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Research Article

IMPACT OF DIFFERENT HERBICIDES AND THEIR COMBINATIONS ON PRODUCTION-ECONOMICS OF WINTER RICE IN NAZ OF WEST BENGAL

Sarkar S.K[1]*., Patra B.C[1]., Jana K[2] and Ghosh K[2]

Department of Agronomy Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741235, Nadia, West Bengal, INDIA

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A B S T R A C T

Field studies were carried out at Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal during *kharif* season of 2015 to reveal the effect of cost effective chemical weed management for getting better production of transplanted rice over hand weeding. Among grassy weeds, *Cynodon dactylon*, *Echinochloa colona* and *Leersia hexandra* were most common. *Fimbristylis dichotoma*, *Scirpus validus* and *Cyperus difformis* were the pre-dominant sedges found at the time of observation. The important broadleaf weeds identified in this study were *Ammania baccifera*, *Ipomeoea reptens*, *Scoparia dulsis*, *Marsilea quadrifolia* etc. Hand weeding twice at 20 & 40 DAT gave best results in reducing both weed density and biomass and ultimately increased the grain (4.53 t ha^{-1}) and straw yield (5.80 t ha^{-1}). However, second highest grain (4.20 t ha^{-1}) and straw yield (5.57 t ha^{-1}) was obtained with Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE + one hand weeding at 40 DAT treatment followed by combined herbicidal treatment (Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE + Bispyribac Sodium 10% SC as POE) giving grain yield 4.17 t ha^{-1} and straw yield 5.53 t ha^{-1}. Considering the benefit: cost ratio, the highest value (1.92) was obtained with the performance of Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE +Metsulfuron methyl 10% + Chlorimuron-ethyl 10% as POE followed by the application of Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE + Bispyribac Sodium 10% SC as POE (1.90). On the other hand, costly hand weeding (20 & 40 DAT) treatment required the maximum cost of cultivation resulting the B: C ratio 1.85.

INTRODUCTION

Rice is the life-blood of the Asia-Pacific Region where 56 percent of humanity lives, producing and consuming more than 90 percent of the world rice. Rice contributes 43% of total food grain production and 46 % of the cereal production of the country. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize. Rice is the staple food of about 3.5 billion people and demand is expected to continue to grow as population increases (GRiSP, 2013). Second to wheat, rice is primarily a source of high energy and high caloric food materials like near about 30% of total energy and 78.2% of carbohydrate etc. Among different states, West Bengal is the leading state of India in rice production. During the year 2007-08, the average productivity of Aus, Aman and Boro was 2009 kg ha^{-1}, 2309 kg ha^{-1} and 3259 kg ha^{-1} respectively and the state average of rice productivity was 2573 kg /ha (Samanta and Mallik, 2004). Weeds are claimed as greatest constraint in rice crop and impose a serious negative effect on crop production and market value. According to the International Rice Research Institute (IRRI, 2015), it was found that, on an average, farmers lose 37% of their rice yield to pests and diseases, and that these losses can range between 24% and 41% depending on the production situation. The rice growing farmers follow the age old traditional cultural methods namely hand weeding or hoeing for controlling weeds in rice field. Between 100 - 200% increases in the current labour price are realistic expectations within 5 - 10 years. Farmers are left with little choice but to reduce labour and production costs, particularly for the most labour intensive tasks, such as weeding. As a result, herbicides are being substituted widely for manual labour. But, in this investigation different herbicides have been tested in a single and combined form to see the effect on economical rice production.

