

Integrated Control of Hardy Weeds in Maize (*Zea mays* L.)

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ABSTRACT

An experiment was conducted on the Research Farm of the Department of Agronomy, Agrometeorology and Forestry, PAU, Ludhiana, during 2005 and 2006 in order to find out effective weed management methods for controlling hardy weeds of maize crop such as *Acrachne racemosa*, *Commelina benghalensis* and *Brachiaria reptans*, etc. During 2005, all the weed control treatments except alone application of pendimethalin 1.0 kg/ha and alachlor 2.5 kg/ha produced significantly higher grain yield and less dry matter accumulation by weeds as compared to the recommended herbicide i. e. atrazine 1.0 kg/ha. During 2006, tank mix application of atrazine 0.75 kg+ pendimethalin 0.50 kg/ha produced significantly higher grain yield as compared to recommended herbicidal treatment. On the basis of mean values, it may be concluded that tank mix application of atrazine 0.75 kg + pendimethalin 0.75 kg/ha, atrazine 0.75 kg + alachlor 1.25 kg/ha and atrazine 0.75 kg + trifluralin 1.2 kg/ha increased grain yield of maize by 48.3, 53.9 and 49.7% over unweeded control. Also integration of HW with pre-emergence application of atrazine 0.75 kg/ha, atrazine 0.50 kg + pendimethalin 0.50 kg/ha, atrazine 0.50 kg + alachlor 0.75 kg/ha and atrazine 0.5 kg + trifluralin 0.60 kg/ha produced significantly higher grain yield and less dry matter accumulation by weeds than pre-emergence application of atrazine 1.0 kg/ha and all these treatments increased grain yield by 68.4, 71.6, 64.6 and 68.9% over unweeded control and 14.7, 17.0, 12.2 and 15.2% than atrazine 1.0 kg/ha.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop of India and plays pivotal role in agricultural economy but the average productivity is very low. Among the factors responsible for low yields, severe infestation of weeds due to wider row to row spacing and coincidence of crop with rainy season, often inflict huge losses in yield, may be upto 52% (Walia *et al.*, 2005). In order to obtain economical yield of maize, weeds must be kept under check.

For controlling weeds from this crop, pre-emergence or early post-emergence application of atrazine from 0.625 to 1.0 kg/ha depending upon the soil type has been recommended by Punjab Agricultural University, Ludhiana. Apart from this, alachlor at 2.5 kg/ha has also been recommended. These herbicides do not control hardy weeds viz., *Acrachne racemosa*, *Brachiaria reptans* and *Commelina benghalensis*, etc. The infestation of these weeds is increasing day by day in the maize growing belt of the state especially where the farmers are using atrazine year after year. So, in order to widen the weed control spectrum, it is desirable to use tank mix combinations of two herbicides having different mode of action. Therefore, tank mix combinations of atrazine with alachlor, pendimethalin and trifluralin were tried. Integration of hand weeding

with reduced levels of herbicides were tried in the present investigation.

MATERIALS AND METHODS

An experiment was initiated at Research Farm, Department of Agronomy, Agrometeorology and Forestry, PAU, Ludhiana during **kharif** seasons of 2005 and 2006 in order to evaluate the performance of tank mix application of different herbicides for the control of hardy weeds (which are not controlled with the recommended herbicide i. e. atrazine) in maize. The experimental field had enough weed population especially of *Acrachne racemosa* (Gha) and *Commelina benghalensis* (Kaon Makki), apart from these, few other weeds i. e. *Trianthema portulacastrum* (It-sit), *Digera arvensis* (Tandla), *Amaranthis viridis* (Chulai), *Eleusine* spp. (Madhana) and *Eragrostris* spp. (Chirian da dana) were also present. Sowing of hybrid maize PMH 1 was done on June 13, 2005 and July 1, 2006 using 20 kg/ha seed rate keeping row to row spacing of 60 cm and plant to plant spacing of 22.5 cm. The experimental field was loamy sand in texture and was low in available N and medium in available P and K. Crop was raised by applying 125 kg N, 60.0 kg P₂O₅ and 30 kg K₂O/ha. Whole of P₂O₅ & K₂O and 1/3 N were applied at sowing and remaining N was applied in two splits 1/3rd N at knee

