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Efficacy of azimsulfuron against complex weed flora in transplanted summer rice

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ABSTRACT

Efficacy of azimsulfuron was studied for controlling broad spectrum of weeds in transplanted summer rice. All the herbicidal treatments were significantly superior to weedy check. There was more than 48% reduction in the grain yield of rice due to competition with weeds in the weedy plots. Azimsulfuron at 30 g a.i. ha^{-1} was found effective in reducing the population of predominant sedges viz., Cyperus difformis and Fimbristylis miliacea and broad leaf weeds viz. Sphenochlea zeylanica and Marsilea quadrifolia. However, complete suppression of all the major weeds including late emergent grassy weed, Leptochloa chinensis, was recorded at the application rate of 35 g a.i. ha^{-1}. The highest grain yield (6.02 tonnes ha^{-1}) and N-use efficiency (60.0) were obtained in weed free check. Among the tested doses, azimsulfuron at 35 g a.i. ha^{-1} applied 18 days after transplanting was found to be the most effective (weed control efficiency 98.5%) in controlling the complex weed flora and produced comparable grain yield (5.95 tonnes ha^{-1}) with weed-free check, thereby realizing an increase of 91% yield over weedy check. The N-use efficiency (59.5) was also higher in azimsulfuron (at 35 g a.i. ha^{-1}) treated plots.

Key words: *weed flora, efficacy, azimsulfuron, transplanted rice, dry season*

Transplanted rice encounters with problem of complex weed flora in different regions of the country resulting 15-76% reduction in grain yield (Singh and Singh,. 2004). It was observed that the major weeds (about 60%) emerge during 7-30 days after transplanting and compete with rice plants up to maximum tillering stage (Saha and Rao, 2007). Timely weed control at early stage is imperative for realizing desired level of productivity from transplanted rice. The use of herbicides offers selective and economic control of weeds right from the beginning, giving crop an advantage of good start and competitive superiority (Saha, 2005). A number of pre-emergence herbicides like butachlor, pretilachlor, anilofos etc. have been recommended for the control of early flushes of grassy weeds in transplanted rice field (Budhar *et. al.,* 1991). However, these herbicides are specific and are effective against narrow range of weed species (Narayana *et. al.*, 1999). The intensive use of such herbicides year after year has resulted herbicide resistance problems and consequently, management of weeds is becoming increasingly more difficult and complex (Rao, 1999). Certain weeds emerging at later growth stages in the season escape the treatment of pre-emergence herbicides. These situations demand for some suitable post-emergence herbicide for controlling broad spectrum of weeds (Yadav *et. al.,* 2008). Moreover, continuous use of these herbicides leads to a shift of weed flora from grassy to non grassy broadleaf weeds and annual sedges (Rajkhowa *et. al.*, 2006). Herbicides like metsulfuron methyl, ehtoxysulfuron, almix and bensulfuron methyl are found effective for post-emergence control of broadleaf weeds and some sedge. Thus, it would be desirable to use alternative herbicides that may provide wide spectrum of weed control. Azimsulfuron is a recently introduced post-emergence sulfonylurea herbicide useful for controlling broad-spectrum of weeds in rice field (Valle *et. al.,* 2006). Its efficacy against sedges has been found excellent (Yadav *et. al*., 2007). Therefore, the present investigation was undertaken to study the efficacy for optimizing the dose of azimsulfuron for controlling broad spectrum of weeds including grassy weeds, sedges and non grassy broadleaf weeds in transplanted summer rice.

MATERIALS AND METHODS

A field experiment was carried out during the dry seasons of 2008 and 2009 at the Central Rice Research Institute, Cuttack in a alluvial (Haplaquept) clay loam soil with pH 6.7, organic carbon 0.82%, total nitrogen 0.093%, Olsen's P 16.2 kg/ha and available K 83 kg/ha to study the weed control spectrum and efficacy of azimsulfuron for controlling complex weed flora in transplanted rice field during dry season. The treatments consisted azimsulfuron 12.5, 17.5, 22.5, 27.5, 30.0 and 35.0 g a.i. ha^{-1} each with 0.2% surfactant applied at 18 days after transplanting (DAT) and recommended herbicide, pretilachlor 625 g a.i. ha^{-1} at 3 DAT along with weed-free and weedy check (Table 1). The total 9 treatments were evaluated in a randomized complete block design with four replications. All the herbicides were applied in saturated soil moisture as per the protocol of application time using knapsack sprayer fitted with flat fan nozzle at spray volume of 500 l ha^{-1} (Table 2).

