Indian Journal of Agricultural Sciences 86 (2): 186–91, February 2016/Article
https://doi.org/10.56093/ijas.v86i2.55940

# Efficacy of azimsulfuron against complex weed flora in transplanted rice (*Oryza sativa*) under rainfed shallow lowland

SANJOY SAHA[1], SUSHMITA MUNDA[2] and TOTAN ADAK[3]

*ICAR-National Rice Research Institute, Cuttack, Odisha 753 006*

Recevied: 26 July 2014; Accepted: 12 October 2015

ABSTRACT

A field experiment was conducted during the wet seasons of 2010 and 2011 at ICAR-National Rice Research Institute, Cuttack to study the efficacy of azimsulfuron for controlling broad spectrum of weeds in transplanted rice (*Oryza sativa* L.) field under rainfed shallow lowland. The present study consisted of 10 treatments which includes seven doses of azimsulfuron, viz. 12.5, 17.5, 22.5, 27.5, 30.0, 35.0 and 40 g/ha each with 0.2% surfactant along with recommended herbicide, pretilachlor at 625 g/ ha, weed-free and weedy as check. Yield attributes of rice were significantly ($P<0.05$) affected by weed control treatments. The highest grain yield (5.72 tonnes/ha) and N-use efficiency (57.2) were obtained in weed free check, realizing 76% increase in grain yield of rice over weedy check. Azimsulfuron at 35 and 40 g/ha applied 18 days after transplanting was found to be very effective (weed control efficiency 92.8 and 95.5%, respectively) in controlling the complex weed flora and produced comparable grain yield with weed-free check. There was more than 45% reduction in the grain yield of rice due to competition with weeds in weedy plots. The negative effect of weed competition in weedy check plot was reflected in significant reduction in crop growth rate (4.66 g/m$^2$/day) and total biomass of rice (6.89 tonnes/ha).

**Key words:** Azimsulfuron, Crop growth rate, Grain yield, Transplanted rice, Weed control efficiency, Weed flora

Rice (*Oryza sativa* L.), the leading cereal crop, is grown in 114 countries across the world, constituting nearly 11% of the world's cultivated land. Transplanting has been a major traditional method of rice establishment in Asia under rainfed environment (Pandey and Velasco 2002). Depending upon the climatic, edaphic and biotic factors including weed seed bank in soil, a mixed population of weed flora (grassy weeds, sedges, broad-leaved and aquatic weeds) gets colonized in rainfed transplanted rice fields resulting 15-76% reduction in grain yield (Nantasomsaran and Moody 1995). The major weeds (about 60%) under such environment emerge during the first 7-30 days of transplanting and compete with rice plants up to maximum tillering stage. 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. A number of pre-emergence herbicides were recommended for the control of early flushes of weeds in transplanted rice field. However, these herbicides are specific and are effective against narrow range of weed species. Certain weeds emerging at later growth stages escape the treatment of pre-emergence herbicides and lead to a shift of weed flora from grassy to non grassy broad-leaved weeds and annual sedges (Rajkhowa *et al.* 2006). Azimsulfuron is a recently introduced post-emergent sulfonylurea herbicide useful for controlling broad-spectrum of weeds in rice field. Its efficacy against rice weeds has been found excellent (Saha and Rao 2012). Therefore, the present investigation was undertaken to study the efficacy of azimsulfuron for optimizing its application rate against broad-spectrum of weeds including grassy weeds, sedges and broad-leaved weeds in transplanted rice field during wet season under rainfed shallow lowland.

## MATERIALS AND METHODS

The experiment was conducted at ICAR-National Rice Research Institute, Cuttack (20.5° N, 86° E and 23.5 m above mean sea-level) during two consecutive wet seasons of 2010 and 2011 to study the weed spectrum and efficacy of azimsulfuron for controlling complex weed flora in transplanted rice field under rainfed shallow lowland. The soil of the experimental field was alluvial (Haplaquept), clay loam in texture, slightly acidic to neutral in reaction with pH 6.5, average EC 0.56 dS/m, organic carbon 0.87%, available nitrogen 318 kg/ha, available P 15.4 kg/ha and available K 118 kg/ha. The weed control treatments consisted of azimsulfuron at seven doses of 12.5, 17.5, 22.5, 27.5, 30.0, 35.0 and 40 g/ha each with 0.2% surfactant

