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Performance of Chemical Herbicides on Weed Dynamics and Economics of Direct *Seeded Rice*

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ABSTRACT: In recent years, direct-seeded rice (DSR) has emerged as a viable alternative to conventional transplanted rice. Direct-seeded rice conserves water and has physical, economical and environmental benefits, but weeds represent a major issue for crop production efficiency. It's tough to manage them with a single pre-or post-emergence herbicide spray since they come in many flushes. Keeping this in mind, a field experiment was conducted during the 2019-20 Kharif season at the Bihar Agricultural University's Agricultural Research Farm at Sabour, Bhagalpur, to evaluate the effectiveness of various pre-and post-emergence herbicides on weed dynamics and the economics of direct seeded rice. The experiment was laid down into split-plot design with three replications having four pre-emergence herbicides (main plot) and five post-emergence herbicides (sub plot) consisting of twenty treatment combinations. Results revealed that use of Pendimethalin @ 1000 g a.i. ha^{-1} as pre-emergence followed by use of Bispyribac @ 25 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} as post-emergence registered significantly lower weed dry matter, weed density and higher weed control efficiency. This treatment combination also resulted in the highest gross return (₹ha^{-1} 88,412/-), net return (₹ha^{-1}54,724/-) and B:C ratio (1.62). This study revealed that the pre-emergence application of Pendimethalin @ 1000 g a.i. ha^{-1} then after post-emergence application of Bispyribac @ 25 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} can be suggested for effective and economic management of weeds in direct seeded rice.

Keywords: B:C ratio, Pendimethalin, Post-emergence, Pre-emergence and Weed Dynamics.

INTRODUCTION

Rice is the most common cereal crop and the primary source of nutrition for more than half of the world's population. Worldwide rice production is 506.23 million tonnes from 163.26 million ha of land, with a productivity of 3.10 t ha^{-1} (USDA, 2020-21). Asia produces and consumes about 90% of the world's rice (FAO, 2014), and rice accounts for two-thirds of Asian people's daily calories (Anonymous, 2017). With a production of 122.27 million tonnes from 45 million hectares and a productivity of 2.71 tonnes ha^{-1}, India is the world's second-largest rice producer (USDA, 2020-21). Rice is grown on 3.09 million hectares in Bihar, with a yield of 6.96 million tonnes and a productivity of 2.25 tonnes per hectare (Directorate of Economics and Statistics, Bihar, 2019-20). In India, direct seeded rice is cultivated on 7.2 million hectares, accounting for 26% of the total rice area in South Asia (Verma *et al*., 2017).

Direct seeded rice has become popular as a rice-growing alternative in the last few years. Rather than puddling the field and then transplanting seedlings from the nursery, this method establishes the crops by sowing the seeds directly in the field (Farooq *et al*., 2011). Direct seeding eliminates three main cultural operations: nursery raising, puddling, and transplanting, saving approximately 25% (250-300 man-hours) of labour (Kachroo and Bazaya, 2011), lowering cultivation costs and generating additional income. DSR conserves 35-57% of irrigation water (Chauhan *et al*., 2012). It allows for 7–10 days earlier crop maturity, allowing for early Rabi crop sowing (Ladha *et al*., 2015). It is critical to replace puddled transplanting with direct sowing to enhance conservation agriculture (CA) with no/minimum tillage. In comparison to puddled transplanted rice (PTR), it also reduces methane emissions (Tyagi *et al*., 2010). Declining water tables, increasing costs of fuel and electricity, and climate change are other reasons to adopt it.

Weeds are a major problem in cultivating direct seeded rice. In this system, seedlings of the crop and weeds emerge simultaneously due to the fact that the crops become more vulnerable to weeds during the initial stage of their growth, resulting in intense competition for resources (nutrients, moisture, space, and light) by the crop. The main reason behind the high weed infestation in DSR is the lack of weed suppression effect of standing water. The critical period for crop-weed competition in direct-seeded rice ranges from 20 to 50 days after sowing (Khaliq and Matloob, 2011), and failure to weed management results in 50 to 90% yield losses (Chauhan and Opeña, 2012).

