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Effect of time of herbicide application on weed and yield of boro rice cv. BRRI dhan29

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Abstract: An experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from November 2005 to May 2006 to study the time of herbicide application on weed and yield of boro rice (BRRI dhan29). Two factors were included in the experiment- methods of crop establishment viz., direct seeded thick row, direct seeded thin row and transplanting method and four time of herbicide application viz. herbicide application after 3, 5, 7 and 9 days of sowing or transplanting with one control. The experiment was laid out in a split plot design assigning methods of crop establishment in the main plot and time of herbicide application in the sub-plot with three replications. Twelve weed species were found to infest the experimental crop. Among the weed species *Echinochloa crusgalli* was the most dominant weed, which was followed by *Marsilea quadrifolia* and the least dominant was *Fimbristylis miliacea*. Methods of crop establishment, time of herbicide application and their interaction significantly influenced the number and dry weight of weeds. The highest number and dry weight of weed were recorded in direct seeded thin row, followed by direct seeded thick row and the lowest in transplanting. Again, the highest number and dry weight of weed were recorded in control and the lowest in herbicide application after 3 days of seeding or transplanting. Weed control efficiency was higher in those receiving early application of herbicide. The highest weed control efficiency was in herbicide application at 3 days after seeding or transplanting. Phytotoxicity of herbicide increased with the earliness of herbicide application and highest phytotoxicity was observed in direct seeded thick row having herbicide application 3 days after sowing.

Key words: herbicide, direct seeded rice

Introduction

Rice (*Oryza sativa* L.) is the staple food for the people of Bangladesh as well as for 3 billion people of the word and it is, therefore, playing an important role in the national economy of many developing countries (Trans, 2001). In Bangladesh rice contributes 9.05% of the national gross domestic product (BBS, 2004). The agricultural land of Bangladesh is being reduced by about 1% per annum (Husain *et al*., 2006) while the population is increasing at an alarming rate of 1.43% (Bangladesh Economic Review, 2006). Farmers are under continuous pressure for producing more and more rice from the reduced land. Weed, the most destructive agricultural pest growing out of place, spontaneously compete with crop plants in every crop, every year. In direct seeded rice, crop-weed competitions are very severe because crop and weed germinate simultaneously and weeds being more vigours, smother the crop. In direct seeded upland rice, weeds cause yield reduction to the extent of 20-90% and sometimes complete failure of crops (Mamun, 1990; DDR, 1995; Rao and Moody, 1994; Chin and Mortimer, 2002). Direct seeded rice needed at least two hand weeding depending on the level of infestation, about 23-31 man-day per hectare to about 40-98 man day per hectare which accounts for as high as 20% of the total pre-harvest cost (Pandey and Velasco, 2002). This fact triggers the farmers to the alternative means and practice so as to minimize the cost of production. Herbicides are used successfully to control weed in rice fields for their rapid effects, easier to application and low cost involvement in comparison to the traditional methods of hand weeding (Mian and Mamun, 1969). There is an increasing trend of direct seeding for rice establishment (Balasubramanian and Hill, 2002) and chemical weed control strategies for less cost involvement. But a very little information is available in Bangladesh on crop establishment by direct seeding (drum seeding) and time of herbicide application.

Materials and Methods

The field lies in Old Brahmaputra Floodplain (Agro-ecological zone No. 9). The area of unit plot was 10 m^2 (4 m × 2.5 m). The experiment was laid out in a split plot design assigning methods of crop establishment in the main plot and time of herbicide application in the sub-plot with three replications. The treatment included (i) three methods of crop establishment viz., direct seeded thick row(M1), direct seeded thin row(M2) and transplanting method(M3) and (ii) four time of herbicide(Rifit 500EC) application viz. herbicide application after 3, 5, 7 and 9 days of sowing with one control. For direct seeding (thick and thin row) sprouted seeds are sown, in well puddled plots using drum seeder. In case of transplanting 30 day old seedlings having similar age that of drum seeding, were transplanted with a spacing of 20 cm × 15 cm. Fertilizers were applied as recommended. The crop was harvested at maturity. Data on weed parameters were collected at 25 and 50 DAT and 55 and 80 DAS by taking randomly 0.25 m^2 (0.5 m × 0.5 m) of land from each unit plot. Mortality of seedlings due to phytotoxicity of herbiciode was recorded on 3 and 15 DAS or DAT.

Percent weed control

The percent weed control by each of the treatments was calculated by the following formula:

$$\text{Percent weed control} = \frac{\text{No. of weeds killed per unit area in treated plots}}{\text{No. of weeds present per unit area in control plots}} \times 100$$

Weed control efficiency

Weed control efficiency (on the basis of dry weight) was calculated using the following formula developed by Sawant and Jadav (1985).

