Short Communication

Weed control in dry-seeded rice with penoxsulam

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The conventional practice of transplanted rice has deleterious effects on the soil environment for the succeeding wheat and other upland crops. Direct seeded rice (DSR) which excludes puddling and drudgery of transplanting provides an option to resolve the edaphic conflict and enhances the sustainability of rice-wheat cropping system. It overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations and facilitates timely establishment of rice and succeeding winter crops. Increased labour costs and area under irrigation, development of modern early-maturing varieties and improved fertilizer and weed management techniques have encouraged many farmers in India, Philippines, Malaysia and Thailand to switch from transplanted to direct-seeded flooded rice culture. Direct seeded rice is becoming more popular as an alternative to transplanted rice as being more remunerative if the crop is managed properly. However, heavy weed infestation observed to be major constraint for low productivity of upland rice (Subbaiah, 2005). The adoption of direct seeding has resulted in a change in the relative abundance of weed species in rice crop. In particular, *Echinochloa spp*., *Ischaemum rugosum, Cyperus difformis*, and *Fimbristylis miliacea* are widely adapted to conditions of DSR. Species exhibit variability in germination and establishment response to the water regime, which is a major factor in inter specifically selecting constituents of the weed flora (Rao *et al*., 2007). The heavy weed infestation is one of the major bottlenecks, for realizing the potential yield of DSR. Aerobic mechanical weeding is largely practiced for managing weeds; however, it is a laborious and time consuming method. More over rice being a wet season crop, the opportunity for manual weeding is also ascertain. Chemical method of weed management is best suited as it can take care of weeds right from the beginning of crop growth and is cost effective. However, regular use of a particular herbicide or different with same mode of action may develop herbicide resistance in weeds. Pendimethalin, pyrazosulfuron are used as pre- emergence and penoxsulam, bispyribac as post-emergence for the control of grasses, sedges and broad leaf weeds (Damalas *et al.,* 2006).

Penoxsulam is a new acetolactate synthase (ALS) inhibitor herbicide for post-emergence control of annual grasses, sedges and broad leaf weeds in rice culture, either grown through transplanting or direct dry or direct wet seeding methods of planting (Jabusch and Tjeerdema, 2005). Identifying suitable dose of penoxsulam for controlling weeds in DSR, and its other effects on crop and weeds will pave a way for successful cultivation in *Tarai* region of the country.

Experiment was conducted at G. B. Pant University of Agriculture and Technology, Pantnagar, India, during *Kharif* 2010. The experimental site was loam having high organic carbon (0.82%), available nitrogen (0.02%), phosphorus (22.4 kg/ha) and potassium (187.5 kg/ha) contents with neutral in reaction (pH 7.4). The eight treatments consisted of application of penoxsulam at 20 , 22.5 and 25 g/ha, pyrazosulfuron 20 g/ha, bispyribac sodium 20 g/ha, pendimethalin 1000 g/ha, weed free and weedy check. The field was prepared by four harrowing and followed by levelling with tractor drawn implements. The experiment was laid out in randomized block design (RBD) and replicated four times. Rice variety "Sarjoo-52" was sown on June 10, 2010 at the line to line distance of 20 cm. The herbicides were applied as spray in aqueous medium using 700 liters water per hectare at 19 days after sowing (DAS), 2 DAS and 1 DAS, using foot sprayer fitted with a flat fan nozzle. In weed free plots, weeds were removed manually as and when required after sowing. The weedy plots remained infested with weeds throughout the crop season.

Effect on weeds

C. rotundus, L. chinensis, Echinocloa colona, *E.*

crus-galli, , *A. sessilis* and were the major weed species in the experimental field and constituted 70%, 10%, 9%, 4% and 4% of total weed population at 60 DAS. The weed population increased from 30 to 45 DAS and stabilized at 60 DAS. (Table 1); rate of decrease was 1.74 weeds/m^2/day. This indicated that competition among weeds themselves and with the crop plants would have resulted into a decrease in weed density. At 30 DAS, application of penoxsulam 22.5 and 25 g/ha, bispyribac sodium and pendimethalin had significantly less weed population than weedy check. At 45 DAS all doses of penoxsulam and bispyribac sodium resulted significantly lower weed density than pyrazosulfuron and weedy check . At 60 DAS, significantly lower in total weed density was recorded in the plots applied with penoxsulam 25 g/ha followed by penoxsulam 22.5 g/ha, bispyribac sodium , pendimethalin and pyrazosulfuron . All the herbicidal treatments recorded significantly lower weed density of total weeds over weedy check. At harvest, all the doses of penoxsulam, bispyribac sodium 20 g/ha and pendimethalin 1000 g/ha recorded significantly lower total weed density than weedy check except pyrazosulfuron (Table 1).

