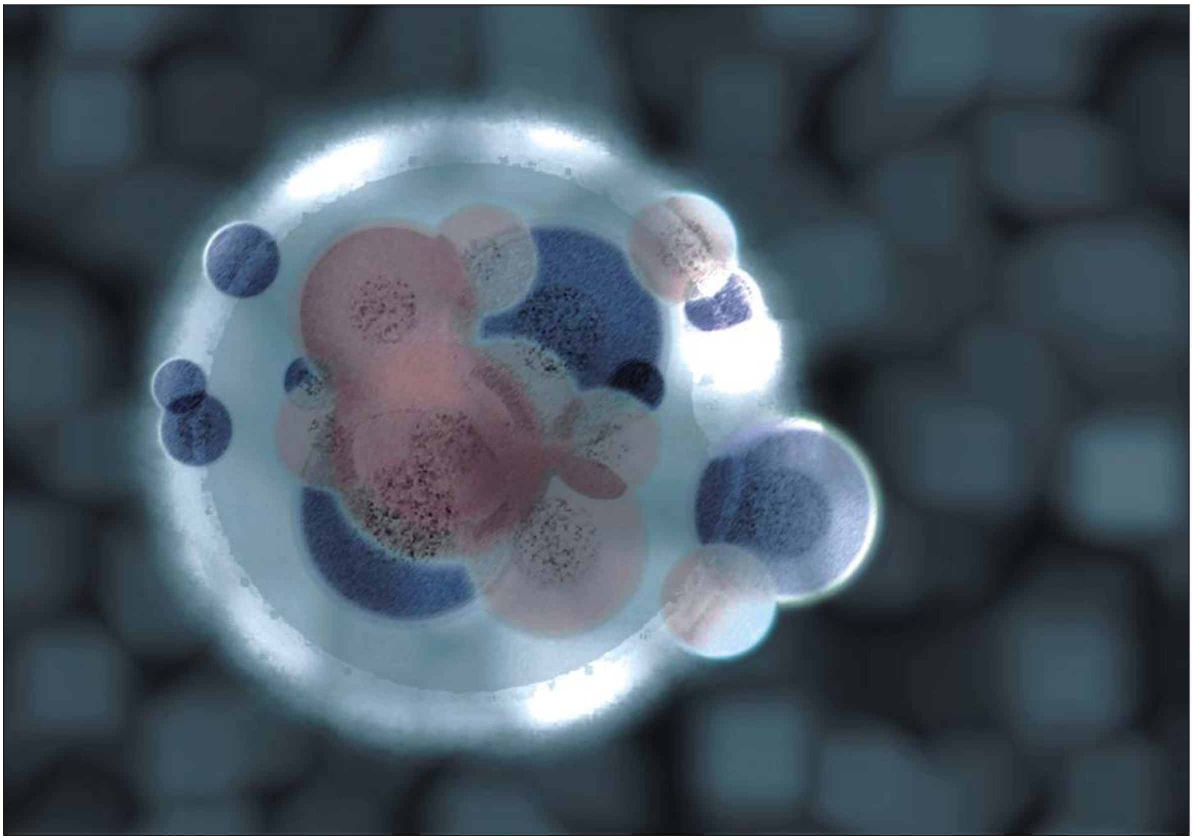

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Evaluation the Efficiency of Three Sulfonylurea Herbicide and Their Effects on Maize (*Zea mays* L.) Grain Yield

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Abstract: Field studies were conducted in 2005 at Karaj, northern of Iran, to evaluate the efficacy of Sulfonyl Urea (SU) herbicides on weed control in maize and compare them with other herbicides at single and double row planting patterns. The treatments were three SU herbicides, nicosulfuron, rimsulfuron, foramsulfuron and most commonly used herbicides in maize. Hoe weeded and unweeded treatments also were included. The findings of this study showed that at both planting patterns all plots that received nicosulfuron had significantly higher maize grain yield than other two SU herbicides. At Double Row (DR) planting pattern, all the treatments controlled weeds more effectively than at Single Row (SR) planting pattern and increased maize grain yield by mean of 1.0 t ha^{-1}. At both planting patterns herbicidal mixture of atrazine and alachlor was the best treatment in controlling weeds. The hoe weeded control and all herbicidal treatments had lower weed dry matter than the untreated control at crop harvest period. In addition the lowest weed dry matter was obtained from the hoe weeded control. Results of this study revealed that nicosulfuron and rimsulfuron were the best and the weakest SU herbicide at both planting patterns, respectively.

