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Bioefficacy of Penoxsulam on Transplanted Rice Weeds

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ABSTRACT

Penoxsulam was found effective especially against *Echinochloa* species and *Cyperus difformis* as compared to butachlor and pretilachlor and it recorded lower weed dry matter. Highest grain yield was obtained with penoxsulam at 22.5 and 25 g/ha at 3 DAT during 2005 and 2006, respectively. Penoxsulam at 22.5 and 20.0 g/ha was found better against weeds than butachlor and pretilachlor. Weedy plot recorded 41.0 and 34.3% lower grain yield as compared to the treatment having highest grain yield during both the years. Based on two-season studies, it can be concluded that penoxsulam at 20-25 g/ha applied as pre-emergence (3 DAT) as well as early post-emergence (10 DAT) effectively controlled weeds in transplanted rice and it had no phytotoxicity effect on rice crop upto 25 g/ha dose.

Key words : Complex weed flora, weed management, rice productivity

INTRODUCTION

Rice is an important food crop of India contributing 45% of the total food grain production. Weed infestation in transplanted rice is a critical factor that reduces the yield to the extent of 15-45% (Chopra and Chopra, 2003). In transplanted rice, *Echinochloa* species, *Ischaemum rugosum*, *Caesulia axillaris*, *Commelina* spp., *Cyperus* spp. and *Fimbristylis miliacea* are dominant weeds. Weeds not only compete with rice nursery for growth factors (Rao and Moody, 1988a) but due to morphological similarities they got transplanted in the field along with rice seedlings (Rao and Moody, 1988b). These weeds also add large amount of seed to the soil as the source of infestation for the subsequent cropping year. Manual removal of weeds is labour intensive, tedious, back-breaking and does not ensure weed removal at critical stage of crop-weed competition. Herbicides do well but many times their pre-emergence application is not possible because of sowing pressure and unfavourable climate (Porwal, 1999). For the last many years, voluminous and high doses of herbicides like, butachlor, thiobencarb and anilofos are being applied as pre-emergence for effective control of weeds (Budha *et al.*, 1991). These herbicides effectively control the grassy weeds but are less effective against sedges and broad-leaved weeds. Due to continuous use of same herbicides, a shift in weed flora from grassy to non-grassy and annual sedges is being observed in transplanted rice. It is necessary to evaluate new herbicides so that they may provide broad spectrum control and also to tackle the problem of herbicide resistance if one herbicide is used continuously. Penoxsulam is a new acetolactate synthase (ALS) inhibitor herbicide for post-emergence control of annual grasses, sedges and broadleaf weeds in rice culture (Jabusch and Tjeerdema, 2005). In this study, penoxsulam was tested at different doses and time of application to evaluate its bio-efficacy and phytotoxicity against wide spectrum of weeds and on rice productivity.

MATERIALS AND METHODS

A field experiment was conducted at Crop Research Centre of G. B. Pant University of Agriculture & Technology, Pantnagar, U. S. Nagar (Uttarakhand) during **kharif** seasons of 2005 and 2006. The soil of experimental plot was silty clay loam in texture with a ph of 7.65. It was high in organic carbon (0.76%), low in available nitrogen (240 kg/ha) and medium in available phosphorus (22.1 kg/ha) and potassium (225 kg/ha). Ten treatments consisting of three doses of penoxsulam (20, 22.5 and 25 g/ha) applied at 3 DAT and three doses of penoxsulam (17.5, 20 and 22.5 g/ha) applied at 10 DAT, butachlor 1250 g and pretilachlor 750 g/ha applied at 3 DAT as standard check. Hand weeding (20 and 40 DAT) and weedy check were included in the experiment. The experiment was laid out in a randomized block design with three replications. Herbicides were sprayed using knapsack sprayer fitted with a flat fan nozzle with the spray volume of water 400 l/ha. Rice cultivar Sarjoo-52 was sown in the nursery on 2 July and 28 May and then transplanted in the main field on 26 July and 23 June at a spacing of 20 × 10 cm during 2005 and 2006, respectively.

All the recommended package of practices except weed control was adopted in the experimental plot during both the years. Seeds of grassy, sedges and broad leaved weeds were spread uniformly in the experimental field prior to transplanting to ensure sufficient population of these weeds in experimental plots. Fertilizer at 120 kg of N, 60 kg P_2O_5 and 40 kg of K_2O/ha were applied in each plot. Half the amount of nitrogen and full amount of phosphorus and potassium were applied as basal. Rest (50%) amount of nitrogen was top dressed in two equal splits at tillering and panicle initiation stages to synchronize with long phase of the rice growth. Need-based irrigation was given to the crop. The crop was harvested on 24 and 17 October during the first and second year, respectively. Observations on weed density were recorded at 45 days after transplanting (DAT) by randomly placing a quadrate of 0.25 × 1.0 m at two places in each plot. The dry weight of weeds was recorded after drying the weeds in oven at 70±1°C upto 48 h. The data on weed density were subjected to logarithmic transformation to normalize their distribution.