Therefore, effective weed management is very necessary for the successful growth of direct-seeded rice. Hand weeding is becoming less popular due to labour scarcity and high wages. For quick and cost-effective weed control, chemical weed control is often preferred. Management of diverse weed flora in direct-seeded rice can be done effectively by applying pre- and post-emergence herbicides sequentially (Mahajan and Chauhan, 2015). Taking this into consideration, this research trial was conducted to evaluate the efficacy of several pre-emergence and post-emergence herbicides and their proper sequence on weed dynamics and economics in direct seeded rice.

MATERIAL AND METHODS

The experiment was performed at the Bihar Agricultural University's Agricultural Research Farm in Sabour, Bhagalpur, Bihar, during the Kharif of 2019-20. Under the middle Gangetic plains, Bhagalpur is located in Agro-Climatic Zone III-A. The experimental region is located in a latitude of 25°15′40″N and a longitude of 87°2′42″E, at a height of 45.75 metres above mean sea level. The average annual rainfall in this area is 1167.0 mm, with approximately 75 to 80 percent of that falling between the middle of June and the middle of October (about 120 days) and relatively little falling the rest of the year (245 days). The hottest month is May, with an average monthly temperature of roughly 36°C, while the coldest month is January, with an average monthly temperature of around 10°C. The total rainfall received in 2019 was 925.6 mm from June to October, which corresponds to the rice-growing season. The wettest month was July (380.3 mm), followed by September (371.3 mm), with the rest of the cropping season receiving significantly less rainfall. The maximum monthly average temperature ranged from 30.8°C to 37.9 °C during the Kharif of 2019-20, while the minimum temperature ranged from 21.7°C to 26.6°C.

The soil type of the experimental site was loamy sand having a slightly alkaline pH of 7.6, electrical conductivity of 0.31 dSm^{-1}, organic carbon 0.51 %, bulk density of 1.34 Mg m^{-3}, available N of 209.2 kg ha^{-1}, available P_2O_5 of 38.5 kg ha^{-1}, and available K_2O of 151.4 kg ha^{-1}.

Details of Experiment.

Crop under trial Variety of rice under trial Experimental Design	: Rice : *Rajendra Sweta* : Split-Plot Design
Sowing date	: 29/06/2019
Harvesting date	: 10/11/2019
Size of the individual plot	: 22.5 square metres
No. of treatment combinations: Total no. of Replications Total number of plots	: 20 : 3 : 60
Spacing between rows RDF	: 20 cm : 120: 60: 40: (N: P_2O_5: K_2O Kg ha^{-1})

Details of Treatments:

Details of Treatments			
Main Plot Treatments			
Pre-emergence Herbicides- 4		**Dose** (g a.i. ha^{-1})	**Time of application**
PE_1	No Pre-emergence	—	—
PE_2	Pendimethalin	1000	2 Days after sowing
PE_3	Oxadiargyl (Topstar)	500	2 Days after sowing
PE_4	Pretilachlor with Safener (Sofit)	500	2 Days after sowing
Sub Plot Treatments			
Post-emergence Herbicides- 5		**Dose** (g a.i. ha^{-1})	**Time of application**
PoE_1	No Post-emergence	—	—
PoE_2	Bispyribac	25	25 Days after sowing
PoE_3	Bispyribac + Pyrazosulfuron	(25+20)	25 Days after sowing
PoE_4	Fenoxoprop + Ethoxysulfuron	(56+18)	25 Days after sowing
PoE_5	Fenoxoprop *fb* Halosulfuron	(56 *fb* 67)	25 Days after sowing

fb: Followed by; PE: Pre-emergence; PoE: Post-emergence

Variety: Rajendra Sweta is a photo-insensitive, medium-duration (135 days) variety having a yield potential of 4–4.5 t ha^{-1}.

RESULT AND DISCUSSION

Effect on weed dynamics: Weed related data like dominant weed species, density of weeds (no. m^{-2}), dry matter of weeds (g m^{-2}) and weed control efficiency were collected and analysed, which showed a huge impact of pre-emergence and post-emergence herbicide applications.