[1]Principal Scientist (Agronomy) (e mail: ssahacrri@gmail.com), Crop Production Division, [2]e mail: sustot@gmail.com, [3]e mail: totanadak@gmail.com

Table 1 Effect of treatments on distribution patterns of different weed flora at vegetative growth stages of rice (pooled data of 2 years)

| Treatment | Weed density (No. $m^{-2}$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAT | | | | | 60 DAT | | | | | | |
| | *Echinochloa crus-galli* | *Cyperus iria* | *Sphenoclea zeylanica* | *Marsilea quadrifolia* | Total | *Echinichloa crus-galli* | *Leptochloa chinensis* | *Cyperus iria* | *Fimbristylis milicea* | *Sphenoclea- zeylanica* | *Monochoria vaginalis* | Total |
| AZM 12.5** | 10(3.17)* | 13(3.71) | 7(2.67) | 9(3.01) | 39(6.26) | 7(2.69) | 10(3.19) | 7(2.67) | 6(2.47) | 7(2.71) | 8(2.87) | 45(6.73) |
| AZM 17.5 | 10(3.16) | 10(3.18) | 7(2.69) | 7(2.69) | 34(5.87) | 7(2.71) | 10(3.17) | 7(2.69) | 6(2.49) | 7(2.67) | 6(2.43) | 43 (6.59) |
| AZM 22.5 | 8(2.84) | 5(2.27) | 6(2.48) | 3(1.73) | 22(4.71) | 5(2.33) | 8(2.87) | 3(1.77) | 6(2.47) | 4(2.07) | 6(2.49) | 32(5.71) |
| AZM 27.5 | 6(2.47) | 2(1.44) | 3(1.74) | 1(1.22) | 12(3.47) | 4(2.02) | 6(2.47) | 0(0.71) | 2(1.47) | 2(1.56) | 4(2.07) | 18(4.29) |
| AZM 30 | 3(1.76) | 0(0.71) | 0(0.71) | 0(0.71) | 3(1.74) | 2(1.47) | 3(1.77) | 0(0.71) | 0(0.71) | 1(1.18) | 3(1.74) | 9(3.07) |
| AZM 35 | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 1(1.18) | 2(1.43) | 0(0.71) | 0(0.71) | 0(0.71) | 1(1.17) | 4(2.07) |
| AZM 40 | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 1(1.15) | 0(0.71) | 0(0.71) | 0(0.71) | 1(1.17) | 2(1.43) |
| PRET 625 | 4(2.01) | 6(2.46) | 6(2.47) | 4(2.01) | 20(4.51) | 4(2.07) | 7(2.68) | 4(2.03) | 5(2.29) | 3(1.74) | 5(2.27) | 28(5.31) |
| Weed-free | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) | 0(0.71) |
| Weedy | 13(3.67) | 17(4.14) | 9(3.01) | 7(2.71) | 46(6.81) | 17(4.17) | 19(4.37) | 12(3.51) | 14(3.77) | 13(3.63) | 10(3.21) | 85(9.23) |
| LSD (P=0.05) | 0.32 | 0.41 | 0.22 | 0.15 | 0.45 | 0.37 | 0.47 | 0.30 | 0.44 | 0.33 | 0.24 | 0.61 |

*Values in parentheses are square root transformed, **AZM 12.5- Azimsulfuron at 12.5 g/ha; AZM 17.5- Azimsulfuron at 17.5 g/ha; AZM 22.5- Azimsulfuron at 22.5 g/ha; AZM 27.5- Azimsulfuron at 27.5 g/ha; AZM 30- Azimsulfuron at 30 g/ha; AZM 35- Azimsulfuron at 35 g/ha; AZM 40- Azimsulfuron at 40 g/ha; PRET 625- Pretilachlor at 625 g/ha.

