Effectiveness of Herbicides and Their Combinations in Direct Seeded Hybrid Rice (*Oryza sativa* L.) in Coastal Belt of West Bengal

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INTRODUCTION

Most rice growers in coastal belt of West Bengal have no other option but to go for rice cultivation in *kharif* season under lowland situations, representing about 17% of total rice area of this state (Banerjee *et al.* 2018). Weeds are the predominant barrier to direct seeded rice production in rainy season (Biswas *et al.* 2020). Bengal farmers traditionally practice hand weeding which is labour and cost intensive. On contrary, the herbicidal application saves time as well as cost. But continuous application of single herbicide facilitates shifting of dominant weed flora and the development of resistant biotypes against the particular herbicides (Kundu *et al.* 2020 a, b). Therefore, sequential or tank-mix application of various post-emergence herbicide would be a good option to control the heavily diversified weed flora in direct seeded rice (Ghosh *et al.* 2016). This study was undertaken to compare the performance of different post-emergence herbicides, mechanical and cultural weeding on weed control efficiency and hybrid rice (cv. PAN 2423) productivity in coastal belt of West Bengal.

Materials and Methods

The Field experiment was conducted at Regional Research Station (coastal saline zone), Bidhan Chandra Krishi Viswavidyalaya, Kakdwip, South 24 Parganas, West Bengal during rainy season of 2017-18 and 2018-19. The farm is situated at 22°40′ N latitude, 88°18′ E longitude and 7 m above mean sea level. The soil was clayey in nature, neutral pH, having medium N, P and rich in K. The trials were laid out in a randomized block design with eight weed control treatments [T1, glyphosate 41 EC at 0.75 kg/ha at 10 days before sowing, T2, butachlor 50 EC at 1.5 kg/ha at 3 days after sowing (DAS), T3, bensulfuron-methyl + pretilachlor 66.60 GR at 0.06 + 0.06 kg/ha at 15 DAS; T4, T1 *fb* T2; T5, T1 *fb* T3; T6, hand weeding at 20 and 40 DAS; T7, cono weeder and T8, control or weedy check] with three replications. The individual plot size was 5 × 4 m. Herbicides were applied with knapsack sprayer fitted with flat fan nozzle by dissolving in 500 liters water per hectare. Other management practices were applied on hybrid rice (cv. PAN 2423) followed standard package and practices. Bio-efficacy was recorded by accounting numbers and dry weights of weed flora by random placing of quadrate 0.5×0.5 m. Rice yield was determined from the net plot area (12 m^2 excluding the border area).

As wide variation existed in data on weed density were transformed through square-root (method before analysis of variance. All the collected data were analyzed statistically by

the analysis of variance (ANOVA) technique using the STAR Software version 2.0.1 of International Rice Research Institute, Philippines, 2013. The differences between treatments means were tested on the significance level of *p* d"0.05.

Result and Discussion

The experimental field was infested with the following weed flora, namely *Echinochloa colona* (30%), *Cyperus iria* (20%), *Marsilea quadrifoliata* (25%) and *Ludwigia parviflora* (25%) during both the years of study, before and after herbicide application. Maximum and minimum weed population and dry weight were recorded in weedy check and hand-weeded plot respectively. Among the herbicidal treatments, application of glyphosate 41 EC at 0.75 kg/ha at 10 days before sowing followed by bensulfuron-methyl + pretilachlor 66.60 GR at 0.06 + 0.06 kg/ha at 15 DAS resulted in minimum weed count at 60 DAT, irrespective of weed species (Table 1). Similar findings were also reported by Ghosh *et al.* (2016) who opined that the collective impact of herbicides inhibits the initial weed seed germination and subsequent weed growth at later stage in rice field. Least weed density irrespective of grass, sedge and broadleaf with herbicide mixture at different crop growth stages was also reported by Banerjee *et al.* (2017). In the present study, however, least weed dry weight (13.10 g/m^2) was recorded in the plot treated with butachlor 50 EC at 1.5 kg/ha at 3 DAS, which had no significant difference with weed dry weight obtained by combined application of glyphosate 41 EC at 0.75 kg/ha at 10 days before sowing followed by bensulfuron-methyl + pretilachlor 66.60 GR at 0.06 + 0.06 kg/ha at 15 DAS (Table 1). Sequential or mixed application of herbicides is the most prominent and effective option than the use of single herbicide, most particularly in complex grass and broadleaf weed infestation in rice fields (Singh *et al.* 2006). Application of glyphosate effectively control the weeds including *Cyperus* spp. before puddling resulted in lesser weed density, dry weight and ultimately higher weed control efficiency in transplanted paddy (Manisankar *et al.* 2019). As compared to control plots (weedy), the maximum reduction in weed dry matter was recorded in hand-weeded plots, closely followed by the plots receiving butachlor 50 EC at 1.5 kg/ha at 3 DAS, as estimated by weed control efficiency of herbicidal treatments. Previously, Singh *et al.* (2016) showed better performance with the application of butachlor at 2 kg/ha in respect to minimum weed dry matter accumulation and maximum dry matter reduction.

Amongst the tested herbicides, the plots receiving glyphosate 41 EC at 0.75 kg/ha at 10 days before sowing followed by bensulfuron-methyl + pretilachlor 66.60 GR at 0.06 + 0.06 kg/ha at 15 DAS produced hybrid rice with higher yield components (300 panicle/m^2 and 2.25g panicle weight, respectively) (Table 1). The same treatment combination registered the significantly highest grain yield (4.58 t/ha), comparatively lower than grain yield obtained in hand-weeded plot. However, the highest B:C ratio was obtained with same treatment combination which might be due to the low cost involvement in weed control practice (Table 1). On other hand, the lowest grain yield with poor economic return was recorded from control plots (weedy check), as there was huge competition between hybrid rice and predominant weeds for essential growth factors (moisture, nutrients, sunlight etc.). Our results are in good conformity with Singh *et al.* (2008) who reported maximum rice productivity along with good economic viability from the plot treated with sequential application of non-selective and selective herbicide at proper time rather than single application.

