ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

# JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 6 (3): 444-448, 2007
ISSN 1812-5379


# Control of Johnsongrass (*Sorghum halepense*) with Nicosulfuron in Maize at Different Planting Patterns

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**Abstract:** This study was conducted in 2005 and 2006 at Research Farm of Tehran University to investigate the influence of four nicosulfuron doses (35, 70, 105 and 210 g a.i. $ha^{-1}$) on the performance of maize and its efficacy in the control of johnsongrass. The experiment was designed as complete randomized block with three replications. All plots that received nicosulfuron had significantly higher maize grain yield than the unweeded control at both planting patterns in both years. Maize grain yield in the weeded control was similar to plots that received nicosulfuron at 35-210 g a.i. $ha^{-1}$ at single row planting pattern (SR) in 2006, 70-210 g a.i. $ha^{-1}$ at double row planting pattern (DR) in 2005 and 35 g a.i. $ha^{-1}$ at DR planting pattern in 2006. The unweeded control had significantly higher weed shoot and rhizome biomass than all other treatments at both planting pattern in both years. Johnsongrass rhizome biomass in the weeded control was similar to that in all nicosulfuron-treated plots. In general at DR planting patterns johnsongrass biomass in both years and at all doses was less than that at SR planting pattern. The findings of this study show that nicosulfuron is a suitable Postemergence (POST) herbicide for johnsongrass control in maize.

**Key words:** Single row planting pattern, double row planting pattern, maize, postemergence and nicosulfuron

## INTRODUCTION

Johnsongrass can reduce corn yields by as much as 100% through competition for light and other resources. Extensive production of rhizomes and prolific seed production contribute to the competitive nature of johnsongrass, making it difficult to control (Holm *et al.*, 1991). Few soil-applied herbicides provide suppression of plants originating from rhizomes and a limited number of selective herbicides can be applied Postemergence (POST) in maize (Ghosheh and Chandler, 1998; Camacho and Moshier, 1991). Herbicidal control of johnsongrass in maize first became possible with the introduction of safened EPTC and Butylate. These herbicides, however, are only partially effective for control of rhizome johnsongrass and fair for control of seedling johnsongrass (Foy and Witt, 1990).

Nicosulfuron is a sulfonylurea herbicide, which is recommended for postemergence control of weeds in maize in the US (Ahrens, 1994; Tweedy and Kapusta, 1995; Gubbiga *et al.*, 1995). It has been reported to be very effective on rhizomatous perennial temperate weeds (Bhowmik and O'Toole, 1992; Bruce and Kells, 1997). The efficacy of nicosulfuron on johnsongrass can be affected by other supplementary control practices such as narrowing row interval and using cultivation. Crops grown in narrow rows may out compete weeds at an earlier stage than those in wide rows because of more rapid canopy closure.

Murphy *et al.* (1996) also reported a decrease in weed biomass when corn row spacing was reduced from 75 to 50 cm. Although narrow rows and high plant density reduced weed biomass, these practices alone were not sufficient to prevent crop yield losses. Therefore, supplemental measures of weed control such as cultivation are necessary and complete elimination of herbicides may not be feasible. However, an opportunity exists for reducing herbicide application rates and frequency by combination of all these strategies. Cultivation plus herbicide application can be beneficial in row crop production (Rosales-Robles *et al.*, 1999; Steckel and DeFelice, 1995; Donald and Johnson, 2003;

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Donald *et al*., 2001). Cultivation can aid weed control, increase crop yield and increase water infiltration by reducing runoff and offsite herbicide movement (Webster and Shaw, 1996). Thus integrating all control practice can be more effective (Swanton and Morphy, 1996).

This study was carried out to evaluation the influence of nicosulfuron on the performance of maize and its efficacy on the control of johnsongrass at single row planting pattern (with cultivation) and at double row planting patterns.

## MATERIALS AND METHODS

The study was carried out in 2005 and 2006 at two separate nearby fields at Research Farm of college of agriculture and Natural Resources, University of Tehran at Karaj, northern of Iran. At the study area soil was clay loam with a PH of 5/7 and 0.85% organic matter.

The experimental fields had been abandoned to natural fallow for 1 year. The land was ploughed and harrowed in April, in both years. The experiment was designed as a complete randomized block with three replications. Treatments consisted of nicosulfuron doses [0 (unweeded control), 3 5, 70,105 and 210 g a.i. $ha^{-1}$]. A hoe weeded control was also included. 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 (Fig. 1).