applied at 18 days after transplanting (DAT) with recommended herbicide, pretilachlor at 625 g/ha applied at 3 DAT, weed-free and weedy check (Table 1). The total 10 treatments were evaluated in a randomized complete block design with four replications. All the herbicides were applied at saturated soil moisture as per the protocol using knapsack sprayer fitted with flat fan nozzle at spray volume of 350 l/ha. Pre-germinated seeds of the test variety Moti (150 days duration) were sown in well prepared seedbed to produce uniform seedlings and 25 days old seedlings were transplanted on 9 July, 2010 and 10 July, 2011 with 2-3 seedlings/hill at a spacing of 20 cm × 15 cm. Full dose of $P_2O_5$ and $K_2O$ (50 kg/ha) were manually broadcasted and incorporated before transplanting at final land preparation. The N fertilizer (100 kg/ha) was applied in four equal splits escaping basal application. The first dose of N fertilizer was applied at early vegetative stage (15 DAT) and the rest at active tillering, panicle initiation and flowering stage. All the other recommended agronomic and plant protection measures were followed 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 were not included in the results. The data on weed density (30 and 60 DAT) were recorded with the help of a quadrate (0.5 m × 0.5 m) in each plot and then converted into per square meter. These were subjected to square root transformation to normalize their distribution. Dry weight of weeds was recorded at 60 DAT after oven-drying at 70°C to constant weight. Weed control efficiency (%) was computed using the dry weight of weeds. Grain yield of rice along with other yield components were recorded at harvest. Panicle number was counted in each hill to determine number of panicles/$m^2$. Filled grains were counted to determine number of grains/panicle. Grain yield was determined from an area of 20 $m^2$ in each plot. Straw dry weight was determined after oven-drying at 70°C to

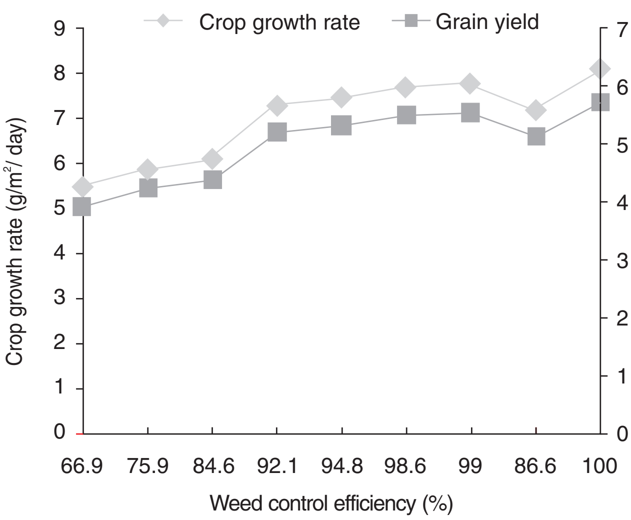


Fig 1 Effect of weed control efficiency on crop growth rate and grain yield

constant weight. Crop growth rate was computed by dividing aboveground total dry weight with growth duration in days. The plant and weed samples collected for dry matter estimation were oven dried at 65°C for 48 hr and were analyzed to determine N content. The N concentration was estimated by micro-kjeldahl method and expressed as %. The total N uptake (kg/ha) was calculated by multiplying dry weight of grain, straw and weed sample (kg/ha) with N concentration (%) and N use efficiency was calculated dividing grain yield by total N applied (kg grain/kg N applied). Data were analyzed following analysis of variance (SAS Software packages, SAS EG 4.3) and means of treatments were compared based on the least significant difference test (LSD) as the 0.05 probability level. Correlation coefficients among traits were determined using SAS EG 4.3.

