*Indian J. Weed Sci.* **40** (3 & 4) : 193-195 (2008) *Short Communication*

# Bio-efficacy of Sulfonylurea Herbicides in Transplanted Rice (*Oryza sativa* L.)

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The total rice area in the country has been stabilized around 43 million hectares. Therefore, the average productivity should reach 3.2 t/ha from the present level of 2.05 t/ha to meet the projected target of 140 million tonnes of rice by 2025 AD (Subbaiah, 2006). There are many reasons for its low productivity, out of that weed infestation has been recognized as major one. In transplanted rice, yield reduction has been reported to be 28 to 45% due to uncontrolled weeds (Singh *et al.,* 2003). There are many herbicides in practice like butachlor, anilophos and pretilachlor providing narrow spectrum of weed control with narrow window of their application (3-4 DAT) and in high quantity. It has been found that sulfonylurea herbicides like triasulfuron and bensulfuron methyl are characterized by broad spectrum weed control with broad window of application (7-20 DAT), with an environmental advantage deriving from their very low application rates in grams rather than kg/ha which markedly reduce the "chemical load" in the environment. These herbicides, however, have not been tested in rice widely in India. Therefore, there is a need for optimizing their doses in rice for effective broad spectrum weed control. Keeping the above facts in view, the present experiment was carried out.

Field experiment was conducted during **kharif** season of 2004-05 at the research farm of Institute of Agricultural Sciences, B. H. U., Varanasi. The soil of the experimental field was sandy clay loam, having pH 7.3, organic carbon 0.43% and available N, $P_2O_5$ and $K_2O$ 208.0, 15.2 and 231.4 kg/ha, respectively. The experiment was laid out in a randomized block design with 14 treatments, comprising butachlor (50 EC) 0.938 kg/ha, pretilachlor (50 EC) 0.5 and 0.75 kg/ha, bensulfuron-methyl at 0.05 and 0.06 kg/ha, applied at 3-5 and 20 days after transplanting (DAT), triasulfuron 20 WSG at 0.006 and 0.009 kg/ha, applied at 7 and 12 DAT against weed free check, two hand weedings and weedy check. The treatments were replicated thrice. Twenty-five days old seedlings of rice variety Sarju-52 were transplanted at spacing of 20 x 15 cm on July 24, 2004. Half of recommended dose of N (60 kg/ha) and full dose of $P_2O_5$ and $K_2O$ (60 kg/ha each) were applied before transplanting and remaining amount of N was top dressed in two equal splits, half at active tillering and half at panicle initiation stage. All the herbicidal treatments were applied after mixing in 500 litres of water/ha with the help of Knapsack sprayer fitted with flat fan nozzle. All the observations were recorded using standard techniques.

The experimental field was infested with 20 weed flora belonging to nine different families and out of that the dominant weed species were *Cynodon dactylon, Echinochloa colona* and *Echinochloa crusgalli* in grasses; and *Cyperus rotundus, Cyperus difformis* and *Fimbristylis miliacea* in sedges. In broad-leaved weeds *Ammania baccifera* and *Ludwigia parviflora* were found dominant during the experimentation.

All the herbicidal treatments exhibited significant influence on weed density and their dry weight. Application of bensulfurom-methyl and triasulfuron at lower doses was found most effective on sedges and broad-leaved weeds than grasses (Table 1) and constituted higher composition of grassy weeds (19.67-31) than butachlor and pretilachlor at higher doses (14-19). This was owing to the fact that low dose herbicides when applied remained unaffected on grasses due to short life period of these herbicides as grassy weeds emerged at later stages. Similar observations were also reported by Lee *et al.* (1989) and Sheriff and Mousavi (1997). Among herbicides, application of triasulfuron 0.009 kg/ha at 12 DAT recorded minimum dry weight (34.28 g) at 60 DAT followed by two hand weddings (46.24 g), and triasulfuron 0.009 kg/ha at 7 DAT (56.16 g). Whereas pretilachlor at 0.5 kg/ha (4 DAT) was found to be least effective and recorded maximum dry weight of weeds (128.18 g) followed by butachlor 0.938 kg/ha at 4 DAT (113.71 g). This is in conformity with the findings of Brar *et al.* (2005). In general, among herbicides application of triasulfurom at 0.009 kg/ha at 12 DAT was found more effective in reducing weed density of sedges and broad-leaved weeds as compared to grasses and was comparable to hand weeding. This may be attributed to broad spectrum properties exhibited by this herbicide.