Weed species of major importance: The experimental plot was infested with mainly three types of weeds. Grassy weeds included *Echinochloa colona*, *Echinochloa crusgalli*, *Dactyloctenium aegyptium*, *Panicum maximum*; broad-leaved weeds included *Amaranthus viridis*, *Caesulia axillaries*, *Phyllanthus niruri*, *Physalis minima*; sedges included *Cyperus rotundus*, *Cyperus iria, Cyperus difformis* and *Fimbristylis milliacea.*

Density of Weeds (count m^{-2}): Application of Pendimethalin (1000 g a.i. ha^{-1}) lowered the density of grassy weeds, broad-leaved weeds, sedges and overall density of weeds at 30, 60 and 90 days after sowing, which was found to be statistically at par with Pretilachlor (500 g a.i. ha^{-1}) and Oxadiargyl (500 g a.i. ha^{-1}). Whereas Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) as PoE resulted in lower weed density of grassy weeds, broad-leaf weeds (BLW), sedges, and overall weed density in sub plot treatments (Table 1).

Table 1: Weed dynamics of direct seeded rice as influenced by different pre and post-emergence herbicides.

Treatments	Density of Weeds (count m^{-2})			Dry Matter of Weeds (g m^{-2})			Weed Control Efficiency (WCE) (%)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Main plot (Pre-emergence herbicides)									
No Pre-emergence	7.5 (59)	8.5 (78)	8.6 (77)	6.4 (41.8)	9.4 (91.6)	10.8 (119.4)	35	47	43
Pendimethalin	5.8 (34)	5.9 (38)	6.2 (40)	5.1 (26.2)	6.7 (45.1)	7.6 (57.9)	59	74	71
Oxadiargyl	6.2 (38)	6.3 (43)	6.5 (45)	5.2 (26.7)	6.9 (48.3)	8.0 (63.9)	58	72	69
Pretilachlor	6.1 (38)	6.4 (45)	6.4 (44)	5.2 (27)	6.7 (45.6)	7.7 (59.4)	58	73	71
S Em (±)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1**	**1**	**1**
C.D at 5 %	**0.4**	**0.4**	**0.3**	**0.2**	**0.2**	**0.2**	**3**	**2**	**3**
Sub plot (Post-emergence herbicides)									
No Post-emergence	8.3 (72)	10.7 (116)	10.4 (109)	6.9 (47.8)	9.9 (100.6)	10.9 (123.1)	25	41	40
Bispyribac	6.1 (37)	5.8 (34)	6.0 (37)	5.1 (26.1)	6.8 (46.7)	7.9 (63.9)	59	73	69
Bispyribac + Pyrazosulfuron	5.6 (31)	5.3 (28)	5.7 (32)	4.8 (22.7)	6.3 (40.4)	7.4 (55.0)	65	76	73
Fenoxoprop + Ethoxysulfuron	5.9 (35)	6 (36)	6.3 (40)	5.2 (26.8)	7 (49.1)	8.0 (65.5)	58	71	68
Fenoxoprop *fb* Halosulfuron	6 (36)	6.2 (40)	6.3 (40)	5.4 (28.7)	7.1 (51.4)	8.2 (68.4)	55	70	66
S Em (±)	**0.1**	**0.1**	**0.1**	**0.0**	**0.0**	**0**	**1**	**0**	**0**
C.D at 5 %	**0.2**	**0.3**	**0.3**	**0.1**	**0.1**	**0.1**	**3**	**1**	**1**

DAS = Days after sowing**;** SQRT Transformed values: $\sqrt{X+0.5}$; Original values are given in parenthesis in case of density and dry matter of weeds.

The interaction effect of pre and post-emergence herbicides resulted in a significantly lower density of grassy, broad-leafy weeds, sedges, and overall weed count with the application of Pendimethalin (1000 g a.i. ha^{-1}) as PE, followed by Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) as PoE, which was seen statistically at par with Pendimethalin as PE and Bispyribac as PoE at almost all the stages of observation. This might be related to Pendimethalin's ability to effectively suppress a broad spectrum of weeds during their emergence. By inhibiting the acetolactate synthase enzyme, Bispyribac + Pyrazosulfuron efficiently suppressed and controlled weeds that developed late in the crop cycle. The result was in conformity with Walia *et al*., (2012); Kumar and Singh, (2016); Gaire *et al*., (2019) (Table 2).

Weed dry matter (g m^{-2}): Among the main plot treatments, Pendimethalin (1000 g a.i. ha^{-1}) had the lowest weed biomass of grassy and broad leafy weeds, which was at par with Pretilachlor (500 g a.i. ha^{-1}) and Oxadiargyl (500 g a.i. ha^{-1}). The highest total weed dry matter was observed by no pre-emergence. Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) produced considerably lower weed dry matter (g m-2) of grasses, broad leaf weeds, sedges, and overall weed dry matter in sub plot treatments. It was calculated at par with Bispyribac (25 g a.i. ha^{-1}) for grasses and broad-leaf weeds, and it was calculated at par with Fenoxoprop *fb* Halosulfuron for sedges (Table 1).