METHODS AND MATERIALS

The field experiment was conducted at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, new alluvial zone of West Bengal under the sub-tropical humid climate during the months from July to November (*Kharif* Season) of 2015 with medium fertility status, having sandy loam in texture (pH- 6.7). The experiment was laid out at Randomized Block Design (RBD) having thirteen treatments *viz*. T_1: Butachlor @1.5 kg-ai ha^{-1} (G) as *PE (2 DAT) with One hand weeding (40 DAT***); T_2: Pyrazosulfuron-ethyl @ 25 g ai ha^{-1} as PE (2 DAT) with One hand weeding (40 DAT); T_3: Bensulfuron-methyl 0.6% + Pretilachlor 6% @ 10 kg (G) ha^{-1} as PE (2 DAT) with One hand weeding (40 DAT); T_4: Bispyribac Sodium 10% SC @ 25g ai ha^{-1} as**POE (20 DAT); T_5: Metsulfuron- methyl 10% + Chlorimuron-ethyl 10% @ 4g as POE (20 DAT); T_6: Butachlor (PE - 2 DAT) + Bispyribac

Sodium 10% SC(POE-20DAT); T_7: Pyrazosulfuron-ethyl (PE - 2 DAT) + Bispyribac Sodium 10% SC (POE-20DAT); T_8: (Bensulfuron-methyl 0.6% + Pretilachlor 6%) as PE (2 DAT) + Bispyribac Sodium 10% SC (POE - 20 DAT); T_9: Butachlor (PE - 2DAT) + (Metsulfuron- methyl 10% + Chlorimuron-ethyl 10% as POE (20 DAT)); T_{10}: Pyrazosulfuron-ethyl (PE-2DAT)+ (Metsulfuron- methyl 10% + Chlorimuron-ethyl 10% as POE(20 DAT)); T_{11}: (Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE - 2DAT) + (Metsulfuron- methyl 10% + Chlorimuron-ethyl 10% as POE (20 DAT)); T_{12}: Two hand weeding at 20 & 40 DAT; T_{13}: Weedy check, replicated thrice. Herbicides were sprayed using knapsack sprayer fitted with a flat fan nozzle at a spray volume of 500 l ha^{-1} except the granular herbicides were applied by mixing with sand @ 50 kg ha^{-1}. The variety Swarna (MTU-7029) was grown with recommended package of practices followed uniformly. The observations on yield and yield attributes like grain yield, straw yield, no. of panicles m^{-2}, filled grains $panicle^{-1}$ and 1000 seeds weight were recorded at harvest. Weed and Crop dry matter at different growth stages of rice, weed index and economics were worked out. All the collected data was analyzed statistically to the design RBD by following the procedure laid out by Gomez and Gomez (1984).

G= Granules,
*PE = Pre-emergence,
**POE = Post- emergence,
***DAT = Days of transplanting

RESULTS AND DISCUSSION

The observations revealed that the predominant weed species were Cynodon dactylon, Leersia hexandra, Echinochloa colona, Commelina benghalensis, Brachiaria mutica, Echinochloa Crusgalli, Cyperus rotundus, Cyperus difformis, Fimbristylis dichotoma, Scirpus validus, Ammannia baccifera, Ageratum haustonianum, Spilanthus paniculata, Marsilea quadrifolia, Scoparia dulcis, Sphenoclea zeylenica, Xanthium strumarium, Ludwigia parviflora, Ipomoea reptens, Lindernia ciliata, and Nymphoides indica.

Effect on plant dry weight (Table 1)

Table 1 Effect of weed control treatments on plant dry biomass

Treatments	Plant dry weight (g/m^2)		
	30 DAT	45 DAT	60 DAT
T_1	92.33	154.25	221.17
T_2	86.08	138.08	182.50
T_3	96.75	173.92	252.50
T_4	85.83	122.02	160.75
T_5	82.58	117.42	160.75
T_6	77.58	109.58	150.17
T_7	90.50	145.83	194.83
T_8	95.25	162.17	231.83
T_9	80.00	113.08	155.75
T_{10}	89.17	143.00	190.50
T_{11}	93.25	156.75	223.83
T_{12}	99.50	192.08	279.17
T_{13}	74.17	104.33	135.50
S.Em.	1.18	3.77	4.79
C.D. at 5 %	3.48	11.07	13.99