Table 1. Dry matter of weeds and yield attributes of maize as influenced by different treatments

Treatment	Dose (kg/ha)	Dry matter ow weeds (kg/ha)		Plant height (cm)		Cob length (cm)		Cob girth (cm)		Weight of cob (g)		No. of cobs/plant			
		At harvest		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006		
		40 DAS	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006		
T ₁ -Atrazine alone	1.0	390	480	510	951	207	215	20.2	16.9	3.6	3.8	173	165	0.63	0.81
T ₂ -Atrazine f. b. HW	0.75	270	360	470	426	208	220	21.1	17.2	3.6	3.8	179	175	0.68	0.82
T ₃ -Atrazine + pendimethalin	0.75+0.75	240	350	490	778	207	212	21.1	17.1	3.6	3.8	185	167	0.74	0.82
T ₄ -Atrazine + pendimethalin	0.50+0.75	310	390	410	917	206	213	20.8	16.9	3.5	3.8	181	165	0.69	0.82
T ₅ -Atrazine + pendimethalin f. b. HW	0.50+0.50	160	230	370	355	212	217	21.0	16.9	3.5	3.8	191	180	0.77	0.85
T ₆ -Pendimethalin alone	1.0	450	520	490	1071	210	199	21.1	16.3	3.5	3.8	180	170	0.69	0.74
T ₇ -Atrazine + alachlor	0.75+1.25	290	360	310	891	211	208	20.9	16.9	3.6	3.7	190	175	0.73	0.74
T ₈ -Atrazine + alachlor f. b. HW	0.50+0.75	180	240	250	330	211	213	20.8	17.3	3.7	3.8	192	167	0.74	0.72
T ₉ -Alachlor alone	2.5	420	510	620	785	210	213	20.6	16.8	3.7	3.7	179	168	0.66	0.74
T ₁₀ -Atrazine + trifluralin	0.75+1.20	310	400	510	806	209	217	20.4	16.8	3.7	3.7	187	180	0.71	0.81
T ₁₁ -Atrazine + trifluralin	0.75+0.75	340	440	470	972	213	214	19.9	16.8	3.6	3.8	182	177	0.70	0.85
T ₁₂ -Atrazine + trifluralin f. b. HW	0.50+0.60	120	250	350	474	215	221	20.2	16.9	3.5	3.8	188	180	0.71	0.88
T ₁₃ -Two hand weedings	20 & 40 DAS	110	220	670	418	201	212	20.3	16.0	3.5	3.7	171	177	0.69	0.84
T ₁₄ -Control (unweeded)	-	1250	1370	2340	3149	191	196	18.9	14.7	3.4	3.7	156	157	0.61	0.67
LSD (P=0.05)		207	240	570	643	13	NS	1.02	0.9	NS	NS	13.7	12	NS	NS

f. b.-followed by. NS-Not Significant.

high stage and 1/3rd N at tasseling stage. Two hand weedings were done 20 and 40 days after sowing of the crop. The hand weeding (followed by treatment) was done 40 days after sowing the crop.