Twenty-five days old seedlings of the test variety 'Naveen' (120 days duration) were transplanted at 15 cm x 15 cm row spacing on Jan 24, 2008 and Jan 25, 2009. Half of the recommended dose of N (40 kg ha^{-1}) and full dose of P_2O_5 and K_2O (40 kg ha^{-1}) were applied before transplanting at final land preparation and remaining N (40 kg ha^{-1}) was top-dressed in 2 equal splits, half at active tillering and the rest half at panicle initiation stage. All the other recommended agronomic and plant protection measures were adopted to raise the crop. Crop phytotoxicity was recorded at 12 and 22 days after spray (30 and 40 DAT, respectively) using 0-100 scale (where 0 = no mortality and 100 = complete mortality). As there was no crop phytotoxicity on rice, the data in these respects have not been included herein. The data on weed density (30 and 60 DAT) and dry weight of weeds (60 DAT) were recorded with the help of a quadrate (0.5 m x 0.5 m) at 2 places and then converted into per square meter. These were subjected to square root transformation to normalize their distribution. Weed control efficiency (%) was computed using the dry weight of weeds (Mani *et. al.,* 1973). Grain yield of rice along with other yield attributing characters like effective panicles m^{-2}, grains $panicle^{-1}$ etc. were recorded at harvest.

RESULTS AND DISCUSSION

The most predominant weed species found in weedy plots at 30 days after transplanting (DAT) were grassy weeds like *Echinochloa colona*, sedges like *Cyperus difformis* and broadleaf weeds like *Sphenochlea zeylanica* and *Marsilea quadrifolia*. The broadleaf weeds constituted 44% along with sedges (33%) and grassy weeds (23%) of the total weed population under weedy conditions (Table 1). But, with the advancement of crop growth, another important grassy weed i.e., *Leptochloa chinensis* and the sedge viz., *Fimbristylis miliacea* were recorded as predominant weeds along with *Echinochloa colona, Cyperus difformis, Sphenochlea zeylanica* and *Marsilea quadrifolia* at 60 DAT in weedy plots. During later stages of crop growth, grassy weeds became predominant and constituted 37% of the total weed population along with broadleaf weeds (35%) and sedges (28%) at 60 DAT under weedy conditions. From the distribution pattern of individual weed flora, it was observed that *Cyperus difformis* was the most prevalent weed species (33% of total weed population) followed by *Sphenochlea zeylanica* (25%) at early vegetative growth stage (30 DAT). But the dominance of *Leptochloa chinensis* (21%) was recorded at maximum tillering stage (60 DAT).

All the treatments registered significantly lower number of weeds and total weed dry matter accumulation than weedy check. The pooled analysis of two years data indicated that the density and dry weight of grassy weeds decreased with increase in application rate of azimsulfuron. All the doses of azimsulfuron within the range of 12.5-30.0 g a.i.ha^{-1} showed higher density of grassy weed viz., *Echinochloa colona* than pretilachlor at 625 g a.i./ha at 30 DAT. However, *Echinochloa colona* was effectively suppressed at the application rate of 35 g a.i. ha^{-1}. It was also found that azimsulfuron was more effective at 35 g a.i. ha^{-1} for suppressing the late emergent grassy weed, *Leptochloa chinensis* than pretilachlor The tested herbicide, azimsulfuron provided excellent control of predominant sedges viz. *Cyperus difformis* and *Fimbristylis miliacea* and broadleaf weeds viz. *Sphenochlea zeylanica* and *Marsilea quadrifolia* at low application rate of 27.5 g a.i. ha^{-1} and it was better than recommended herbicide, pretilachlor with respect to weed density. Complete

Table 1. Effect of treatments on distribution patterns of different weed flora at vegetative growth stages of rice

