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Effect of post-emergence dual herbicides on weeds and yield of maize (*Zea mays* L.) in order to decrease environmental biology pollution of Atrazine in semi-arid region of Khuzestan, Iran

Fateme Nuraky[1] and Hassan Rahmany[2]*

[1]Shoushtar Branch, Islamic Azad university, Shoushtar, Iran.
[2]Payame Noor University of Khuzestan, Iran.

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Many of the chemicals used in pesticides are persistent soil, groundwater and drinking water contaminants. Use of efficient methods of weed integrated management with as regards environmental sustainability and reduce pollution as well as increased crop yield and also weed resistance to herbicides is essential. An experiment was conducted in 2010 in the north of Khuzestan in Iran. Experiment treatments were compared in a split plot design by a randomized completely block design with 4 replication. The used variety of maize was S.C. 704. Main factors included 3 levels of cultivation, once, twice and without cultivation. Sub factors were weed control by application of indicated herbicide in 4 levels: Nicosulfuron, Foramsulfuron, Atrazin + Alachlor and no control. The results conducted that the highest of weed control followed the highest yield by ranged 15.47 ton per hectare related to Nicosulfuron + once cultivation treatment and lowest yield by ranged 10.56 ton per hectare related to Atrazin + Alachlor + once cultivation treatment. There were difference between treatments in yield and yield components during the whole growing season, the kind of index harvest in the level of probability 1% and all in the level of 5% significant.

Key words: Maize, dual herbicides, Atrazine, biology pollution, weed integrated management.

INTRODUCTION

Maize (*Zea mays* L.) is the world's third most important cereal grain after wheat and rice. It is grown primarily for grain and secondarily for fodder in Iran. It is grown on an area of 320,000 ha with a production of 2,560000 tons an average grain yield of 8,000 kg ha^{-1}. Among various factors responsible for low yield, weed infestation is of supreme importance. Worldwide maize production is hampered up to 40% by competition from weeds which are the most important pest group of this crop (Oerke and Dehne, 2004). Atrazine is an herbicide registered in the United States for the control of broadleaf weeds and some grassy weeds. It is currently used on corn, sorghum, sugarcane. Atrazine acts by inhibiting photosynthesis. Many Atrazine-tolerant mutations have begun to appear in weeds, and this tolerance is predominantly based on detoxifying Atrazine by binding it to glutathione, a mechanism in naturally Atrazine-tolerant corn. Efforts have been made to select or produce Atrazine-tolerant mutant's crops such as soybean that is otherwise difficult to rotate with Atrazine-treated corn or

*Corresponding author. E-mail: rahmany2003@yahoo.com.

potato (Joe and Mae-Wan, 2011). The environmental impact of pesticides is often greater than what is intended by those who use them. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including no target species, air, water, bottom sediments, and food (Miller, 2004). Pesticide residues have also been found in rain and groundwater (Kellogg et al., 2000). Studies by the UK government showed that pesticide concentrations exceeded those allowable for drinking water in some samples of river water and ground water (Bingham, 2007). Atrazine can be presented in parts per million in agricultural run-offs and can reach 40 parts per billion in precipitation. The global impact of Atrazine is staggering. Significant Atrazine pollution has been found in the Lio-He and Yangtse rivers of China, and a review of the atmospheric dispersion of Atrazine shows impacts of the herbicide even in isolated areas of the globe (Joe and Mae-Wan, 2011). Atrazine has a higher risk than Metolachlor in all soils because of its higher toxicity. Surface application of pesticide generally increases the chance of pesticide loss in runoff, which possess a greater risk to surface water, while soil incorporation may increase pesticide loss in percolation. There is a trade-off in managing practices to protect surface and groundwater quality. The objective of this research was to determine how well selected post emergence herbicides worked when applied at normal use rates for weed control instead of Atrazin towards environmental sustainability and reduce groundwater contamination as well as increased crop yield with in-row cultivation in maize.

