Himachal Journal of Agricultural Research 37 (2): 165-173, 2011

Weed control efficiencies as influenced by different tillage and weed control methods in maize (*Zea mays* L.) under mid hill conditions of Himachal Pradesh

Pankaj Chopra, N.N. Angiras and Suresh Kumar
Department of Agronomy, Forages and Grassland Management
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.

Manuscript Received: 30.10.2009; Accepted: 02.04.2011

Abstract

A field experiment was conducted during *kharif* 2002 and 2003 to study the influence of different tillage and weed control methods for the control of weeds in maize. Integration of atrazine 1.5 kg ha^{-1} with raised seed bed had the highest efficiecy to control *Echinochloa colona, Cyperus iria*, other weeds and total weeds during both the years and of *Digitaria sanguinalis* and *Panicum dichotomiflorum* during second year. The highest efficacy to control *Digitaria sanguinalis* and *Panicum dichotomiflorum* was obtained with raised seed bed in combination with acetachlor 1.25 kg ha^{-1} during first year, while it was the next best to control *Echinochloa colona, Cyperus iria* and other weeds during both the years. The combination of conventional tillage either with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1} were close to the combinations of raised seed bed either with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1} in their efficacy to control these different weeds and all these combinations being statistically at par with each other resulted in significant increase in grain and stover yield during both the years. However, with respect to *Commelina benghalensis*, integration of zero tillage with atrazine 1.5 kg ha^{-1} gave highest WCE and proved to be statistically as effective as other superior combinations in increasing grain yield and stover yield during second and first year, respectively. Integration of acetachlor 1.25 kg ha^{-1} with zero tillage was found to be the next best in its efficacy to control *Commelina benghalensis* and behaved statistically similar to above said combination in increasing stover yield during first year.

Key words: Tillage, weed control methods, weed control efficiency, yield, maize.

Introduction

Maize being a *kharif* crop, faces an acute weed competition for various resources like water, nutrient, light and space etc. during the initial growth period of 30 days, thereby reducing the yield of maize from 30-95 per cent (Pandey *et al.*, 2001). In the present era, competition for various resources in favour of crop along with alleviating residue pollution problems, obtaining higher production and benefits on effective, economical and sociological viable basis can be best achieved through integration of various agronomic practices like tillage and chemical methods of weed control. The bio-efficacy of various methods used can be best judged by their weed control efficiency particular to specific weed. Thus, an attempt has been made to find out the efficacy of different tillage and weed control methods to control different weeds and their influence on the productivity of maize.

Materials and Methods

A field experiment was conducted during *Kharif* 2002 and 2003 at the experimental farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. Experiment was conducted in Split Plot Design, keeping three tillage methods *viz.* zero, conventional and

raised seed bed in main plots and four weed control treatments *viz.* acetachlor 0.75 kg ha^{-1}, acetachlor 1.25 kg ha^{-1} and atrazine 1.5 kg ha^{-1} and unweeded check in sub plots with three replications. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.5-5.6) and medium in available N (296.6-302.8 kg ha^{-1}), P (17.8-18.6 kg ha^{-1}) and K (316.7-321.9 kg ha^{-1}). Maize hybrid variety PSCL-3438 was sown at 60 cm apart rows with plant to plant distance of 20 cm on 11th June, 2002 and 2003 by adopting recommended package of practices except treatments. The sowing in zero tillage and raised seed bed plots was done with power tiller driven zero till maize planter and raised bed planter, respectively. All the herbicides were applied as pre-emergence with flat fan nozzle attached to power sprayer using 600 litre of water ha^{-1}. The crop was harvested on 27th and 24th Sept., 2002 and 2003, respectively. Dry matter of total weeds was recorded at maximum dry matter accumulation stage *i.e.* 60 DAS and was subjected to square root transformation for statistical analysis. Species-wise and total weed control efficiency of different treatments was worked out at maximum weed dry matter stage as per the formula given below:

