

## Control of Complex Weed Flora of Dry-seeded Rice (*Oryza sativa* L.) with Pre- and Post-emergence Herbicides

U. S. Walia, M. S. Bhullar, Shelly Nayyar and S. S. Walia

Department of Agronomy

Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

### ABSTRACT

To tackle the serious problems of weeds in dry direct-seeded rice (DSR), a field experiment was conducted on loamy sand soil at Ludhiana, Punjab during 2006 and 2007 with an objective to identify effective herbicides for the control of complex weed flora of DSR. It is difficult to raise weed free DSR with the application of only one herbicide. Integration of pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence (30 DAS) application of bispyribac 25 g/ha or azimsulfuron 20 g/ha or 2,4-D 500 g/ha resulted in effective weed control and higher rice grain yields. Pendimethalin pre-emergence application provided effective control of non-predominant paddy weeds, whereas bispyribac controlled all typical predominant paddy weeds including *Echinochloa colona* and all *Cyperus* species. Azimsulfuron or 2, 4-D was effective against all *Cyperus* spp. and broad-leaved weeds. Integration of pre-emergence application of pendimethalin 0.75 kg/ha with post-emergence application of bispyribac 25 g/ha resulted in 372% increase in rice grain yield as compared to unweeded control.

**Key words :** Effective weed management, DSR, herbicide efficacy

### INTRODUCTION

Rice is very popular crop of Punjab farmers because of its higher yield potential as well as due to assured procurement price and due to well established systems. During 2007, rice occupied 26.21 lakh hectares with total production of 101.38 lakh tonnes and with average paddy yield of 5802 kg/ha in Punjab (Anonymous, 2008). Before the start of rice cultivation on large scale i. e. during 1964, the underground water level of the Punjab state was very shallow i. e. from 5-20 ft in different districts of Punjab. During the green revolution era, farmers started raising short duration high input responsive rice and wheat varieties. Consequently, a sharp decline in water table was observed. The scientists have reported a decline of 55 cm per year in the underground water table from 1993 to 2007 which is very unfortunate for the people of Punjab.

To make paddy cultivation cost effective, water use efficient and eco-friendly, direct-seeded rice provides an option which saves not only labour required for transplanting but also helps to preserve natural resources especially under ground water. Direct-seeding is now fast replacing traditional transplanted rice in areas with good drainage and irrigation facilities (Balasubramanian and Hill, 2000). However, for cultivation of direct-seeded rice, weeds are major hurdle for its success (Rao *et al.*, 2007; Rao and Nagamani, 2007) as nearly all **kharif**

season weeds depending upon seed bank in the field infest this crop. Weeds pose major problem in rice production due to the prevalence of congenial atmosphere during **kharif** season and uncontrolled weeds compete with dry-seeded rice and reduce yield upto 30.17 % (Singh *et al.*, 2005). So, present investigations were undertaken to find out suitable weed control measures to keep dry-seeded rice free from weeds.

### MATERIALS AND METHODS

A field investigation was conducted at the research farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab, during **kharif** 2006 and 2007 to determine the efficacy of different pre- and post-emergence herbicides for controlling weeds in dry (without puddling) direct-seeded rice (DSR). Sixteen herbicide treatments were laid out in randomized block design during first year. Pre-emergence application of pretilachlor 0.40 kg/ha, pendimethalin 0.75 kg/ha, flufenacet 120 g/ha, pendimethalin 0.75 kg/ha followed by pendimethalin 0.56 kg/ha (20 DAS), thiobencarb 1.25 kg/ha, thiobencarb 1.25 kg/ha followed by thiobencarb 1.25 kg/ha (20 DAS), thiobencarb 1.25 kg/ha+pendimethalin 0.75 kg/ha, oxadiargyl 90 g/ha and pendimethalin 0.75 kg/ha+oxadiargyl 60 g/ha were applied after mixing in sand by broadcast method. Bispyribac

was applied as post-emergence application (30 DAS) at 30 and 40 g/ha, penoxasulam at 20 and 25 g/ha (10 DAS) and azimsulfuron at 20 and 25 g/ha (30 DAS) were applied through spray applications. An unweeded (control) treatment was kept for comparison.

