J. Pest Cont. & Environ. Sci. 14 (2): 381 - 390 (2006).

Effectiveness of herbicides treatments against weeds in maize and their action on yield and yield components

Farid S. Sabra[1], Ahmed M. El-Bakry[2], Abd El-Salam H. Belal[3], Ibrahim M. El-Nabarawy[2], Moustafa A. Abbassy[3]

[1] Pesticide Chemistry Dept., Fac. of Agric., Alex. Univ. [2] Pests & Plant Protection, National Research Center, Cairo, [3] Pest Control & Environ. Protection Dept., Fac. of Agric. (Damanhour) Alex., Univ.

ABSTRACT

Field experiments were conducted to evaluate the efficiency of some herbicides for controlling weeds and their effectiveness on yield and yield components in maize plant. The mixture of atrazine + pendimethalin and metribuzin alone were used as pre-emergence herbicides, while bentazone and fluroxypyr used as post-emergence herbicides. Predominant weed species in the field were mainly annual grassy weeds, *Digitaria sanguinalis*, *Eleusine indica* and *Dinebra retroflexa,* (87.61 %), while the broadleaf weeds, *Amaranthus cruentus* and *Portulaca oleracea,* represented only (12.39 %). The mixture of atrazine and pendimethalin seemed to be the most effective herbicide since it controls more than 98% of the total weeds, while metribuzin gave approximately, 67 % control in the two seasons. Fluroxypyr was found to be the most effective in the reduction of broadleaf weeds than bentazone. All applied herbicides caused highly significant increase of maize yield and enhanced plant characters and yield components such as plant height, leaf area index (LAI), ear length, ear diameter, ear weight, kernels weight / ear and weight of 1000 kernels.

Keywords: Herbicides, broad leaf weeds, narrow leaf weed, maize, yield, yield components.

INTRODUCTION

Maize is the major summer cereal crop grown in Egypt. It is very important plant to use as feed and food. The total cultivation area of both summer and Nili crop is approximately 2 million feddan, the average yield and the total maize production of summer maize are 3.402 ton / feddan and 5.676 million tons, respectively (Anonymous, 2002).

Weeds can cause tremendous crop losses depending on the

competitiveness of the crop, composition of the weed flora, and level of weed infestation (Akobundu *et al*., 2000 and Chikoye and Ekeleme, 2003). In West Africa, for example, maize yield losses ranging from 50 to 90 % have been attributed to weed competition (Remison, 1979; Akobundu, 1987 and Darkwa *et al*., 2001).

Manual weeding is difficult due to inadequate availability of labour and lack of workable field conditions at critical stage of weed - crop competition, besides the hand labor began to be expensive, so the recent herbicides are cheaper and more efficient (El-Deeb *et al*., 1986). Weeds that are allowed to grow to adult stages demand more time and labour for effective control. Untimely weeding causes significant crop losses (Chikoye *et al*., 2004).

Atrazine has been recommended for the control of weeds in grain maize besides, pendimethalin (Pandey *et al*., 2000). These herbicides gave good control of annual grasses and broadleaf weeds (Akinyemiju, 1988). Saini (2000) reported that atrazine application significantly increased maize yield and yield components. Metribuzin was effective against broadleaf and annual grassy weeds (Bloomberg, 1994 and Fausey and Renner, 2001). Bentazone gave high level of broadleaved weed control in maize fields (Bloomberg, 1994). In addition, Yehia *et al*., (1992) found that fluroxypyr gave effective for controlling broadleaf weeds.

The objective of this research was to evaluate the efficacy of a mixture of atrazine and pendimethalin, compared with metribuzin, bentazone and fluroxypyr as well as hand weeding treatments.

MATERIALS AND METHODS

1. Study area: Field research was conducted at El-Behera Governorate, (Research Experimental Station of Faculty of Agriculture-Damanhour, Alex. Univ. at El-Bostan district), in 2002 and 2003 seasons. The predominant weeds at the experimental site were *Digitaria sanguinalis*, *Eleusine indica*, *Dinebra retroflexa*, *Amaranthus cruentus* and *Portulaca oleracea.* The soil was loamy sand with a pH of 8.23 and the composition of its texture was 10 % clay, 5.76 % silt, 10 % fine sand and 74.24 % coarse sand as reported by El-Sanhory (2004).