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

Where, WCE = Weed control efficiency, DWC = Dry weight of weeds in weedy check, DWT = Dry weight of weeds in mechanical or chemical treatment.

Collected data on weed parameters and different crop characters were statistically analyzed and the mean differences were judged by DMRT (Duncan's Multiple Range Test).

Results and Discussion

Data collected for weed density revealed that 12 weed species belonging to five families were found to infest the experimental crop, of which 4 were edges, 3 were broadleaved and 5 were grasses. The most dominant weed species was *Echinochloa crusgalli* followed by *Marsilea quadrifolia* and the least dominant was *Fimbristylis miliacea*.

Effect of methods of crop establish

Weed population

The number of weeds m^{-2} at 55 and 80 DAS was significantly higher in the direct seeded fields (M_1-direct seeded thick row and M_2-direct seeded thin row) compared with transplanted field (M_3) at 25 and 50 DAT. The highest number of weeds m^{-2} was in direct seeded thin row (62.60 and 78.40) at 55 and 80 DAS and the lowest was recorded in transplanting (35.40 and 67.00 m^{-2}) at 25 and 50 DAT (Table 2).

Dry weight of weeds

Dry weight of weeds was significantly differed in respect of methods of crop establishment At 25 DAT/55 DAS, the highest dry weight of weed was (22.12 g m^{-2}) in M_2 which was followed by M_1 (19.49 g m^{-2}) and the lowest was in M_3 (10.82 g m^{-2}). At 50 DAT/80 DAS, the highest dry weight of weed was 27.33 g m^{-2} in M_2 which was followed by M_1 (24.91 g m^{-2}) and the lowest was in M_3 (22.15 g m^{-2}) (Table 2).

Table 1. Infesting weed species found in the experimental plots in boro rice cv. BRRI dhan29

SL. No.	Local name	Scientific name	Family	Life cycle	Type
01	Shama	*Echinochloa crusgalli*	Gramineae	Annual	Grass
02	Shusni shack	*Marsilea quadrifolia*	Marsileaceae	Annual	Broad leaf
03	Angulee ghas	*Digitaria sanguinalis*	Gramineae	Annual	Grass
04	Khude shama	*Echinochloa colonum*	Gramineae	Annual	Grass
05	Goycha	*Paspalum distichum*	Gramineae	Perennial	Grass
06	Boro chucha	*Cyperus iria*	Cyperaceae	Annual	Sedge
07	Chechra	*Scirpus maritimus*	Cyperaceae	Annual	Sedge
08	Holood mutha	*Cyperus difformis*	Cyperaceae	Annual	Sedge
09	Panee kachu	*Monochoria vaginalis*	Potederiaceae	Perennial	Broad leaf
10	Panigash	*Lindernia anagalis*	Scrophuleriaceae	Annual	Broad leaf
11	Angta	*Paspalum scrobiculatum*	Gramineae	Perennial	Grass
12	Joina	*Fimbristylis miliacea*	Cyperaceae	Annual	Sedge

Table 2. Effect of methods of crop establishment on the population density and dry weight of weeds

Treatment	Weed infestation at 25 DAT/55 DAS		Weed infestation at 50 DAT/80 DAS	
	No. (m-2)	Dry weight (g m-2)	No. (m-2)	Dry weight (g m-2)
M1	57.40 b	19.49 b	71.80 b	24.91 b
M2	62.60 a	22.12 a	78.40 a	27.33 a
M3	35.40 c	10.82 c	67.00 c	22.15 c
CV(%)	9.75	22.48	5.16	3.93
Sx	1.208	0.8358	0.2708	0.3055
Level of significance	**	**	**	**

DAS = Day after sowing, DAT = Day after transplanting, M_1 = Direct seeded thick-row, M_2 = Direct seeded thin-row, M_3 = Transplanting, ** = Significant at 1% level of probability

