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Study on bio-efficacy of Ipfencarbazone 25% SC (Dinkar) on weed population in transplanted rice (*Oryza sativa* L.)

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ABSTRACT

Weed causes serious damage and high yield loss in rice and other crops. Most of the improved crop management practices fail due to poor management of weed flora present in the field. Apart from yield loss, weeds increase cost of cultivation, reduce input efficiency, interfere with agricultural operations, impair crop quality along with many other disadvantages. Therefore, weed control is imperative during crop growth. Use of appropriate herbicides at right time and doses is an important measure in modern concept of weed-management. Two years field experiments were carried out at research farm of BCKV, Kalyani, West Bengal during kharif season of 2017 and 2018 to study the bio-efficacy of Ipfencarbazone 25% SC on the weeds of transplanted rice. Efficacy of different doses of Ipfencarbazone 25% SC (Dinkar) was tested against other herbicides. Herbicide Ipfencarbazone 25% SC @ 625 ml ha^{-1} was found best in respect to highest control over major weeds in transplanted rice along with highest net return and B:C ratio.

Keywords: Bioefficacy, ipfencarbazone, transplanted rice, weed density

Rice (*Oryza sativa* L.) is the major staple food crop in the world providing 40% of the total world's population (Virdia and Mehta, 2009). In India, it is grown in an area of 43.2 m ha with total production of 112.91 m tonnes (Ministry of Agriculture, 2018).West Bengal is the largest producing state contributing 13.26% of total production in India (Ministry of Agriculture, 2018). Transplanted rice harbours diverse kind of weeds consisting of grasses, sedges and broad leaf weeds. Weed problem has been always a major reducing factor for production in transplanted rice nearly reducing to an extent of 15-45% (Chopra and Chopra, 2003). So, in order to increase rice production the rice-weed competition needs to be reduced. Hand weeding may be an effective tool for controlling weeds but labour crisis at peak period of agricultural operations and high labour wages can delay the timely weeding of the crop, hence, drastically hampering the grain yield. Use of herbicides can control weeds rapidly and economically at the beginning of the crop, giving competitive superiority to the crop. Most of the herbicides are applied in large amounts which is not economical for the farmer as well as environmentally suitable. So alternative and effective low dose high efficiency herbicides are gaining popularity recently. They will reduce the total volume per unit area and at the same time their application will be easier and economical to the farmer. Hence, this experiment was carried out to study the bio-efficacy of Ipfencarbazone 25% SC on the weeds of the transplanted rice.

MATERIALS AND METHODS

The field experiment was carried out at research farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal during *kharif* season of 2017 and 2018 to assess the bio-efficacy of Ipfencarbazone 25% SC (Dinkar) along with 3 herbicides as checks against major weeds in transplanted Rice. The soil of the experimental field is gangetic alluvium. The experiment was laid out in Randomized Block Design with three replications (Table 1). Twenty one days old seedlings of rice variety Shatabdi (IET-4786) was transplanted on 1st September of 2017 and 2018 at a spacing of 20 x 20cm. 3-4 seedlings were sown per hill. Recommended dose of fertilizers i.e. 80:40:40 kg N, P_2O_5, K_2O ha^{-1} was applied. Full doses of P_2O_5 (Single Super Phosphate) and K_2O (Muriate of Potash) and half doses of N in the form of urea were applied at basal dose. And the rest half of N in the form of urea was top-dressed in two equal splits at tillering and panicle initiation stage of the crop. All intercultural operations were followed accurately. Irrigations are given as and when needed. From panicle initiation stage (PI) to hard dough stage 2-3 cm water was kept in the plots and during ripening stage water was removed from the plot.

Weed density (species wise) was recorded at 60 days after transplanting of rice using a quadrate of 1.0 m^2 placed at 3 places/plot randomly. The weeds were collected and oven dried in electric oven for 72 hrs at 60^{0}C and dry weed biomass was recorded.

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The weed control efficiency (WCE) was calculated by using following formula.

$$WCE\ (\%) = \frac{\text{Dry weed biomass in untreated control plot} - \text{Dry weed biomass in treated plot}}{\text{Dry weed biomass in untreated control plot}} \times 100$$

The relative dry weight (RDw) of weeds was calculated by using following formula.

$$(RD_W) = \frac{\text{Dry weight of a weed species per unit area}}{\text{Total dry weight of composite weed in that unit area}} \times 100$$

Weed persistence index(WPI) has been calculated by the formula :

$$WPI = \frac{\text{Weed weight in treated plot}}{\text{Weed weight in control plot}} \times \frac{\text{Weed count in control plot}}{\text{Weed count in treated plot}}$$