2. Field experiments: Maize (c.v. Single Hybrid 10 "Giza") was planted on

29th May 2002 and 1st June 2003. The experimental design was a randomized complete block design with four replicates (21 m^2 for each replicate). Common, trade and chemical names of the tested herbicides, their formulae and rates of application are listed in Table (1).

Table (1): Trade, common, chemical names, formulation and rate of application of the tested herbicides.

Tr. No.	Trade name	Common name	Chemical name	Formula	Rate/F
1	Gesaprim	atrazine	6-chloro-*N*-ethyl-*N*-isopropyl-1,3,5-triazine-2,4-diamine.	WG90%	600 gm
2	Stomp	pendimethalin	*N*-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine.	EC 50%	1L
3	Sencor	metribuzin	4-amino-6-tert-butyl-4,5-dihydro-3-methylthio-1,2,4-triazin-5-one.	WP 70%	250 gm
4	Basagran	bentazone	3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide.	SL 48%	500 ml
5	Starane	fluroxypyr	4-amino-3,5-dichloro-6-fluoro-2-pyridyloxyacetic acid.	EC 20	200 ml

Two application techniques were made in the two seasons, (a) pre-applied (after sowing and before irrigation), the herbicides used were a mixture of atrazine + pendimethalin and metribuzin and (b) post-applied (2-5 leaf stage of maize), and the herbicides used were bentazone and fluroxypyr. All herbicidal treatments were applied using a CP3 knapsack sprayer, with the red type nozzle. Hand weeding (twice) and un-weeded checks were also included in the two seasons. All the cultural practices e.g. fertilization, insecticide treatment and irrigation were applied as usually in maize plantation.

3. Data collection and analysis: Evaluation of herbicides efficiency was carried out 45 days, after planting by collecting all the weeds which grown in 1 m^2 at random by throwing a wooden quadrangle for each plot. The

weeds were sorted out, and weighed. Percentage of control of each weed species was calculated.

The effect of the tested herbicides on growth parameters, yield and yield components were recorded, such as plant height, leaf area index, ear length, ear diameter, ear weight, kernels weight/ ear and weight of 1000 kernels.

Statistical analysis of the obtained data was done using Cohort Software Inc. (1986).

RESULTS AND DISCUSSION

Effectiveness of herbicides on weeds:

1. Effectiveness of herbicides on broad leaf weeds: The herbicidal efficiency of the tested herbicides was presented as percentages of reduction in each weed species as well as weed weight (Wt.) of the total weeds, and the percentages of reduction of fresh weight of weed (% R), are shown in Table (2). Major weed flora found in the experimental field was common purslane (*Portulaca oleracea* L.) among broad leaf weeds, which contributed as 96.98 % during 2002 and 96.76 % during 2003 to total annual

Table (2): Effectiveness of broad leaves herbicides on broad leaf weeds in maize field during two seasons 2002 (1st) and 2003 (2nd), shown as % R (Reduction percent)

Treatments	Annual broad leaf weeds											
	Amaranthus cruentus				*Portulaca oleracea*				Total			
	2002		2003		2002		2003		2002		2003	
	wt.*	%R**	wt.	%R	wt.	%R	wt.	%R	wt.	%R	wt.	%R
Bentazone	0	100	0	100	110.26	71.8	113.46	74.26	110.26	72.65	113.46	75.09
Fluroxypyr	0	100	0	100	6.41	98.36	14.36	96.74	6.41	98.41	14.36	96.85
Hand weeding	0	100	0	100	90.13	76.95	87.31	80.19	90.13	77.65	87.31	80.83
Control	12.18	0	14.74	0	391.03	0	440.77	0	403.21	0	455.51	0
%I	3.02		3.24		96.98		96.76		100		100	
B.L.S.D $_{0.01}$***	-		-		-		-		34.26		20.95	

* Weed weight gm/m^2

** Percent of weed reduction calculated from weight weed/gm in m^2 compared with control

*** B.L.S.D $_{0.01}$ means Baysian least significant difference at 0.01 level of probability

%I = percent of infestation

broad leaf weeds. The most effective herbicide in both seasons was fluroxypyr, since the percentages of reduction of the total weeds were 98.41 % during 2002 and 96.85 % during 2003. This compound belong to pyridinecarboxylic acid herbicides group which acting like the natural auxins, indole acetic acid, while bentazone gave 72.65 % and 75.09 % reduction in total broad leaf weeds, in 2002 and 2003 maize seasons, respectively. This effect may be due to the inhibition of photosynthesis at photosystem II. The obtained results are similar to those reported by several investigators (Yehia *et al*., 1992; Bloomberg, 1994 and Roushdy, 1997). Roushdy (1997) showed that fluroxypyr treatment decreased the content of growth promoters (auxins, gibberellins and cytokinins), increased growth inhibitors and considerably reduced the total amount of photosynthetic pigments by 18.3 % for treated weeds as compared with the untreated weeds (control).