RESULTS AND DISCUSSION

The major weeds recorded from the experimental field were *Echinochloa colona* (L.) Link., *Cyperus difformis* L., *Fimbristylis miliacea* (L.) Vahl, *Eragrostis japonica* (Thunb) Trin. and *Caesulia axillaris* Roxb. which accounted for 32.9, 26.2, 24.0, 7.1 and 7.0%, respectively, at 45 DAT in 2005 (Table 1), whereas in second year (2006) *C. difformis*, *C. axillaris*, *E. japonica*, *Alternanthera sessilis* (L.) R. Br. Ex Roem. & Schult., *E. crus-galli* (L.) P. Beauv. and *E. colona* were dominant which accounted for 34.8, 22.5, 19.1, 13.5, 4.5 and 2.9% in weedy plot (Table 2). Penoxsulam was found effective against established weed of rice i. e. *E. colona* and *C. difformis* during 2005 and against *E. crus-galli*, *E. japonica*, *C. difformis*, *A. sessilis* and *C. axillaris* compared to application of herbicide butachlor and pretilachlor as pre-emergence.

Effect on Weeds

Penoxsulam applied as pre-emergence (3 DAT) to weeds was more effective in reducing the weed density as well as crop weed competition as compared to early post-emergence (10 DAT) during both the years (Table 3). Penoxsulam applied at 20 g/ha was more effective when applied at 3 DAT as compared to 10 DAT. Penoxsulam was also effective against established weeds of rice i. e. *E. colona* and *C. difformis* compared to application of butachlor and pretilachlor as pre-

Table 1. Effect of different treatments on density of weed species (No./m^2) at 45 DAT during 2005

Treatments	Dose (g/ha)	Application time	*E. colona*	*E. crus-galli*	*I. rugosum*	*E. japonica*	*C. rotundus*	*C. difformis*	*Alternanthera sessilis*	*Caesulia axillaris*	*F. miliacea*
Untreated	-	-	(5.3) 1.8	(8.0) 2.1	(3.3) 1.1	(34.0) 3.6	(0.7) 0.4	(62.0) 4.1	(24.0) 2.9	(40.0) 3.7	(0.7) 0.4
Penoxsulam	20	3 DAT	(0.0) 0.0	(5.3) 1.8	(1.3) 0.5	(1.3) 0.5	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(3.3) 1.2	(0.0) 0.0
Penoxsulam	22.5	3 DAT	(0.0) 0.0	(3.3) 1.4	(1.3) 0.5	(1.3) 0.5	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(3.0) 1.1	(0.0) 0.0
Penoxsulam	25	3 DAT	(0.0) 0.0	(3.3) 1.4	(0.7) 0.4	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(3.3) 1.4	(0.0) 0.0
Penoxsulam	17.5	10 DAT	(0.7) 0.4	(3.3) 1.4	(1.3) 0.5	(24.7) 3.2	(0.0) 0.0	(0.0) 0.0	(1.3) 0.5	(3.3) 1.2	(0.0) 0.0
Penoxsulam	20	10 DAT	(0.7) 0.4	(2.0) 0.9	(0.7) 0.4	(11.3) 2.5	(0.0) 0.0	(0.0) 0.0	(1.3) 0.5	(1.3) 0.7	(0.0) 0.0
Penoxsulam	22.5	10 DAT	(0.7) 0.4	(2.0) 0.9	(0.7) 0.4	(8.0) 2.2	(0.0) 0.0	(0.0) 0.0	(1.3) 0.5	(1.0) 0.6	(0.0) 0.0
Butachlor	1250	3 DAT	(0.0) 0.0	(12.0) 2.6	(1.3) 0.4	(10.0) 2.4	(0.7) 0.4	(18.7) 2.8	(6.7) 1.3	(7.3) 2.1	(0.0) 0.0
Pretilachlor	750	3 DAT	(0.0) 0.0	(1.3) 0.7	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(12.7) 2.6	(5.3) 1.8	(0.0) 0.0
Hand weeding (two)	20-40 DAT	20 & 40 DAT	(0.7) 0.4	(0.0) 0.0	(0.0) 0.0	(5.3) 1.7	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(5.3) 1.8	(0.7) 0.4
LSD (P=0.05)			0.8	0.8	NS	0.7	NS	0.4	1.1	1.1	NS

Values in parentheses are original, and transformed to log (x+1) for analysis. DAT–Days after transplanting. NS–Not Significant.

emergence. The effective control of weeds was evident from the lower weed dry weight recorded when herbicides applied at 3 DAT as compared to 10 DAT (Table 3). It was reported that penoxsulam at 40 g/ha was a broad-spectrum herbicide that controls *Echinochloa* spp. (all tested biotypes) and major broad-

Table 2. Effect of different treatments on density of weed species (No./m^2) at 45 DAT during 2006.