## RESULTS AND DISCUSSION

*Weed composition, dry weight and weed control efficiency*

The dominant weed species in weedy plots at 30 DAT were the grassy weed, viz. *Echinochloa crus-galli* (L.), sedge, viz. *Cyperus iria* L. and broad-leaved weeds, viz. *Sphenoclea zeylanica* Gaertn. and *Marsilea quadrifolia* L.. The sedges constituted the highest population (37%) followed by broad-leaved (35%) and grassy weeds (28%) (Table 1). However, with the advancement of cropping season, grassy weed, i.e. *Leptochloa chinensis* (L.) Nees, sedge, viz. *Fimbristylis miliacea* (L.) Vahl. and the broad-leaved weed, viz. *Monochoria vaginalis* (Burm. F.) C. Presl ex Kunth were recorded as predominant weeds in weedy plots along with *Echinochloa crus-galli, Cyperus iria* and *Sphenoclea zeylanica* at 60 DAT. At this stage, the grassy weeds were predominant and constituted 41% of the total weed population followed by sedges (31%) and broad-leaved weeds (28%). The distribution pattern of individual weed flora indicated that *Cyperus iria* was the most prevalent weed species at 30 DAT, occupying 37% of total weed population followed by *Echinochloa crus-galli* (33%). But the dominance of *Leptochloa chinensis* (23%) was recorded at 60 DAT (Fig 2).

All the treatments registered significantly lower number of weeds than weedy check. The test herbicide, azimsulfuron at relatively lower doses from 12.5 to 22.5 g/ha was not found effective in controlling dominant weed species in rice field. The pooled analysis of two years data indicated that the density of grassy weeds decreased with increase in application rate of azimsulfuron. The predominant grassy weeds, *Echinochloa crus-galli* and *Leptochloa chinensis* were effectively suppressed by azimsulfuron at 35 g/ha. However, it showed excellent control of dominant sedges, viz. *Cyperus iria* and *Fimbristylis miliacea* and broad-leaved weeds, viz. *Sphenoclea zeylanica* and *Marsilea quadrifolia* at relatively lower application rate of 27.5 g/ha (Table 1). The recommended herbicide, viz. pretilachlor applied at 625 g/ha suppressed the grassy weed *Echinochloa crus-galli* partially but could not control the predominant sedges and

