	1.35	242.6	232.4	2.50	2.42	16.51	15.987	8.80	8.27	1.14	1.07
Pendimethalin 1.0 kg/ha pre-em.	189.4	181.2	1.23	1.19	234.5	225.1	2.30	2.22	15.25	14.70	6.92	6.37	0.83	0.76
Pendimethalin 1.0 kg/ha pre-em. + HW	199.5	191.2	1.29	1.24	258.2	248.1	2.53	2.48	16.67	16.35	7.74	7.43	0.87	0.83
Blackgram as smother crop	195.8	190.7	1.36	1.30	237.2	226.5	2.48	2.44	16.40	16.15	9.37	9.13	1.33	1.30
Dhaincha as smother crop	206.3	196.5	1.41	1.36	246.6	237.5	2.51	2.44	16.55	16.10	9.54	9.10	1.36	1.30
2 hand-weeding (20 and 40 DAS)	223.2	215.7	1.48	1.43	278.8	272.0	3.36	3.31	22.12	21.80	14.02	13.69	1.73	1.69
Earthing-up	216.8	205.8	1.43	1.40	271.6	261.6	3.14	3.06	20.64	20.17	13.13	12.66	1.75	1.69
Weed-free	229.6	226.6	1.51	1.45	283.3	273.0	3.70	3.63	24.35	23.87	14.45	13.97	1.46	1.41
Weedy-check	165.2	166.7	1.02	0.96	224.7	211.2	1.10	1.08	7.32	7.20	1.00	0.88	0.16	0.14
SEm ±	9.1	8.8	0.06	0.06	11.1	11.4	0.08	0.10						
CD (P=0.05)	26.7	25.8	0.18	0.18	32.6	33.4	0.23	0.32						

Maize Sale price: (Rs/t): Grain: 6000; stover: 350

gave grain yield statistically similar to that under two HW at 20 and 40 DAS but significantly superior to that under pendimethalin and atrazine alone and in combination with one HW at 30 DAS. Earthing-up increased the grain yield by 36.15 and 39.86% during the first year and by 37.96 and 38.71% during the second year over the application of pendimethalin and atrazine alone respectively. This may be attributed to better drainage and efficient utilization of resources. Higher yield under integrated weed control treatments (herbicide+ HW at 30 DAS) may be attributed mainly to the better control of weeds due to application of pre-emergence herbicides during early stages and manual removal of weeds emerging at subsequent stages, resulting in reduced crop–weed competition and thereby providing better yield attributes (Pandey *et al.*, 2002).

Nitrogen uptake

Significant differences for N uptake by grain and stover were recorded with different weed-management treatments (Table 2). The highest N uptake by grain and stover was recorded under the weed-free treatment and it was significantly higher than the rest of the treatments. This was followed by two HW at 20 and 40 DAS, which was statistically similar to the application of alachlor 2.0 kg/ha + HW at 30 DAS in respect of N uptake by grain and stover (Jat and Gaur, 2000). Earthing-up also gave the similar N uptake by stover as recorded under two hand-weedings at 20 and 40 DAS.

Economics

All the weed-control treatments proved superior in terms of monetary returns to the unweeded check. The weed-free treatment recorded the highest net return, followed by two hand-weedings at 20 and 40 DAS and alachlor @ 2.0 kg/ha + HW at 30 DAS. However, earthing-up gave higher benefit : cost ratio (1.75) during the first year and two hand-weedings (1.69) during the second year. Among herbicides, the maximum net returns as well as benefit : cost ratio were recorded under alachlor, followed by atrazine and pendimethalin.

It was concluded that application of alachlor 2.0 kg/ha supplemented with one hand weeding at 30 DAS and earthing-up were found effective to control the weeds and improve the crop yield. Earthing-up proved to be the most remunerative treatment, followed by two hand weedings at 20 and 40 days after sowing.

REFERENCES

Jat, R.L. and Gaur, B.L. 2000. Effect of weed control, fertilizer application and *Rhizobium* on nutrient uptake under maize + soybean intercropping system. *Indian Journal of Agronomy* **45**(1): 54–58.

Pandey, A.K., Prakash, V. and Gupta, H.S. 2002. Effect of integrated weed management practices on yield and economics of babycorn. *Indian Journal of Agricultural Sciences* **72**(4): 206–209.

Pandey, A.K., Prakash, V., Singh, R.D. and Mani, V.P. 2000. Integrated weed management in maize (*Zea mays* L.). *Indian Journal of Agronomy* **46**(2): 260–265.

Sharma, V. and Thakur, D.R. 1998. Integrated weed management in maize (*Zea mays*) under mid-hill condition of north-western Himalayas. *Indian Journal of Weed Science* **30**(3&4): 158–162.

Thakur, D.R. and Sharma, V. 1996. Integrated weed management in rainfed maize. *Indian Journal of Weed Science* **28**(3&4): 207–208.