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Evaluation of bensulfuron-methyl for weed control in wet direct-sown summer rice

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ABSTRACT

The efficacy of bensulfuron-methyl alone or as tank mixture with pretilachlor was evaluated in conjunction with recommended herbicides pretilachlor and pyrazosulfuron-ethyl for controlling sedges and broad leaf weeds in wet direct- sown summer rice during the dry season of 2006 and 2007 at Cuttack. The major weed flora constituting in weedy plots were Echinochloa colona (8.7%), Cyperus difformis (26.1%), Fimbristylis miliacea (14.5%), Sphenochlea zeylanica (27.5%) and Marsilea quadrifolia (23.2%) at 30 days after sowing (DAS). Bensulfuron-methyl either alone at 60 g ha^{-1} or as tank mixture with pretilachlor (50+450 g ha^{-1}) applied at 20 DAS were found to be equally effective in controlling weeds (weed control efficiency 90.0 and 92.2%, respectively) and produced comparable grain yield of 5.48 and 5.53 t ha^{-1}, respectively. Both these herbicide treatments were at par with recommended practice of hand weeding twice at 20 and 40 DAS in terms of weed control efficiency (WCE) and grain yield. Bensulfuron-methyl at 30 to 60 g ha^{-1} applied alone or as tank mixture with pretilachlor at 450 g ha^{-1} was found superior in reducing the total weed density and dry matter production with WCE of 80-92.2% in comparison to the recommended herbicides pretilachlor and pyrazosulfuron-ethyl with WCE of 74 and 75.8% respectively. There was more than 49% reduction in the grain yield of rice due to competition with weeds in weedy plots.

Key words: *efficacy, bensulfuron-methyl, weed control, wet direct-sown rice*

The direct sowing of rice with pre-germinated seeds in wet (saturated) puddle soil offers a good alternative method of crop establishment to transplanting system during 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, 2006). However, transforming the crop establishment technique from transplanted to wet direct-seeded rice has resulted in dramatic changes in the type and degree of weed infestation in rice fields. Weed competition is more intense in wet direct-sown rice because of similarities in age of rice and weed seedlings than that of transplanted system where aged seedlings with better competitive ability are raised (Saha, 2008). 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 like butachlor, pretilachlor, pendimethalin, anilofos etc. have been recommended as pre-emergence herbicides for the control of early flushes of weeds. All these herbicides have differential effects on weeds and are having narrow spectrum of controlling annual grasses and some sedges. Of late, some new herbicide formulations with low dosage-high efficacy, herbicide mixtures and safened compounds are showing promise with wide spectrum of weed control (Moorthy and Saha, 2002). One of such class of herbicides that has become popular all over the world is sulfonylurea herbicides and are found effective in controlling sedges and non grassy weeds which are more predominant in rice fields during the dry season. Therefore, the present investigation was undertaken to find out the efficacy of bensulfuron-methyl for controlling sedges and other non-grassy weeds including broad leaf weeds and its comparative advantage over traditional recommended herbicides in wet direct-sown summer rice.

MATERIALS AND METHODS

A field experiment was conducted during the dry season of 2006 and 2007 at the Central Rice Research Institute, Cuttack in an alluvial (Haplaquept) clay loam soil with pH 6.4, organic carbon 0.63%, total nitrogen 0.070%, Olsen's P 27 kg ha^{-1} and available K 99 kg ha^{-1} to study the weed control spectrum and efficacy of bensulfuron-methyl (Londax 60 DF) for controlling sedges and non-grassy weeds in wet direct-sown rice field. The treatments consisted of different doses of bensulfuron-methyl (30, 40, 50 and 60 g ha^{-1}) applied alone and in combination with pretilachlor at 450 g ha^{-1} as tank mixture and compared with recommended herbicides pretilachlor (600 g ha^{-1}) and pyrazosulfuron-ethyl (20 g ha^{-1}) along with hand weeding twice (20 and 40 DAS) as recommended practice, weed-free (15, 30, 45 and 60 DAS) and weedy check (Table 1). A total 12 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). The rice variety Naveen (115 days duration) was sown during January 14, 2006 and January 15, 2007 by spot seeding (dibbling) with pre-germinated seeds at 15 cm x 15 cm row spacing. Full dose of P_2O_5 and K_2O (50 kg ha^{-1}) were applied before sowing at final land preparation and N (100 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 5 and 8 weeks after sowing. 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 i.e., at 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 values 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 yield attributing characters viz., panicles m^{-2} were recorded at harvest.

