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Efficacy of sulfonylurea herbicides for broad-spectrum weed control in wet direct-sown summer rice

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ABSTRACT

The efficacy of some potent herbicides of sulfonylurea group in conjunction with other traditional recommended herbicides was studied in wet direct- sown summer rice (Oryza sativa) during the dry season of 2005 and 2006 at Cuttack, Orissa. The major weed flora found during the crop growing season were Echinochloa colona (9.6%), Cyperus difformis (21.9%), Fimbristylis miliacea (19.2%), Sphenochlea zeylanica (23.3%), and Ludwigia parviflora (26.0%) at 30 days after sowing (DAS). Bensulfuron methyl (60 g ha^{-1}) applied at 20 DAS was found to be the most effective herbicide in controlling weeds (weed control efficiency 95.2%) and maximizing rice grain yield (5.82 t ha^{-1}). This was at par with hand weeding twice at 20 and 40 DAS in terms of weed control efficiency and grain yield. Other herbicides of sulfonylurea group viz., pyrazosulfuron ethyl (25 g ha^{-1}) applied at 10 DAS, triasulfuran (9 g ha^{-1}) applied at 7 DAS and Almix (metsulfuron methyl + chlorimuron ethyl) + 0.2% surfactant (4 g ha^{-1}) applied at 20 DAS also showed good suppression of weeds with weed control efficiency (WCE) 93.4, 91.7 and 88.6%, respectively. Among the traditional recommended herbicides, pretilachlor + safener (750 g ha^{-1}) performed relatively better with WCE 85.0%. There was more than 46% reduction in the grain yield of rice due to competition with weeds in weedy plots

Key words: *Sulfonylurea herbicides, weed control, wet direct-sown rice*

In recent years, rice production systems are undergoing several changes and one of such changes is shift from transplanted to direct-sown rice. Sowing pre-germinated seeds in wet (saturated) puddle soils offers an attractive alternative stand establishment practice to transplanting system in dry season. It is becoming very popular and spreading rapidly in several Asian countries like Malaysia, Thailand, Philippines, Vietnam and even in Bangladesh under controlled water condition (Saha, 2008). Asian rice farmers are shifting to direct seeding mainly to reduce labour input, drudgery and cultivation cost. It also serves several other advantages like faster and easier planting, earlier crop maturity by 7-10 days, more efficient water use and higher tolerance to water deficit and often higher profit in areas with an assured water supply (Balasubramanian and Hill, 2002). There are, however, several constraints associated with wet seeding. Among them, severe competition from rapidly emerging weeds is a major one due to absence of standing water in the crop field during the first 7-10 days after sowing. Unchecked weed competition causes yield losses to the tune of 50-65% under such situations (Subbaiah and Sreedevi, 2000). The key to success to direct-sown rice is the availability of efficient weed control techniques (Pandey and Velasco, 2002). A number of herbicides herbicides like butachlor, pretilachlor, pendimethalin, anilofos etc. have been recommended as pre-emergence for the control of early flushes of weeds (Moorthy and Saha, 2002). All these herbicides have differential effects on weeds and are having narrow spectrum of weed control. In view of the above fact, it was desirable to identify alternative herbicides that may provide wide spectrum of weed control. Of late, some new herbicide formulations with low dose-high efficacy, herbicide mixtures and safened compounds are showing promise (Saha, 2006). One of such class of herbicides that has become popular all over the world is sulfonylurea herbicides that represent high level of activity, application flexibility, excellent selectivity and low mammalian toxicity even at a very low dose with broad spectrum weed control (Saha and Rao, 2007). Therefore, the present investigation was undertaken to find out the efficacy of new generation herbicides of sulfonylurea group for broad-spectrum

weed control and their comparative advantage over traditional recommended herbicides in direct-sown summer rice.

MATERIALS AND METHODS

A field experiment was conducted during the dry season of 2005 and 2006 at the Central Rice Research Institute, Cuttack in an alluvial (Haplaquept) clay loam soil with pH 6.3, organic carbon 0.59%, total nitrogen 0.071%, Olsen's P 24 kg ha^{-1} and available K 94 kg ha^{-1}. The treatments consisted of various doses of butachlor + safener, pretilachlor + safener, pyrazosulfuron ethyl, bensulfuron methyl, triasulfuran and Almix (metasulfuron methyl + chlorimuron ethyl) + surfactant and were compared with hand weeding twice (20 and 40 days after sowing) as recommended practice and weedy check (Table 1). Thirteen treatments were evaluated in a randomized complete block design with four replications. All the herbicides were applied in saturated soil moisture using knapsack sprayer fitted with flat fan nozzle at spray volume of 500 l ha^{-1}. The rice variety 'Naveen' (115 days duration) was sown during January 24, 2005 and January 25, 2006 by broadcasting of 80 kg seed ha^{-1}. Full dose of P_2O_5 and K_2O (40 kg ha^{-1}) were applied before sowing at final land preparation and N (80 kg ha^{-1}) was applied in 3 splits, half at early vegetative stage (2 weeks after sowing) and the rest half at two equal splits at active tillering and panicle initiation stages. All the other recommended agronomic and plant protection measures were adopted to raise the crop. The data on weed density and dry weight of weeds were recorded at two different growth stages (30 and 60 DAS) 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 was recorded at harvest.