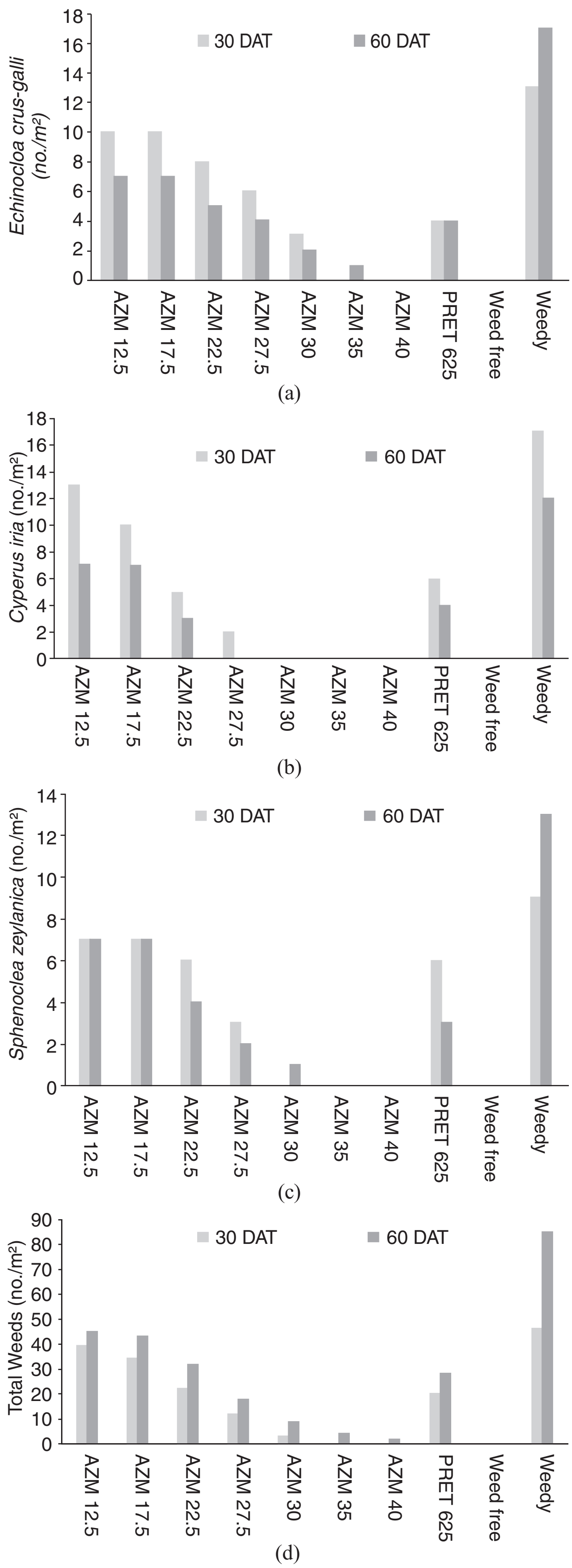


Fig 2 Dose response of azimsulfuron against complex weed flora in transplanted rice: (a) *Echinochloa crus-galli*, (b) *Cyperus iria*, (c) *Sphenoclea zeylanica*, (d) Total weeds

Table 2 Effect of weed-control treatments on weed dry matter production, weed-control efficiency, N—uptake and N—use efficiency of transplanted rice (pooled data of 2 years)

| Treat-ment | Weed dry matter (g m$^{-2}$) at 60 DAT | Weed control efficiency (%) | N—uptake (kg/ha) | | N—use efficiency (kg grain per kg N applied) |
|---|---|---|---|---|---|
| | | | Crop | Weeds | |
| AZM 12.5 | 28.6 | 66.9 | 54.3 | 18.3 | 39.10 |
| AZM 17.5 | 21.1 | 75.6 | 56.7 | 15.7 | 42.30 |
| AZM 22.5 | 13.3 | 84.6 | 61.1 | 13.6 | 43.80 |
| AZM 27.5 | 6.8 | 92.1 | 70.7 | 10.1 | 52.10 |
| AZM 30 | 4.5 | 94.8 | 74.2 | 5.6 | 53.20 |
| AZM 35 | 1.2 | 98.6 | 80.3 | 3.8 | 54.90 |
| AZM 40 | 0.9 | 99.0 | 83.8 | 2.9 | 55.40 |
| PRET 625 | 11.8 | 86.6 | 64.7 | 14.8 | 51.20 |
| Weed-free | 0.0 | 100 | 89.6 | 0 | 57.20 |
| Weedy | 86.3 | | 47.5 | 31.3 | 31.20 |
| LSD (P=0.05) | 4.71 | | 5.67 | 2.74 | |

broad-leaved weeds, viz. *Cyperus iria, Fimbristylis miliacea, Sphenoclea zeylanica* and *Marsilea quadrifolia* as well as the late emergent grassy and broad-leaved weeds, viz. *Leptochloa chinensis* and *Monochoria vaginalis*, respectively. Irrespective of different application rate of azimsulfuron, the density of three major weeds, viz. *Echinochloa crus-galli, Cyperus iria* and *Sphenoclea zeylanica* was reduced at 60 DAT in comparison to 30 DAT (Fig 2).

All weed control treatments registered a significant reduction in total dry weight of weeds at 60 DAT compared to weedy check. The effects of various treatments on total weed dry matter production were similar to that of weed density. Sharp decrease in dry weight of weeds was recorded with the increase in application rate of azimsulfuron. There was significant reduction in weed dry weight (13.8 g/m$^2$) in plots treated with azimsulfuron at 27.5 g/ha in comparison to recommended herbicide, pretilachlor (18.8 g/ m$^2$) thus indicated higher efficacy of azimsulfuron even at lower dose with respect to pretilachlor. Yadav *et al.* (2007) have also recorded better efficacy of azimsulfuron against rice weeds. Though the highest value (95.5%) of weed control efficiency (WCE) was recorded in azimsulfuron at 40 g/ha, but excellent suppression of grassy weeds along with complete control of sedges and broad-leaved weeds were obtained in the plots treated with azimsulfuron at 35 g/ha (WCE of 92.8%) (Table 2). It was found that the weed dry weight was strongly and negatively correlated with grain yield of rice (Table 4). This indicated a strong detrimental effect of weed competition on yield performance of rice.