Table 1: Details of the treatments

Treatment No.	Treatments	Dose ha^{-1}		Time of application (DAT*)
		a.i. (g)	Formulation (ml)	
T_1	Ipfencarbazone 25% SC (Dinkar)	93.75	375	2
T_2	Ipfencarbazone 25% SC (Dinkar)	125.00	500	2
T_3	Ipfencarbazone 25% SC (Dinkar)	156.25	625	2
T_4	Pretilachlor 50% EC	750	1500	2
T_5	Butachlor 50% EC	2000	4000	2
T_6	Bispyribac Sodium 10% SC	20	200	23
T_7	Two hand weedings	-	-	25 & 50 DAT
T_8	Untreated control	-	-	-

*DAT: Days After Transplanting.

RESULTS AND DISCUSSION

Weed density (no./m^2) and % control of weeds

Three types of weeds were recorded in experimental plots in both the years of experiment. The most dominant narrow leaf weeds constituted *Echinochloa crusgalli* and *Setaria glauca*; broad leaf weeds, *Commelina benghalensis*, *Ammania baccifera, Ludwigia octovalvis, Marselia quadrifolia, Eclipta prostrata* and *Alternanthera phyloxeroides* and sedges, *Cyperus iria* and *Cyperus difformis* in both the years of experiment.

Efficacy against narrow leaf weeds

Two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded significantly less population of *Echinochloa crusgalli* and *Setaria glauca* in comparison to remaining herbicidal treatments at observations recorded at 60 days after transplanting. Weed population per m^{2}area of two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} were 0.67, 1.33, 1.00, respectively for first year and 1.00, 1.33, 1.33, respectively for the second year. The above three treatments were found to be at par (Table 2).

Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded 82.61 and 86.96 % (respectively for first year); 82.61 and 82.61% (respectively for second year) control of narrow leaf weeds over untreated control at 60 days after transplanting (Table 2).

Efficacy against broad leaf weeds

Significantly less broad leaf weeds population was recorded in all herbicidal treatments in comparison to untreated control at 60 days after transplanting. Two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded significantly less population of *Commelina benghalensis*, *Ammania baccifera, Ludwigia octovalvis, Marselia quadrifolia, Eclipta prostrata* and *Alternanthera phyloxeroides* in comparison to remaining herbicidal treatments recorded at 60 days after transplanting. The weed population per m^2 area of two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} were 5.00, 5.67, 5.00 respectively for the first year and 5.33, 6.67, 6.00 respectively for the second year. Above three treatments were at par with each other for both the years.

Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded 77.92 and 80.52 % (respectively for first year); 80.58 and 82.52% (respectively for second year) control of broad leaf weeds over untreated control at 60 days after transplanting (Table 2).

Efficacy against sedges

Significantly less sedges population was recorded in all herbicidal treatments in comparison to untreated control at 60 days after transplanting.

Two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded significantly less population of *Cyperus iria* and *Cyperus difformis* which were among the dominant weeds, in comparison to remaining herbicidal treatments recorded at 60 days after transplanting. The weed population per m^2 area of two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} were 2.67, 3.33, 3.00 respectively for the first year and 2.00, 2.67, 2.33 respectively for the second year. Above three treatments were at par with each other for both the years.

Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded 76.74 and 79.07 % (respectively for the first year); 78.95 and 81.58% (respectively for the second year) control of sedges over untreated control at 60 days after transplanting. The highest control of three types of weed over the control plot was observed in the treatment having two hand weedings in both the years (Table 2). The results are in conformity with Narolia *et al.,* (2014). Treatments receiving Pretilachlor 50% EC, Butachlor 50% EC and Bispyribac Sodium 10% SC recorded higher density of all three categories of weed per m^2area over Ipfencarbazone 25 % SC during both the years under study (Table 2).

Effect on dry weed biomass (g/m^2) and weed control efficiency (%)

Two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded significantly less dry weed biomass of narrow leaf weeds, broad leaf weeds and sedges in comparison to remaining herbicidal treatments recorded at 60 days after transplanting for both the years. So, two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml ha^{-1} recorded significantly less total dry weed biomass *i.e.*, 4.17, 6.12, 5.31g m^2, respectively in the first year and 4.72, 6.15, 5.68 g m^2, respectively in the second year. Above three treatments were found to be at par with each other for both the years. Other herbicides *viz*., Pretilachlor 50% EC, Butachlor 50% EC and Bispyribac Sodium 10% SC showed less control over weeds recording higher dry biomass of weed per unit area during both the years under study (Table 3).