Key words: Planting pattern, rimsulfuron, foramsulfuron, nicosulfuron

INTRODUCTION

Over the past 20 year an important discovery in herbicide chemistry has been herbicides that inhibit enzyme Acetolactate Synthase (ALS). Sulfonyl Urea (SU) herbicides, one family of ALS-inhibitor group, have become very important in agricultural production since the registration of chlorsulfuron in 1982 (Beyer *et al.*, 1988). SU herbicides provide excellent broad-spectrum control of broad-leaved weeds and some grasses with excellent user safety (Robinson *et al.*, 1996). They are used at extremely low doses in the range of g ha^{-1} rather than kg or L ha^{-1} of other herbicides. SU herbicides are also attractive from an environmental and human standpoint because of their low application rates, selectivity in many crops, high efficacy and low mammalian toxicity (Foy and Witt, 1990; Palm *et al.*, 1989). Rimsulfuron, foramsulfuron and nicosulfuron are three SU herbicides which are used in maize production extensively. Rimsulfuron provide good to excellent control of seedling and rhizome johnsongrass as well as several annual grass weeds (Camacho *et al.*, 1991; Foy and Witt, 1990).

Foramsulfuron is a new postemergence (POST) herbicide labeled for selective control of grasses and some broadleaf weeds in maize. This herbicide is formulated with the safener, Isoxadifen-ethyl, at a 1:1 ratio. Nicosulfuron was registered for use on field maize in 1990, which is recommended for POST control of weeds in maize in the US (Ahrens, 1994) it has been reported to be very effective on rhizomatous perennial temperate weeds (Bruce and Kells, 1997).

Public concern about undesirable pesticide impacts on environment has led to increased emphasis on reducing pesticide use in crop production systems. Therefore other control practices like use herbicide having different mode of action, cultivation, narrowing rows are necessary (Forcella *et al.*, 1992; Teasdale, 1995). Cultivation plus herbicide application can be beneficial in row crop production. Cultivation can aid weed control, increase crop yield and increase water infiltration by reducing runoff and offsetting herbicide movement (Webster and Shaw, 1997).

The objective of this study was to evaluate the performance of SU herbicides on weed control and compare their efficacy with other commonly-used

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herbicides in maize in two maize planting patterns, first, single row planting pattern and second, double row planting pattern.

MATERIALS AND METHODS

Field studies were conducted in 2004 at Research Farm of College of Agriculture and Natural Resources, University of Tehran, Karaj, northern of Iran. The study area soil was loam with a pH of 5.7 and 0.85% organic matter and at previous year barely had been planted. Sc 704 maize was planted May 19, 2004. One week prior to planting, the fertilizer, 336 kg ha^{-1} N:P_2O_5:K_2O (19:19:19) was applied broadcast. Three weeks after planting nitrogen or urea fertilizer 202 kg ha^{-1} was side-dressed. Permethrin (224 g a. I. ha^{-1}) was applied in furrow at planting for insect control. SU and other herbicides were evaluated at single row planting patter (SR) and double row planting pattern (DR). The applied treatments and their rates and timing application in both planting patterns are listed in Table 1. A nonionic surfactant at 0.25% (v/v) was added to all postemergence (POST) treatments. POST treatments applied in both trail when maize had four leaves. Treatments were arranged in a randomized complete block design with four replications. A hoe weeded and weed infested control were also included. Maize seed (cultivar Sc704) was planted on 19 May 2005. The plots were 10 m long and 3 m wide, with four rows of maize spaced at 75 and 15 cm while at double row planting pattern on the top each ridge two rows of maize were spaced 20 cm apart and maize plants spacing in row was 30 cm so that the arrangement of plants on ridge was similar to parallelogram, giving a final density of approximately 88,000 plants ha^{-1} in both planting patterns.

Herbicide treatments (Table 1) were applied with an electric backpack sprayer and a hand-held boom calibrated to deliver 140 L/ha spray volume at 166 Kpa. Weed parameter assessed from two 75×75 cm stable quadrates placed randomly in plots. With in each quadrate, weed species were identified, counted, clipped at ground level and oven-dried at 80°C for 48 h, then weighed to determine their dry matter. The counting of weeds was made two weeks after treatment and at maize harvesting period. Maize was harvested 1-3 October 2005 and maize grain yield was obtained from an area of 4 m^2 of plots and was adjusted to 12% moisture content. The non-transformed data were analyzed using analysis of variance (ANOVA) in SAS. Means of significant effect were separated using Fisher's protected Least Significant Difference (LSD) at probability level of $p<0.05$.