Total weeds dry matter production increased in all the treatments up to harvest stage and highest dry matter accumulation was recorded in weedy plot (Table 1). The rate of dry matter production of weeds in weedy treatment was 9.48, 7.87 g/m^2/day during 30 to 45, 45 to 60; dry matter accumulation was highest from 30 to 60 days. This indicates that in case of direct dry seeded rice the critical period of crop-weed competition was from 30 to 60 days. The highest dry matter accumulation of weeds reveals that it will compete with the crop dry matter as well if the weeds are not managed during critical period, this competition may result decline in yield also. The similar result has also been reported by Singh and Bhan (1985), Huh *et al*. (1995) and Mukherjee *et al.,* (2008).

Effect on crop and grain yield

The dry matter increased with duration of the crop growth being the highest dry matter was recorded at harvest stage. At 30 DAS, significantly the highest dry matter accumulation was recorded in case of weed free followed by penoxsulam 25 g/ha than rest of the treatments. The lowest dry matter accumulation of crop was recorded in case of weedy plot followed by penoxsulam 20 g/ha followed by pendimethalin 1000 g/ha, penoxsulam 22.5 g/ha and pyrazosulfuran 20 g/ha. Significantly higher dry matter accumulation was recorded in weed free followed by penoxsulam 25 g/ha than weedy check. At 45 DAS, significantly highest dry matter accumulation was recorded in case of weed free plot followed by penoxsulam 25 g/ha and the later was at par to penoxsulam 22.5 g/ha, and penoxsulam 20 g/ha. The lowest dry matter accumulation was recorded by weedy plot being at par with pyrazosulfuron 20 g/ha. Weed free treatment recorded significantly higher dry matter accumulation at 45 DAS. Pyrazosulfuron 20 g/ha and pendimethalin 1000 g/ha were at par with weedy check. At 60 DAS, significantly higher dry matter accumulation was recorded in case of weed free followed by penoxsulam 25 g/ha, bispyribac sodium 20 g/ha, penoxsulam 22.5 g/ha, pendimethalin 1000 g/ha and pyrazosulfuron 20 g/ha than weedy check. The lowest dry matter accumulation was recorded in case of weedy plot followed by pyrazosulfuron 20 g/ha. At harvest, significantly higher dry matter accumulation was recorded in case of weed free plot followed by

Table 1: Effect of treatments on total weed density (No. /m^2), total weed dry matter (g/ m^2) and weed control efficiency (%) at different stages of crop growth.

Treatment	Doses (g a.i./ha)	Stage of application (DAS)	Total weed density		Total weed dry weight		WCE
			45 DAS	60 DAS	45 DAS	60 DAS	60 DAS
Penoxsulam 24 SC	20	19	5.72 (316)	4.81(132.66)	43.20	77.57	73.66
Penoxsulam 24 SC	22.5	19	5.57 (268)	4.63 (108.16)	39.00	54.80	81.39
Penoxsulam 24 SC	25	19	5.07 (171)	4.23 (72.5)	26.80	46.13	84.34
Pyrazosulfuron10 WP	20	2	6.21(516.5)	5.09 (168.83)	153.25	242.46	17.69
Bispyribac sodium10 EC	20	19	5.26 (215)	4.70 (112.32)	50.50	80.91	72.53
Pendimethalin 30 EC	1000	1	6.15 (474)	4.97 (154.32)	91.70	100.63	65.84
Weed free	-	-	0.00 (0)	0.00 (0)	00.00	00.00	100
Weedy	-	-	6.39 (632)	5.93 (288.66)	176.40	294.59	00.00
SEm±			0.16	0.15	4.50	9.01	0.11
C.D. at 5%			0.48	0.46	13.36	26.50	0.33

Note: Original values are given in parentheses penoxsulam 25 g/ha, penoxsulam 22.5 g/ha and bispyribac sodium 20 g/ha than weedy check and pyrazosulfuron 20 g/ha, pendimethalin 1000 g/ha and penoxsulam 22.5 g/ha were recorded at par with weedy check. The lowest dry matter accumulation was recorded in case of weedy check followed by pyrazosulfuron 20 g/ha.