2. Effectiveness of herbicides treatments against all types of weeds: The data recorded in Table (3), indicated that the total broad leaf weeds represented 11.82 and 12.96 %, while grassy weeds accounted 88.18 and 87.04 % for 2002 and 2003 maize seasons, respectively. The predominant grassy weed was gaertn goosegrass (*Eleusine indica* L.), which represented 56.37 and 56.01 %, followed by (vahl) panz (*Dinebra retroflexa*) 30.38 and 29.57 % for 2002 and 2003 maize seasons, respectively. The most effective herbicide against all type of weeds (broad leaves and grassy weeds) in the two seasons was the mixture of atrazine and pendimethalin, the average weight of weeds were 47.44 and 51.28 gm / m^2, respectively, compared with un-weeded check (3411.28 and 3513.84 gm / m^2, respectively). The reduction percentages were 98.61 and 98.54 % for 2002 and 2003 maize seasons, respectively. This result agrees with the finding of many authors such as Pandey (1989); El-Bially (1995); Anil *et al*. (1996) and Marnotte and Tehia (1996).

On the other hand, metribuzin was more toxic to broad leaf weeds than to narrow leaves, since the reduction percentages (% R) of narrow leaf weeds due to this compound were 43.8 and 44.3%, in the two maize seasons, respectively (Table 3).

3. Effect of herbicides treatments on maize plant characters, yield and yield components: The effect of herbicides treatments on maize plant characters, yield and yield components in both seasons were recorded in Tables 4 and 5.

Table (3): Effectiveness of herbicidal treatments on broad leaf and grassy weeds in maize field during season 2002 (1st) and 2003 (2nd) and their average (m).

Treatment		Annual broad leaf weeds						Annual narrow leaf weeds								Total of all weeds	
		Amaranthus cruentus		*Portulaca oleracea*		Total		*Digitaria sanguinalis*		*Eleusine indica*		*Dinebra retroflexa*		Total			
		wt.	%R	Wt.	%R	wt	%R	wt.	%R	wt.	%R	wt.	%R	wt.	%R	wt.	%R
Atrazine + pendimethalin	1st	0*	100**	11.54	97.05	11.54	97.14	0	100	35.9	98.13	0	100	35.9	98.81	47.44	98.61
	2nd	0	100	14.1	96.8	14.1	96.68	0	100	37.18	98.11	0	100	37.18	98.78	51.28	98.54
	m	0	100	12.82	96.93	12.82	96.91	0	100	36.54	98.12	0	100	36.54	98.8	49.36	98.58
metribuzin	1st	0	100	34.62	91.15	34.62	91.41	7.69	84.21	1080.8	43.8	0	100	1088.5	63.82	1123.1	67.08
	2nd	0	100	35.9	91.86	35.9	91.55	9.62	81.25	1096.2	44.3	0	100	1105.8	63.84	1141.7	67.51
	m	0	100	35.26	91.51	35.26	91.48	8.66	82.73	1088.5	44.05	0	100	1097.1	63.83	1132.4	67.3
Hand weeding	1st	0	100	90.13	76.95	90.13	77.65	5.13	89.48	45.51	97.63	0	100	50.64	98.32	140.77	95.87
	2nd	0	100	87.31	80.19	87.31	78.43	6.41	87.5	48.72	97.52	0	100	55.13	98.2	142.44	95.95
	m	0	100	88.72	78.57	88.72	78.04	5.77	88.49	47.12	97.58	0	100	52.89	98.26	141.61	95.91
Control	1st	12.18	0	391.03	0	403.21	0	48.72	0	1923.1	0	1036.3	0	3008.1	0	3411.3	0
	2nd	14.74	0	440.77	0	455.51	0	51.28	0	1968	0	1039.1	0	3058.3	0	3513.8	0
	m	13.46	0	415.9	0	429.36	0	50	0	1945.5	0	1037.7	0	3033.2	0	3462.6	0
%I***	1st	0.36		11.46		11.82		1.43		56.37		30.38		88.18		100	
	2nd	0.42		12.54		12.96		1.46		56.01		29.57		87.04		100	
	m	0.39		12		12.39		1.45		56.19		29.98		87.61		100	

B.L.S.D$_{0.01}$= (Wt. 1st)= 176.9, 2nd= 95.52

In regard to corn plant height, leaf area index, ear length, ear diameter, ear weight, kernels weight/ ear and weight of 1000 kernels, the data revealed that all of the tested herbicides significantly enhanced these parameters, when compared with un-weeded treatment.