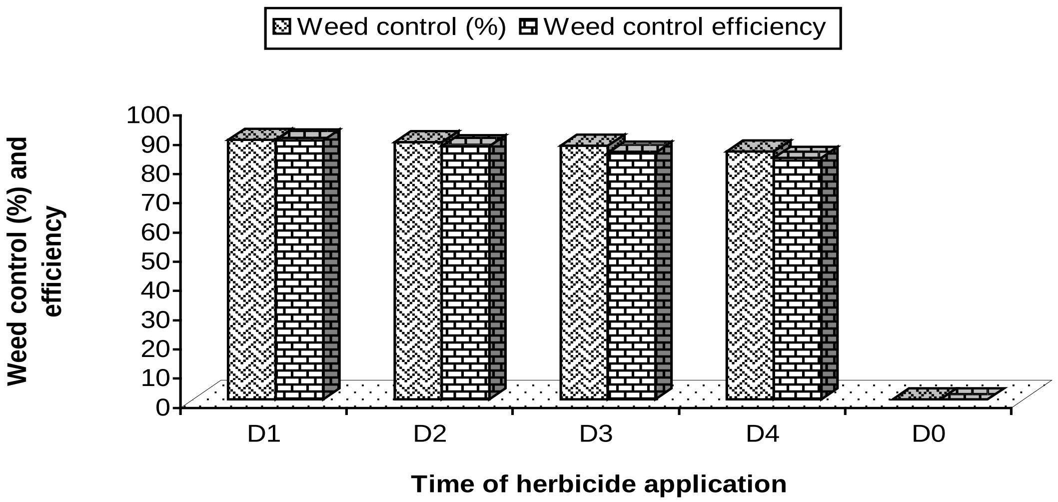
Time of herbicide application

Weed population

The number of weeds m^{-2} varied significantly both at 25 DAT/55 DAS and 50 DAT/80 DAS by the time of herbicide application. At 25 DAT/55 DAS the highest number of weeds (183.00 m^{-2}) was recorded in control treatment which was followed by D_4 and the lowest was in D_1(Table 3).The highest number of weeds at 50 DAT/80 DAS was 239.00 m^{-2} in D_0 (control treatment), which was followed by D_4 (36.33) and D_3 (31.33). D_3 was statistically similar to D_2 but dissimilar to D_1. The highest weed control percent was in D_1 and there was an increasing trend in respect of percent of weed control with the earliness of herbicide application (Fig. 1).

Dry weight of weeds

The dry weight of weeds varied significantly due to the time of herbicide application At 25 DAT or 55 DAS the highest dry weight of weeds (61.62 gm^{-2}) was recorded in D_0 (control treatment) (Table 3). At 50 DAT or 80 DAS, the highest dry weight of weeds (78.93 gm^{-2}) was observed in D_0 (control treatment) which was followed by D_4 (13.72 gm^{-2}), D_3 (11.85 gm^{-2}), D_2 (10.54 gm^{-2}) and D_1 (8.96 gm^{-2}) (Table 3). Weed control efficiency was increased with the earliness of herbicide application (Fig. 1).



D1 = Herbicide application after 3 days of sowing or transplanting
D2 = Herbicide application after 5 days of sowing or transplanting
D3 = Herbicide application after 7 days of sowing or transplanting
D4 = Herbicide application after 9 days of sowing or transplanting
D0 = Unweeded control

Fig. 1. Effect of time of herbicide application on weed control (%) and weed control efficiency at 55 DAT or 80 DAS

Interaction of methods of crop establishment and time of herbicide application

Weed population

The interaction effect of methods of crop establishment and time of herbicide application exerted significant influence on number of weeds m^{-2} both at 25 DAT/55 DAS and 50 DAT/80 DAS. At 25 DAT or 55 DAS, the highest number of weeds m^{-2} (224.00) was in M_2D_0 which was followed by M_1D_0 (210.00) and M_3D_0 (115.00) (Table 4). At 50 DAT or 80 DAS, the highest weed population was recorded in M_2D_0 (248.00) and the lowest number of weeds was in M_3D_2 (23.0). There was an increasing trend in respect of number of weeds m^{-2} irrespective of methods of crop establishment, with the increase in time of herbicide application from seeding or transplanting. This might be due to the higher weed control efficiency of the pre-emergence herbicide (Rifit 500EC) in the early application than those of late application.

Dry weight of weeds

Interaction effect of methods of crop establishment and time of herbicide application was significant in respect of dry weight of weeds. At 25 DAT or 55 DAS the highest dry weight of weeds was recorded in M_2D_0 (78.09gm$^{-2)}$ and the lowest dry weight of weeds was recorded in M_3D_1 (3.83 gm^{-2}). At 50 DAT or 80 DAS the highest dry weight of weed (81.53 gm^{-2}) was recorded in M_2D_0 and the lowest dry weight of weeds (7.93 gm^{-2}) was recorded in $M_3D_{1.}$

Table 3. Effect of time of herbicide application on the population density and dry weight of weeds