The maize was planted on 19 May 2005 and 22 May 2006. Nicosulfuron was applied postemergence 2 weeks after planting maize (WAP) with an electronic backpack sprayer calibrated to deliver 250 L $ha^{-1}$ at 210 kPa using a Flooding-fan nozzle. At SR row planting pattern, 10 days after herbicide treatment free space between rows was cultivated with a sweeper cultivator. The hoe weeded plots were weeded 5 times in each year at both planting patterns. At 2-week intervals with the first weeding conducted 2 WAP. Basal fertilizer [45 kg $ha^{-1}$ of NPK

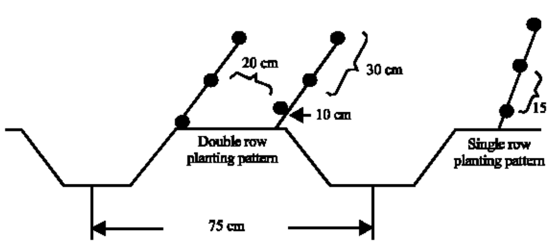


Fig. 1: Position of maize plants on the ridge at double row planting pattern and single row planting pattern

(15:20:15)] was applied 2 WAP at both planting patterns in both years while urea (45 kg N $ha^{-1}$) was side-dressed to the maize at 5 WAP.

Maize and johnsongrass shoot biomass were sampled 3 Weeks after Treatment (WAT) at both planting patterns in 2005 and 2006 to determine if herbicide injury occurred early in the season. Maize biomass was obtained by harvesting three plants consecutively, 0.5 m into each plot, from each of the two center rows. Maize grain yields were determined from an area of 6.38 $m^2$ (approximately 34 plants) in the two center rows of each plot excluding a1m border in October 2005 and September 2006. Maize grain yields were adjusted to 12% moisture content.

At 3 WAT, Johnsongrass shoot biomass was determined from three 0.25 $m^2$ quadrates in each plot while at crop harvest it was determined from two 0.25 $m^2$ quadrates in each plot.

Johnsongrass rhizome biomass was obtained by digging to a depth of 25 cm after obtaining the Johnsongrass shoot biomass at crop harvest. All the plant samples were dried in an oven at 80°C for 48 h for biomass determination. Total weed biomass was obtained by adding the shoot biomass to the rhizome biomass. All data were analysed using the mixed model procedure of SAS. The data were analysed over the 2 planting patterns and 2 years using a combined analysis. Treatment means were separated using standard errors of the mean. The relationships between maize grain yield and total Johnsongrass biomass at crop harvest were determined using linear regression analysis.

## RESULTS

There was a significant interaction between year and planting patterns for maize biomass. At SR planting pattern, maize biomass obtained in 2005 (163.4732.9 kg $ha^{-1}$) was significantly lower than that obtained in 2006 (354.8732.9 kg $ha^{-1}$), while at DR pattern there were no differences in maize biomass in both years (560.7732.9 kg $ha^{-1}$ in 2005 and 530.4732.9 kg $ha^{-1}$ in 2006). Significant differences were obtained for maize biomass at the different doses of nicosulfuron applied In general, maize biomass decreased with increase in nicosulfuron dose at both trails and in both years (Fig. 2). The highest maize biomass was obtained in the weeded control while the lowest was obtained in the unweeded control.

At crop harvest there was a significant year-planting pattern-nicosulfuron dose interaction for maize grain yield at the two planting patterns in both years (Fig. 3). The unweeded control had the lowest maize grain yield at both planting patterns in both years. At SR

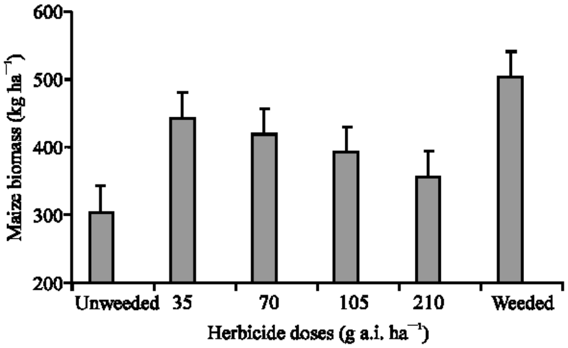


Fig. 2: Effect of nicosulfuron on maize biomass 3 WAT at single row planting pattern (SR) and double row planting pattern DR patterns in 2005 and 2006