Table 1. Effect of treatments on density of grasses, sedges and broad-leaved weeds, dry matter of weeds at 60 DAT, weed index and on weed control efficiency

| Treatments | Dosage (kg/ha) | Time of application (DAT) | Weed density (No./m$^2$) (30 DAT) | | | Dry matter of weeds (g/m$^2$) (60 DAT) | Weed control efficiency | Weed index |
|---|---|---|---|---|---|---|---|---|
| | | | Grasses | Sedges | BLW | | | |
| $T_1$–Butachlor 50 EC | 0.938 | 4 | 4.35 (19.00) | 4.58 (21.00) | 3.05 (9.33) | 10.68 (113.71) | 33.28 | 28.89 |
| $T_2$–Pretilachlor 50 EC | 0.500 | 4 | 4.57 (21.00) | 4.93 (24.00) | 3.15 (10.00) | 11.33 (128.18) | 24.79 | 33.71 |
| $T_3$–Pretilachlor 50 EC | 0.750 | 4 | 3.73 (14.00) | 4.43 (19.67) | 2.93 (8.67) | 9.53 (90.55) | 46.86 | 27.76 |
| $T_4$–Bensulfuron methyl 60 DF | 0.050 | 4 | 5.56 (31.00) | 4.20 (17.67) | 2.64 (7.00) | 9.26 (85.32) | 49.93 | 19.83 |
| $T_5$–Bensulfuron methyl 60 DF | 0.060 | 4 | 5.29 (28.00) | 3.99 (16.00) | 2.44 (6.00) | 8.87 (78.36) | 54.02 | 17.84 |
| $T_6$–Bensulfuron methyl 60 DF | 0.050 | 20 | 5.09 (26.00) | 3.46 (12.00) | 2.23 (5.00) | 8.49 (71.68) | 57.94 | 14.73 |
| $T_7$–Bensulfuron methyl 60 DF | 0.060 | 20 | 4.92 (24.00) | 3.36 (11.00) | 2.07 (4.33) | 8.10 (65.23) | 61.72 | 12.18 |
| $T_8$–Triasulfuron 20 WSG | 0.006 | 7 | 5.50 (30.00) | 4.24 (18.00) | 2.70 (7.33) | 9.3 (86.07) | 49.49 | 22.09 |
| $T_9$–Triasulfuron 20 WSG | 0.006 | 12 | 5.09 (26.00) | 3.78 (14.00) | 2.37 (5.67) | 8.81 (77.25) | 54.67 | 15.86 |
| $T_{10}$–Triasulfuron 20 WSG | 0.009 | 7 | 4.79 (23.00) | 3.90 (9.67) | 1.79 (3.33) | 7.45 (56.16) | 67.04 | 11.33 |
| $T_{11}$–Triasulfuron 20 WSG | 0.009 | 12 | 4.42 (19.67) | 2.29 (5.33) | 2.63 (7.00) | 5.89 (34.28) | 79.88 | 1.60 |
| $T_{12}$–Two hand weedings | - | 20 & 40 | 3.99 (16.00) | 2.82 (8.00) | 1.72 (3.00) | 6.83 (46.24) | 72.86 | 5.30 |
| $T_{13}$–Weed free | - | 15 days internal | 2.44 (6.00) | 1.99 (4.00) | 2.82 (8.00) | 3.41 (10.60) | 93.34 | 0.00 |
| $T_{14}$–Unweeded check | - | - | 7.51 (56.00) | 7.54 (57.00) | 6.16 (38.00) | 13.06 (170.43) | - | 44.75 |
| LSD (P=0.05) | - | - | 0.58 | 0.50 | 0.48 | 8.31 | - | - |

Figures in parentheses are the original values. D. F.–Dry formulation, WSG–Water soluble granules.



sulfonylurea herbicides (triasulfurom) inhibit acetohydroxy acid synthase (AHAS) (Sridhan and Singh, 1991) which is necessary for the production of the three branched chain mino acids : isoleucine, leucine and valine. The three classes of AHAS inhibitors are structurally diverse and each herbicide has a unique set of interactions with the enzyme (Sridhan, 1991). Susceptible plants die very slowly from these herbicides with meristematic tissues showing the first symptoms. These herbicides can be considered as growth inhibitors and cause plant death within a period ranging from several days to more than a week.