Herbicidal and cultural treatments were significantly differed with unweeded control treatment (T_{13}) at all the observations.The dry matter accumulation increased progressively from 30 DAT to 60 DAT. But, variations were followed in different treatments. The better weed control made the availability of soil moisture, nutrients etc. by reducing the crop-weed competition. On average 33.8% weed dry weight was reduced due to competition from Aus rice (Karim, 2000). So, T_{12} (twice hand weeding at 20 and 40 DAT) treatment resulted maximum dry matter accumulation of rice crop followed by T_3 and T_8. Reddy *et al*., 2012 reported that pre-emergence application of Bensulfuron methyl 0.6% + Pretilachlor 6.0% G @ 75 + 750 g ha^{-1} at 5 DAT effectively controlled sedges, grasses and broad leaf weeds.

Effect on yield attributes (Table 2) 1000-seed weight (g)

Table 2 Effect of weed control treatments on yield attributes

Treatments	Yield attributes		
	No. of Panicles m^{-2}	No of Filled Grains $Panicle^{-1}$	1000 Seed Weight (g)
T_1	318.8	116.7	17.62
T_2	287.5	104.0	17.91
T_3	350.0	140.3	18.47
T_4	285.4	101.3	17.34
T_5	277.1	99.0	17.31
T_6	245.8	83.7	17.31
T_7	310.4	114.3	17.66
T_8	331.3	138.3	17.85
T_9	264.6	91.7	17.32
T_{10}	304.2	108.0	17.59
T_{11}	325.0	135.8	18.38
T_{12}	370.8	153.0	18.41
T_{13}	225.0	77.0	16.59
S.Em.	6.59	3.80	0.37
C.D. at 5 %	19.34	11.15	NS

Thousand grains weight is one of the main contributing factors towards yield. During the first year of the experiment statistically significant differences were noticed between treated and untreated plots. There were no significant differences among different treatments because it is a genetical character and thus it is not affected by crop-weed competition or moisture and nutrients present into the soil. Sandeep et al., (2002) noted higher 1000- grain weight for weed control with different herbicides which was at par with those for plots kept weed free.

Numbers of panicles m^{-2} and filled grains $panicle^{-1}$

Hand weeding twice at 20 and 40 DAT (T_{12}), Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE with one hand weeding at 40 DAT (T_3), combined application of Bensulfuron-methyl

Table 3 Effect of weed control treatments on yield and weed index

Treatments	Yield (t/ha)		Weed Index (%)
	Grain Yield (t/ha)	Straw Yield (t/ha)	
T_1	3.63	5.20	19.85
T_2	3.23	4.83	28.68
T_3	4.20	5.57	7.35
T_4	3.10	4.73	31.62
T_5	2.87	4.63	36.76
T_6	2.33	4.47	48.53
T_7	3.53	5.17	22.06
T_8	4.17	5.53	8.09
T_9	2.67	4.53	41.18
T_{10}	3.27	4.87	27.94
T_{11}	4.07	5.47	10.29
T_{12}	4.53	5.80	-
T_{13}	2.23	4.30	50.74
S.Em.	0.24	0.32	-
C.D. at 5 %	0.71	0.94	-

0.6% + Pretilachlor 6% as PE + Bispyribac Sodium 10% SC as POE (T_8) gave more numbers of panicles m^{-2} and filled grains panicles^{-1} because the plants under these treatments faced lesser degree of crop weed competition and absorbed proper nutrients for better growth and development of panicles. Although the number of panicles was not much lesser in control (weedy check) yet it was significantly different from the treated plants. Prasad *et al.*, (2001) reported that manual weeding gave the highest value for filled grains/panicle as compared to herbicides.