All the treatments were recorded significantly higher number of panicles than weedy check (46 /m^2). Penoxsulam 25 g/ha was recorded significantly higher in number of panicles (182 /m^2) than all the treatments except weed free plot (191/m^2). The higher number of panicles was recorded in weed free plot (191 /m^2) followed by penoxsulam 25 g/ha (182 /m^2), bispyribac sodium 20 g/ha (143 /m^2) and penoxsulam 22.5 g/ha (138 /m^2). The lowest number of panicles was recorded by weedy check (46 /m^2).

All the treatments except weed free (217) did not influence number of grains per panicle than weedy plot. The higher number of grains per panicle was recorded with the application of penoxsulam 25 g/ha (203) followed by bispyribac sodium 20 g/ha (201), pyrazosulfuron 20 g/ha (194), penoxsulam 22.5 g/ha (190). Application of pendimethalin 1000 g/ha (177) recorded significantly lower number of grains per panicle than with weed free plot (217).

Penoxsulam 25 g/ha gave significantly higher in 1000 grains weight than weedy plot. All the treatments were recorded non significant than weedy check. Minimum 1000 grain weight was found in weedy check followed by pyrazosulfuron 20 g/ha, pendimethalin 1000 g/ha and maximum 1000 grain weight was found in penoxsulam 25 g/ha treated plots which was at par with penoxsulam 22.5 g/ha and weed free.

Weedy plot caused 69 per cent reduction in grain yield of rice than weed free plot which yielded highest grain yield (4870 kg/ha) which was at par with penoxsulam 25 g/ha (4477 kg/ha), penoxsulam 20 g/ha (4062 kg/ha), penoxsulam 22.5 g/ha (4166 kg/ha), bispyribac sodium 20 g/ha (4166 kg/ha) and lowest in weedy check (1499 kg/ha). The higher grain yield in weed free and penoxsulam 25 g/ha treatments were due to better control of weeds in these plots and had less weed competition. Similar grain yield was also recorded with the application of penoxsulam 22.5 g/ha and bispyribac sodium 20 g/ha .The higher grain yield in weed free treatment was mainly attributed to higher number of panicles and grains per panicle (Table 2). The rice yield with pendimethalin 1000 g/ha and pyrazosulfuron 20 g/ha was lower than all other treatments due to lower number of panicles and grains per panicle which were the consequences of higher weed density and dry matter accumulation of the weeds (Table 2). The loss of rice grain yield due to weeds up to 40 to 100 per cent has also been reported (Choubey *et al*. 2001).

CONCLUSION

It can be concluded that early post emergence application of herbicides was more effective than pre emergence application. Penoxsulam 25 g/ha achieved highest weed control efficiency (84%) and grain yield (4477 kg/ha).

Table 2: Effect of weed control treatments on crop dry matter (g/m^2), yield attributing characters and grain yield at different stages of crop growth

Treatment	Doses (g a.i./ha)	Stage of application (DAS)	Crop dry matter		Yield contributing characters			
			45 DAS	60 DAS	Panicles (No. /m^2)	No. of grains/ panicle	1000 grains weight	Grain yield (kg/ha)
Penoxsulam 24 SC	20	19	121.50	257.60	118	174	21.62	4062
Penoxsulam 24 SC	22.5	19	124.80	286.40	138	190	22.88	4166
Penoxsulam 24 SC	25	19	135.60	313.20	182	203	24.40	4477
Pyrazosulfuron 10 WP	20	2	106.70	194.40	119	197	21.13	2812
Bispyribac sodium 10 EC	20	19	114.20	296.60	143	201	21.75	4166
Pendimethalin 30 EC	1000	1	110.30	262.50	96	177	21.50	3010
Weed free	-	1	165.50	355.90	191	217	23.50	4870
Weedy	-	-	102.00	156.00	46	167	21.00	1499
SEm±			4.00	9.67	4.53	13	0.85	317
C.D. at 5%			11.70	28.46	13.34	38	2.51	935

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