Treatment	Weed density (No./m2)											
	30 DAT					60 DAT						
	Echinochloa colona	*Cyperus difformis*	*Sphenochlea zeylanica*	*Marsilea quadrifolia*	Total	*Echinichloa colona*	*Leptochloa chinensis*	*Cyperus difformis*	*Fimbristylis milicea*	*Sphenochlea zeylanica*	*Marsilea quadrifolia*	Total
Azimsulfuron @12.5 g a.i. ha^{-1}	10(3.18)	13(3.61)	9(3.02)	7(2.72)	39(6.25)	11(3.33)	13(3.62)	8(2.87)	10(3.19)	15(3.88)	9(3.02)	60(7.77)
Azimsulfuron @17.5 g a.i. ha^{-1}	10(3.16)	8(2.87)	7(2.65)	6(2.56)	31(5.57)	9(3.02)	12(3.48)	5(2.27)	8(2.88)	14(3.76)	6(2.58)	54(7.36)
Azimsulfuron @22.5 g a.i. ha^{-1}	8(2.86)	2(1.44)	6(2.57)	3(1.76)	19(4.38)	8(2.86)	10(3.25)	3(1.78)	6(2.58)	10(3.16)	6(2.57)	43(6.57)
Azimsulfuron @27.5 g a.i./ha	7(2.71)	-	2(1.41)	-	9(3.01)	6(2.58)	9(3.01)	-	1(1.01)	2(1.43)	-	18(4.26)
Azimsulfuron @30.0 g a.i./ha	5((2.26)	-	-	-	5(2.25)	3(1.76)	6(2.57)	-	-	-	-	9(3.02)
Azimsulfuron at 35.0 g a.i./ha	2(1.42)	-	-	-	2(1.42)	1(1.01)	2(1.42)	-	-	-	-	3(1.73)
Pretilachlor at 625 g a.i./ha	3(1.77)	2(1.43)	5(2.24)	4(2.01)	14(3.76)	4(2.02)	9(3.01)	4(2.02)	5(2.27)	9(3.01)	10(3.25)	41(6.41)
Weed-free	-	-	-	-	-	-	-	-	-	-		
Weedy	12(3.48)	17(4.12)	13(3.63)	10(3.24)	52(7.22)	16(4.02)	20(4.02)	14(3.75)	13(3.64)	18(4.25)	16(4.25)	97(9.86)

suppression of all the predominant sedges and broadleaf weeds was recorded at the application rate of 30 g a.i. ha^{-1} (Table 1).

It was found that azimsulfuron at relatively lower doses i.e., 12.5 and 17.5 g a.i. ha^{-1} was not so effective in controlling predominant weeds in rice field. So far the individual predominant weed species concerned, there was complete control of *Cyperus difformis* and *Marsilea quadrifolia* at 27.5 g a.i. ha^{-1}. Remarkable reduction in the density of the other predominant sedge viz., *Fimbristylis miliacea* and broad leaf weed viz., *Sphenochlea zeylanica* was also recorded with this application rate of 27.5 g a.i. ha^{-1} except the grassy weeds viz., *Echinochloa colona* and *Leptochloa chinensis*. However, azimsulfuron at 30 g a.i. ha^{-1} was found significantly superior in reducing the population of all the predominant weeds including the grassy weeds and almost complete suppression of all the major weeds was recorded at the application rate of 35 g a.i. ha^{-1}. The traditional recommended herbicide viz., pretilachlor at 625 g a.i. ha^{-1} suppressed the grassy weed *Echinochloa colona* and sedge viz., *Cyperus difformis* and *Fimbristylis miliacea* effectively but could not control the predominant broadleaf weeds viz., *Sphenochlea zeylanica* and *Marsilea quadrifolia* and the late emergent grassy weed viz., *Leptochloa chinensis*.

All weed control measures registered a significant reduction in weed dry matter accumulation (at 60 DAT) compared to weedy check. Sharp decrease in dry weight of weeds was recorded with the increase in dose of azimsulfuron. The weed dry weight was significantly lower (7.5 g m^{-2}) in plots treated with azimsulfuron at 27.5 g a.i. ha^{-1} over recommended herbicide, pretilachlor (14.2 g m^{-2}). Drastic reduction in dry weight of weeds was recorded in azimsulfuron at 30 and 35 g a.i./ha due to better control of weeds with these doses. The effects of various treatments on total dry mater production were similar to that of weed density (Table 2).