Ipfencarbazone 25 % SC @ 500 and 625 ml/ha recorded 79.47, 82.20 % weed control efficiency respectively for first year and 80.28, 81.79% weed control efficiency for the second year at 60 days after transplanting. Highest weed control efficiency (86.01% and 84.85% in the respective years) was observed with the treatment having two hand weedings at 25 and 50 DAT. Results are in similarity with Uma *et al.* (2014) and Bhattacharya *et al*. (2019)

Effect on relative dry weight of weeds

Two hand weedings at 25 and 50 DAT, Ipfencarbazone 25 % SC @ 500 and 625 ml/ha recorded significantly less relative dry weight of weeds in both the years for each narrow leaf weeds (11.90, 12.61, 12.22, respectively in 2017 and 11.33, 15.69, 14.67 respectively in 2018), broad leaf weeds (69.57, 70.51, 69.14, respectively for 2017, and 64.01, 62.82, 63.21 respectively in 2018) and sedges (15.29, 15.51, 15.75, respectively in 2017 and 17.82, 18.47, 18.20 respectively in 2018) at 60 days after transplanting. The highest relative dry weight of weeds was observed in the untreated control plot for both the years in each weed classes (Table 4).

Effect on weed persistence index and treatment efficiency index

Highest weed persistence index has been observed in untreated control plot for both the years of experiment. The lowest weed persistence index has been observed in treatment receiving Ipfencarbazone 25 % SC @ 625 ml/ha (0.81, 0.99 in respective years) and was followed by 500 ml/ha(0.94,0.95 in respective years) and then two hand weedings at 25 and 50 DAT (0.07, 1.00 in respective years).

Highest treatment efficiency index was recorded in two hand weedings at 25 and 50 DAT (0.19,0.18 in respective years) due to appropriate timing of weed control followed by treatments with Ipfencarbazone 25 % SC @ 500 ml/ha and 625 ml/ha for both the years (Table 4).

Yield attributes, yield and economics

Herbicide Ipfencarbazone 25% SC at different doses recorded higher number of panicle /m^2 and grains / panicle over other herbicidal treatments. Among different doses of Ipfencarbazone 25% SC, application @ 625 ml/ha recorded the highest yield attributes and also yield of rice. However, among different weed management treatments, the highest yield was observed with the application of two hand weedings (4.58 and 4.70 t/ha in the successive years, respectively) and which was close to the treatments of Ipfencarbazone 25% SC @ 625 ml/ha and 500 ml/ha during both the years of study. The reason for the highest yield in two hand weedings treatment might be due to early and timely removal of weeds which might lead to more number of panicle /m^2 and grains / panicle due to lesser competition from weeds. Similar results were found by Prakash *et al*. (2013) and Singh *et al*. (2007). Highest net return (Rs 57378 and 59337 /ha, respectively) and B:C ratio

Table 2: Effect of different weed management practices on weed density (no./m²) and % control of weeds over untreated control

Tr. No.	Treatments	Dose /ha a.i (gm)	Dose /ha Formu-lation	Number of weeds/m² after 60 days of transplanting						% control of narrow leaf weeds over untreated control		% control of broad leaf weeds over untreated control		% control of sedges over untreated control	
				Total narrow leaf weeds		Total Broad leaf weeds		Total Sedges weed							
				2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
T1	Ipfencarbazone 25% SC (Dinkar)	93.75	375	3.33 (2.08)	3.33 (2.08)	12.00 (3.61)	16.00 (4.12)	7.33 (2.89)	6.00 (2.65)	56.52	56.52	53.25	53.40	48.84	52.63
T2	Ipfencarbazone 25% SC (Dinkar)	125.00	500	1.33 (1.53)	1.33 (1.55)	5.67 (2.58)	6.67 (2.77)	3.33 (2.08)	2.67 (1.91)	82.61	82.61	77.92	80.58	76.74	78.95
T3	Ipfencarbazone 25% SC (Dinkar)	156.25	625	1.00 (1.41)	1.33 (1.53)	5.00 (2.45)	6.00 (2.65)	3.00 (2.00)	2.33 (1.83)	86.96	82.61	80.52	82.52	79.07	81.58
T4	Pretilachlor 50% EC	750	1500	3.67 (2.16)	3.33 (2.08)	11.67 (3.56)	17.67 (4.32)	7.67 (2.94)	6.33 (2.71)	52.17	56.52	54.55	48.54	46.51	50.00
T5	Butachlor 50% EC	2000	4000	3.67 (2.16)	4.00 (2.24)	13.67 (3.83)	18.33 (4.40)	8.00 (3.00)	7.00 (2.83)	52.17	47.83	46.75	46.60	44.19	44.74
T6	Bispyribac Sodium 10% SC	20	200	4.00 (2.24)	4.00 (2.24)	13.00 (3.74)	18.00 (4.36)	7.67 (2.94)	6.00 (2.65)	47.83	47.83	49.35	47.57	46.51	52.63
T7	Two hand weedings	25 and 50 DAT		0.67 (1.29)	1.00 (1.41)	5.00 (2.45)	5.33 (2.52)	2.67 (1.91)	2.00 (1.73)	91.30	86.96	80.52	84.47	81.40	84.21
T8	Untreated control	___	___	7.67 (2.94)	7.67 (2.94)	25.67 (5.16)	34.33 (5.94)	14.33 (3.92)	12.67 (3.70)	-	-	-	-	-	-
SE(m) ±				**(0.08)**	**(0.13)**	**(0.16)**	**(0.15)**	**(0.09)**	**(0.09)**	-	-	-	-	-	-
CD (0.05)				**(0.24)**	**(0.39)**	**(0.49)**	**(0.47)**	**(0.27)**	**(0.29)**	-	-	-	-	-	-

