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Weed Management in Dry Direct Seeded Rice for Enhancement of Production

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ABSTRACT

Dry direct-seeded rice (*Oryza sativa* L.) is an enchanting alternative to transplanted rice, as it saves the peonage of raising seedlings and transplanting, lessening labor and cost of cultivation. As direct-seeded rice stands in the farm for a longer duration than transplanted rice so weed control is one of the major challenges for its success. An field experiment was conducted at Bangladesh Rice Research Institute, Bangladesh during Aus season of 2014, to evaluate effectiveness of different weed management practices; weedy, hand weeding, pre to post and post-emergence herbicides; pretilachlor + pyrazosulfuran ethyl and bispyribac sodium followed by one hand weeding on the performance of dry direct-seeded rice in RCB design with three replications. Results showed that yield and yield attributing parameters and weed dynamics were significantly affected and the trend of higher production influence by weed management practices. Among the weed control practices, *Cyperus difformis* and *Scripus maritimus* were effectively control by pretilachlor + pyrazosulfuran ethyl along with one hand weeding whereas Bispyribac sodium along with one hand weeding effectively control both *Cyperus difformis*, *Scripus maritimus* and also *Echinochloa colonum* in direct dry seeded rice.
KEY WORDS: Direct seeding, weed management, hand weeding, weed density, rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is the key source of food for over half of the world population, especially in Bangladesh. It is the great source to nutritional calories, providing 35-80% of total calorie uptake [1]. Rice production desires to be improved by 50% or more above the present production level to meet up the increasing food demand [2, 3]. More than 20% people of Bangladesh are under poverty line and rice is the main carbohydrate, protein, vitamins and minerals source of their daily diet. In Bangladesh, rice is commonly grown by transplanting seedling into puddle soil. Higher water requirements and increasing labor costs are the major problems of the traditional rice production system. Direct seeded rice cultivation, growing rice without standing water, can be a good-looking alternate. Direct seeding rice avoids the puddling and maintains continuous moist soil conditions and thus reduces the overall water demand for rice culture. Weed infestation continues to be a serious problem in dry seeded rice. Aerobic soil environment and dry-tillage practices, besides alternate wetting and drying situations, are favorable for germination and growth of highly aggressive weeds, which is the reason of grain yield losses of 50–91% [4, 5]. The threat of crop yield failure due to struggle from weeds by direct seeding methods is higher than for transplanted rice because of the deficiency of the size differential among the crop and weeds and the suppressive effect of standing water on weed development at crop establishment [6]. Weeds compete for nutrient, space, sunlight and consume the available moisture with crop plant resulting in crop yield reduction [7, 8]. The common practice of weed control in rice field is hand pulling which makes the practice to be labour intensive and many a times not satisfactorily executed. As a result, yields in farmers' fields are lower than the well managed researchers' fields. However, weed-crop competition is abundant, natural and undesirable in agricultural plant communities. Therefore, the degree of weed control depends on costs or benefits and the resources available. So weed management are component technologies essential to the control of weeds in direct seeding of rice. Herbicides are one of the most important tools for managing weeds in direct seeded rice systems. Herbicides in particular are an important tool of weed management, but hand weeding is either partially or extensively practiced in country. Timely weed control is of vital importance to increase rice productivity [9]. Several pre and post emergence herbicides have been reported to provide a fair degree of weed control in direct seeded rice [10, 11]. Thus, it is crucial to upgrade the direct seeded rice technology along with effective weed management and make it more cost effective, environment and farmer's friendly. Therefore, the present study was undertaken to determine effective weed control management system in direct seeded rice cultivation.

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MATERIALS AND METHODS

A field experiment was conducted at Bangladesh Rice Research Institute (BRRI), Gazipur field laboratory during Aus season of 2014 to find out an appropriate method of weed management with its impacts on yield of rice. The soil of the experimental site was non-calcareous dark grey flood plain with pH around 6.2 and low in organic matter (1.2%). In direct seeding method, seeds of BRRI dhan43 were sown in line on 22th April, 2014 and line to line distance 20 cm with continuous seeding. The experiment was carried out with four treatments viz. i) Pre to post emergence herbicide followed by one hand weeding, ii) Post-emergence herbicide followed by one hand weeding, iii) Hand weeding at 15, 30 and 40 days after sowing (DAS), and compared with iv) Control (unweeded). The pre to post -emergence herbicide: Pretilachlor + Pyrazosulfuran ethyl @ 800 g/ha applied at 3 days after sowing (DAS) and post-emergence herbicide: Bispyribac sodium @ 150 g/ha applied at 5 DAS with the help of a knapsack sprayer. In herbicide treated plot one hand weeding was done at 25 DAS. The treatments were distributed following RCB design with three replications. The phytotoxicity of the weedicide to rice plants was determined by visual observations (yellowing leaves, burring leaf tips, stunting growth etc). The degree of toxicity on rice plant was measured by the following scale used by [12].