Among the tested doses, azimsulfuron at 27.5 g a.i.ha^{-1} showed very good suppression of predominant sedges and broadleaf weeds with weed control efficiency (WCE) of 90.6% (Table 2). Yadav *et. al.* (2007) have also recorded better efficacy of azimsulfuron against sedges in rice. However, the grassy weeds could not suppress fully at this application

Table 2. Effect of weed-control treatments on weed dry matter production, weed-control efficiency, panicle numbers, grains/ panicle and grain yield, N uptake and N-use efficiency of transplanted rice (pooled data of 2 years)

Treatments	Weed dry wt. (g m^{-2}) at 60 DAT	Weed control efficiency (%)	Panicles (no. m^{-2})	No. of grains $panicle^{-1}$	Grain Yield (t ha^{-1})	N uptake (kg. ha^{-1})		N–use efficiency (kg grain/ kg N applied)
						Crop	Weeds	
Azimsulfuron at 12.5 g a.i. ha^{-1}	31.2	60.7	233	69	4.21	59.7	14.4	42.10
Azimsulfuron at 17.5 g a.i. ha^{-1}	22.3	71.9	240	74	4.38	61.8	12.7	43.80
Azimsulfuron at 22.5 g a.i./ha	15.1	81.0	256	80	4.67	65.5	10.3	46.70
Azimsulfuron at 27.5 g a.i./ha	7.5	90.6	270	87	5.58	77.1	7.2	55.80
Azimsulfuron at 30.0 g a.i./ha	2.6	96.7	281	91	5.76	83.2	3.1	57.60
Azimsulfuron at 35.0 g a.i./ha	1.2	98.5	294	94	5.95	87.6	2.7	59.50
Pretilachlor at 625 g a.i./ha	14.2	82.6	261	82	4.77	69.4	6.8	47.70
Weed-free	0	100	302	99	6.02	90.4	0	60.02
Weedy	79.4	-	167	62	3.11	48.0	34.8	31.10
CD(P=0.05)	6.6	-	19.4	8.7	0.29	5.7	2.6	-

rate. The percent control of grassy weeds increased with the corresponding increase in dose of azimsulfuron. Excellent suppression of grassy weeds along with complete control of sedges and broad leaf weeds was recorded in the plots treated with azimsulfuron at 35 g a.i. ha^{-1} with WCE of 98.5%. The weed suppression was as good as weed free check at the application rate of 35 g a.i.ha^{-1}. The tested herbicide, azimsulfuron was found to be superior for arresting the total weed density and dry matter production at 27.5 g a.i.ha^{-1} (WCE 90.6%) in comparison to the traditional recommended rice herbicide, pretilachlor (WCE 82.6%). It was due to predominance of grassy weed, *Leptochloa chinensis* along with broadleaf weeds in rice fields at later stages during both the years. Similar observation was also recorded by Singh *et. al.*(2007) and Saha and Rao (2010).

In general there was an increase in the number of panicles m^{-2} and grains $panicle^{-1}$ with corresponding increase in dose of azimsulfuron. However, azimsulfuron at the application rate 12.5-17.5 g a.i. ha^{-1} provided less number of panicles m^{-2} and grains $panicle^{-1}$ than the recommended herbicide, pretilachlor (625 g a.i. ha^{-1}) while it was at par with azimsulfuron at the application range of 22.5-27.5 g a.i. ha^{-1}. Significantly higher no. of panicles m^{-2} and grains $panicle^{-1}$ were recorded at the application rate of 30.0-35.0 g a.i. ha^{-1} of azimsulfuron over pretilachlor. Yadav *et. al.*(2008) also recorded similar results showing the effectiveness of azimsulfuron for improving the yield attributing characters of rice with respect to the recommended herbicide, pretilachlor. Azimsulfuron at 35 g a.i. ha^{-1} was found at par with weed free check in respect of panicles m^{-2} and no. of grains $panicle^{-1}$.

All the weed control treatments significantly outnumbered and out-weighed the weedy check in respect to grain yield of rice. The weed control measures also reduced the weed biomass substantially, which in turn caused better N uptake by crop and might have helped in realizing higher grain yield of rice. Jacob and Syriac (2005) and Saha and Rao (2009) also reported similar findings. Among the weed control measures, the highest grain yield (6.02 t/ha) was obtained in weed free check owing to manual removal of associated weed flora and keeping the plots weed free. Better control of weeds facilitated the crop for better absorption of nutrients in weed free plots, as evident from nitrogen uptake (89.2 kg ha^{-1}) by crops resulted higher yield in comparison to other treatments (Table 2). On an average, there was more than 48% reduction in the grain yield of rice due to competition with weeds in weedy plots (Table 2). Among the tested doses of azimsulfuron, significantly higher grain yield (5.95 t ha^{-1}) was recorded with the application rate of 35 g a.i. ha^{-1} and it was at par with weed free check, thereby realizing an increase of 91% yield over weedy check. This might be due to complete control of sedges and broad leaf weeds as well as better suppression of