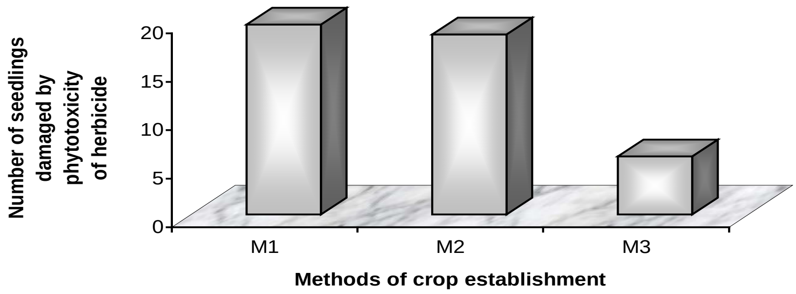
Treatment	Weed infestation at 25 DAT/55 DAS		Weed infestation at 50 DAT/80 DAS	
	No. (m^{-2})	**Dry weight (gm^{-2})**	**No. (m^{-2})**	**Dry weight (gm^{-2})**
D_1	15.00 d	5.37 b	26.67 d	8.96 e
D_2	17.33 cd	5.92 b	28.67 cd	10.54 d
D_3	20.67 bc	6.93 b	31.33 c	11.85 c
D_4	23.00 b	7.57 b	36.33 b	13.72 b
D_0	183.00 a	61.62 a	239.00 a	78.93 a
CV(%)	9.75	22.48	5.16	3.93
Sx	1.683	1.310	1.245	0.3249
Level of significance	**	**	**	**

DAS = Day after sowing, DAT = Day after transplanting, D_1 = Herbicide application after 3 days of sowing or transplanting, D_2 = Herbicide application after 5 days of sowing or transplanting, D_3 = Herbicide application after 7 days of sowing or transplanting, D_4 = Herbicide application after 9 days of sowing or transplanting, D_0 = Unweeded control, ** = Significant at 1% level of probability

Table 4. Interaction effect of methods of crop establishment and time of herbicide application on the population density and dry weight of weeds

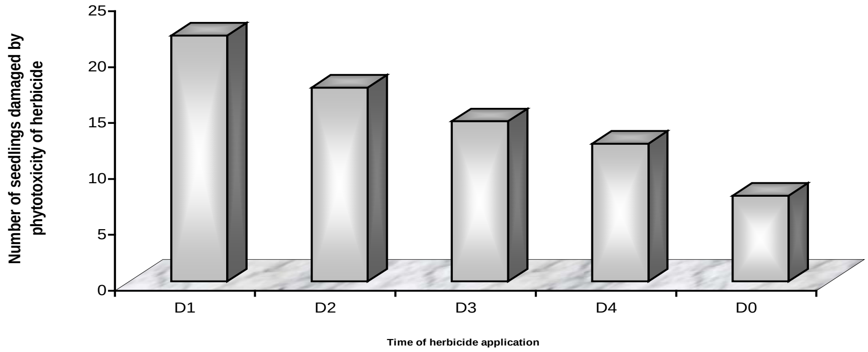
Treatment	Weed infestation at 25 DAT/55 DAS		Weed infestation at 50 DAT/80 DAS	
	No. (m^{-2})	Dry weight ($g\ m^{-2}$)	No. (m^{-2})	Dry weight ($g\ m^{-2}$)
M_1D_1	15.00 ef	6.09 d	26.0 g	8.74 jk
M_1D_2	17.00 ef	9.07 d	28.0 g	10.72 hi
M_1D_3	21.00 ef	6.97 d	30.0 efg	12.04 gh
M_1D_4	24.00 de	7.95 d	37.0 de	14.09 ef
M_1D_0	210.00 b	70.35 b	238.0 b	78.97 b
M_2D_1	17.00 ef	6.09 d	30.0 efg	10.21 ij
M_2D_2	21.00 def	7.67 d	35.0 ef	12.57 fg
M_2D_3	24.00 de	8.97 d	37.0 de	14.87 e
M_2D_4	27.00 d	9.78 d	42.0 d	17.49 d
M_2D_0	224.00 a	78.09 a	248.0 a	81.53 a
M_3D_1	13.00 f	3.83 d	24.0 g	7.93 k
M_3D_2	14.00 f	4.03 d	23.0 g	8.34 k
M_3D_3	17.00 ef	4.87 d	27.0 g	8.63 k
M_3D_4	18.00 def	4.97 d	30.0 efg	9.57 ijk
M_3D_0	115.00 c	36.41 c	231.0 c	76.28 c
CV(%)	9.75	22.48	5.16	3.93
Sx	2.76	2.268	2.156	0.5927
Level of significance	**	**	*	*