RESULTS AND DISCUSSION

The highest population of weeds was recorded in weedy check (Table 1). The major weed species found in the weedy plots at 30 days after sowing were *Echinochloa colona* (9.6%), *Cyperus difformis* (21.9%), *Fimbristylis miliacea* (19.2%), *Sphenochlea zeylanica* (23.3%) *and Ludwigia parviflora* (26.0%),

Table 1. Effect of treatments on distribution patterns of different weeds at vegetative growth stages of rice (pooled data of 2004 and 2006)

Treatment	Dose	Weed density (No. m^{-2})											
		Echinochloa colona		*Cyperus difformis*		*Fimbristylis miliacea*		*Sphenochlea zeylanica*		*Ludwigia parviflora,*		Total	
	(g ha^{-1})	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Butachlor + safener	1000	0	0	2	5	2	7	7	15	9	16	20	43
Pretilachlor + safener	500	2	0	2	6	3	9	13	18	10	19	30	52
Pretilachlor + safener	750	0	0	0	2	0	3	4	9	6	14	10	28
Pyrazo sulfuron ethyl	20	2	3	0	2	0	4	2	6	4	9	8	24
Pyrazo sulfuron ethyl	25	1	0	0	1	0	2	1	5	2	7	4	15
Bensulfuron methyl	50	5	4	0	2	0	5	2	6	3	8	10	25
Bensulfuron methyl	60	4	0	0	0	0	2	0	3	0	4	4	9
Triasulfuran	6	3	4	3	5	2	7	2	7	1	8	11	31
Triasulfuran	9	0	0	1	2	1	5	0	4	2	7	4	18
Almix + surfectant	4	4	6	0	0	0	3	0	6	0	8	4	23
Almix + surfectant	4	5	8	2	5	2	6	4	15	6	18	19	52
Hand weeding (2)		0	0	0	0	0	1	1	2	0	2	1	5
Weedy		7	5	16	9	14	16	17	28	19	26	73	84

DAS, Days after sowing

Table 2. Effect of weed-control treatments on weed dry matter production, weed-control efficiency, panicle numbers and grain yield of direct-sown rice (pooled data of 2004 and 2006)

Treatment	Dose (g ha^{-1})	Time of application (DAS)	Weed dry weight (g m^{-2}) 60 DAS	Weed-control efficiency (%)	Panicles (no. m^{-2})	Grain yield (t ha^{-1})
Butachlor + safener	1000	3	23.0	73.5	230	5.06
Pretilachlor + safener	500	7	24.6	71.7	218	4.73
Pretilachlor + safener	750	7	13.2	85.0	261	5.52
Pyrazo sulfuron ethyl	20	10	17.7	79.6	247	5.40
Pyrazo sulfuron ethyl	25	10	5.7	93.4	292	5.77
Bensulfuron methyl	50	20	16.4	81.1	256	5.47
Bensulfuron methyl	60	20	4.2	95.2	297	5.82
Triasulfuran	6	7	20.5	76.4	242	5.33
Triasulfuran	9	7	7.2	91.7	279	5.68
Almix + surfectant	4	20	9.9	88.6	273	5.62
Almix + surfectant	4	25	24.3	72.0	211	4.84
Hand weeding (2)		20 & 40	1.6	98.2	314	5.96
Weedy			86.8		191	3.21
CD(P=0.05)			2.80		22.6	0.21