1. No toxicity
2. Slightly toxicity
3. Moderate toxicity
4. Severe toxicity
5. Toxic (plant kill)

The rating of toxicity was done within 7 days after application of herbicides. It was observed three times at 3, 5 and 7 days after application of herbicide and the mean rate was calculated from 10 sample plants of a unit plot.

Data on weed density and dry weight were taken from each plot at 35 DAS. The weeds were identified species-wise. Dry weights of weeds were taken by drying them in electric oven at 60^0 C for 72 hours followed by weighing by digital balance. Relative weed density (RWD), relative weed biomass (RWB) and weed control efficiency (WCE) of different weed control treatments were calculated with the following formulas [13, 14]:

$$\text{RWD (\%)} = \frac{\text{Density of individual weed species in the community}}{\text{Total density of all weed species in the community}} \times 100$$

$$\text{RWB (\%)} = \frac{\text{Dry weight of a given oven dried weed species}}{\text{Dry weight of all oven dried weed species}} \times 100$$

$$\text{SDR (\%)} = \frac{\text{RWD (\%)} + \text{RWB (\%)}}{2}$$

$$\text{WCE (\%)} = \frac{\text{(Dry weight of weeds in weedy check plots - Dry weight of weeds in treated plots)}}{\text{Dry weight of weeds in weedy check plots}} \times 100$$

Data on panicle no. m^{-2}, grains $panicle^{-1}$ and grain yield were collected according to the protocol of [15]. Graphical representation of the data was carried out using MS-Excel. The data was subjected to statistical analyses following [15] using Crop-Stat 7.2 statistical program.

RESULTS AND DISCUSSION

Phytotoxicity of herbicides on rice plant

The degree of toxicity of the weedicide to rice plants and the symptoms created on plant are offered in Table 1. It is observed that phytotoxicity symptoms were not more prominent for using pretilachlor + pyrazosulfuran ethyl @ 800 g ha^{-1} and bispyribac sodium @ 150 g ha^{-1}. Phytotoxicity of rice plant found by combined herbicide is less which is similar to the findings of [14, 16].

Table 1. Rating of herbicide toxicity on rice plant under different treatments in Aman

Treatments	Rating	Symptom observed in rice field
Pretilachlor + pyrazosulfuran ethyl @ 800 g ha^{-1} (280 g a.i. ha^{-1})	1.15	No toxicity
Bispyribac sodium @ 150 g ha^{-1} (30 g a.i. ha^{-1})	1.14	No toxicity

Weed infestation

Experimental field was infested with different types of weeds. The relative density of these weed species was also dissimilar (Table 2). Different weed species were observed in control (unweeded) plot where most dominating weeds were sedges and grassess. Among the weed species maximum relative weed density (RWD) was observed for *Echinochloa colonum* (31.60%), *Scripus maritimus* (30.83%) and *Cyperus difformis* (28.72%), respectively. Higher weed biomass (RWB) was observed for *Echinochloa colonum* (36.50%), *Scripus maritimus* (28.91%) and *Cyperus difformis* (26.63%), respectively. So grass and sedge weeds are dominant in dry direct rice cultivation which is similar to the findings of [17, 18].

Table 2: Weed composition, Relative density (RWD), Biomass (RWB) and Summed dominance ratio (SDR) in the untreated control plots

Name of Weed Species	Family	Class	RWD (%)	RWB (%)	SDR (%)
Echinochloa colonum	Poaceae	Grass	31.60	36.50	34.05
Cynodon dactylon	Poaceae	Grass	8.19	6.73	19.96
Paspalum comersoni	Poaceae	Grass	12.79	9.32	11.06
Cyperus difformis	Cyperaceae	Sedge	28.72	26.63	27.67
Scripus maritimus	Cyperaceae	Sedge	30.83	28.91	29.87
Fimbristylis miliaceae	Cyperaceae	Sedge	17.42	18.79	18.10
Cyanotis axillaris	Commelinaceae	Broad leaf	19.67	18.59	19.13
Euphorbia hitra	Euphorbiaceae	Broad leaf	10.67	12.04	11.35

Weed ranking

The summed dominance ratio (SDR) is an important indicator of showing ranking of weeds. Figure 1 represents SDR of infested weeds. The three most dominant weeds at 35 DAS were *Echinochloa colonum* (34.05%), *Scirpus maritimus* (29.87%) and *Cyperus difformis* (27.67%). So broad leaf weeds were less dominant than other weeds.