*Crop growth rate, yield components and yield of rice*

The highest CGR (8.08 g/m$^2$/d) was recorded in weed free check. The CGR showed an increasing trend with the increase in application rate of azimsulfuron and the highest

Table 3 Effect of weed-control treatments on yield attributes, crop growth rate and yield performance of transplanted rice (pooled data of 2 years)

| Treatments | Panicles (no/m$^2$) | No. of grains/ panicle | Crop growth rate (g/m$^2$/day) | Grain yield (t/ha) | Total biomass (t/ha) |
|---|---|---|---|---|---|
| AZM 12.5 | 215 | 69 | 5.48 | 3.91 | 8.11 |
| AZM 17.5 | 222 | 73 | 5.86 | 4.23 | 8.71 |
| AZM 22.5 | 225 | 77 | 6.11 | 4.38 | 9.05 |
| AZM 27.5 | 243 | 83 | 7.26 | 5.21 | 10.75 |
| AZM 30 | 249 | 87 | 7.44 | 5.32 | 11.01 |
| AZM 35 | 255 | 91 | 7.68 | 5.49 | 11.36 |
| AZM 40 | 264 | 93 | 7.77 | 5.54 | 11.50 |
| PRET 625 | 238 | 81 | 7.16 | 5.12 | 10.60 |
| Weed-free | 273 | 97 | 8.08 | 5.72 | 11.86 |
| Weedy | 176 | 63 | 4.66 | 3.12 | 6.89 |
| LSD (P=0.05) | 8.67 | 4.61 | 0.27 | 0.23 | 0.37 |

CGR of 7.77 g/m$^2$/d was recorded at 40 g/ha. But it was comparable with azimsulfuron at 35 g/ha that indicated that azimsulfuron at 35 and 40 were equally effective for suppressing the dominant weed species in rice field. All the other weed control treatments showed the similar trend as CGR. The correlation of weed dry matter with crop growth rate and rice biomass production was highly significant and negative, indicating a direct impact of weed competition on reduction in crop growth rate and total biomass of rice crop (Table 4).

The number of panicles/m$^2$ and grains/panicle showed an increasing trend with increase in application rate of azimsulfuron. There was significant increase in panicle numbers/m$^2$ and grains/panicle with azimsulfuron at lower dose of 30.0 g/ha while comparing with pretilachlor. This might be due to poor control of late emergent grassy weed, *Leptochloa chinensis* and also the broad-leaved weeds in rice fields at late vegetative stage (60 DAT) during both the years. Yadav *et al*. (2007) also recorded similar results showing the effectiveness of azimsulfuron for improving the yield components of rice with respect to the recommended herbicide, pretilachlor. It was observed that the number of panicles/m$^2$ and grains/panicle both were reduced by 36% each in weedy plots over weed free check. This was confirmed by highly significant and negative correlation between weed dry weight with number of panicles/m$^2$ and grains per panicle thus indicated the negative effects of weed growth on development of yield components in rice plants as emphasized in the past by various authors (Zhang 1996). Among the herbicide treated plots, good control of weeds in the treatments of azimsulfuron at 40 g/ha helped in producing more than 34% of panicles/m$^2$ and 32% of grains/panicle over weedy check. Similar observation was also recorded by Singh *et al.* (2007).

All the weed control treatments significantly outnumbered and out-weighed the weedy check in respect to grain yield of rice. The highest grain yield (5.72 tonnes/

Table 4 Pearson Correlation Coefficients among different growth parameters, weed control traits, N uptake with biomass, grain and straw yield of rice

| | Pearson Correlation Coefficients, N = 10Prob > \|r\| under H0: Rho=0 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PN* | G/P | CGR | BIO | GY | WDM | WCE | NUC | NUW | NUE |
| PN | 1.000 | 0.971** | 0.970** | 0.960** | 0.977** | -0.922** | 0.922** | 0.954** | -0.984** | 0.977** |
| G/P | | 1.000 | 0.977** | 0.981** | 0.969** | -0.829** | 0.828** | 0.992** | -0.963** | 0.968** |
| CGR | | | 1.000 | 0.997** | 0.997** | -0.864** | 0.864** | 0.955** | -0.941** | 0.997** |
| BIO | | | | 1.000 | 0.990** | -0.830** | 0.830** | 0.963** | -0.929** | 0.990** |
| GY | | | | | 1.000 | -0.897** | 0.897** | 0.940** | -0.949** | 1.00** |
| WDM | | | | | | 1.000 | -1.00** | -0.779** | 0.918** | -0.897** |
| WCE | | | | | | | 1.000 | 0.779** | -0.917** | 0.897** |
| NUC | | | | | | | | 1.000 | -0.950** | 0.940** |
| NUW | | | | | | | | | 1.000 | -0.949** |
| NUE | | | | | | | | | | 1.000 |

