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Economics of chemical weed control in direct seeded Puddled wet rice under cauvery command area of Karnataka

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Abstract

A field experiment was entitled "Economics of chemical weed control in direct seeded Puddled wet rice" was conducted during *kharif* 2015 at Zonal Agricultural research station, V. C. Farm, Mandya, Karnataka. The experiment consisted of 13 treatments laid out in randomized complete block design with three replications consisting of two pre-emergence herbicides integrated with hand weeding twice at 20 and 40 days after sowing, compared with weed free and unweeded check. The predominant weed flora observed in the experimental field were, *Alternanthera sessalis*, *Eclipta alba*, *Monochoria vaginalis*, *Marsilia quadrifolia* and *Mollugo distica* among broad-leaved weeds; *Echinochloa colona*, *Echinochloa crusgalli* and *Leptochloa chinensis* among the grassy weeds and *Cyperus iria*, *Cyperus difformis* and *Flmbristylis miliaceae* among sedges. The results revealed that pre-emergence application of Pendimethalin 750 g *a.i./ha* at 3 DAS fb Penoxsulam (24% SC) 22.5 g *a.i./ha* at 30 DAS recorded significantly higher grain yield and straw yield (6328 kg ha⁻¹ and 7432 kg ha⁻¹ respectively), lower weed population and their dry weight (9.20 /m² and 3.07 g m² respectively). Further the net returns (Rs. 34753) and B:C (2.03) Ratio was also high with the pre-emergence application Pendimethalin 750 g *a.i./ha* at 3 DAS fb Penoxsulam (24% SC) 22.5 g *a.i./ha* at 30 DAS.

Keywords: Wet direct seeded rice, economics, pre emergence herbicide, post emergence herbicide

Introduction

India has the largest area under rice (41.85 m ha) accounting for 26 per cent of rice area in the world (161.3 m ha) during 2012-13 (Anon., 2014). However, the production (153.09 mt) accounted for just 21.40 per cent. This was because of comparatively lower productivity of 3195 kg ha⁻¹ as against the world average of 4329 kg ha⁻¹. Rice is also a staple food crop in Karnataka and is cultivated in an area of 1.28 m ha producing about 5.01 m t with a productivity of 4126 kg ha⁻¹.

The crop is grown in all the 30 districts of the state under varied soil and climatic conditions. Around 44 per cent of the total area is under irrigation and rest is under rainfed situation. The rice is the principle crop in Mandya district of Karnataka and it occupies an area of 88,657 ha with a production of 2, 66, 775 tonnes and productivity of 3143 kg/ha. In Cauvery command area, the rice is establishing through transplanting method, which is more laborious and time consuming operation. Further, timely availability and efficiency of labourers for transplanting operation makes the rice cultivation more difficulty. In order to overcome these problems, the other method of rice establishment such as direct seeded rice (DSR) method can be used. In DSR seeds are directly sown in the field as like other arable crops. Since, crop is establishing thorough seed which induce more menace of weeds. Hence for better weed management by using pre and post emergent herbicides in DSR may become need of the hour.

Materials and Method

A field experiment was conducted during *kharif* season of 2015, at Zonal Agricultural Research Station, V. C. Farm, Mandya district. The soil of the experimental site was sandy loamy in texture and p^H was alkaline (7.5). The soil was low available in nitrogen (230 kg/ha), medium in available phosphorus (30 kg/ha) and medium in available potassium (148 kg/ha). The organic carbon content was high (0.61) in range. CTH-3 a popular variety was sown in September. Experiment included 13 treatments consisted of T₁: Pretilachlor + Bensulfuronmethyl (6.6% G) 660 g *a.i./ha* 3 DAS fb one HW at 30 DAS, T₂: Bispyribac-sodium (10% SC) 25 g *a.i./ha* at 15 DAS fb one HW at 30 DAS, T₃: Penoxsulam (24% SC)