grassy weeds which were prevalent in the rice field during both the years. However, the differences in grain yields due to application of azimsulfun at 30 and 35 g a.i. ha^{-1} were comparable showing its effectiveness for controlling weeds even at lower dose of 30 g a.i. ha^{-1} except few grassy weeds specially *Leptochloa chinensis* in transplanted rice field during dry season. The traditional recommended herbicides, pretilachlor (at 625 g a.i. ha^{-1}) yielded significantly less (4.77 t ha^{-1}) than azimsulfuron at lower dose of 27.5 g a.i. ha^{-1}. The poor yield with pretilachlor was mainly due to poor control of predominant sedges, broad leaf weeds along with the late emergent grassy weed, *Leptochloa chinensis*. There was no phytotoxic effect of any herbicides at any of the applied doses in transplanted rice crop.

The crop yield and weed control efficiency was positively correlated with correlation coefficient of 0.856 (Fig 1). This was further supported by the regression analysis (Equation 1). Thus, unit increase in weed control efficiency causes increase in rice grain yield by 28.8 kg ha^{-1}. The increase in rice grain yield by increasing weed control efficiency was also reported by Singh and Singh (2006), Singh *et. al.* (2007) and Saha and Rao (2010).

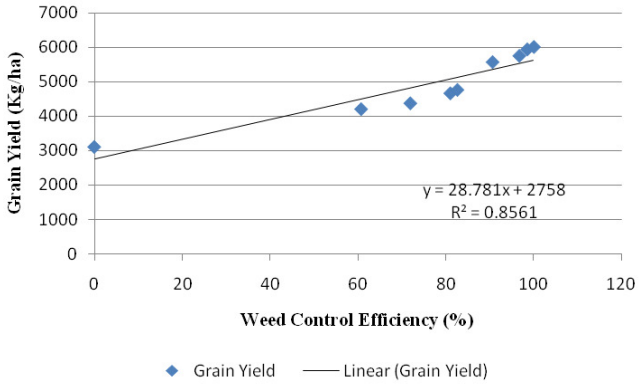

Fig. 1. Regression between grain yield and weed control efficiency

$$Y = 2758 + 28.8X \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The highest N-use efficiency i.e., the efficiency of N-utilization by rice (kg grain/ kg N applied) was recorded in weed free plots (60.0). Among the tested herbicides, the highest value of N-use efficiency (59.5) was obtained in azimsulfuron (35 g a.i. ha^{-1}). It was lowest (31.1) in weedy plots. The N-uptake by rice crop was also shown the similar trend. The highest N-uptake by rice was recorded in weed free plots (90.4 kg ha^{-1}). But, the trend was reversed in case of weeds and the highest N-uptake (34.8 kg ha^{-1}) by weeds was recorded in weedy plots. Therefore, effective weed control measures reduced the weed biomass which in turn might have reduced weed competition thereby resulting higher N-uptake by rice crops. Similar results were also reported by Amarjit *et. al.* (2006).

Based on the present investigation it might be concluded that the application of azimsulfuron 35 g a.i. ha^{-1} at 18 DAT proved to be superior for controlling complex weed flora in transplanted summer rice. However, it showed complete suppression of sedges and broad leaf weeds at low dose of 30 g a.i. ha^{-1}. Its efficacy was excellent at 27.5 g a.i. ha^{-1} against sedges particularly *Cyperus difformis* which was one of the most prevalent weeds in transplanted rice field during dry season. The tested herbicide, azimsulfuron was found effective in controlling sedges and broad leaf weeds even at lower rates (27.5-30.0 g a.i. ha^{-1}), while higher concentration (30.0-35.0 g a.i. ha^{-1}) was needed when there was complex weed flora in rice field including grassy weeds particularly *Leptochloa chinensis* which was recently found to be one of the dominant weeds in rice-rice cropping sequence. Thus these two doses of azimsulfuron (30.0 and 35.0 g a.i. ha^{-1}) may be recommended based on prevalence of weed flora in transplanted rice field during dry season.

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