Weed control efficiency (WCE)

Echinochloa colonum was effectively control by Bispyribac sodium followed by one hand weeding (78.51) whereas Pretilachlor + Pyrazosulfuran ethyl with one hand weeding (71.32). Both herbicide control *Cyperus difformis* effectively (more than 80%). *Scripus maritimus* was control by both herbicides similarly. But herbicides had less effect on *Cynodon dactylon, Euphorbia hitra* and *Cyanotis axillaris*, compared to other weeds. The WCE of hand weeded plots was more than 80%. Hand weeded treatment easily control *Echinochloa colonum*, *Cyperus difformis, Scripus maritimus* and *Fimbristylis miliaceae* (Table 3) which was more effective than herbicide treatment. But three times hand weeding is more laborious and consequently more costly than herbicide application with one hand weeding. However, the highest weed control was given by hand weeding. These findings are in agreement with [19].

Table 3: Weed control efficiency different herbicides and manual weeding in direct dry seeded rice

Name of weeds	W_1	W_2	W_3
Echinochloa colonum	71.32	78.51	82.63
Cynodon dactylon	26.51	29.63	70.27
Paspalum comersoni	56.49	59.54	78.42
Cyperus difformis	80.56	80.97	83.85
Scripus maritimus	79.87	81.23	82.70
Fimbristylis miliaceae	74.63	72.39	80.54
Cyanotis axillaris	35.75	43.62	59.36
Euphorbia hitra	25.73	32.85	79.53

W_1= Pretilachlor + Pyrazosulfuran ethyl with one hand weeding, W_2= Bispyribac sodium with one hand weeding and W_3= Hand weeding

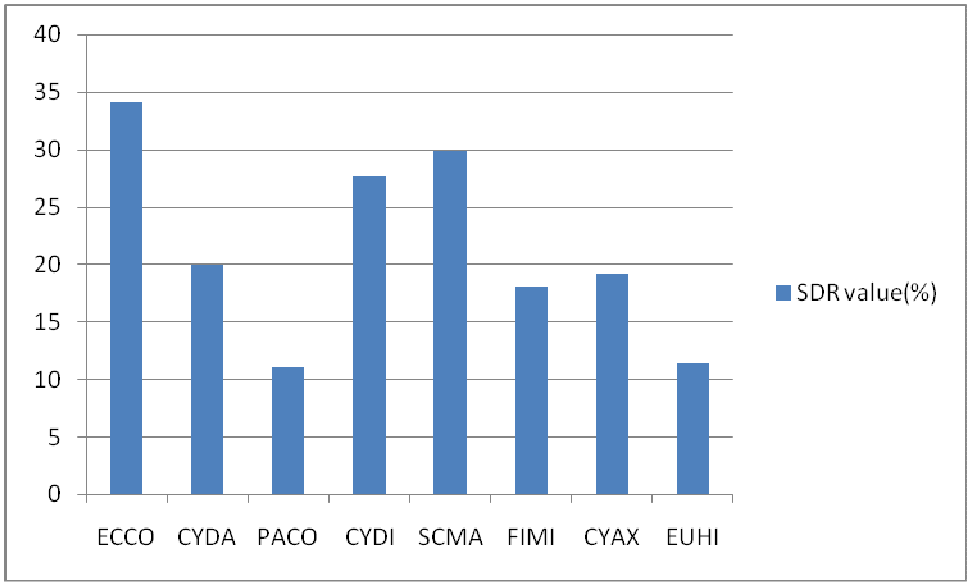

Figure 1: Summed dominance ratio (SDR) of infesting weeds

[ECCO= *Echinochloa colonum,* CYDA= *Cynodon dactylon,* PACO= *Paspalum comersoni,* CYDI=*Cyperus difformis,* SCMA=*Scirpus maritimus,* FIMI= *Fimbristylis miliaceae,* CYAX= *Cyanotis axillaris,* EUHI= *Euphorbia hitra*]

Plant height

The effect of weed management system on plant height showed that there is no significant effect on plant height irrespective of different days after sowing (Figure 2). Its indicate that weed management system have no significant effect on suppressing plant height although unweeded condition produced little lower plant height than weed free and other weed management systems.