RESULTS

Weed density (plants m^{-2}): The data showed that different treatment significantly affected weed density ($p<0.05$) at 14 Day After Treatment (DAT) and harvesting period in both DR and SR plantations, except grass weeds in DR plantation (Table 2).

Maximum weed density recorded in weedy check plots while minimum was recorded in weeded check plots. In general broadleaf weed density was more than grass weeds. At weed density from all treatments was less than that of DR planting pattern as shown in the table, along the time from two weeks after treatments until the end of growing season, total weed density spatially grass weeds decreased. At both planting patterns, the plots which received 2,4-D had broadleaf density similar to weeded check plot. Among SU herbicides, nicosulfuron was the best treatment and reduced weed density by mean of 70% and compared to the best treatment, atrazine + alachlor, significantly reduced weed density at both sampling time in both trails.

Weed dry matter: Grasses: The data of grass weeds revealed that various treatments have significant effect ($p<0.05$) on weed dry matter at both planting pattern (Fig. 1). The highest weed dry matter obtained from untreated plots while minimum obtained from weed free check plot. About SU herbicides, nicosulfuron was the

Table 1: An application rate (g h^{-1}) of various herbicidal treatments on preemergence (PRE) and postemergence (POST) control of weeds in the field trial

Treatments	Rate (g h^{-1})	Application timing
Atrazine+Alachlor	1,500+4,000	PRE[a]
Atrazine+Acetocher	1,500+2,500	PRE
2, 4-D+MCPA	1,000	POST
Antrazine+Pendimetaline	1,500+1,500	PRE
Bentazon	1,500	POST
Nicosulfuron	35	POST
Foramsulfuron	37	POST
Rimsulfuron	30	POST
Eradicane	6,000	PPI

Abbreviations: PRE, preemergence; POST, postemergence, PPI, preplant incorporation; prepackaged mixture in the ratio of 2, 4-D (36%) + MCPA (31.5%)

Table 2: Effect of various herbicidal treatments on broadleaf and grass weed density in Double Row (DR) and Single Row (SR) planting patterns of maize at 14 day after treatment (DAT) and harvesting period

		Weed density						
		Single row				Double Row		
		Broadleaves		Grasses		Broadleaves		Grasses
Treatment	Rate ($g h^{-1}$)	14 DAT	Corn harvest	14 DAT	Corn harvest	14 DAT	Corn harvest	14 DAT
2,4-D+MCPA	1,500	4.00	1.33	14.00	1.33	2.66	1.33	13.33
Bentazon	1,500	6.00	3.33	14.00	3.00	5.00	3.00	14.00
Nicosulfuron	35	16.00	13.33	8.00	2.33	15.00	12.30	8.83
Foramsulfuron	37	13.00	10.00	7.00	9.00	15.00	12.30	18.16
Rimsulfuron	30	20.00	17.00	2.67	16.00	19.00	16.00	14.33
Hand weeded		16.67	13.67	6.66	12.67	12.00	9.00	8.00
Nontreated		0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD (0.05)		0.86	1.19	0.50	1.54	0.67	0.67	0.94

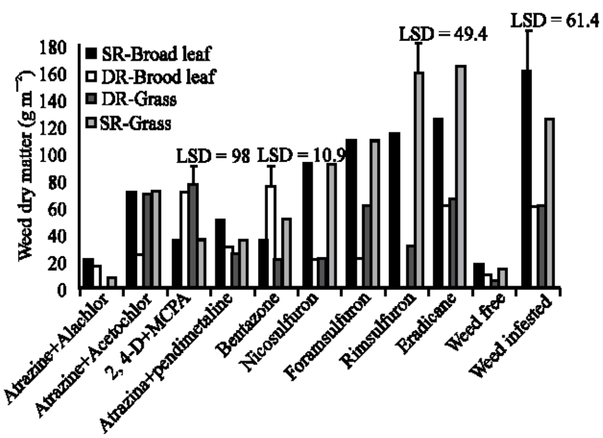

Fig. 1: Effect of various herbicidal treatments on grass and broad leaf weeds dry matter in double row (DR) and single row (SR) planting patterns of maize at harvesting period