*PN = Panicles/ m$^2$; G/P = No. of grains/panicle; CGR= Crop growth rate; BIO = Biomass; GY= Grain yield; WDM = Weed dry matter; WCE = Weed control efficiency; NUC = Nitrogen uptake by crop; NUW= Nitrogen uptake by weeds; NUE = Nitrogen use efficiency.

ha) was obtained in weed free check owing to manual removal of associated weed flora and keeping the plots weed free. The weed free condition facilitated highest number of panicles/m$^2$ and grains/panicle through better absorption of nutrients, as evident from highest nitrogen uptake and N-use efficiency by crops in this treatment plot, which resulted highest grain yield production in comparison to other treatments. It was evident from the results that there was 45% reduction in rice yield due to weed competition in weedy plots over weed free check (Table 3). Among the tested doses of azimsulfuron, significantly higher grain yield (5.54 tonnes/ha) was recorded at application rate of 40 g/ha and it was at par with weed free check, realizing an increase of 78% yield over weedy check. This might be due to complete control of sedges and broad-leaved weeds as well as better suppression of grassy weeds which were prevalent in the rice field during both the years (APVMA 2006). However, the differences in grain yields due to application of azimsulfuron at 35 and 40 g/ha were comparable showing the effectiveness of the herbicide for controlling weeds even at low dose of 35 g/ha in transplanted rice field during wet season. Similar observation was also recorded by earlier field experiment on wet direct sown rice during dry season (Saha and Rao 2012). There was 7% yield reduction in pretilachlor (at 625 g/ha) treated plots over azimsulfuron at 35.0 g/ha. It shows higher efficacy of azimsulfuron at 35.0 g/ha than the existing recommended herbicide, pretilachlor. The less efficacy of pretilachlor for controlling dominant weed species was mainly due to poor control of predominant sedges, broad-leaved weeds along with the late emergent grassy weed, *Leptochloa chinensis* (Table 1).

*N-uptake and N-use efficiency*

The weed control treatments showed significant increase in N-uptake by rice crop. The highest N-uptake was recorded in weed free plots (89.6 kg/ha). The N-uptake by rice crop was increased from 54.3 to 83.8 kg/ha with the increase in application rate of azimsulfuron from 12.5 to 40 g/ha. The trend was reversed in case of weeds and the highest N-uptake (31.3 kg/ha) by weeds was recorded in weedy plots and it was least (2.9 kg/ha) in the plots treated with azimsulfuron at 40 g/ha. There was 47% reduction in N-uptake by rice plants in weedy plots over weed free check that resulted in poor crop growth rate and biomass production. Similar observation was also recorded by Wortwman *et al*. (2011). The N-use efficiency was also showed the similar trend as N-uptake. 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 (57.2) and it was least (31.2) in weedy check. Among the herbicide treated plots, the maximum N-use efficiency (55.6) was recorded with azimsulfuron at 40 g/ha (Table 3). It was found that the higher efficacy of azimsulfuron at 35 and 40 g/ha helped in increasing the N-uptake by more than 40% in rice plants over weedy check that helped in higher crop growth rate and grain yield in these two treatment plots over other weed control treatments (Fig 1). The significant and positive correlation between grain yield of rice with N-uptake by crop and N-use efficiency was also supported with the findings of Jacob and Elizabeth (2005).