$$WCE\ (\%) = \frac{W_C - W_t}{W_C} \times 100$$

where, W_C - Weed dry weight in unweeded conventional tillage plots

W_t - Weed dry weight in treated plot

Results and Discussion

Effect on weeds

On an avarage, *Digitaria sanguinalis* (L.) Scop., *Echinochloa colona* (L.) Link. and *Panicum dichotomiflorum* Michx were the major grassy weed present in the experimental field and on an average, constituted 36.98, 24.62 and 13.43 %, respectively of the total weed flora. *Commelina benghalensis* L. the major broad leaf weed constituted 11.18 % of the total weed flora. *Cyperus iria* L. was the only sedge present in the field with 4.81 % proportion. *Brachiaria ramosa* L. *and* other weeds (*viz. Oxalis latifolia* L., *Ageratum conyzoides* L., *Cynodon dactylon* L., *Ipomoea purpurea* (L.) Roth, and *Polygonum alatum* L.) had per cent proportion of 3.46 and 5.53, respectively.

Effect on dry matter of weeds

Raised seed bed resulted in significantly lowest dry matter accumulation of total weeds at their maximum dry matter accumulation stage (*i.e.* 60 DAS). Conventional tillage being the next best was significantly superior to zero tillage. Among weed control treatments, atrazine 1.5 kg ha^{-1} being statistically at par with acetachlor 1.25 kg ha^{-1} was significantly superior to remaining weed control treatments in decreasing dry matter accumulation of total weeds (Table 1).

The data further revealed that integration of raised seed bed either with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1} being statistically at par with each other resulted in significantly lower total dry matter accumulation of total weeds during both the

Table 1. Effect of tillage and weed control methods on total weed dry matter (g/ m^2) at 60 DAS

Tillage methods \ Weed control method	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean
			2002					**2003**		
Zero	16.00 (253.93)*	10.14 (101.47)	7.20 (50.07)	6.83 (44.73)	10.04 (112.55)	16.95 (285.33)	11.71 (135.13)	8.57 (71.53)	8.21 (65.40)	11.36 (139.35)
Conventional	15.10 (226.00)	8.42 (69.00)	6.97 (46.60)	6.21 (36.60)	9.18 (94.55)	16.34 (264.93)	11.30 (125.67)	8.45 (69.47)	8.20 (65.20)	11.07 (131.32)
Raised seed bed	13.38 (177.00)	7.61 (56.00)	5.79 (31.60)	5.67 (30.20)	8.11 (73.70)	15.74 (245.70)	9.42 (86.67)	7.24 (50.43)	6.94 (46.27)	9.84 (107.27)
Mean	14.83 (218.98)	8.72 (75.49)	6.65 (42.76)	6.24 (37.18)		16.34 (265.32)	10.81 (115.82)	8.09 (63.81)	7.78 (58.96)	

CD (P=0.05)	**2002**	**2003**
Tillage methods	0.4	0.3
Weed control methods	0.5	0.3
To compare two weed control methods at same level of tillage methods	0.45	0.78
To compare two tillage methods at same or different level of weed control methods	0.47	0.80

*Values in parentheses are means of original values

years. However, combination of conventional tillage with atrazine 1.5 kg ha^{-1} was equally effective during first year, while, during second year it was the next best combination and was statistically alike to the combination of conventional tillage with acetachlor 1.25 kg ha^{-1} and zero tillage with either atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1}.

Effect on weed control efficiency

It is evident from Table 2 (a & b) that among tillage methods, raised seed bed resulted in highest efficiency to control *D. sanguinalis, E. colona, P. dichotomiflorum, C. iria* and total weeds during both the years and other weeds during first year. However, with respect to *C. benghalensis* zero tillage had the highest efficacy during both the years. Raised seed bed by virtue of reducing the seed bank of grass weeds in upper (0-10 cm) seed layers and zero tillage by checking the exposure of *C. benghalensis* rhizomes to upper layers significantly reduced the population and thereby dry matter accumulation of almost all the grass weeds and *C. benghalensis*, respectively, which was ultimately reflected in achieving better weed control efficiencies by these tillage methods. Conventional tillage was the next best in getting better efficacy to control *D. sanguinalis, E. colona, C. benghalensis* and total weeds during both the years and *P. dichotomiflorum* and other weeds during first year. Zero tillage was proved to be superior to control other weeds during second year of experimentation and next best to achieve better efficiency to control *Cyperus iria* during both the years.