During 2007, herbicide treatments were modified and 13 treatments were laid out in randomized block design. The treatments were pre-emergence application of pendimethalin 0.75 kg/ha alone, pendimethalin 0.75 kg/ha followed by bispyribac 25 g/ha (30 DAS), pendimethalin 0.75 kg/ha followed by azimsulfuron 20 g/ha (30 DAS), pendimethalin 0.75 kg/ha followed by 2,4-D 0.50 kg/ha (30 DAS), pre-emergence application of pretilachlor 0.50 kg/ha alone, pretilachlor 0.50 kg/ha followed by post-emergence application of bispyribac 25 g/ha/azimsulfuron 20 g/ha/2,4-D 0.50 kg/ha (30 days after sowing the crop). Other treatments were post-emergence application (30 DAS) of bispyribac at 25 and 30 g/ha, as well as tank mix application of bispyribac 25 and 30 g/ha with azimsulfuron 20 g/ha. Bispyribac and azimsulfuron were applied as post-emergence application (30 DAS) through spray applications, whereas pendimethalin and pretilachlor were applied after mixing in sand by broadcast method. An unweeded (control) treatment was also kept for comparison. Sowing of PR 115 variety of rice was done on June 10, 2006 and June 8, 2007 by using 50 kg/ha seed rate. Dry-seeding of rice was done in rows 20 cm apart during both the years. Experimental field had complex weed flora including predominant paddy and non-predominant paddy weeds. The important weed flora was *Trianthema portulacastrum* L., *Eragrostis tenella* (L.) P. Beauv. Ex Roem. & Schult., *Eragrostis pilosa* (L.) P. Beauv., *Dactyloctenium aegyptium* (L.) Willd., *Eleusine indica* (L.) Gaertn., *Digera arvensis* (L.), *Commelina benghalensis* L., *Echinochloa colona* (L.) Link, *Echinochloa crus-galli* (L.) P. Beauv., *Cyperus rotundus* L., *Cyperus iria* L., *Cyperus difformis* L., *Fimbristylis* spp., *Caesulia axillaris* Roxb. and *Sphenoclea* spp. The weed pressure was very high during both the years.

## RESULTS AND DISCUSSION

During 2006, among different tested herbicides, the performance of bispyribac at 30 and 40 g/ha when applied 30 days after sowing (DAS), penoxasulam at 20 and 25 g/ha applied 10 DAS and azimsulfuron 20 and 25 g/ha applied 30 DAS were found very effective as all

these treatments resulted in significant reduction in dry matter accumulation by weeds as compared to pre-emergence application of pendimethalin at 0.75 kg/ha alone (Table 1). Accordingly, all these herbicidal treatments produced significantly higher rice grain yield as compared to pre-emergence application of pendimethalin alone at 0.75 kg/ha. Porwal (1999) also reported similar findings that post-emergence application of pretilachlor with safener at 0.375 kg/ha gave 13.4% higher yield over its pre-emergence application. The highest grain yield of 4684 kg/ha was recorded in post-emergence application of bispyribac at 30 g/ha which was significantly higher than penoxasulam 20 g/ha and azimsulfuron 20 g/ha. The performance of pendimethalin 0.75 kg/ha alone or followed by pendimethalin 0.56 kg/ha, pendimethalin 0.75 kg plus oxadiargyl 60 g/ha, thiobencarb 1.25 kg/ha and oxydiargyl 90 g/ha were found unsatisfactory as all these treatments produced rice grain yield at par with unweeded (control) treatment.

During 2007 (Table 2), the performance of pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence application of bispyribac 25 g/ha (30 DAS) was found very effective which resulted in significant reduction in weed dry weight as compared to all other treatments. Pendimethalin 0.75 kg/ha as pre-emergence application followed by azimsulfuron 20 g/ha or 2, 4-D 500 g/ha as post-emergence application also resulted in significantly less weed dry matter accumulation compared to other herbicide treatments. This was due to the reason that all non-predominant paddy weeds i. e *Eleusine indica*, *Eleusine indica*, *Digitaria sanguinalis* and *Cyperus rotundus* were controlled with the pre-emergence application of pendimethalin and predominant paddy weeds particularly *Echinochloa colona* and *Cyperus* species were very effectively controlled with post-emergence application of bispyribac. Pre-emergence application of pendimethalin 0.75 kg/ha or pretilachlor 0.50 kg/ha as well as post-emergence application of bispyribac 25 and 30 g/ha or bispyribac+azimsulfuron alone, at both the levels did not provide effective control of weeds as compared to pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence application of bispyribac 25 g/ha or azimsulfuron 20 g/ha or 2,4-D 500 g/ha. Singh *et al.* (2005) also reported similar findings that combination of post-emergence application of 2, 4-D 500 g/ha with pre-emergence application of pendimethalin 1.0 kg/ha recorded highest rice grain yield and weed control efficiency. Non-paddy

Table 1. Effect of pre- and post-emergence application of different herbicides on associated weeds dry weight and grain yield and yield attributes of dry direct-seeded rice (2006).