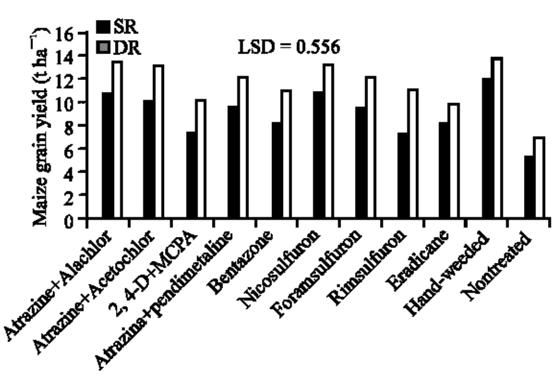

Fig. 2: Effect of various herbicidal treatments on grain yield (t ha^{-1}) in double row (DR) and single row (SR) planting patterns of maize field trial

best treatment and decreased weed dry matter by 87%. Rimsulfuron, among SU herbicides had the highest weed dry matter and in SR planting pattern had more dry matter than of DR planting pattern while foramsulfuron had less weed dry matter.

Broadleaf weeds: In case of broadleaf weeds, dry matter at harvesting period significantly affected by various recorded in untreated plot while the minimum weed dry matter was recorded in unweeded plots. Among SU herbicides, nicosulfuron was the most effective herbicide and decreased weed dry matter by 73% at DR and 33% at SR planting pattern.

Maize grain yield: The data showed that Different treatments had significant ($p<0.05$) effect on seed yield of maize at both planting patterns (Fig. 2). The maximum maize grain yield recorded in weedy check plots while minimum grain yield recorded in untreated check plots. Among SU herbicides, nicosulfuron was the best treatment and increased maize grain yield as much as herbicidal mixture atrazine+alachlor at both planting patterns. Rimsulfuron was the weakest SU herbicide. In general in DR planting pattern the maize grain yield was higher than that of SR. herbicidal mixture of atrazine+alachlor had thee greatest effect on grain yield. The efficacy of nicosulfuron on weed control does not differ among planting patterns.

DISCUSSION

Results of this study showed that the grain yield was lowest in unweeded controls in both trails. This is due to weed interference which has caused strong competition between maize and weeds for growth factors because these plots had the highest weed dry matter and density as shown in the Table 2 and 3. This study revealed that nicosulfuron is a suitable SU herbicide for POST control of weeds in maize in SR at DR. the treatment was herbicidal mixture of atrazine and alachlor. This is due to broad spectrum range of weed control by this mixture as reported by other researchers (Akinyemiju, 1988; Chikoye *et al.*, 2005). Nicosulfuron was the best SU herbicide. The reason for this is the fact that the predominant grass species in the study area was johnsongrass. Nicosulfuron is a new alternative for POST control of perennial weeds in maize. Several researches had shown that it can controls rhizomatous perennial temperate weeds in maize effectively (Bhowmik *et al.*, 1992; Bruce and Kells, 1997). In both planting patterns, broadleaf weeds were predominant. In DR in general, weed dry matter and biomass was more than SR resulting in more maize grain yield. As reported in previous studies (Flenet *et al.*, 1996; Teasdale, 1998, 1995), row interval reduction result in earlier canopy closure and therefore critical period of weed control decreased. Cultivation which carried out at SR, comparing with narrow row interval, had less effect on keeping maize. As shown in the former studies, cultivation sometimes damages the crop plants and wide free space between rows at SR allow weeds to compete with maize spatially at early growing season. Other two SU herbicides, foramsulfuron and rimsulfuron had little effect on weed control. The reason for this result is the type of present weeds in the study area and the maize injury which caused by application of these herbicides (Green and Ulrich, 1993; Bunting *et al.*, 2004). From two WAT until maize harvest, weed reduced and at DR was more than that of SR. in general this study showed that at DR herbicides were more efficient on weed control and nicosulfuron was the best SU herbicide in controlling weeds. Effect of all treatments on weed control at SR planting pattern was less than that of DR planting pattern.

CONCLUSION

Results of this study revealed that nicosulfuron was the best SU herbicide at both planting patterns. Maize grain yield at DR planting pattern was higher than of SR planting pattern.

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