Among herbicidal treatments, the highest weed control efficiency (79.88) and minimum weed index (5.30) were recorded with triasulfuron 0.009 kg/ha applied at 12 DAT followed by applied at 7 DAT. Sulfonylurea herbicides are translocated in the apoplast and symplast to all actively growing plant parts, especially in the meristematic areas and are most effective on small rapidly growing annual weeds (Sridham, 1991).

Among herbicidal treatments, application of triasulfuron 0.009 kg/ha applied at 12 DAT and at 7 DAT as well as bensulfurom methyl 0.06 kg/ha at 20 DAT recorded maximum yield attributes (No. of panicles/m$^2$, pancile weight and grain yield) (Table 2). The higher yield and yield attributes under these treatments were attributed to lower weed density, weed dry weight and better weed control efficiency. The maximum grain yield

Table 2. Effect of treatments on yield attributes, harvest index and grain yield

| Treatments | Dosage (kg/ha) | Time of application (DAT) | Panicles/ $m^2$ | Panicle weight (g) | Grain yield (kg/ha) | Harvest index |
|---|---|---|---|---|---|---|
| $T_1$–Butachlor 50 EC | 0.938 | 4 | 193 | 3.81 | 4321 | 42.83 |
| $T_2$–Pretilachlor 50 EC | 0.500 | 4 | 195 | 3.58 | 4028 | 42.87 |
| $T_3$–Pretilachlor 50 EC | 0.750 | 4 | 206 | 3.67 | 4390 | 42.92 |
| $T_4$–Bensulfuron methyl 60 DF | 0.050 | 4 | 209 | 3.69 | 4872 | 42.88 |
| $T_5$–Bensulfuron methyl 60 DF | 0.060 | 4 | 221 | 3.57 | 4993 | 43.02 |
| $T_6$–Bensulfuron methyl 60 DF | 0.05 | 20 | 206 | 4.06 | 5182 | 42.39 |
| $T_7$–Bensulfuron methyl 60 DF | 0.06 | 20 | 226 | 3.73 | 5337 | 43.05 |
| $T_8$–Triasulfuron 20 WSG | 0.006 | 7 | 210 | 3.80 | 4734 | 43.03 |
| $T_9$–Triasulfuron 20 WSG | 0.006 | 12 | 214 | 3.81 | 5113 | 42.91 |
| $T_{10}$–Triasulfuron 20 WSG | 0.009 | 7 | 228 | 3.77 | 5389 | 42.87 |
| $T_{11}$–Triasulfuron 20 WSG | 0.009 | 12 | 231 | 3.79 | 5974 | 43.30 |
| $T_{12}$–Two hand weedings | - | 20 & 40 | 224 | 3.81 | 5750 | 42.70 |
| $T_{13}$–Weed free | - | 15 days internal | 228 | 4.07 | 6077 | 42.83 |
| $T_{14}$–Unweeded check | - | - | 190 | 3.57 | 3357 | 38.93 |
| LSD (P=0.05) | - | - | 10 | NS | 349.4 | NS |

D. F.–Dry formulation, WSG–Water soluble granules. NS–Not Significant.



(5974 kg/ha) was obtained with application of triasulfurom 0.009 kg/ha at 12 DAT, which was at par with hand weeding (weed free). Increase in grain yield due to application of triasulfuron 0.009 kg at 12 DAT was also reported by Brar *et al.* (2005). The entire weed control treatments failed to have significant influence on harvest index. However, maximum harvest index (43.30) was obtained with triasulfuron 0.009 kg/ha at 12 DAT.

On an average, triasulfuron at 0.009 kg/ha applied at 12 days after transplanting and bensulfuron methyl 0.06 kg/ha 20 DAT were found most effective in reducing the density of sedges and broad-leaved weeds and relatively low with respect to grassy weeds. Butachlor and pretilachlor were found more effective against grassy weeds. Among the herbicidal treatments, application of triasulfuron 0.009 kg at 12 DAT maximized the rice grain yield (5974 kg/ha) which was comparable to hand weeding twice (20 and 40 DAT). The weed competition in weedy check caused 41% reduction in grain yield.

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