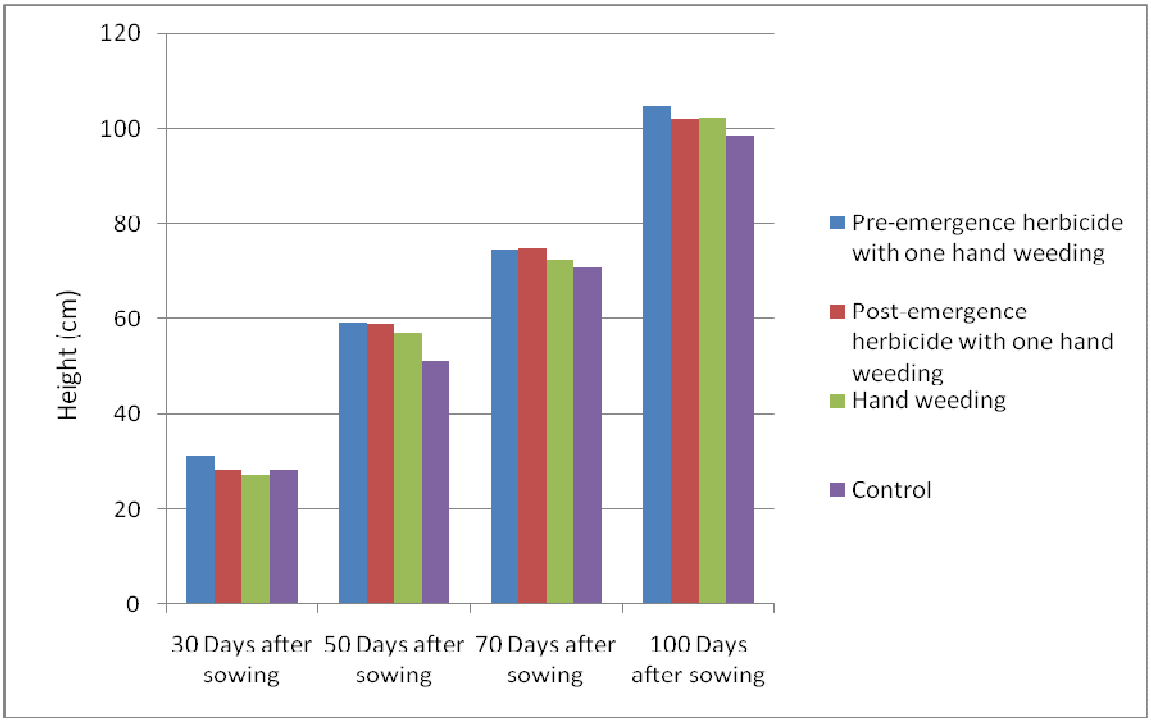

Figure 2: Plant height at different days after sowing on different weed management system

Dry weight

The effect of weed management system on plant dry weight showed that there is no significant effect on weight irrespective of 30 DAS (Figure 3) but later stage at 50 DAS, 70 DAS and 100 DAS there was significant difference between treated plots and unweeded plot.