Effect on yield and weed index **(Table 3)**

Straw and grain yield

Highest straw and grain yield ((5.80 and 4.53 t ha^{-1}) was recorded to the treatment of hand weeding twice at 20 and 40 DAT (T_{12}) which gave significantly higher grain yield of transplanted rice over all the treatments of this experiment followed by T_3 (5.57 and 4.20 t ha^{-1}) and T_8 (5.53 and 4.17 t ha^{-1}). All the cultural and herbicidal treatments gave significantly higher grain yield that weedy check. Hand weeding twice (20 and 40 DAT) performed the best and increased the grain yield 42%, the straw yield 24% and the biological yield 32% over weedy check treatment due to the fact that this treatment required two hand weeding for eradicating different types of weeds. But, combined herbicides (Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE + Bispyribac Sodium 10% SC as POE) also showed a broad herbicidal spectrum to manage both annual and perennial weeds. Similar observation was also corroborated the findings of Teja *et al*. (2015).

Economics **(Table 4)**

Table 4 Effect of weed control treatments on economics of transplanted rice production

Treatment	Straw Return (Rs.)	Grain Return (Rs.)	Gross Return (Rs.)	Cost of cultivation (Rs.)	Net Return (Rs.)	B:C
T1	8295	50820	59115	33860	25255	1.74
T2	7605	46620	54225	33721	20504	1.61
T3	8850	54180	63030	34060	28970	1.85
T4	7500	50400	57900	31401	26499	1.84
T5	7395	42950	50345	30300	20045	1.66
T6	7155	38220	45375	32502	12873	1.40
T7	7950	49420	57370	32363	25007	1.77
T8	8505	53620	62125	32702	29423	1.90
T9	7245	43820	51065	31392	19673	1.63
T10	7800	48020	55820	31253	24567	1.79
T11	8400	52220	60620	31592	29028	1.92
T12	9195	58800	67995	36728	18921	1.85
T13	6945	33600	40545	28808	11737	1.41

The application of Bensulfuron-methyl 0.6% + Pretilachlor 6% @ 10 kg (G) ha^{-1} as PE and Metsulfuron methyl 10% + Chlorimuron-ethyl 10% @ 4g-ai ha^{-1} as POE recorded the most cost saving and environmentally sound treatment followed by the application of PE (Bensulfuron-methyl 0.6% + Pretilachlor 6%) + POE (Bispyribac Sodium 10% SC) treatment. The maximum cost of cultivation was observed in hand weeding at 20 & 40 DAT compared to other treatments.Pre-emergence application of Bensulfuron-methyl 0.6% +Pretilachlor 6% @ 10 kg (G) ha^{-1} + one hand weeding at 40 DAT was also found to be effective on the basis of the evaluation of treatment on weed control. Similar results were also opined by Reshma *et al*. (2015). Among herbicidal treatments, the highest b: c value (1.92) was obtained from the treatment T_{11} followed by T_8 treatment (1.90). Singh *et al*. (2007) also reported that Almix @ 8 g/ha provided higher profitable returns and B: C which corroborated the present findings. But, T_3 and T_4 also resulted higher b: c values that were 1.85 and 1.84 respectively compared to other treatments. In case of T_{12} (hand weeding twice at 20 and 40 DAT treatment) treatment the b: c value was 1.85.

CONCLUSION

According to the availability of herbicides and economical point of view, combined herbicides may profitably be replaced the time consuming and expensive hand weeding for weed control in transplanted winter rice. Among single herbicidal treatments, the application of Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE with one hand weeding at 40 DAT showed better weed control and higher economical return (Rs. 28970/- ha^{-1}) but involved labour cost which ultimately increased the cost of cultivation. On the other hand, the treatment applied Bispyribac Sodium 10% SC as POE recorded higher B: C ratio but obtained comparatively lower value of produce. So, the application of of Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE with Bispyribac Sodium 10% SC as POE is more superior over hand weeding twice (20 & 40 DAT). However, Bensulfuron-methyl 0.6% + Pretilachlor 6% as PE with Metsulfuron methyl 10% + Chlorimuron-ethyl 10% as POE can also give promising results.

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