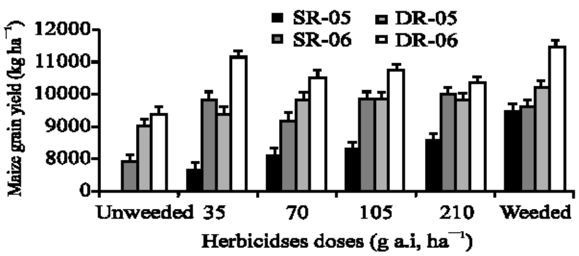


Fig. 3: Effect of nicosulfuron on maize grain yield at single row planting pattern (SR) and double row planting pattern (DR) in 2005 and 2006

pattern in 2005, maize grain yield increased with increase in nicosulfuron dose. However, the weeded control had the highest yield. In 2006, the weeded control and all plots that received nicosulfuron had similar maize grain yields except the dose of 70 g a.i. ha$^{-1}$ which had lower grain yield.

At DR pattern in 2005, the weeded control and doses of 70-210 g a.i. ha$^{-}$2$^{1}$ had similar and higher maize grain yield than all other plots. In 2006, the weeded control and plots that received 35 g a.i. ha$^{-1}$ had the highest maize grain yield. Doses of 70-210 g a.i. ha$^{-1}$ had similar grain yield which was higher than the unweeded control. There was a negative linear relationship between maize grain yield and total Johnsongrass biomass at both planting patterns in both years (Fig. 4). At 3 WAT, the interaction between year-planting pattern-nicosulfuron doses was significant Johnsongrass shoot biomass. Johnsongrass shoot biomass was highest in the unweeded plots and similar at all doses of nicosulfuron applied at SR pattern in both years and DR pattern in 2005 (Fig. 5a). At DR pattern in 2006, 35-105 g a.i. ha$^{-1}$ of nicosulfuron gave higher Johnsongrass shoot biomass than a dose of 210 g a.i. ha$^{-1}$. The weeded control had the lowest Johnsongrass shoot biomass and this was similar to that in plots treated with nicosulfuron at doses of 35-210 g a.i. ha$^{-1}$ at SR pattern in 2005.

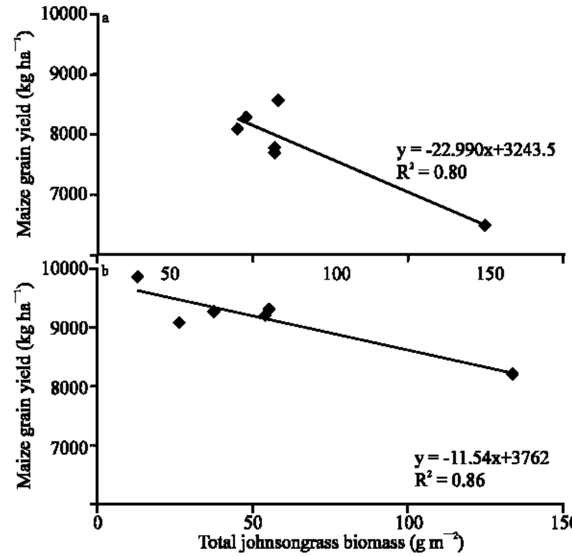


Fig. 4: Relationship between maize grain yield and total johnsongrass biomass combined at crop harvest at (a) single row planting pattern and (b) double row planting pattern in 2005 and 2006

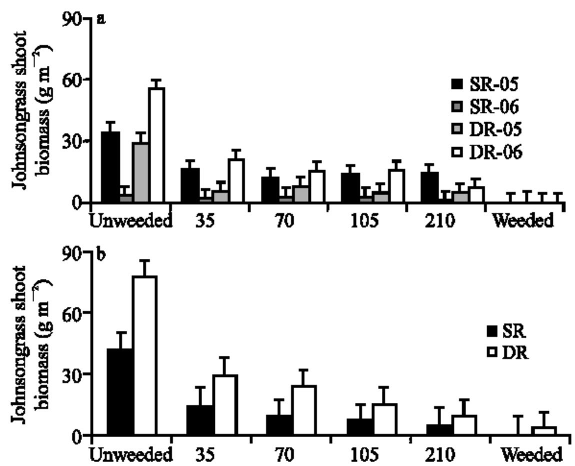


Fig. 5: Effect of nicosulfuron on johnsongrass shoots biomass (a) 3 WAT and (b) at crop harvest single row planting pattern (SR) and double row planting pattern (DR) in 2005 and 2006