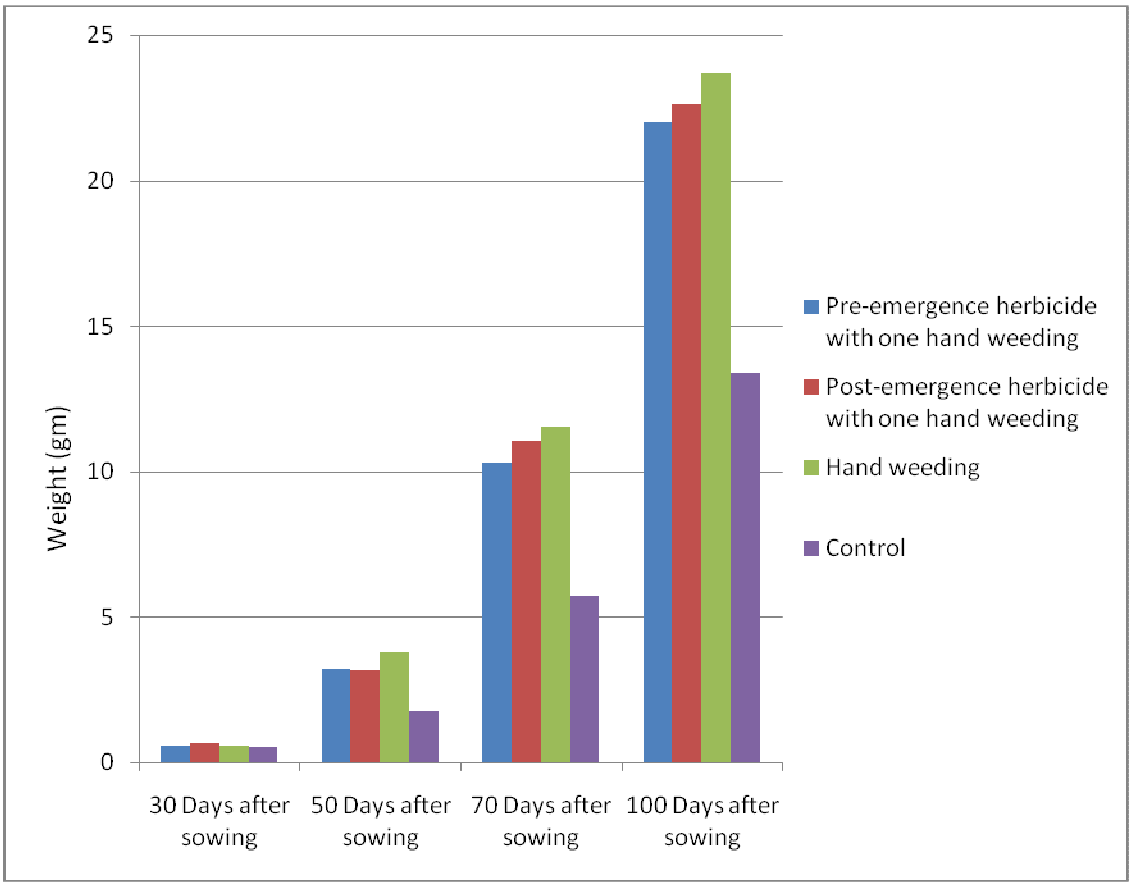

Figure 3: Dry matter production at different DAS in different weed management system during Aus season, 2014

Yield and yield attributes

Results of yield and yield characters were presented in table 4. Results indicated that the highest panicle m^{-2} was observed in hand weeding treatment. Grains $panicle^{-1}$ was highest in hand weeding treatment irrespective of control treatment followed by pre to post -emergence herbicide with one hand weeding, post-emergence herbicide with one hand weeding and pre-emergence one hand weeding treatment. The minimum number of panicles m^{-2} in the control plot was the result of higher competition for nutrient, air space, light and water between crop plants and weeds, which is similar to the findings of [20]. In this study, the number of panicle m^{-2}, number of grains $panicle^{-1}$ were severely reduced by weed competition, similar result finding by and [14]. Competition with weed may reduce the panicle length which indirectly reduced the number of grains $panicle^{-1}$. The variation of grain yield among the treatments was statistically significant, highest grain yield was found in hand weeding treatment over control (unweeded) treatment. Weeds caused severe reductions to yields which were similar to the finding by [21].

Table 4: Performance of the integrated weed control option for increasing yield of rice

Treatments	Panicle m^{-2}	Grains $panicle^{-1}$	Panicle length	Sterility (%)	Grain yield (t ha^{-1})
Pre-emergence herbicide with one hand weeding	231	71	22.86	22.47	3.01
Post-emergence herbicide with one hand weeding	237	69	21.37	21.37	3.07
Hand weeding	237	75	19.82	19.82	3.18
Control	143	45	19.53	28.16	1.27
LSD $_{(0.05)}$	19.86	7.88	1.87	4.12	0.23
CV (%)	4.7	6.1	4.3	9.0	4.3

Conclusion

The area under direct-seeded rice systems is expected to increase in the future because of labor and water shortages. Weeds, however, are the major constraints to direct-seeded rice production. To achieve effective, long-term, and sustainable weed control in direct-seeded systems, there is a need to integrate different weed management strategies. Based on the results, yield, yield attributing parameters and weed dynamics were greatly influenced by different weed management practice in higher production and lower weed dynamics in different growing stage of direct-seeded rice. It can be concluded from these studies that in direct dry seeded rice an effective control of weeds and ultimately a higher paddy yield could be achieved with application of pretilachlor + pyrazosulfuran ethyl or bispyribac sodium with hand weeding treatment.

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