MATERIALS AND METHODS

This study was carried out in north of Khuzestan in Iran during summer 2010. The experimental site had mean soil pH of 7.70 with 22.8, 55.7 and 21.5% clay, silt and sand, respectively. The experimental was split plot in randomized completely block design (RCBD) design with four replications. Maize variety (Single cross 704) was used in the study as this is the widely used variety used in the area. Soils were fertilized according to NMSU recommendation based on soil tests. The field were plowed, fertilized, and leveled before the field maize was planted. The size of each treatment was 6 × 5 m^2. There were 12 treatments in the experiment with row to row distance of 75 cm, each treatment having eight rows. Distance of seeds inter row was 17 cm. Experimental field was irrigated as and when needed. Main factor was cultivation in three levels and sub factor was herbicides in four levels. Herbicides included Atrazin (WP80, P80), Alachlor (EC48), Foramsulfuron (OD 22.5) and Nicosulfuron (SC4) by the balance (1 $kgha^{-1}$), (4 Lha^{-1}), (2.5 L/ha) and (2 Lha^{-1}) respectively. The experiment comprised of the following treatments:

1. Foramsulfuron + once cultivation
2. Nicosulfuron + once cultivation
3. Atrazin + Alachlor + once cultivation
4. Weedy + once cultivation
5. Foramsufuron + twice cultivation
6. Nicosulfuron + twice cultivation
7. Atrazin + Alachlor + twice cultivation
8. Weedy + twice cultivation
9. Foramsulfuron + non-cultivation
10. Nicosulfuron + non-cultivation
11. Atrazin + Alachlor + non-cultivation
12. Weedy + non-cultivation

During the course of experiment, the data were recorded on weed density m^{-2} 26 days after sowing, yield and particulars included 100 grains weight (g) number of grains per row – number of row in ear, biological yield (tha^{-1}) and economical yield (tha^{-1}).

Each time quadrate having size 0.5 × 0.5 m^2 was placed randomly four times in each treatment and the weeds inside the quadrate was counted. For recording the grain yield data, two central rows were harvested in each treatment bundled, sun dried and weighed. The data recorded were statistically analyzed using MSTAT-C software. The purpose of analysis of variance was to determine the significant effect of treatments on weeds and maize. Duncan's multiple range tests at 1% probability level was applied for mean separation of significant parameters.

RESULTS AND DISCUSSION

Dominant weed species in field were Cyperus and Chenopodium, respectively

Weed density (m^2) 26 days after sowing (15 days after herbicides application). The data regarding weed population revealed that weed density at 26 days after sowing (DAS) was significantly affected by all weed control treatments (Table 1). The results indicated that maximum weed density 26 days after sowing was recorded in weedy (Table 1). Table 2 shows the control percentage for the treatments. The data (Table 2) reveal that maximum control percentages for Cyperus, Convolvulus, Chenopodium and Nicosulfuron are 55.63, 74.42 and 100 respectively. Maximum control of Amaran tus was for Foramsulfuron treatment. These results are in line with that of Jodie (2008) and Nurse et al. (2007).

100 - Grain weight

The highest 100 – grain weight (31 g) was recorded in Table 3 weedy + twice cultivation. Significantly minimum 100 – grain weight (25.75 g) was recorded in Atrazin + Alachlor + non cultivation. In those treatment where the weeds were controlled, 100 – grain weight were greater as compared to uncontrolled treatments as weeds share the resources with the crop plants. These results were in agreement with Khan et al. (2002) and EL- Bially (1995). They reported that weed infestation decreased the 100 – grain weight in maize.

Number of grain per row

Number of grain is an important yield contributing trait and can greatly affect the economic return. It could be inferred from the data that maximum (45.33) number of grains per row was obtained in Nicosulfuron + once cultivation. Minimum (33.41) grains per row were recorded

Table 1. Weed control percentage with herbicides.