Table 1. Effect of weed control measures on diverse weed-flora, yield components, yield and economics of direct seeded hybrid rice (pooled data of two years)

ents	Weed density (nos./m^2) at 60 DAS			Total weed dry weight at 60 DAS (g/m^2)	Weed control efficiency (%)	Panicle number / m^2	Panicle weight (g)	Grain yield (t/ha)	Weed index (%)	B:C ratio
	Grass	Sedge	BLW							
	2.75 (7.67*)	2.82 (7.99)	3.15 (9.97)	13.67	77.09	259	2.00	3.03	34.97	1.04
	2.47 (6.11)	2.46 (6.07)	3.02 (9.17)	13.10	78.04	269	2.08	3.46	25.75	1.13
	2.57 (6.65)	2.42 (5.87)	3.03 (9.17)	14.17	76.25	273	2.16	3.77	14.09	1.25
	2.65 (7.09)	2.50 (6.29)	3.19 (10.21)	14.67	75.41	288	2.07	4.17	10.51	1.39
	2.21 (4.89)	2.42 (5.87)	2.41 (6.03)	13.90	76.70	300	2.25	4.58	1.71	1.68
	1.57 (2.50)	2.09 (4.43)	2.55 (6.52)	5.30	91.11	342	2.39	4.66	0	1.47
	2.36 (5.58)	2.33 (5.46)	2.89 (8.37)	17.27	71.05	307	2.41	4.10	12.01	1.12
	5.55 (31.07)	4.29 (18.40)	4.34 (18.80)	59.67	0	164	1.63	1.73	62.87	0.48
	0.57	0.29	0.48	8.05	-	32	0.07	0.27	-	-

*Figures in parenthesis represent the original value

DAS, Days after sowing; BLW, Broad leaved weed; B:C , Benefit : cost; LSD: Least significant difference

Conclusion

The diverse weed-flora in direct seeded hybrid rice was effectively controlled by the combined application of glyphosate 41 EC at 0.75 kg/ha at 10 days before sowing followed by bensulfuron-methyl + pretilachlor 66.60 GR at 0.06 + 0.06 kg/ha at 15 DAS. This superior treatment may be recommended as it recorded maximum yield and profitability than any other tested chemical or cultural or mechanical weed control measures in direct seeded hybrid rice cultivation in coastal Bengal.

References

Banerjee, H., Das, T.K., Ray, K., Laha, A., Sarkar, S., Pal, S. 2017. Herbicide ready-mixes effects on weed control efficacy, non-target and residual toxicities, productivity and profitability in sugarcane–green gram cropping system. *International Journal of Pest Management* **64**: 221–229.

Banerjee, H., Samanta, S., Sarkar, S., Garai, S., Pal, S., Brahmachari, K. 2018. Growth, productivity and nutrient uptake of different rice cultivars under coastal eco-system of West Bengal. *Journal of the Indian Society of Coastal Agricultural Research* **36**(2): 115–121.

Biswas, B., Timsina, J., Garai, S., Mondal, M., Banerjee, H., Adhikary, S., Kanthal, S. 2020. Weed control in transplanted rice with post- emergence herbicides and their effects on subsequent rapeseed in Eastern India. *International Journal of Pest Management* **64**(4): 1–13.

Ghosh, D., Singh, U.P., Brahmachari, K., Singh, N.K., Das, A. 2016. An integrated approach to weed management practices in direct-seeded rice under zero-tilled rice–wheat cropping system. *International Journal of Pest Management* **63**: 37–46.

Kundu, R., Mondal, M., Garai, S., Mondal, R., Poddar, R. 2020a. Bio-efficacy of post-emergence herbicides in boro rice nursery as well as main field and their residual effects on non-target microorganisms. *Oryza* **57**(3): 199-210.

Kundu, R., Mondal, R., Garai, S., Mondal, M., Poddar, R., Banerjee, S. 2020b. Weed management efficiency of post emergence herbicides in direct seeded rice and their residuality on soil microorganisms. *Journal of Experimental Biology and Agricultural Sciences* **8**(3): 276–286.

Manisankar, G., Ramesh, T., Selvaraj, R., Ponnusamy, J. 2019. Evaluation of sequential herbicide application on transplanted paddy under sodic soil. *The Pharma Innovation* **8**(5): 633-638.

Singh, S., Bhushan, L., Ladha, J.K., Gupta, R.K., Rao, A.N., Sivaprasad, B. 2006. Weed management in dry-seeded rice (*Oryza sativa*) cultivated on furrow irrigated raised bed planting system. *Crop Protection* **25**(5): 487–495.

Singh, S., Ladha, J.K., Gupta, R.K., Bhushan, L., Rao, A.N. 2008. Weed management in aerobic rice systems under varying establishment methods. *Crop Protection* **27**(3-5): 660–671.

Singh, V.P., Joshi, N., Bisht, N., Kumar, A., Satyawali, K., Singh R.P. 2016. Impact of various doses of butachlor on weed growth, crop yield of rice, microbial population and residual effect on wheat crop. *International Journal of Science, Environment and Technology* **5**(5): 3106–3114.

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