The interaction of pre-and post-emergence herbicides had a significant impact on weed dry matter, as shown in (Table 2). Pendimethalin (1000 g a.i. ha^{-1})-Bispyribac (25 g a.i. ha$^{-1)}$ + Pyrazosulfuron (20 g a.i. ha^{-1}) resulted in significantly decreased weed biomass of grasses, broad-leaf weeds, and sedges, which was at par with Pendimethalin - Bispyribac. This could be due to the use of Pendimethalin, which effectively controlled weeds that emerged early in the crop, followed by a combined application of Bispyribac + Pyrazosulfuron, which provided a broad spectrum of weed control at later stages of crop growth, resulting in lower weed density and weed biomass. The same types of results were observed by Walia *et al*., (2012); Kumar and Singh, (2016); Saphi *et al*., (2018).

Weed Control Efficiency (%): A gradual increase in weed control efficiency was observed from 30 to 60 days after sowing, then fell gradually up to 90 days after sowing. Pendimethalin (1000 g a.i. ha^{-1}) as pre-emergence had the highest weed control efficiency (WCE %) among the main plot treatments at all dates of observation, which was statistically at par with Pretilachlor (500 g a.i. ha^{-1}) and Oxadiargyl (500 g a.i. ha^{-1}). The weed control efficiency was lowest with no pre-emergence herbicide application. In the case of sub-plot treatments, WCE was considerably greater with Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) than Bispyribac, Fenoxoprop + Ethoxysulfuron and Fenoxoprop *fb* Halosulfuron at all the dates of observation (Table 1).

At all dates of observation, the interaction effect of pre- and post-emergence herbicides on weed control efficiency at different growth stages of DSR resulted in significantly higher weed control efficiency with Pendimethalin (1000 g a.i. ha^{-1}) as pre-emergence followed by Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) as post-emergence herbicide. This was attributed to the sequential use of pre-emergence and post-emergence herbicides, which successfully suppressed weeds and resulted in the lowest weed dry matter and hence the maximum weed control efficiency. Outcomes were in accordance with Dixit *et al*., (2008); Sharma *et al*., (2014); Gaire *et al*., (2019) (Table 2).

Table 2: Weed dynamics affected by the interaction of several pre-emergence and post-emergence herbicides in direct seeded rice.