*Correlation among different traits*

The results on correlation coefficient showed that the correlation of weed dry matter production with crop growth rate (-0.864), panicle number/m$^2$ (-0.922), number of grains/panicle (-0.829), total biomass (-0.830) and grain yield of rice (-0.897) was highly significant and negative (Table 4). While, the correlation of weed control efficiency with N-use efficiency (0.897) and N-uptake by crop (0.779) was highly significant and positive. The highly significant and positive correlation between weed control efficiency with crop growth rate and total biomass production of rice confirmed the suppression of weeds in herbicide treated plots. Similar results were also reported by Amarjit *et al.* (2006). The N-uptake by crop and N-use efficiency had significant and positive correlation with crop growth rate, panicle number/$m^2$, grains/panicle as well as both total biomass and grain yield of rice. Nitrogen uptake by weeds was strongly and negatively correlated with total biomass (-0.929) and grain yield of rice (-0.949). Results also indicated that nitrogen uptake by crop was significantly and negatively correlated with nitrogen uptake by weeds (-0.950) as well as with weed dry matter production (-0.779).

Based on the present investigation, it might be concluded that the efficacy of azimsulfuron was excellent at 27.5 g/ha against sedges particularly *Cyperus iria* which was one of the most prevalent weeds in transplanted rice field during wet season. However, it showed complete suppression of sedges and broad-leaved weeds at 30 g/ha. Azimsulfuron at application rate of 35 g/ha proved to be superior for controlling complex weed flora including grassy weeds, sedges, and non grassy broad-leaved and aquatic weeds in transplanted rice field during wet season. Thus, azimsulfuron at a concentration of 30.0 g/ha could be recommended for controlling sedges and broad-leaved weeds, while higher concentration (35.0 g/ha) was needed to suppress complex weed flora in rice field including late emergent grassy weeds, *Leptochloa chinensis* which was recently found to be one of the dominant weed species in rice-rice cropping sequence.

## REFERENCES

Amarjit S, Singh B M, Kachroo D, Sharma B C and Shivam D R. 2006. Efficacy of herbicides in transplanted, medium-duration rice under sub-tropical conditions of Jammu. *Indian Journal of Agronomy* **51**(3): 128—30.

APVMA, 2006. Evaluation of the new active Azimsulfuron. Australian Pesticides and Veterinary Medicines Authority, Canberra, Australia. http://www.apvma.gov.au/

Jacob D and Elizabeth S. 2005. Relative efficacy of different spacings and weed control methods in scented rice. *Oryza* **42**(2): 75—7.

Nantasomsaran R and Moody K. 1995. Weed management for rainfed lowland rice. (in) *Rainfed Lowland Rice: Agriculrtural Research for High Risk Environments,* pp. 157—66. International Rice Research Institute, Philippines.

Pandey S and Velasco L. 2002. Economics of direct seeding in Asia: patterns of adoption and research priorities. (in) Direct Seeding: Research Strategies and Opportunities, pp. 3—14 International Rice Research Institute, Philippines.

Rajkhowa D J, Borah N, Barua I C and Deka N C. 2006. Effect of pyrazosulfuron ethyl on weeds and productivity of transplanted rice during rainy season. *Indian Journal of Weed Science* **38** (1&2): 25—8.

Saha S and Rao K S. 2010. Efficacy of Metsulfuron methyl for controlling broadleaf weeds in transplanted rice (*Oryza sativa* L.) under rainfed shallow lowland. *Indian Journal of Agricultural Sciences* **80**(6): 522—6.

Saha S and Rao K S. 2012. Efficacy of Azimsulfuron against complex weed flora in transplanted summer rice. *Oryza* **49**(3): 184—9.

Singh P, Singh P, Singh R and Singh K N. 2007. Efficacy of new herbicides in transplanted rice under temperate conditions of Kashmir. *Indian Journal of Weed Science* **39**(3&4): 167—71.

Wortman S E, Davis A S, Schutte B J and Lindquist J L. 2011. Integrating management of soil nitrogen and weeds. *Weed Science* **59**: 162—70.

Yadav D B, Yadav A, Malik R and Gill G. 2007. Efficacy of PIH 2023, penoxsulam and azimsulfuron for post emergence weed control in wet direct seeded rice. (in) Proceedings of ISWS Biennial Conference on New and Emerging Issues in Weed Science, CCS HAU, Hisar, 2-3 November, p. 92.

Zhang Z P. 1996. Weed management in transplanted rice. (in) Weed Management in Rice, p 75—86 Auld, B and Kim KU (Eds.). FAO, Rome.