Table (4): Effect of herbicidal treatments on maize plant characters and yield components during two seasons 2002 (1st) and 2003 (2nd)

Treatment	Plant height (cm)		Leaf area index (cm)²		Ear length (cm)		Ear diameter (cm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Atrazine + Pendimethalin	90.9	92.6	923	796.5	25.4	23.3	5.3	4.8
Metribuzin	85.4	83.8	537.4	478.6	22.9	20.3	4.7	4.6
Bentazone	78.5	78	450.3	377.9	21.7	20.2	4.3	4.3
Fluroxypyr	82.1	82.1	494.3	409.2	21.6	21.3	4.3	4.5
Hand weeding	89.9	89.5	815.6	697.2	23	21.7	5	4.8
Control	30.8	30.5	329.3	256.9	17.1	15.5	3.6	3.5
B.L.S.D $_{0.01}$	2.08	2.71	34.66	46.17	1.14	1.65	0.321	0.243

These enhancements may be due to the absence of weeds competition with corn plants, leading to the increase in corn yields. This result confirms the earlier studies (El-Deeb *et al.*, 1986; Panwar *et al*., 1995; Soliman, 1995; Akobundu *et al*., 2000 and Chikoye and Ekeleme, 2003). The mixture of atrazine and pendimethalin was the best in enhancing the previous characters followed by hand weeding.

Concerning the effect of herbicides treatments on the yield, percent of increase in corn yield, all the tested treatments significantly increased the yield of maize, which was confirmed by the percent of increase in corn yield. The most effective treatment in this respect was the mixture of atrazine and pendimethalin which gave 5.08 and 4.958 ton / feddan, respectively, and increase of corn yield with 137.1 and 145.2 %, respectively, when compared with the control 2.143 and 2.022 ton/feddan, respectively. In the same manner, metribuzin was one of the most effective compounds, which gave 4.276 and 4.103 ton / feddan, respectively, but less than that of hand weeding. This observation may be due to % R of *Eleusine indica* by metribuzin was 43.8 and 44.3 %, respectively.

The mixture of atrazine and pendimethalin was the most effective treatment to control broad and grassy leaf weeds, and significantly increased in plant characters, yield, and yield components. On the other hand, fluroxypyr was the most effective herbicide to control broad leaf weeds grown in maize fields and also caused significant increase in plant characters, yield, and yield components.

Table (5): Effect of herbicidal treatments on maize yield and yield components during two seasons 2002 (1st) and 2003 (2nd)

Treatment	Ear weight (gm)		Kernels weight/ear (gm)		Weight of 1000 kernels (gm)		Yield (ton/feddan)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Atrazine + Pendimethalin	310.8	302.9	246.5	237.1	399	369.4	5.08	4.958
Metribuzin	266.5	252.9	208.3	201.1	344.8	335	4.276	4.103
Bentazone	195.8	185.7	160.5	148.6	269.5	252.5	3.155	2.998
Fluroxypyr	196	186.5	157.3	148.4	271	260.5	3.165	3.036
Hand weeding	293.8	285.3	232.3	223	372	349.8	4.865	4.62
Control	132.3	125.8	103.5	96.8	199.3	180.3	2.143	2.022
B.L.S.D $_{0.01}$	11.46	7.59	11.52	7.4	18.56	17.16	0.135	0.144

REFERENCES

Akobundu, I. O. (1987). Weed science in the tropics principles and practice. Wiley, Chichester, Great Britain 522pp.

Akobundu, I. O.; U. E. Udensi and D. Chikoye (2000). Velvetbean (Mucuna spp.) suppresses *Imperata cylindrica* (L.) Research. and increases maize yield. Int. J. Pest Manag. 46: 103-108.