22.5 g a.i./ha) at 15 DAS fb one HW at 30 DAS, T₄: Azimsulfuron (50% DF) 26.25 g a.i./ha at 15 DAS fb one HW at 30 DAS, T₅: Pretilachlor + Bensulfuronmethyl (6.6% G) 660 g a.i./ha at 3 DAS fb Bispyribac-sodium (10 per cent SC) 25 g a.i./ha at 30 DAS, T₆: Pretilachlor+ Bensulfuronmethyl (6.6% G) 660 g a.i./ha at 3 DAS fb Penoxsulam (24 per cent SC) 22.5 g a.i./ha at 30 DAS, T₇: Pretilachlor + Bensulfuronmethyl (6.6% G) 660 g a.i./ha at 3 DAS fb Azimsulfuron (50 per cent DF) 26.25 g a.i./ha at 30 DAS, T₈: Pendimethalin 750 g a.i./ha at 3 DAS fb one hand weeding at 30 DAS, T₉: Pendimethalin 750 g a.i./ha at 3 DAS fb Bispyribac-sodium (1% SC) 22.25 g a.i./ha at 30 DAS, T₁₀: Pendimethalin 750 g a.i./ha at 3 DAS fb Penoxsulam (24% SC) 22.5 g a.i./ha at 30 DAS, T₁₁: Pendimethalin 750 g a.i./ha at 3 DAS fb Azimsulfuron (50% DF) 26.25g a.i./ha at 30 DAS, T₁₂: Two hand weedings at 20 and 40 DAS and T₁₃: Unweeded check were laid out in Randomized Complete Block Design (RCBD) with three replications. Pre-emergence application of herbicides was done at three days after sowing. Since the data on weed count and weed dry weight showed high variation the data was subjected to square root transformation using the formula $X+0.05$ and the statistical analysis was done.

Results and Discussion

Effect on weeds

The predominant weed flora observed in the experimental field were, *Alternanthera sessalis*, *Eclipta alba*, *Monochoria vaginalis*, *Marsilia quadrifolia* and *Mollugo distica* among broad-leaved weeds; *Echinochloa colona*, *Echinochloa crusgalli* and *Leptochloa chinensis* among the grassy weeds and *Cyperus iria*, *Cyperus difformis* and *Flimbristylis miliaceae* among sedges. Pre-emergence application of Pendimethalin 750 g a.i./ha at 3 DAS fb Penoxsulam (24% SC) 22.5 g a.i./ha at 30 DAS, recorded lower population and dry weight of weeds respectively. Whereas, unweeded check recorded significantly higher weed population and dry weight respectively. these lines are in conformity with findings of Mohan *et al.*, 2010^[5] and Charan Teja *et al.*, 2015^[2].

Higher weed control efficiency and lower weed index was recorded with Pre-emergence application of Pendimethalin 750 g a.i./ha at 3 DAS fb Penoxsulam (24% SC) 22.5 g a.i./ha at 30 DAS, followed by Pendimethalin 750 g a.i./ha at 3 DAS fb Azimsulfuron (50%DF) 26.25g a.i./ha at 30 DAS. This was mainly due to better control of weeds growth even upto harvest resulting lower dry weight of weeds. The results are in conformity with findings of Walia *et al.* (2011)^[8].

Effect on crop growth

Pre-emergence application of Pendimethalin 750 g a.i./ha at 3 DAS fb Penoxsulam (24% SC) 22.5 g a.i./ha at 30 DAS, recorded more number of tillers, higher plant height and more dry matter production. Followed by pre-emergence application of Pendimethalin 750 g a.i./ha at 3 DAS fb Azimsulfuron (50%DF) 26.25g a.i./ha at 30 DAS.

Effect on yield and yield parameters

Pre-emergence application of of Pendimethalin 750 g a.i./ha at 3 DAS fb Penoxsulam (24% SC) 22.5 g a.i./ha at 30 DAS, recorded significantly higher yield components like panicle

length, panicle weight, percent chaffyness and 1000 grain weight and grain yield, straw yield and harvest index respectively.

Economics

Cost on weed management

The highest cost on weed management was recorded in two hand weeding at 20 and 40 DAS (Rs 6500 ha⁻¹). Among different herbicides treatments pre-emergence application of pendimethalin followed by post emergence application of bispyribac-sodium incurred less cost on weed management (Rs.3462 ha⁻¹) it was slightly followed by pre-emergence application of pendimethalin followed by postemergence application of penoxsulam or azimsulfuron (Rs. 3573 & 3496 ha⁻¹ respectively).

Total cost of cultivation

The highest cost of cultivation was recorded with the two hand weeding at 20 & 40 DAS (Rs. 36500 ha⁻¹) followed by pre-emergence application of pretilachlor + bensulfuronmethyl @ 660 g a.i./ha at 3 DAS fb azimsulfuron @ 26.25 g a.i./ha at 30 DAS (Rs. 33381 ha⁻¹).