Treatments	Dose (g/ha)	Weeds dry weight* (q/ha)	Rice plant height (cm)	Rice effective tillers/m <sup>2</sup>	Rice panicle length (cm)	Rice grain yield (kg/ha)
Pretilachlor PRE	400	4.05 (16.28)	51.47	235	18.5	2934
Pendimethalin PRE	750	6.57 (45.43)	45.67	152	15.4	1666
Pendimethalin PRE fb Pendimethalin POE	750+500	3.79 (17.71)	42.60	174	18.1	1134
Thiobencarb PRE	1250	4.00 (19.54)	43.80	172	17.0	1984
Thiobencarb PRE fb Thiobencarb 20 DAS	1250+250	1.48 (1.65)	55.87	302	22.0	3500
Thiobencarb+Pendimethalin PRE	1250+750	3.67 (16.43)	51.47	281	21.7	3500
Oxadiargyl PRE	90	2.33 (5.50)	55.20	267	20.4	1984
Bispyribac POE (30 DAS)	30	3.02 (10.78)	55.20	300	20.3	4684
Bispyribac POE (30 DAS)	40	3.25 (12.10)	52.07	226	19.2	4150
Penoxsulam 10 DAS	20	3.48 (14.30)	54.00	309	22.2	3500
Penoxsulam 10 DAS	25	3.64 (15.99)	54.60	376	22.1	3800
Flufenacet PRE	120	5.03 (32.49)	46.40	157	16.4	2884
Azimsulfuron POE (30 DAS)	20	3.09 (11.04)	47.93	181	15.5	2750
Azimsulfuron POE (30 DAS)	25	3.16 (11.29)	46.40	211	17.1	3934
Pendimethalin+Oxadiargyl PRE	750+600	3.49 (23.65)	49.53	207	19.9	1896
Control (unweeded)	-	9.24 (84.52)	40.0	150	15.9	1400
LSD (P=0.05)		3.56	9.7	113	4.91	1119

PRE–Pre-emergence application, POE–Post-emergence application, DAS–Days after seeding.

\*Original values are given in parentheses.

Table 2. Effect of pre- and post-emergence application of different herbicides on associated weeds dry weight and grain yield and yield attributes of dry direct-seeded rice (2007)

Treatments	Dose (g/ha)	Weeds dry weight* (q/ha)	Rice plant height (cm)	Rice effective tillers/m <sup>2</sup>	Rice panicle length (cm)	Rice grain yield (kg/ha)
Pendimethalin PRE	750	4.44 (19.55)	51.7	41.4	18.8	3952
Pendimethalin PRE fb Bispyribac POE (30 DAS)	750 fb 25	2.95 (9.64)	59.2	50.4	21.4	5618
Pendimethalin PRE fb azimsulfuron POE (30 DAS)	750 fb 20	3.52 (11.51)	50.1	47.9	20.9	4747
Pendimethalin PRE fb 2,4-D 30 DAS	750 fb 20	3.96 (15.50)	55.7	48.1	20.1	4675
Pretilachlor PRE	750 fb 500	8.94 (80.74)	38.9	35.5	15.7	1317
Pretilachlor PRE fb bispyribac 30 DAS	500	6.02 (35.40)	45.9	42.9	18.3	3920
Pretilachlor PRE fb azimsulfuron 30 DAS	500 fb 25	7.12 (49.80)	39.1	39.3	18.3	2111
Pretilachlor PRE fb 2,4-D 30 DAS	500 fb 20	7.11 (50.00)	46.6	37.2	18.1	2222
Bispyribac 30DAS	500 fb 500	6.57 (42.30)	45.5	37.5	18.6	1991
Bispyribac 30 DAS	25	6.43 (42.90)	49.3	40.2	19.5	2420
Bispyribac+azimsulfuron 30 DAS	30	5.26 (27.20)	46.5	38.8	19.7	2372
Bispyribac+azimsulfuron 30 DAS	25+20	4.44 (19.60)	51.1	39.5	17.9	1602
Control (unweeded)	30+20	8.49 (71.60)	36.7	29.6	19.1	1191
LSD (P=0.05)	-	1.87	7.79	5.29	NS	425

PRE–Pre-emergence application, POE–Post-emergence application, DAS–Days after seeding.

\*Original values are given in parentheses.

weeds were controlled by pendimethalin or pretilachlor applied as pre-emergence application but these were not controlled with post-emergence application of bispyribac, azimsulfuron or 2, 4-D. Among the pre-emergence herbicides, pendimethalin was found safe

to rice crop, whereas pretilachlor was found slightly phytotoxic to the crop resulting in reduced tillers and height of rice. Among the post-emergence herbicides, bispyribac 25 g/ha was found slightly better than azimsulfuron 20 g/ha and 2, 4-D 0.50 kg/ha. Highest

rice grain yield (5618 kg/ha) was obtained with the pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence application of bispyribac 25 g/ha as compared to all other herbicidal treatments as this treatment provided effective control of associated complex weed flora. The increased yield in this treatment was due to significant reduction in dry matter accumulation by the weeds and significantly higher number of effective tillers per metre row length and plant height when compared to other treatments. This treatment was closely followed by pre-emergence application of pendimethalin followed by post-emergence application of azimsulfuron 20 g/ha treatments as compared to unweeded control.

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