Treatments	Dose (g/ha)	Application time	*E. colona*	*E. crus-galli*	*I. rugosum*	*E. japonica*	*C. difformis*	*C. iria*	*C. sessilis*	*Cyanotis axillaris*	*Caesulia axillaris*	*F. miliacea*
Untreated	-	-	(56.0) 4.0	(0.0) 0.0	(0.0) 0.0	(12.7) 2.32	(44.7) 3.64	(1.3) 0.73	(1.3) 0.73	(1.3) 0.82	(12.0) 2.48	(40.7) 3.64
Penoxsulam	20	5 DAT	(14.7) 1.98	(0.7) 0.36	(0.0) 0.0	(11.3) 2.35	(0.0) 0.0	(0.7) 0.36	(0.0) 0.0	(0.0) 0.0	(2.0) 0.90	(6.0) 0.98
Penoxsulam	22.5	5 DAT	(10.0) 2.39	(0.0) 0.0	(0.0) 0.0	(10.7) 2.43	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(1.3) 0.53	(0.0) 0.0
Penoxsulam	25	5 DAT	(9.0) 2.27	(0.7) 0.36	(0.0) 0.0	(10.0) 1.81	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0
Penoxsulam	17.5	10 DAT	(25.3) 3.23	(0.0) 0.0	(0.7) 0.36	(10.7) 2.06	(13.3) 2.48	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(9.0) 2.22	(2.0) 0.65
Penoxsulam	20	10 DAT	(20.0) 3.02	(0.0) 0.0	(4.0) 1.26	(8.7) 2.01	(8.0) 2.13	(0.0) 0.0	(0.0) 0.0	(1.3) 0.73	(7.7) 1.87	(4.0) 1.26
Penoxsulam	22.5	10 DAT	(16.0) 2.47	(0.0) 0.0	(0.0) 0.0	(1.3) 0.73	(7.3) 1.59	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(6.7) 1.41	(0.0) 0.0
Butachlor	1250	5 DAT	(46.0) 3.70	(0.7) 0.36	(2.7) 1.26	(8.0) 2.0	(5.3) 1.27	(0.0) 0.0	(0.0) 0.0	(0.7) 0.36	(6.0) 1.53	(0.0) 0.0
Pretilachlor	750	5 DAT	(32.7) 3.37	(0.0) 0.0	(0.7) 0.36	(0.0) 0.0	(14.0) 2.05	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0	(13.3) 2.53	(3.3) 1.18
Hand weeding (two)		20 and 40 DAT	(8.0) 1.67	(0.0) 0.0	(0.7) 0.36	(2.7) 1.07	(17.3) 1.93	(1.3) 0.73	(0.0) 0.0	(0.0) 0.0	(0.7) 0.36	(0.0) 0.0
LSD (P=0.05)			1.33	NS	0.88	1.67	1.98	NS	0.34	0.47	1.43	0.47

Values in parentheses are original, and transformed to log (x+1) for analysis. DAT–Days after transplanting. NS–Not Significant.

Table 3. Effect of penoxsulam on weed density and dry weight in transplanted rice at 45 DAT

Treatments	Dose (g/ha)	Application stage	Weed density (No./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
			2005	2006	2005	2006	2005	2006
Penoxsulam	20.0	3 DAT	3.5 (35)	2.1 (9)	40.9	6.5	53.8	86.1
Penoxsulam	22.5	3 DAT	3.2 (24)	2.3 (9)	40.6	6.5	54.1	86.1
Penoxsulam	25.0	3 DAT	3.2 (24)	2.1 (7)	42.8	4.3	51.6	90.8
Penoxsulam	17.5	10 DAT	4.4 (88)	3.6 (35)	53.4	10.7	39.7	77.2
Penoxsulam	20.0	10 DAT	4.2 (75)	2.9 (17)	44.6	8.4	49.6	82.1
Penoxsulam	22.5	10 DAT	3.6 (35)	2.7 (14)	38.0	8.0	57.1	82.9
Butachlor	1250	3 DAT	4.1 (69)	4.0 (57)	55.0	6.5	37.9	86.1
Pretilachlor	750	3 DAT	4.1 (64)	3.0 (19)	52.7	2.9	40.5	93.8
Hand weeding	–	20 & 40 DAT	3.3 (29)	2.6 (12)	19.3	2.3	78.19	95.1
Weedy	–	–	5.1 (171)	5.2 (178)	88.5	46.9	–	–
LSD (P=0.05)	–	–	0.76	0.60	29.3	6.5	–	–