RESULTS AND DISCUSSION

The highest population of weeds was recorded in weedy check (Table 1). The mean relative density of major weed species in weedy plots at 30 days after sowing (DAS) were *Echinochloa colona* (8.7%), *Cyperus difformis* (26.1%), *Fimbristylis miliacea* (14.5%), *Sphenochlea zeylanica* (27.5%) *Marsilea quadrifolia* (23.2%). Thus grasses constituted 8.7%, sedges 40.6% and broad leaf weeds 50.7% of the total weed population at 30 days stage. All the treatments registered significantly lower number of weeds than

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 2006-2007

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})
Bensulfuron methyl	30	3	17.4	80.0	251	4.73
Bensulfuron methyl	40	7	15.8	81.9	258	4.85
Bensulfuron methyl	50	7	11.5	86.8	270	5.34
Bensulfuron methyl	60	10	8.7	90.0	283	5.48
Bensulfuron methyl + pretilachlor	30+450	10	12.3	85.9	267	5.17
Bensulfuron methyl + pretilachlor	40+ 450	20	9.9	88.7	279	5.39
Bensulfuron methyl + pretilachlor	50 + 450	20	6.8	92.2	287	5.53
Pyrazo sulfuron ethyl	20	7	21.1	75.8	247	4.63
Pretilachlor	600	7	22.2	74.5	244	4.60
Hand weeding (2)		20	4.9	94.4	291	5.61
Weed free		25	87.2	100.0	298	5.79
Weedy		20 & 40		-	176	2.93
CD(P=0.05)			2.51		18.6	0.20

DAS, Days after sowing

weedy check. The recommended herbicide, pretilachlor at 600 g ha^{-1} controlled *Echinochloa colona* effectively but could not suppress the growth of sedges and non grassy broad-leaf weeds. Another recommended herbicide, pyrazosulfuron-ethyl (at 20 g ha^{-1}) reduced the density of grasses and to some extent sedges but not the broad leaf (non-grassy) weeds. Bensulfuron-methyl at none of the doses could control *Echinochloa colona* effectively. However, the density of *Echinochloa colona* was reduced due to tank mixing of pretilachlor at less than recommended dose (450 g ha^{-1}) with different doses of bensulfuron-methyl (30, 40 and 50 g ha^{-1}) in comparison to application of bensulfuron-methyl alone. It indicated the compatibility of tank mixing of pretilachlor with bensulfuron-methyl. Singh *et al.* (2005) also recorded similar results by tank-mix application of butachlor and bensulfuron-methyl. Bensulfuron-methyl at all the doses applied either alone or as tank mixture with pretilachlor reduced the density of all the sedges observed in the experimental field as well as non-grassy (broad leaf) weeds. At higher doses of bensulfuron-methyl (50 and 60 g ha^{-1}), there was almost complete control of sedges and non-grassy weeds while suppression of *Echinochloa colona* was also recorded at 60 g ha^{-1} during both the years (Table 1).