DAT: Days After Transplanting; Figures in parentheses are transformed values (X = √x+1).

Table 3: Effect of different herbicides on dry weed biomass (g/m²),total dry weed biomass (g/m²)and weed control efficiency at 60DAT.

Tr. No.	Treatments	Dose /ha a.i (gm)	Dose /ha Formulation (ml)	Dry weed biomass (g/m²) Narrow lead weeds 2017	Narrow lead weeds 2018	Broad leaf weeds 2017	Broad leaf weeds 2018	Sedges 2017	Sedges 2018	Total dry weed biomass 2017	Total dry weed biomass 2018	WCE (%) 2017	WCE (%) 2018
T1	Ipfencarbazone 25% SC (Dinkar)	93.75	375	4.83 (2.41)	3.89 (2.21)	4.59 (2.37)	5.96 (2.64)	5.35 (2.52)	4.60 (2.37)	14.78 (3.97)	14.45 (3.93)	50.47	53.66
T2	Ipfencarbazone 25% SC (Dinkar)	125.00	500	1.89 (1.70)	1.72 (1.65)	1.75 (1.66)	2.40 (1.84)	2.48 (1.87)	2.03 (1.74)	6.12 (2.67)	6.15 (2.67)	79.47	80.28
T3	Ipfencarbazone 25% SC (Dinkar)	156.25	625	1.59 (1.61)	1.71 (1.65)	1.56 (1.60)	2.18 (1.78)	2.17 (1.78)	1.79 (1.67)	5.31 (2.51)	5.68 (2.58)	82.20	81.79
T4	Pretilachlor 50% EC	750	1500	5.47 (2.54)	3.87 (2.21)	3.82 (2.20)	6.69 (2.77)	5.67 (2.58)	4.83 (2.41)	14.97 (4.00)	15.39 (4.05)	49.83	50.63
T5	Butachlor 50% EC	2000	4000	5.11 (2.47)	4.60 (2.37)	5.01 (2.45)	6.82 (2.80)	5.77 (2.60)	5.34 (2.52)	15.89 (4.11)	16.75 (4.21)	46.73	46.26
T6	Bispyribac Sodium 10% SC	20	200	4.99 (2.45)	3.77 (2.18)	4.80 (2.41)	6.87 (2.81)	5.88 (2.62)	4.59 (2.36)	15.68 (4.08)	15.23 (4.03)	47.45	51.15
T7	Two hand weedings	25 and 50 DAT		1.01 (1.42)	1.23 (1.49)	1.21 (1.49)	1.95 (1.72)	1.96 (1.72)	1.54 (1.59)	4.17 (2.27)	4.72 (2.39)	86.01	84.85
T8	Untreated control	___	___	10.84 (3.44)	8.42 (3.07)	8.37 (3.06)	13.08 (3.75)	10.62 (3.41)	9.67 (3.27)	29.83 (5.55)	31.18 (5.67)	-	-
SE(m) ±				**(0.15)**	**(0.12)**	**(0.12)**	**(0.10)**	**(0.08)**	**(0.08)**	**(0.12)**	**(0.12)**	**-**	**-**
CD (0.05)				**(0.45)**	**(0.37)**	**(0.37)**	**(0.30)**	**(0.23)**	**(0.25)**	**(0.38)**	**(0.38)**	**-**	**-**

DAT: Days After Transplanting; WCE – Weed Control Efficiency; Figures in parentheses are transformed values (X=”x+1).

Table 4: Effects of different herbicides on relative dry weight of weeds, Weed persistence index and treatment efficiency index.