Economics was calculated by taking MSP of maize as Rs. 540 per quintal and stover prices at the rate of Rs. 75 per quintal. Cost of cultivation excluding the cost on weed control was taken as Rs. 15000 per hectare. Herbicide prices used for calculating economics were taken as atrazine Rs. 245 per kg, treflan Rs. 380 per litre, stomp Rs. 390 per litre and lasso Rs. 260 per litre. Cost of hand weeding was taken as Rs. 2000 per hectare for first hand weeding and Rs. 1250 per hectare for second or followed by treatment of hand weeding. Net return was worked out as follows :

Net returns (Rs.) = Gross returns (Rs.) – Cost of cultivations excluding cost on weed control – Cost on weed control in a particular treatment
Benefit : cost ratio was calculated by using the formula given below :

B : C ratio = Gross returns / Cost of cultivation

The experiment was laid out in randomized block design with 14 treatments (Table 1) replicated four times. Spray of different herbicidal treatments was done within two days of sowing of maize (pre-emergence) using knap-sack sprayer with discharge rate of 500 litre/ha. Weed dry matter was recorded randomly from two locations per plot with the use of quadrat measuring 50 cm × 50 cm at 45 DAS and at harvest.

RESULTS AND DISCUSSION

Effect on Weeds

The experimental field was dominated with *Commelina benghalensis* and *Acrachne racemosa*, apart from other weeds. The dry matter accumulation data recorded 45 DAS and at harvest indicated that all the weed control treatments resulted in significant reduction in dry matter accumulation by weeds during both the years as compared to unweeded control (Table 1). Among the herbicidal treatments alone application of atrazine at the recommended rate i. e. 1.0 kg/ha was found to be slightly poor for controlling weeds as compared to other herbicidal treatments but it was statistically at par with other treatments during both the years. Integration of herbicide with hand weeding or tank mix application of two herbicides proved effective for controlling hardy weeds in maize as indicated by

slight reduction in dry matter accumulation by weeds as compared to recommended treatment i. e. atrazine 1.0 kg/ha but the differences were non significant during both the years (Table 1). Reduction in dry matter accumulation by weeds with tank mix application of herbicide and integration of hand weeding has also been reported by Ready *et al.* (2002), Mundra *et al.* (2003) and Patel *et al.* (2006).

Effect on Crop

The plant height under the influence of all herbicidal treatments was significantly higher as compared to unweeded control during first year (Table 1). Cob length of unweeded control plot during both the years was found to be significantly less as compared to all herbicidal treatments. The differences in cob girth and number of cobs/plant were found to be non-significant during both the years. During 2005, the differences in weight of cob (g) among all herbicidal treatments were non-significant and it was significantly higher than unweeded control treatment. During 2006, weight of cob was significantly higher in atrazine 0.75 kg f. b. hand weeding, atrazine 0.75 kg + pendimethalin 0.50 kg f. b. one hand weeding , pendimethalin 1.0 kg alone, atrazine 0.75 kg + alachlor 1.25 kg, atrazine 0.75 kg + trifluralin 1.2 kg , atrazine 0.5 kg + trifluralin 0.6 kg/ha f. b. one hand weeding and two hand weedings treatment as compared to unweeded control treatment.

During 2005, all the weed control treatments except alone application of pendimethalin 1.0 kg and alachlor 2.5 kg/ha produced significantly higher grain yield as compared to the recommended treatment i. e. atrazine 1.0 kg/ha. During 2006, tank mix application of atrazine 0.75 kg + pendimethalin 0.50 kg/ha produced significantly higher grain yield as compared to atrazine 1.0 kg/ha (Table 2). On the basis of mean values, it can be concluded that integration of HW with pre-emergence application of atrazine 0.75 kg, atrazine 0.75 kg + pendimethalin 0.50 kg, atrazine 0.50 kg + alachlor 0.75 kg and atrazine 0.5 kg + trifluralin 0.60 kg/ha produced significantly higher grain yield than pre-emergence application of atrazine 1.0 kg/ha (recommended) and all these treatments increased grain yield by 68.4, 71.6, 64.6 and 68.9% over control and 14.7, 17.0, 12.2 and 15.2% than atrazine 1.0 kg/ha. Also tank mix application of atrazine 0.75 kg + pendimethalin 0.75 kg , atrazine 0.75 kg + alachlor 1.25 kg and atrazine 0.75 kg + trifluralin 1.2 kg/ha increased grain yield of maize by