Treatment Combinations	Weed Density (count m^{-2})			Weed Dry matter (g m^{-2})			Weed control efficiency		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
No PE - No PoE	11.3 (127)	12.9 (166)	12.5 (155)	8 (64.1)	13.1 (171.7)	14.4 (208.2)	0	0	0
No PE - Bispyribac	6.8 (46)	7.5 (56)	7.7 (59)	6.1 (36.1)	8.6 (74.3)	10.1 (101.0)	43	57	53
No PE - Bispyribac + Pyrazosulfuron	6.3 (40)	6.7 (44)	7.1 (50)	5.5 (29.5)	7.8 (60)	9.1 (81.7)	54	65	62
No PE - Fenoxoprop + Ethoxysulfuron	6.5 (42)	7.5 (56)	7.5 (57)	6.2 (38)	8.6 (74)	10.1 (101.7)	40	57	52
No PE – Fenoxoprop *fb* Halosulfuron	6.4 (40)	8.2 (67)	8 (64)	6.5 (41.3)	8.9 (78.1)	10.3 (104.7)	35	54	50
Pendimethalin - No PoE	6.9 (48)	9.1 (83)	9.1 (83)	6.6 (42.8)	8.9 (78.3)	9.7 (94.0)	33	54	52
Pendimethalin -Bispyribac	5.6 (31)	5.1 (25)	5.1 (26)	4.7 (21.9)	6 (35.2)	7.0 (49.0)	66	79	75
Pendimethalin -Bispyribac + Pyrazosulfuron	5.2 (26)	4.4 (19)	4.9 (23)	4.5 (19.5)	5.8 (33.2)	6.7 (43.8)	70	81	79
Pendimethalin -Fenoxoprop + Ethoxysulfuron	5.5 (30)	5.8 (33)	5.8 (34)	4.8 (22.5)	6.3 (39.6)	7.1 (49.8)	65	77	74
Pendimethalin –Fenoxoprop *fb* Halosulfuron	5.8 (33)	5.3 (27)	5.8 (34)	5 (24.4)	6.3 (39.2)	7.3 (52.8)	62	77	74
Oxadiargyl - No PoE	7.7 (58)	10.2 103)	10.2(103)	6.5 (42.2)	9 (80)	9.8 (96.0)	34	53	52
Oxadiargyl - Bispyribac	6 (35)	5.3 (27)	5.5 (30)	4.8 (23)	6.3 (39.7)	7.5 (56.3)	64	77	74
Oxadiargyl - Bispyribac + Pyrazosulfuron	5.5 (29)	5 (25)	5.4 (28)	4.7 (21.3)	5.9 (34.7)	7.0 (48.7)	67	80	76
Oxadiargyl - Fenoxoprop + Ethoxysulfuron	5.8 (33)	5.4 (28)	5.7 (32)	4.8 (22.3)	6.5 (41.7)	7.6 (58.0)	65	76	72
Oxadiargyl – Fenoxoprop *fb* Halosulfuron	6 (36)	5.7 (33)	5.8 (33)	5 (24.8)	6.8 (45.2)	7.8 (60.7)	61	74	70
Pretilachlor - No PoE	7.4 (54)	10.5 (111)	9.8 (95)	6.5 (42)	8.5 (72.5)	9.7 (94.3)	34	58	57
Pretilachlor - Bispyribac	6 (36)	5.3 (27)	5.7 (32)	4.9 (23.5)	6.2 (37.5)	7.0 (49.1)	63	78	75
Pretilachlor - Bispyribac + Pyrazosulfuron	5.5 (30)	5.1 (26)	5.3 (27)	4.6 (20.5)	5.9 (33.8)	6.8 (45.8)	68	80	77
Pretilachlor - Fenoxoprop + Ethoxysulfuron	6 (35)	5.4 (28)	6 (36)	5 (24.5)	6.4 (41)	7.3 (52.5)	61	76	73
Pretilachlor – Fenoxoprop *fb* Halosulfuron	5.8 (34)	5.8 (33)	5.5 (29)	5 (24.4)	6.6 (43.2)	7.5 (55.3)	62	75	72
S Em (±)	**0.1**	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**	**2**	**1**	**1**
C.D at 5 %	**0.4**	**0.6**	**0.6**	**NS**	**0.3**	**0.3**	**5**	**2**	**2**

fb :Followed by; PE: Pre-emergence; PoE: Post-emergence

Economics of direct seeded rice: Among main-plot treatments, Pendimethalin (1000 g a.i. ha^{-1}) provided significantly higher net return, gross return and B:C ratio of ₹44300 ha^{-1}, ₹77740 ha^{-1} and 1.33 respectively, which was statistically at par with Pretilachlor (500 g a.i. ha^{-1}) of ₹37966 ha^{-1}, ₹71131 ha^{-1} and 1.15 respectively. When compared to no pre-emergence herbicide treatment, the use of Pendimethalin resulted in a 58 percent increase in net returns. Pretilachlor, Oxadiargyl, and no pre-emergence herbicide treatment decreased the B:C ratio by 14 percent, 23 percent, and 33 percent, respectively, over Pendimethalin, used as a pre-emergence herbicide.

In the case of sub plot treatments, Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) had the greatest net return, gross return and B:C ratio of ₹45991 ha^{-1}, ₹80001 ha^{-1} and 1.36 respectively. When compared to no post-emergence herbicide treatment, the net returns were 70% greater. Over post-emergence treatment of Bispyribac + Pyrazosulfuron, the B:C ratio was decreased by 10% with just Bispyribac application and 18% with Fenoxoprop + Ethoxysulfuron application. Fenoxoprop *fb* Halosulfuron or no post-emergence herbicide treatment resulted in the greatest decrease in the B:C ratio (Table 3).`

Table 3: Economic effect of several pre-emergence and post-emergence herbicides in direct seeded rice.