Among weed control methods, atrazine 1.5 kg ha^{-1} had the highest weed control efficiency to control various weeds both individually and collectively. Sharma *et al.* (2000) also reported better weed control efficiency with atrazine 1.5 kg ha^{-1}. Acetachlor 1.25 kg ha^{-1} was the next best in this regard during both the years. Atrazine 1.5 kg ha^{-1} and acetachlor 1.25 kg ha^{-1} had recorded efficacy of more than 77 per cent in controlling *D. sanguinalis* and *E. colona* during both the years. The weed control efficiency of both these herbicides to control *C. benghalensis* and total weeds ranged between 71-77 and 81-84 per cent, respectively during first year and 74-78 and 76-78 per cent, respectively during second year. These herbicides achieved better weed control efficiencies to control these said weeds due to significant reduction in the dry matter of these weeds in such plots over unweeded check plots of conventional tillage.

Integration of atrazine 1.5 kg ha^{-1} with raised seed bed had the highest efficiency of 91.53 & 85.53 % to control *E. colona*, 75.02 & 82.47 % for *C. iria*, 79.53 & 86.49 % for other weeds and 86.64 & 82.54 % for total weeds during first and second year, respectively and 84.50 and 89.13 % to control *D. sanguinalis* and *P. dichotomiflorum*, respectively during second year. However, raised seed bed in combination with acetachlor 1.25 kg ha^{-1} was proved to be the best in achieving highest efficacy of 91.5 and 100 % to control *D. sanguinalis* and *P. dichotomiflorum*, respectively during first year and was the next best in getting better efficiencies to control different weed species, which was

Table 2 (a). Weed control efficiency (%) of treatments to control *D. sanguinalis, E. colona* and *P. dichotomiflorum* in maize

Weed control methods / Tillage methods	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean
	2002					2003				
				Digitaria sanguinalis						
Zero tillage	-32.48	49.23	76.73	80.44	43.48	-33.05	42.75	72.25	74.98	39.23
Conventional tillage	-	72.70	81.33	81.47	58.88	-	66.52	77.16	79.46	55.79
Raised seed bed	26.03	81.78	91.50	89.26	72.14	5.60	72.87	82.98	84.50	61.49
Mean	-2.15	67.90	83.19	83.73		-9.15	60.71	77.46	79.65	
				Echinochloa colona						
Zero tillage	2.68	67.41	78.77	87.71	59.14	-2.88	59.03	74.75	81.31	53.05
Conventional tillage	-	79.70	86.41	89.39	63.88	-	58.85	80.77	82.39	55.50
Raised seed bed	34.45	85.85	89.66	91.53	75.37	17.30	74.39	83.92	85.53	65.29
Mean	12.38	77.65	84.95	89.54		48.10	64.09	79.81	83.08	
				Panicum dichotomiflorum						
Zero tillage	-13.45	37.79	74.38	68.28	41.75	10.89	36.87	67.98	71.61	46.84
Conventional tillage	-	43.89	80.48	92.68	54.26	-	22.67	66.17	72.21	40.26
Raised seed bed	65.84	92.68	100.00	95.12	88.41	37.77	72.21	89.13	89.13	72.06
Mean	17.46	58.12	84.95	85.36		16.22	43.92	74.43	77.65	

Table 2 (b). Weed control efficiency (%) of treatments to control *C. benghalensis*, *C. iria*, other weeds and total weeds in maize