All weed control measures registered a significant reduction in weed dry matter accumulation (60 DAS) compared to weedy check. The effects of various treatments on total dry mater production were similar to that of weed density (Table 2). Among the herbicide treatments, the lowest weed dry weight (6.8 g m^{-2}) was recorded in bensulfuron-methyl + pretilachlor at 50+450 g ha^{-1} and showed better suppression of all types of weeds with weed control efficiency (WCE) of 92.2%. It was at par with the recommended practice of hand weeding twice at 20 and 40 DAS with WCE of 94.4%. However, there was reduction of sedges and non-grassy weeds during both the years in the plots treated with bensulfuron-methyl + pretilachlor (40+450 g ha^{-1}) and bensulfuron-methyl alone (60 g ha^{-1}) with WCE of 88.7 and 90.0%, respectively (Table 2). Bensulfuron methyl at all the doses applied alone or as tank mixture with pretilachlor were found superior in reducing the total weed density and dry matter production with WCE of 80-92.2% in comparison to the recommended herbicide pretilachlor and pyrazosulfuron-ethyl with WCE of 74.5 and 75.8%,

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

Treatment	Dose ($g\ ha^{-1}$)	Weed density (no. m^{-2})											
		Echinochloa colona		*Cyperus difformis*		*Fimbristylis miliacea*		*Sphenochlea zeylanica*		*Marsilea quadrifolia*		Total	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Bensulfuron methyl	30	8	6	5	6	4	7	4	6	4	9	25	34
Bensulfuron methyl	40	7	7	4	3	2	5	4	8	2	7	19	30
Bensulfuron methyl	50	5	7	0	2	0	4	2	5	0	6	7	24
Bensulfuron methyl	60	3	6	0	0	0	2	0	4	0	4	3	16
Bensulfuron methyl + pretilachlor	30+450	1	6	3	6	3	4	4	5	2	5	13	26
Bensulfuron methyl + pretilachlor	40+450	0	4	2	4	1	4	3	5	1	4	7	21
Bensulfuron methyl + pretilachlor	50+450	0	2	0	2	0	3	1	3	0	2	1	12
Pyrazo sulfuron ethyl	20	2	4	3	8	5	9	7	10	8	11	25	42
Pretilachlor	600	0	5	4	8	4	6	9	13	10	15	27	47
Hand weeding (2)		0	0	2	0	0	2	2	0	0	4	4	6
Weed free		0	0	0	0	0	0	0	0	0	0	0	0
Weedy		6	4	18	11	10	16	19	30	16	19	69	80

DAS, Days after sowing

respectively (Table 2).

All the herbicide treated plots produced significantly more grain yield than weedy plots. On an average, more than 49% reduction in the grain yield of rice due to competition with weeds in weedy plots was observed (Table 2). The highest grain yield of rice (5.79 t ha^{-1}) was obtained in weed free check. However, it was at par with the recommended practice of hand weeding twice (5.61 t ha^{-1}). The recommended herbicides viz., pretilachlor (600 g ha^{-1}) and pyrazosulfuron ethyl (20 g ha^{-1}) yielded significantly lower than different doses of bensulfuron methyl whether applied alone or tank mixture with pretilachlor at 450 g ha^{-1}. The poor yield in these treatments could mainly due to be controlling the sedges and broad leaf weeds which were predominant in the rice plots. It was also found that application of bensulfuron methyl either alone at 60 g ha^{-1} or tank mixture with pretilachlor at 50 + 450 g ha^{-1} produced significantly higher grain yield of 5.48 and 5.53 t ha^{-1}, respectively and it was at par with the recommended practice of hand weeding twice. There was marginal increase in the grain yield due to tank mixing of pretilachlor (450 g ha^{-1}) with bensulfuron methyl at 40 and 50 g ha^{-1} over the application of bensulfuron methyl alone at 50 and 60 g ha^{-1}. There was no phytotoxic effect of bensulfuron methyl at any of the doses applied alone or tank mixed with pretilachlor on direct-sown summer rice crop. Thus, it can be inferred that application of bensulfuron-methyl either alone at 60 g ha^{-1} and tank mixture of bensulfuron-methyl + pretilachlor at relatively lower dose of 50 + 450 g ha^{-1} proved to be effective for wide spectrum weed control in wet direct-sown rice field during dry season.

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