Gross returns (Rs. ha⁻¹)

The higher gross return of DSR was with treatment two hand weeding at 20 & 40 DAS (T₁₂) (Rs. 68614 ha⁻¹), followed by pre emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb penoxsulam (24% SC) @ 22.5 g a.i./ha at 30 DAS (T₁₀) (Rs. 68296 ha⁻¹).

Net return (Rs. ha⁻¹)

The higher net return of Rs. 68296 ha⁻¹ observed with pre emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb penoxsulam @ 22.5 g a.i./ha at 30 DAS (T₁₀). Followed by pre emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb bispyribac -sodium @ 22.25 g a.i./ha at 30 DAS (T₉) (Rs. 32534 ha⁻¹).

B:C ratio (Rs. ha⁻¹)

The higher benefit cost ratio (2.03) was observed with pre emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb penoxsulam (24% SC) @ 22.5 g a.i./ha at 30 DAS (T₁₀) (2.03 ha⁻¹) followed by two hand weeding at 20 & 40 DAS (T₁₂) (1.88).

Increment B:C ratio (Rs. ha⁻¹)

The higher increment benefit cost ratio was observed with pre emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb penoxsulam (24% SC) @ 22.5 g a.i./ha at 30 DAS (T₁₀) (Rs. 9.72), followed by Pendimethalin @ 750 g a.i./ha at 3 DAS fb Bispyribac-sodium (10% SC) @ 22.25 g a.i./ha or one hand weeding at 30 DAS (Rs. 9.38 & 9.22 respectively).

The above study concludes that pre-emergence application of pendimethalin @ 750 g a.i./ha at 3 DAS fb penoxsulam (24% SC) @ 22.5 g a.i./ha at 30 DAS (T₁₀) significantly recorded lesser cost on weed management, total cost of cultivation, more gross return, net return, B:C ratio and increment benefit cost ratio. (Prameela *et al.*, 2014^[6]; Vijay Singh *et al.* (2015); Anay Rawat *et al.*, 2011^[1]; Hussian *et al.* (2008)^[3] and Khawr Jabnar *et al.*, 2012.

Table-1: Effect of weed control treatments on weed density (No. m⁻²) and dry weight (g m⁻²)

Treatment	Weed density at harvest (No. m ⁻²)				Weed dry weight at harvest (g m ⁻²)				WCE (%)	WI (%)
	Grasses	Sedges	BLW	Total weeds	Grasses	Sedges	BLW	Total weeds		
T ₁	3.5(12.1)	2.3(4.90)	4.7(22.0)	6.5(42.33)	2.2(4.43)	2.2(4.52)	4.7(22.0)	4.0(15.69)	62.06	7.28
T ₂	3.5(12.0)	2.8(7.30)	5.3(27.7)	7.5(56.37)	2.2(4.50)	2.5(5.68)	5.3(27.7)	4.3(18.43)	55.38	10.39
T ₃	3.2(9.7)	2.6(6.47)	4.8(22.4)	6.9(46.70)	2.3(4.73)	2.5(5.65)	4.8(22.4)	4.2(17.56)	57.49	10.22
T ₄	3.7(13.0)	2.9(7.80)	5.3(28.0)	7.6(57.63)	2.7(6.63)	2.3(4.87)	5.3(28.0)	4.4(19.26)	53.51	13.19
T ₅	3.7(13.0)	2.0(3.37)	4.6(20.4)	6.2(37.40)	2.2(4.53)	1.9(3.14)	4.6(20.4)	3.7(13.18)	68.12	5.83
T ₆	3.2(10.3)	1.9(3.17)	4.1(16.4)	5.4(28.90)	2.1(4.00)	1.6(2.17)	4.1(16.4)	3.3(10.20)	75.26	4.73
T ₇	3.6(12.4)	2.1(3.97)	4.8(22.5)	6.5(41.33)	2.2(4.43)	2.2(4.45)	4.8(22.5)	3.8(13.97)	66.16	7.43
T ₈	3.4(11.4)	1.8(2.87)	4.4(18.6)	5.7(31.63)	2.1(4.00)	2.0(3.51)	4.4(18.6)	3.6(12.27)	70.33	5.35
T ₉	3.1(10.1)	1.9(2.97)	4.0(15.8)	5.3(28.10)	2.0(3.43)	1.5(1.67)	4.0(15.8)	3.0(8.73)	78.93	3.20
T ₁₀	3.4(11.7)	1.5(1.87)	3.8(14.0)	4.6(20.80)	1.6(1.97)	1.3(1.14)	3.8(14.0)	2.3(4.78)	88.36	0.37
T ₁₁	3.5(12.0)	1.7(2.53)	4.3(17.9)	5.5(30.30)	2.0(3.37)	1.6(2.31)	4.3(17.9)	3.1(9.50)	77.16	4.65
T ₁₂	1.2(1.1)	1.1(0.80)	1.9(3.1)	2.3(4.63)	0.7(0.00)	1.1(0.74)	1.9(3.1)	1.8(2.58)	93.71	0.00
T ₁₃	6.0(36.0)	4.4(18.50)	8.4(70.2)	11.8(138.53)	3.4(11.03)	3.6(12.83)	8.4(70.2)	6.5(14.43)	0.00	29.11
S.Em.±	0.38	0.11	0.14	0.16	0.08	0.11	0.14	0.12	-	-
CD (P=0.05)	1.12	0.32	0.42	0.46	0.24	0.31	0.42	0.34	-	-
CV%	19.13	8.56	5.33	4.37	6.79	9.10	5.33	5.40	-	-