DAS, Days after sowing

respectively (Table 1). Thus grasses constituted 9.6%, sedges 41.1% and broad leaf weeds 49.3% of the total weed population at 30 days stage. All the treatments registered significantly lower number of weeds than weedy check. Progressive increase in doses of all the sulfonylurea herbicides viz., bensulfuron methyl (from 50 to 60 g ha^{-1}), pyrazosulfuron ethyl (from 20 to 25 g ha^{-1}) and triasulfuran (from 6 to 9 g ha^{-1}) along with Almix (metsulfuron methyl + chlorimuron ethyl) at 4 g ha^{-1} applied 20 DAS resulted in decreased density and dry weight of all the weeds in comparison to the traditional recomemded herbicides viz., butachlor + safener at 1000 g ha^{-1} and pretilachlor + safener at 500 and 750 g ha^{-1}. Observation recorded on weed population at 30 DAS revealed that the herbicides viz., butachlor + safener at 1000 g ha^{-1}, pretilachlor + safener at 750 g ha^{-1} and triasulfuran at 9 g ha^{-1} controlled the *Echinochloa colona* effectively. While, the herbicides like bensulfuron methyl and Almix at their respective tested doses were found to be inferior in controlling *Echinochloa colona*. Pyrazosulfuron ethyl at 20 and 25 g ha^{-1}, bensulfuron methyl at 50 and 60 g ha^{-1}, pretilachlor + safener at 750 g ha^{-1} along with Almix at 4 g ha^{-1} applied at 20 DAS registered its superiority in controlling both the predominant sedges viz., *Cyperus difformis* and *Fimbristylis miliacea* completely over other herbicides. Spectacular mortality of broad-leaf weeds viz., *Sphenochlea zeylanica* and *Ludwigia parviflora* was recorded due to bensulfuron methyl at 60 g ha^{-1} and Almix at 4 g ha^{-1} (applied 20 DAS). All weed control measures registered a significant reduction in weed dry matter accumulation compared to weedy check. The effects of various treatments on total dry mater production were similar to that of weed density (Table 2). The weed control efficiency (WCE) of different treatments was assessed on the basis of weed dry weight recorded at 60 days stage. The highest weed control efficiency (95.2%) was observed with bensulfuron methyl at 60 g ha^{-1} followed by pyrazosulfuron ethyl (93.4%) at 25 g ha^{-1} and triasulfuran (91.7%) at 9 g ha^{-1}. Almix + 0.2% surfactant (at 4 g ha^{-1}) was found to be effective only when applied at 20 DAS with WCE 88.6%. Among the traditional recommended herbicides, pretilachlor + safener (750 g ha^{-1}) performed relatively better with WCE 85.0% (Table 2).

Significantly higher number of panicles m^{-2} was recorded in hand weeding twice over herbicide treatments (Table 2). Among the herbicides, bensulfuron methyl at 60 g ha^{-1} registered significantly higher number of panicles m^{-2} followed by pyrazosulfuron ethyl at 25 g ha^{-1} than rest of the herbicide treatments. On an average, there was more than 46% reduction in the grain yield of rice due to competition with weeds in weedy plots (Table 2). However, all the herbicide

treated plots produced grain yields significantly more than the weedy plots. The highest grain yield of rice (5.96 t ha^{-1}) was obtained in hand weeding twice and it was at par with bensulfuron methyl at 60 g ha^{-1} and pyrazosulfuron ethyl at 25 g ha^{-1}. The higher efficacy of pyrazosulfuron ethyl at 25 g ha^{-1} for improving the productivity of wet direct-sown summer rice was also recorded from earlier studies (Saha, 2006). The herbicides viz., butachlor + safener at 1000 g ha^{-1} and pretilachlor + safener at 500 g ha^{-1} yielded significantly less mainly due to poor control of broad leaf weeds viz., *Sphenochlea zeylanica and Ludwigia parviflora* which were predominance at peak vegetative and flowering stages. The poor yields with Almix + 0.2% surfactant at 4 g ha^{-1} applied late at 25 days after sowing was mainly due to non-control of predominant grasses and broad leaf weeds. However, there was significant yield increase in bensulfuron methyl, pyrazosulfuron ethyl, triasulfuran and pretilachlor + safener at their respective higher doses along with Almix + 0.2% surfactant applied at 20 DAS and the recommended practice of hand weeding twice (at 20 and 40 days after sowing). There was no phytotoxic effect of any herbicide at any of the doses applied on wet direct-sown rice crop.

Thus, it can be inferred that application of new generation sulfonylurea herbicides like bensulfuron methyl at 60 g ha^{-1}, pyrazosulfuron ethyl at 25 g ha^{-1}, triasulfuran at 9 g ha^{-1} and Almix + 0.2% surfactant at 4 g ha^{-1} proved to be superior for wide spectrum weed control in wet direct-sown rice field during dry season. Application of bensulfuron methyl at 60 g ha^{-1} and pyrazosulfuron ethyl at 25 g ha^{-1} was found to be the most effective and may be recommended for wet direct-sown summer rice cultivation.

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