Treatment	Cyperus (control %)	Convolvulus (control %)	Chenopodium (control %)	Amaranthus (control %)
Foramsulfuron	26.94	71.47	91.20	100
Nicosulfuron	55.63	74.42	100	93.80
Atrazin+lasso	27.92	36.70	84.88	56.01
Weedy	0	0	0	0

Table 2. Weed density at 26 days after sowing.

Treatment	Cyperus (number)	Convolvulus (number)	Chenopodium (number)	Amaranthus (number)
Foramsulfuron	1.56	1.28	0	0
Nicosulfuron	1.25	0	0	0
Atrazin+lasso	3	1.41	0	0
Weedy	9.48	2.31	9.25	6.91

Table 3. Results of mean comparisons between treatments.

Treatment	100 – grain weight (g)	Number of grain per row	Number of row in ear	Economical yield (tha^{-1})	Biological yield (tha^{-1})
1	28.25^{bcd}	38.42^{bced}	14.99^{a}	12.81^{c}	24.19^{bcd}
2	28.75^{abc}	45.33^{a}	15.16^{a}	15.47^{a}	29.55^{a}
3	25.7^{cde}	33.41^{f}	14.49^{a}	10.65^{d}	20.09^{f}
4	27.75^{cde}	36.33^{cdef}	14.49^{a}	11.46^{d}	21.81^{def}
5	30.25^{ab}	40^{bc}	14.83^{a}	14.10^{b}	26.44^{bc}
6	30.5^{ab}	39.33^{bcd}	14.66^{a}	13.82^{bc}	26.06^{bc}
7	26.25^{de}	37.67^{bcde}	14^{a}	10.87^{d}	19.91^{f}
8	31^{a}	40.17^{b}	14^{a}	13.73^{bc}	26.74^{b}
9	29.25^{abc}	39.41^{bcd}	14.33^{a}	12.96^{bc}	23.88^{cd}e
10	28.75^{abc}	41.16^{b}	14.50^{a}	13.45^{bc}	25.56^{bc}
11	25.75^{e}	36.17^{def}	14.83^{a}	10.84^{d}	20.0^{5f}
12	29^{abc}	35.33^{ef}	14.16^{a}	11.31^{d}	21.28^{ef}

Means with similar letter(s) in each trait is not significantly different at 1% probability level according to Duncan's multiple range test.

in Atrazin + Alachlor + once cultivation. From these results it was observed that good weed control was effective to get higher number of grain per row and it was also observed that less grain per row in uncontrolled plot (Naveed et al., 2008)

Number of row in ear

The results revealed that, treatments have no significant variance by genetics but affected by environmental factors.

Economical yield (tha^{-1})

The highest grain yield (15.47 tha^{-1}) was recorded in Nicosulfuron + once cultivation. Higher grain yield was due to more number of grains per cob, grain weight per cob and 100 – grain weight as compared to uncontrolled treatments.

Efficiency of chemicals and other weed control practices in increasing grain yield had also been demonstrated by some scientists (Khan and Hag, 2004).

Biological yield (tha^{-1})

The data presented indicated that maximum biological yield (29.55 tha^{-1}) was recorded in Nicosulfuron + once cultivation. As all vegetative parameters were significantly affected by different treatments, the biological yield was also significantly affected because leaf area, number of leaves plant, plant height and number of grains cob contributes in increasing the biological yield. Ullah et al. (2008) also reported similar results.

Conclusion

Results of study indicated that additional of grain yield, others affected by treatments. Single herbicide application cannot control weeds but integrated control was exceedingly weed control significantly. Thus for high yield and better control of weed with modern methods of weed integrated management In order to decrease of environmental biology pollution of Atrazine on base of use of integrated methods, the most qualify treatment of weed control that recommending is Nicosulfuron +once cultivation instead of Atrazin (conventional herbicide) in Maize field.

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