T1:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fb one HW at 30 DAS	T8:Pendimethalin 750 g a.i./ha (PRE) fb one hand weeding at 30 DAS
T2:Bispyribac-sodium @ 25 g a.i./ha (POST) fb one HW at 30 DAS	T9:Pendimethalin 750 g a.i./ha (PRE) fbBispyribac-sodium 22.25g a.i./ha (POST)
T3:Penoxsulam @ 22.5 g a.i./ha (POST) fb one HW at 30 DAS	T10:Pendimethalin750 g a.i./ha (PRE) fbPenoxsulam 22.5 g a.i./ha (POST)
T4:Azimsulfuron @ 26.25 g a.i./ha (POST) fb one HW at 30 DAS	T11:Pendimethalin 750 g a.i./ha (PRE) fbAzimsulfuron 26.25 g a.i./ha (POST)
T5:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fbBispyribac-sodium (POST) 25 g a.i./ha	T12:Two hand weeding at 20 and 40 DAS
T6:Pretilachlor+ Bensulfuronmethyl 660 g a.i./ha (PRE) fbPenoxsulam 22.5 g a.i./ha (POST)	T13:Unweeded check Note: HW- Hand weeding, fb- Followed by
T7:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fbAzimsulfuron 26.25 g a.i./ha (POST)	

Figures indicating (□x+0.5) transformed values, Figures in parenthesis indicate original value

Table-2: Effect of weed control treatments on growth, yield and yield attributing parameters of DSR

Treatment	Plant height	Number of tillers	Dry matter production	No. of panicles	Panicle length	Panicle weight	No. of grains per panicle	Percent chaffiness	1000 grain weight	Grain yield (Kg/ha)	Straw yield (Kg/ha)	Harvest index (%)
T ₁	99.83	45.33	184.9	49.6	18.5	3.60	168.9	16.3	21.47	5889	7066	0.46
T ₂	97.24	43.33	187.3	42.3	17.8	3.18	159.2	13.7	20.70	5691	6675	0.46
T ₃	98.50	42.33	185.9	42.3	18.1	3.18	158.2	12.7	21.30	5702	6638	0.46
T ₄	98.97	42.67	190.6	42.7	17.7	3.17	160.1	1.7	20.77	5514	6634	0.46
T ₅	94.33	42.67	166.5	41.7	18.5	3.76	167.7	12.3	21.50	5979	7123	0.46
T ₆	102.33	47.33	185.9	51.8	20.5	3.46	171.9	14.0	22.17	6190	7332	0.46
T ₇	97.50	43.33	175.1	45.3	19.3	3.45	174.7	13.7	21.33	5880	7077	0.46
T ₈	96.50	43.33	186.7	47.3	18.6	3.30	169.3	14.3	22.17	6012	7232	0.46
T ₉	98.93	43.67	160.1	51.1	19.6	3.45	170.7	14.3	21.80	6148	7049	0.46
T ₁₀	106.87	48.67	291.1	60.5	20.5	4.22	183.7	9.3	23.60	6328	7432	0.46
T ₁₁	97.70	43.67	207.1	58.7	19.1	3.42	171.3	17.3	22.17	6056	6974	0.47
T ₁₂	111.50	50.67	279.7	59.3	21.6	4.45	193.7	9.7	23.17	6352	7589	0.46
T ₁₃	81.43	34.33	104.3	32.3	16.7	3.01	104.2	26.1	18.83	4503	5400	0.44
S.Em.±	4.64	1.49	17.71	1.83	0.57	0.11	6.02	1.10	0.74	208.91	205.24	0.03
CD @ 5%	13.55	4.35	51.69	5.34	1.65	0.32	17.58	3.21	NS	609.40	598.96	NS
CV%	8.15	5.88	15.9	6.59	5.16	5.36	6.30	13.38	5.95	6.05	5.12	10.67