Tr.	Treatments	Dose /ha		Relative dry weight of weeds						Weed Persistence Index		Treatment efficiency Index	
		a.i (gm)	Formu-lation	Narrow leaf weeds		Broad leaf weeds		Sedges					
				2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
T1	Ipfencarbazone 25% SC (Dinkar)	93.75	375	14.02	18.17	71.64	65.55	16.42	20.85	1.00	1.01	0.07	0.08
T2	Ipfencarbazone 25% SC (Dinkar)	125.00	500	12.61	15.69	70.51	62.82	15.51	18.47	0.94	0.95	0.14	0.17
T3	Ipfencarbazone 25% SC (Dinkar)	156.25	625	12.22	14.67	69.14	63.21	15.75	18.20	0.81	0.99	0.18	0.18
T4	Pretilachlor 50% EC	750	1500	13.46	15.96	70.59	65.08	15.84	18.95	1.04	1.00	0.06	0.07
T5	Butachlor 50% EC	2000	4000	13.54	16.08	71.44	64.48	15.78	20.83	1.01	0.99	0.04	0.09
T6	Bispyribac Sodium 10% SC	20	200	13.71	15.98	70.95	65.39	15.96	18.91	1.02	1.00	0.11	0.12
T7	Two hand weedings	25 and 50 DAT		11.90	11.33	69.57	64.01	15.29	17.82	0.97	1.00	0.19	0.18
T8	Untreated control	___	___	15.02	18.23	72.50	65.73	16.66	23.59	1.04	1.03	0.00	0.00
SE(m) ±		**2.497**	**3.376**	**2.003**	**2.943**	**1.460**	**2.250**	**0.050**	**0.052**	-	-		
CD (0.05)		**7.486**	**10.119**	**6.004**	**8.823**	**4.376**	**6.743**	**0.149**	**0.156**	-	-		

Table 5:Effects of different herbicides on yield attributes, yield and economics

Tr. No.	Treatments	Time of application (DAT)	Doses/ha g (a. i.)	Formu lation (ml)	Panicle No./m^2		Grains No./ panicle		Grain yield (t/ha)		Straw yield (t/ha)		Net return (Rs/ha)		B:C Ratio	
					2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
T_1	Ipfencarbazone 25% SC (Dinkar)	2	93.75	375	360.55	365.21	60.13	62.00	4.19	4.37	5.65	5.93	50965	53883	1.10	1.17
T_2	Ipfencarbazone 25% SC (Dinkar)	2	125.00	500	363.16	388.59	61.08	66.58	4.34	4.63	5.80	6.02	55055	59212	1.19	1.21
T_3	Ipfencarbazone 25% SC (Dinkar)	2	156.25	625	390.71	400.23	66.54	68.91	4.53	4.68	6.01	5.92	57378	59337	1.24	1.27
T_4	Pretilachlor 50% EC	2	750	1500	348.12	354.45	58.96	60.87	3.97	4.15	5.43	5.58	46724	49548	1.02	1.05
T_5	Butachlor 50% EC	2	2000	4000	341.57	375.05	57.35	62.23	3.90	4.23	4.99	5.35	45969	50996	1.01	1.03
T_6	Bispyribac Sodium 10% SC	23	20	200	352.03	359.12	59.71	60.52	4.02	4.18	5.48	5.62	45900	48334	0.97	1.01
T_7	Two hand weedings	25 & 50 DAT	-	-	401.33	391.00	68.29	67.00	4.58	4.70	5.76	5.99	52723	54630	1.03	1.09
T_8	Untreated control	-	-	-	327.63	338.56	53.81	55.37	3.73	3.86	4.82	4.99	41734	43825	0.95	1.02
SE(m) ±					**0.61**	**0.84**	**1.02**	**0.08**	**0.19**	**0.27**	**0.24**	**0.13**	-	-	-	-
CD (0.05)					**1.92**	**2.61**	**3.11**	**0.32**	**0.62**	**0.89**	**0.78**	**0.41**	-	-	-	-

Sale price of paddy grains-Rs. 18000/t, sale price of paddy straw-Rs. 3500.00/t, labour wage per man-day-Rs. 275.00.

(1.24 and 1.27, respectively) were observed in the treatment of Ipfencarbazone 25% SC @ 625 ml /ha (Table 5).

CONCLUSION

Results of the two years experiment showed that, treatment receiving two hand weedings at 25 and 50 DAT maintained its superiority with least density and dry weight of weeds in plot and highest yield of rice. But, as per economics of the experiment, herbicide Ipfencarbazone 25% SC @ 625 ml/ha was found best in respect to highest net return and B:C ratio.

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