Treatments	Total Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Main plots (Pre-emergence herbicides)				
No Pre-emergence	31335	59312	27977	0.89
Pendimethalin	33440	77740	44300	1.33
Oxadiargyl	37106	74875	37768	1.02
Pretilachlor	33165	71131	37966	1.15
S Em (±)	—	**2347**	**2347**	**0.07**
C.D at 5 %	—	**8122**	**8122**	**0.23**
Sub plots (Post-emergence herbicides)				
No Post-emergence	30888	57918	27030	0.87
Bispyribac	33209	74230	41020	1.23
Bispyribac + Pyrazosulfuron	34009	80001	45991	1.36
Fenoxoprop + Ethoxysulfuron	33385	70682	37297	1.12
Fenoxoprop *fb* Halosulfuron	37316	70991	33675	0.90
S Em (±)	—	**1048**	**1048**	**0.03**
C.D at 5 %	—	**3019**	**3019**	**0.09**

fb: Followed by

As data shown in Table 4, it is clear that due to the interaction effect, pre-emergence application of Pendimethalin (1000 g a.i. ha^{-1}) and post-emergence application of Bispyribac (25 g a.i. ha^{-1}) + Pyrazosulfuron (20 g a.i. ha^{-1}) produced the greatest net return, gross return, and B:C ratio of ₹54724 ha^{-1}, ₹88412 ha^{-1} and 1.62 respectively. This might be because the aforementioned treatment combination was applied at the right time, resulting in improved weed control and, as a result, higher crop biomass and grain production resulting in greater net return, gross return and B:C ratio. No pre-emergence followed by no post-emergence had the lowest net return, gross return and B:C ratio. Similar types of outcomes were also observed by Chakraborti *et al.*, (2017); Saphi *et al.*, (2018); Gaire *et al.*, (2019).

Table 4. Economics of DSR influenced by Interaction of several pre-emergence and post-emergence. herbicides.

Treatment Combinations	Total Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
No PE - No PoE	28462	40741	12279	0.43
No PE - Bispyribac	30783	60746	29963	0.97
No PE - Bispyribac + Pyrazosulfuron	31583	72667	41084	1.30
No PE - Fenoxoprop + Ethoxysulfuron	30958	61127	30169	0.97
No PE – Fenoxoprop *fb* Halosulfuron	34890	61279	26389	0.76
Pendimethalin - No PoE	30566	64332	33766	1.10
Pendimethalin -Bispyribac	32887	81200	48313	1.47
Pendimethalin -Bispyribac + Pyrazosulfuron	33687	88412	54724	1.62
Pendimethalin - Fenoxoprop + Ethoxysulfuron	33063	77616	44553	1.35
Pendimethalin - Fenoxoprop *fb* Halosulfuron	36994	77138	40144	1.09
Oxadiargyl - No PoE	34233	60736	26503	0.77
Oxadiargyl - Bispyribac	36554	78750	42196	1.15
Oxadiargyl - Bispyribac + Pyrazosulfuron	37354	82046	44692	1.20
Oxadiargyl - Fenoxoprop + Ethoxysulfuron	36729	74603	37874	1.03
Oxadiargyl - Fenoxoprop *fb* Halosulfuron	40661	78238	37577	0.92
Pretilachlor - No PoE	30292	65863	35571	1.17
Pretilachlor - Bispyribac	32613	76222	43609	1.34
Pretilachlor - Bispyribac + Pyrazosulfuron	33413	76879	43466	1.30
Pretilachlor - Fenoxoprop + Ethoxysulfuron	32788	69382	36594	1.12
Pretilachlor - Fenoxoprop *fb* Halosulfuron	36720	67309	30589	0.83
S Em (±)	—	**2096**	**2096**	**0.06**
C.D at 5 %	—	**6037**	**6037**	**0.18**

fb :Followed by; PE: Pre-emergence; PoE: Post-emergence

CONCLUSION

Based on the results obtained from this research, it can be concluded that pre-emergence application of Pendimethalin @ 1000 g a.i. ha^{-1} followed by post-emergence application of Bispyribac @ 25 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} can manage the weeds effectively and it also proved to be more economical in the cultivation of direct seeded rice.

FUTURE SCOPE

Direct seeded rice is a fouling crop. It always requires proper management of weeds. Due to the continuous application of the same types of herbicides, there may be chances of weed shift or the growth of resistant weeds. So further research should also be carried out to tackle these adverse circumstances.

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Conflict of Interest. None.

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