Note: HW- hand weeding

T1:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fb one HW at 30 DAS	T8:Pendimethalin 750 g a.i./ha (PRE) fb one HW at 30 DAS
T2:Bispyribac-sodium @ 25 g a.i./ha (POST) fb one HW at 30 DAS	T9:Pendimethalin 750 g a.i./ha (PRE) fbBispyribac-sodium 22.25g a.i./ha (POST)
T3:Penoxsulam @ 22.5 g a.i./ha (POST) fb one HW at 30 DAS	T10:Pendimethalin750 g a.i./ha (PRE) fbPenoxsulam 22.5 g a.i./ha (POST)
T4:Azimsulfuron @ 26.25 g a.i./ha (POST) fb one HW at 30 DAS	T11:Pendimethalin 750 g a.i./ha (PRE) fbAzimsulfuron 26.25 g a.i./ha (POST)
T5:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fbBispyribac-sodium (POST) 25 g a.i./ha	T12:Two HW at 20 and 40 DAS

T6:Pretilachlor+ Bensulfuronmethyl 660 g a.i./ha (PRE) fbPenoxsulam 22.5 g a.i./ha (POST)	T13:Unweeded check
T7:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fbAzimsulfuron 26.25 g a.i./ha (POST)	

Table-3: Economics of DSR rice as influenced by different weed management practices

Treatment	Cost of weed management (Rs. ha ⁻¹)	Total cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B:C ratio	Increment benefit cost ratio
T ₁	4338	34308	63633	29325	1.85	6.76
T ₂	4037	34355	61455	27100	1.78	6.71
T ₃	4198	34168	61509	27341	1.80	6.51
T ₄	4121	34019	59587	25496	1.74	6.18
T ₅	4657	34645	64581	29936	1.86	6.42
T ₆	4450	34458	66836	32378	1.93	7.27
T ₇	4411	34381	63538	29157	1.84	6.61
T ₈	3423	33393	64966	31573	1.94	9.22
T ₉	3462	33730	66264	32534	1.96	9.38
T ₁₀	3573	33543	68296	34753	2.03	9.72
T ₁₁	3496	33466	65287	31821	1.95	9.10
T ₁₂	6500	36500	68614	32114	1.98	5.00
T ₁₃	0.0	30018	48650	18632	1.62	-

Note: HW- hand weeding

T1:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fb one HW at 30 DAS	T8:Pendimethalin 750 g a.i./ha (PRE) fb one HW at 30 DAS
T2:Bispyribac-sodium @ 25 g a.i./ha (POST) fb one HW at 30 DAS	T9:Pendimethalin 750 g a.i./ha (PRE) fb Bispyribac-sodium 22.25g a.i./ha (POST)
T3:Penoxsulam @ 22.5 g a.i./ha (POST) fb one HW at 30 DAS	T10:Pendimethalin750 g a.i./ha (PRE) fb Penoxsulam 22.5 g a.i./ha (POST)
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T5:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fb Bispyribac-sodium (POST) 25 g a.i./ha	T12:Two HW at 20 and 40 DAS
T6:Pretilachlor+ Bensulfuronmethyl 660 g a.i./ha (PRE) fb Penoxsulam 22.5 g a.i./ha (POST)	T13:Unweeded check
T7:Pretilachlor + Bensulfuronmethyl @ 660 g a.i./ha (PRE) fb Azimsulfuron 26.25 g a.i./ha (POST)	

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