At crop harvest, there was a significant interaction between planting pattern and nicosulfuron doses "but not year. At both planting patterns, weed shoot biomass decreased with increase in nicosulfuron dose, while the unweeded control had the highest (Fig. 5b). Johnsongrass shoot biomass was lowest in the weeded control and this was similar to that at doses of 70-210 g a.i. ha$^{-1}$ at SR pattern and 210 g a.i. ha$^{-1}$ at DR pattern. Weed shoot biomass was higher at crop harvest than at

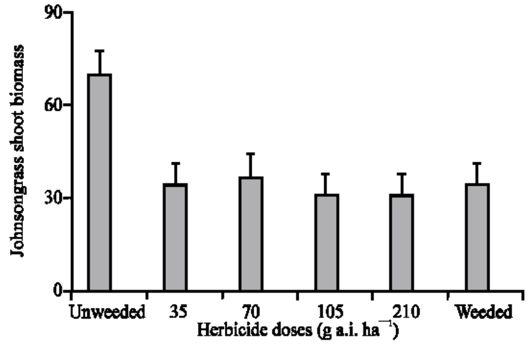


Fig. 6: Effect of nicosulfuron on johnsongrass rhizome biomass at crop Harvest at single row planting pattern (SR) and double row planting pattern (DR) in 2005 and 2006

3WAT, but the increase was lower in plots with nicosulfuron than in the unweeded control. The rhizome biomass varied significantly among the doses of nicosulfuron applied in both planting patterns and years (Fig. 6), but all interactions were not significant. The weeded control and all plots that received nicosulfuron had similar Johnsongrass rhizome biomass, which was significantly lower than that in the unweeded control plots.

## DISCUSSION

The results of this study showed that the grain yield and biomass of maize were lowest in the unweeded control at both planting patterns in both years. This might be due to weed interference, which may have caused strong competition between the maize and Johnsongrass for growth factors, because these plots had the highest Johnsongrass biomass.

This observation is supported by the regression analysis, which showed that total Johnsongrass biomass accounted for 80-86% of the reduction in maize grain yield. It also showed that Johnsongrass biomass should be reduced to levels below 50 g m$^{-2}$ to prevent significant maize yield loss. Johnsongrass competition from emergence to 5WAP maize is adequate to affect maize (expressed low biomass) and thus lower grain yield at crop harvest. Thus an increase in the biomass of Johnsongrass leads to a decrease in maize grain yield. Maize grain yield obtained from plots treated at 70-210 g a.i. ha$^{-1}$ was similar to that in the weeded control because there was good Johnsongrass control at these doses. This is confirmed by the low Johnsongrass biomass in these treatments.

These results confirm that nicosulfuron controls perennial grasses including Johnsongrass as earlier reported by researchers (Bruce and Kells, 1997; Rabaey and Harvey, 1997). The 210 g a.i. ha$^{-1}$ dose did not reduce grain yield, suggesting that the crop recovered from initial injury, which was earlier (3 WAT) expressed a slow biomass. These results agree with O'sullivan *et al.* (1995) who reported that, despite early season crop injury, nicosulfuron did not reduce maize yield. The different climatic conditions during the 2 years could also be responsible for the differences in yield across years and planting patterns.

In general, rainfall at both planting patterns was higher and more evenly distributed in 2006, a year when higher maize yields were recorded. Totally at DR planting patterns johnsongrass biomass in both years and at all doses was less than that of SR planting pattern. As reported in previous studies (Flenet *et al.*, 1996; Teasdale, 1998 and 1995) row interval reduction result in earlier canopy closure and therefore critical period of weed control decreased (Bedmar *et al.*, 1999). Reduction in weed control observed for the 2 year at SR planting pattern, compare with DR was attributed primarily to injury which maize suffered from cultivation and free wide space between rows at the early growing season, subsequently weeds could compete with maize more strongly

This study reveals that nicosulfuron is a suitable herbicide for the postemergence control of Johnsongrass in maize. Application doses of 70-210 g a.i. ha$^{-1}$ gave maize grain yields that were similar to that obtained from the hoe weeded control. Therefore, nicosulfuron was effective in controlling Johnsongrass to levels that prevented maize yield losses, similar to hoe weeding 4 times. Further work on the economics of Johnsongrass control using nicosulfuron is recommended before the herbicide is promoted for on-farm testing by farmers.

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