Tillage methods \ Weed control methods	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean
	2002					2003				
				Commelina benghalensis						
Zero tillage	39.75	71.38	85.54	89.46	71.53	25.85	55.77	81.62	85.04	62.07
Conventional tillage	-	34.93	77.71	82.83	48.87	-	27.56	66.88	84.15	44.65
Raised seed bed	-78.34	8.12	50.59	64.15	11.13	-72.22	18.38	57.05	66.24	17.36
Mean	-12.86	38.14	71.28	78.81		-15.46	33.90	68.52	78.48	
				Cyperus iria						
Zero tillage	-2.56	32.94	56.61	68.44	38.86	26.26	47.42	62.22	57.39	48.32
Conventional tillage	-	53.98	42.14	55.29	37.85	-	28.98	47.72	51.34	32.01
Raised seed bed	39.51	59.24	68.44	75.02	60.55	47.42	74.92	79.75	82.47	71.94
Mean	12.32	48.72	55.73	66.25		24.56	50.44	63.23	63.73	
				Other weeds						
Zero tillage	-54.97	15.47	68.10	34.08	15.67	25.49	51.20	60.13	67.10	80.98
Conventional tillage	-	50.03	52.60	51.62	24.76	-	40.52	53.16	51.42	36.28
Raised seed bed	46.04	63.05	60.93	79.53	62.39	55.99	84.53	85.40	86.49	78.10
Mean	-2.98	42.85	60.54	55.08		27.16	58.75	66.23	68.34	
				Total weeds						
Zero tillage	-12.36	55.10	77.85	80.21	50.20	-7.70	48.99	73.07	75.31	47.42
Conventional tillage	-	69.47	79.38	83.81	58.17	-	52.57	73.78	75.39	50.44
Raised seed bed	21.68	75.22	86.02	86.64	67.39	7.26	67.29	80.96	82.54	59.51
Mean	3.11	66.60	81.08	83.55		-0.15	56.28	75.94	77.75	

closely followed by the combination of conventional tillage with atrazine 1.5 kg ha^{-1}. With respect to *C.benghalensis,* integration of zero tillage with atrazine 1.5 kg ha^{-1} resulted in highest efficacy of 89.46 and 85.04 % during first and second year, respectively. Integration of zero tillage with acetachlor 1.25 kg ha^{-1} and conventional tillage with atrazine 1.5 kg ha^{-1} were found to be the next best combinations in term of getting better efficiency to control this weed.

Effect on grain and stover yield

It is evident from the table 3 that conventional tillage being statistically at par with raised seed bed increased the grain and stover yield of maize significantly over zero tillage during both the years. The per cent increase in grain yield was 17.22 and 13.24 with conventional tillage and raised seed bed, respectively during first year, while, during second year this corresponding increase was 16.58 and 14.23 per cent, respectively. Barry and Miller (1986) and Fausey (1990) also reported similar results with conventional and raised seed bed, respectively over zero tillage.

All the weed control treatments were significantly superior to unweeded check in increasing grain and stover yield of maize during both the years (Table 3). Among weed control treatments, atrazine 1.5 kg ha^{-1} and acetachlor 1.25 kg ha^{-1} being statistically at par with each other produced significantly higher grain and stover yield of maize during both the years. These two herbicides *i.e.* atrazine 1.5 kg ha^{-1} and acetachlor 1.25 kg ha^{-1} increased the grain yield to the tune of 72.20 and 71.89 percent, respectively over unweeded check during first year and 78.16 and 71.43 per cent, respectively during second year. The better growth and development of the crop attained due to better weed control reflected by higher weed control efficiencies by these herbicides resulted in getting higher yield attributes and ultimately yield of the maize crop. Thakur and Sharma (1996) also reported increase in grain yield of maize with atrazine 1.5 kg ha^{-1} and Tomordi (1985) with acetachlor.