Table 2. Grain yield, stover yield, net returns and B : C ratio of maize as influenced by different treatments

Treatment	Dose (kg/ha)	Grain yield (kg/ha)		Stover yield (t/ha)		Net returns (Rs./ha)		B : C ratio	
		2005	2006	2005	2006	2005	2006	2005	2006
T ₁ -Atrazine alone	1.0	2969	4625	12.1	16.2	1744	10994	1.13	1.75
T ₂ -Atrazine f. b. HW	0.75	3648	5066	14.2	16.5	5117	12947	1.38	1.91
T ₃ -Atrazine + pendimethalin	0.75+0.75	3739	3937	13.7	15.1	5681	6855	1.41	1.49
T ₄ -Atrazine + pendimethalin	0.50+0.75	3596	4167	13.4	15.5	4935	8176	1.36	1.58
T ₅ -Atrazine + pendimethalin f. b. HW	0.50+0.50	3729	5156	13.6	16.7	5309	13247	1.41	1.94
T ₆ -Pendimethalin alone	1.0	3208	4067	12.9	15.4	2772	7598	1.22	1.54
T ₇ -Atrazine + alachlor	0.75+1.25	3641	4327	13.8	16.0	5338	9208	1.38	1.64
T ₈ -Atrazine + alachlor f. b. HW	0.50+0.75	3719	4802	14.1	16.4	5386	11407	1.41	1.81
T ₉ -Alachlor alone	2.5	2875	3908	12.1	15.3	913	6731	1.10	1.48
T ₁₀ -Atrazine + trifluralin	0.75+1.20	3611	4140	13.8	15.5	5007	7992	1.37	1.57
T ₁₁ -Atrazine + trifluralin	0.75+0.75	3427	4817	13.2	16.5	4111	11864	1.30	1.82
T ₁₂ -Atrazine + trifluralin f. b. HW	0.50+0.60	3721	5025	13.8	16.6	5340	12592	1.41	1.89
T ₁₃ -Two hand weedings	20 & 40 DAS	3374	4406	13.5	16.0	2932	8692	1.28	1.67
T ₁₄ -Control (unweeded)	-	2412	2765	8.3	12.1	-1353	839	0.91	1.06
LSD (P=0.05)		370	522	1.3	0.9	-	-	-	-

MSP of maize was taken as Rs. 540/q and straw prices at Rs. 75/q and cost of cultivation excluding herbicides was taken as Rs. 15000/ha.

48.3, 53.9 and 49.7% over unweeded control and 1.0, 4.9 and 2.0% as compared to recommended treatment i. e. atrazine 1.0 kg/ha. These results corroborate the earlier findings of Ready *et al.* (2002), Mundra *et al.* (2003) and Patel *et al.* (2006).

The stover yield in control (unweeded) plot was found to be significantly less as compared to all weed control treatments during both the years. During 2005, all weed control treatments except pre-emergence application of pendimethalin 1.0 kg, alachlor 2.5 kg, atrazine 0.5 kg + pendimethalin 0.75 kg and atrazine 0.75 kg + trifluralin 0.75 kg/ha produced significantly higher stover yield as compared to recommended treatment i. e. atrazine 1.0 kg/ha. During 2006, alone application of alachlor 2.5 kg/ha and atrazine 0.75 kg + pendimethalin 0.75 kg/ha produced significantly less stover yield as compared to recommended treatment. All the tank mix and integrated treatments recorded higher net returns and benefit : cost ratio than control. However, on the average of two years, the highest net return was obtained in pre-emergence application of atrazine 0.50 kg + pendimethalin 0.50 kg/ha followed

by one hand weeding treatment and it was closely followed by atrazine 0.75 kg (pre-emergence) f. b. hand weeding, atrazine 0.50 kg + alachlor 0.75 kg/ha f. b. hand weeding and atrazine 0.75 kg + trifluralin 0.75 kg/ha.

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