DAT–Days after transplanting.
Data subjected to logarithmic transformation. Data in parentheses are original values.

leaf weeds and sedges including *Alisma plantago-aquatica* L., *Ammannia coccinea* Rottb., *C. difformis*, *C. serotinus* C. B. Clarke, *Scirpus maritimus* L. and *S. mucronatus* L. (Larelle *et al.*, 2003). During 2005, among the doses i. e. 22.5 and 25.0 g were comparable in reducing the weed biomass. In 2006, pre-emergence (3 DAT) application of penoxsulam @ 25.0 g/ha resulted in lowest weed dry weight among the different doses of penoxsulam, whereas in case of early post-emergence at 10 DAT penoxsulam 20 and 22.5 g/ha doses were at par with each other and better than lowest dose with respect to their dry weight. Hand weeded plots showed highest weed control efficiency than all other treatments. It was followed by penoxsulam 22.5 g/ha and pretilachlor during 2005 and 2006, respectively. Penoxsulam applied at 20.0 and 22.5 g/ha at 3 DAT recorded higher weed control efficiency due to better effect on weeds during both the years. Weed density and weed dry weight were found lower during 2006 than 2005 (Table 3). It might be due to weed seeds broadcasted only in 2005.

Effect on Crop

There was no phytotoxic effect on transplanted rice due to penoxsulam at any dose either applied at 3 or 10 DAT. Highest grain yield was obtained with the application of penoxsulam at 22.5 and 25 g/ha at 3 DAT during 2005 and 2006, respectively. Penoxsulam at 22.5 and 20.0 g/ha was found better against weeds than both butachlor and pretilachlor. The higher yield of penoxsulam treated plots may be attributed to higher number of panicles per unit area due to less weed competition (Table 4). Penoxsulam (22.5 g at 3 DAT) treated plots recorded the highest number of panicles 374 and 325, respectively during both the years. In 2005, number of panicles per plant were recorded at par with other treatments except weedy check, whereas during the second year, number of panicles were recorded significantly higher with the application of penoxsulam 22.5 g at 3 DAT followed by penoxsulam 20 g (3 DAT) which was at par with remaining treatments except butachlor and weedy check. Untreated plots recorded 37.11 and 31.6% lower yields as compared to hand weeded plots. Weedy plot recorded 40.95 and 34.3% lower grain yield as compared to the treatment having highest grain yield (penoxsulam 22.5 and 25.0 g applied at 3 DAT during 2005 and 2006, respectively). Butachlor and pretilachlor were found inferior to control weeds during first year where it recorded significantly lower yield as compared to penoxsulam treated plot at 3 DAT. However, during second year, only butachlor recorded lower yield as compared to penoxsulam (applied at 3 DAT). Based on two season studies it can be concluded that penoxsulam at 20 to 25 g/ha applied as pre-emergence (3 DAT) and 22.5 g/ha applied as early post-emergence (10 DAT) effectively controlled major weeds in transplanted rice.

Table 4. Effect of penoxsulam on yield and yield attributes of transplanted rice.

Treatments	Dose (g/ha)	Application stage	No. of panicles/m^2		1000-grain weight (g)		No. of grains/ panicle		Grain yield (q/ha)	
			2005	2006	2005	2006	2005	2006	2005	2006
Penoxsulam	20.0	3 DAT	328	243	131	167	25.0	25.1	48.42	46.30
Penoxsulam	22.5	3 DAT	374	325	118	168	24.0	24.0	48.61	47.13
Penoxsulam	25.0	3 DAT	353	231	117	173	24.5	24.3	47.72	48.33
Penoxsulam	17.5	10 DAT	328	224	130	163	24.2	23.4	45.46	42.73
Penoxsulam	20.0	10 DAT	341	221	116	163	23.5	23.1	44.90	43.00
Penoxsulam	22.5	10 DAT	366	219	106	168	24.1	24.1	43.05	44.90
Butachlor	1250	3 DAT	242	211	129	165	24.9	24.0	39.16	43.43
Pretilachlor	750	3 DAT	313	231	126	179	24.2	23.1	40.83	47.77
Hand weeding	–	20 & 40 DAT	360	226	113	177	23.1	23.2	45.64	46.40
Weedy	–	–	240	194	106	153	23.2	23.1	28.70	31.73
LSD (P=0.05)	–	–	84	24	4.0	NS	NS	NS	5.67	5.1

DAT–Days after transplanting. NS–Not Significant.

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