Akinyemiju, A. O. (1988). Chemical weed control in maize (Zea mays L.) and cowpea [*Vigna unguiculata* (L.) Walp.] in the rainforest zone of southwestern Nigeria. Niger. J. Weed Sci., 1: 29-41.

Anil, D.; K. C. Gautam, and A. Dixit (1996). Effect of atrazine on growth and yield of winter maize. Ann. Agric. Res., 17 (2): 121-124.

Anonymous (2002). The Annual Report of Agricultural Statistics. Ministry of Agriculture & Land Reclamation, Economic Affairs Sector, Vol. 2. Summer and Nili Crops.

Bloomberg, J. R. (1994). Post-emergence weed control with Sencor (metribuzin) in field corn in the United States. Pflanzenschutz-Nachrichten-Bayer-English-ed. 47 (1): 5-18.

Chikoye, D. and F. Ekeleme (2003). Cover crops for cogongrass [*Imperata cylindrica* (L.) Raeusch.] management and effects on subsequent maize yield. Weed Sci., 51: 792-797.

Chikoye, D.; S. Schulz, and F. Ekeleme (2004). Evaluation of integrated weed management practices for maize in the northern Guinea savanna of Nigeria. Crop Prot., 23: 895-900.

Cohort Software Inc. (1986). Costat user's manual, Version 3.03. Berkeley. California, USA.

Darkwa, E. O.; B. K. Johnson; K. Nyalemegbe; M. Yangyuoru; C. Oti-Boateng; T. J. Willcocks and P. J. Terry (2001). Weed management on Vertisols for small-scale farmers in Ghana. Int. J. Pest Manag., 47: 299-303.

El-Bially, M. E. (1995). Efficiency of atrazine with other herbicides used alone in sequence or as tank mix in maize. Ann. Agric. Sci., 40 (2): 709-721.

El-Deeb, S. T.; A. A. Galelah and E. E. Shalaby (1986). Chemical weed control in wheat, with respect to its effect on yield and yield components. Proc. 2nd Conf. Agron., Alex., Egypt. (1): 619-634.

El-Sanhory, R. A. (2004). Biochemical effects of irrigation waters and soil conditioners on calcareous soil properties and eggplant quality. M.Sc. Thesis. Fac. of Agric., Damanhour, Alexandria University.

Fausey, J. C. and K. A. Renner (2001). Incorporating CGA-248757 and flumiclorac into annual weed control programs for corn (*Zea mays*) and soybean (*Glycine max*). Weed Technol., 15 (1): 148-154.

Marnotte, P. and K. E. Tehia (1996). Assessment of weed control trials on yam crops in the central zone of Cote d'Ivoire. Seizieme conference du columa. Journees internationales sur la lutte contre les mauvaises herbes, Reims, France, 6-8 decembre 1995. Tome 3. 1355-1363.

Pandey, J. (1989). Effect of Cannabis sativa infestation on yield of rabi maize. Indian J. Agron., 34 (1): 109-110.

Pandey, A. K.; V. Prakash; P. Singh; K. Prasad; R. D. Singh and V. P. Mani (2000). Weed management in major crops of North-western Himalayas. Research Bulletin 16, Vivekanada Parvatiya Krishi Anusandhan Sansthan, Almora, Uttaranchal.

Panwar, R. S.; S. S. Rathi and R. K. Malik (1995). Effect of isoproturon and 2,4-D combination on weed control in wheat. Haryana Agric. Univ. J. Res., 25 (3): 101-105.

Remison, S. U. (1979). Effect of weeding and nitrogen treatments on maize yield in Nigeria. Weed Res., 19: 71-74.

Roushdy, S. S. (1997). Differential response of *Zea mays* and *Corchorus olitorius* to post-emergence application of fluroxypyr. Egyptian J. Physiol. Sci., 21 (3): 395-408.

Saini, J. P. (2000). Efficacy of atrazine as post-emergence herbicide for weed control in maize (*Zea mays*) under rainfed conditions. Indian J. Agric. Sci., 70 (11): 801-803.

Soliman, F. S. (1995). Assessment of some herbicidal combinations in wheat fields of Dierab, Saudi Arabia. Arab Gulf J. Sci. Res., 13 (3): 521-534.

Yehia, Z. R.; H. R. El-Wekil; G. M. Mekhail and M. S. Tewfik (1992). Control of atrazine-tolerant broad-leaved weeds in maize by fluroxypyr. Assiut J. Agric. Sci., 23 (3): 159-170.