On integrated basis, combination of conventional tillage or raised seed bed either with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1} being statistically at par with each other resulted in significantly higher grain and stover yield during both the years. On mean basis of two years, the percent reduction in grain yield due to combination of zero tillage with unweeded check was 56.6 and 58.4 per cent over combination of conventional tillage with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg. ha^{-1}, respectively, while, this corresponding decrease was 57.2 and 57.0 percent, over combination of raised seed bed with atrazine 1.5 kg ha^{-1} or acetachlor 1.25 kg ha^{-1}, respectively. In addition, integration of zero tillage with atrazine 1.5 kg ha^{-1} was statistically as effective as these said combinations in increasing grain and stover yield during first and second year, respectively. In addition, zero tillage in integration with acetachlor 1.25 kg ha^{-1} was also equally effective during first year in significantly increasing the stover yield. This increase in grain and stover yield by these combinations could be ascribed to less crop weed competition because of significant

Table 3. Effect of tillage and chemical weed control methods on grain and stover yield (kg ha^{-1}) of maize

Weed control methods / Tillage Methods	Grain yield (kg ha^{-1})					Stover yield (kg ha^{-1})				
	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean	Unweeded	Acetachlor 0.75 kg ha^{-1}	Acetachlor 1.25 kg ha^{-1}	Atrazine 1.5 kg ha^{-1}	Mean
2002										
Zero	3316.23	5771.45	7200.23	7161.29	5862.30	7036.22	12121.77	15571.06	15805.18	11002.45
Conventional	5115.66	6812.98	7662.92	7896.73	6872.07	10826.77	14555.41	16404.15	17001.98	12025.80
Raised seed bed	4705.40	6513.99	7718.95	7564.52	6625.72	9913.01	13909.93	16422.99	16232.71	11693.84
Mean	4379.10	6366.14	7527.37	7540.85		9258.67	13529.04	16132.73	16346.62	
2003										
Zero	3164.62	5905.23	6760.30	7113.30	5735.86	6538.50	12267.66	14147.45	15018.22	10289.66
Conventionai	4863.34	6918.10	7269.52	7695.73	6686.67	10148.84	14594.87	15527.67	16337.97	11504.49
Raised seed bed	4487.96	6803.49	7426.05	7489.94	6551.86	9428.37	14461.61	15894.10	15923.47	11436.11
Mean	4171.97	6542.27	7151.96	7432.99		8705.24	13774.71	15189.74	15759.89	
		2002 CD(P=0.05)	2003 CD (P=0.05)				2002 CD (P=0.05)	2003 CD (P=0.05)		
Tillage methods		236.45	446.30				1143.99	473.77		
Weed Control Methods		311.74	289.31				751.81	586.67		
To compare two weed control methods at same level of tillage methods		539.88	500.68				1302.18	1016.14		
To compare two tillage methods at same or different level of weed control methods		521.34	616.63				1591.91	993.91		

reduction in the population and dry matter of weeds, which was reflected in getting higher weed control efficiencies in these treatments.

References

Barry DAJ and Miller MH 1986. Corn response to restricted nodal root growth with relevance to zero tillage. Canadian J. Soil Sci. **66** (4): 689-99.

Fausey NR 1990. Experiment with ridge-till on slowly permeable soils in Ohio. Soil Till. Res. **18**: 195-205.

Pandey AK, Prakash V, Singh RD and Mani VP 2001. Integrated weed management in maize. Indian J. Agron. **46**: 260-65.

Sharma AR, Toor AS and Sur HS 2000. Effect of interculture operations and scheduling of atrazine application on weed control and productivity of rainfed maize *(Zea mays)* in Shiwalik foothills of Punjab. Indian J. Agric. Sci. **70** (11): 757-61.

Thakur DR and Sharma V 1996. Integrated weed management in rainfed maize *(Zea mays* L.). Indian J. Weed Sci. **28** (3&4): 207-08.

Tomordi E 1987. Selective pre-emergent herbicides for field crops. Agrochemia **27** (12): 374-76.

VIR SOFTECH