DAS = Day after sowing, DAT = Day after transplanting, M_1 = Direct seeded thick-row, M_2 = Direct seeded thin-row, M_3 = Transplanting, * = Significant at 5% level of probability, ** = Significant at 1% level of probability, D_1 = Herbicide application after 3 days of sowing or transplanting, D_2 = Herbicide application after 5 days of sowing or transplanting, D_3 = Herbicide application after 7 days of sowing or transplanting, D_4 = Herbicide application after 9 days of sowing or transplanting, D_0 = Unweeded control



M_1 = Direct seeded thick-row, M_2 = Direct seeded thin-row, M_3 = Transplanting

Fig. 2. Number of seedlings damaged by phytotoxicity of herbicide under different mehtods of crop esablishment



D_1 = Herbicide application after 3 days of sowing or transplanting
D_2 = Herbicide application after 5 days of sowing or transplanting
D_3 = Herbicide application after 7 days of sowing or transplanting
D_4 = Herbicide application after 9 days of sowing or transplanting

Fig. 3. Number of seedlings damaged by phytotoxicity of herbicide under different time of herbicide application

Phytotoxicity of herbicide
Methods of crop establishment

The mortality of seedling was significantly influenced by methods of crop establishment. The highest number of damaged seedling was recorded in M_1(19.6m^{-2}) which was statically similar to M_2 (18.60 m^{-2}), the lowest being 6.00 m^{-2} in M_3 (transplanting) (Fig. 2). This might be due to the higher phytotoxicity of herbicide in direct seeding compared to transplanting or due to the extreme cold injury or due to submergence of seedlings during herbicide treating or simultaneous effects of all. This result confirmed the findings of Mobbayand and Moody (1992).

Time of herbicide application

Time of herbicide application significantly influenced the mortality of seedlings. The highest number of damaged seedlings (22.00 m^{-2}) was recorded in D_1 and it was followed by D_2 (17.33 m^{-2}); D_3 (14.33 m^{-2}) and D_4 (12.33 m^{-2}) (Fig. 3). The lowest damaged seedlings (7.67m^{-2}) were recorded in D_0 (control). This result reveals that there was an increasing trend in mortality of seedling with the earliness of time of herbicide application. This might be due to higher absorption of herbicides by the young seedlings that disturbed the physiological activities of rice plant and hampered growth and ultimately reduced plant stand. Almost similar findings were reported by Mobbaynd and Moody (1992) who stated that herbicide treatments reduced plant stand when applied as seed treatment and weed control in wet sown rice, while plant stand was not significantly influenced by herbicide treatments when applied few days after sowing/seeding. However, depending on the extent of injury, plants regained their normal growth within 2-15 days.

Interaction effect of methods of crop establishment and time of herbicide application

The number of seedlings damaged by phytotoxicity of herbicide varied significantly due to interaction of methods of crop establishment and time of herbicide application. The highest number of seedlings damaged by phytotoxicity of herbicide was recorded in M_1D_1 (30.00) which was statistically identical to M_2D_1 and it was followed by M_1D_2 (24.00), M_1D_3 (21.00), M_2D_3 (18.00), M_2D_4 (15.00), M_2D_0 (9.00) and M_3D_0 (7.00). The lowest mortality of seedling (4.0) was recorded in M_3D_3 (Table 5).

From the above results and discussions, direct seeded rice under early application of herbicide reduced population and dry weight of weed effectively but showed significantly higher phytotoxicity to rice plant. Direct seeded thick row sown rice under herbicide application at 7 days after sowing would be promising both for effective weed control as well as lower phytotoxicity.

Table 5. Interaction effect of methods of crop establishment and time of herbicide application and phytotoxicity on plants

Treatment	Seedling damaged by phytotoxicity of herbicide (no. m^{-2})
M_1D_1	30 a
M_1D_2	24 b
M_1D_3	21 c
M_1D_4	16 de
M_1D_0	7 fgh
M_2D_1	28 a
M_2D_2	23 bc
M_2D_3	18 d
M_2D_4	15 e
M_2D_0	9 f
M_3D_1	8 fg
M_3D_2	5 hi
M_3D_3	4 i
M_3D_4	6 ghi
M_3D_0	7 fgh
CV(%)	8.67
S$\overline{X}$	0.7378
Level of significance	**

M_1 = Direct seeded thick-row, M_2 = Direct seeded thin-row, M_3 = Transplanting, ** = Significant at 1% level of probability, D_1 = Herbicide application after 3 days of sowing or transplanting, D_2 = Herbicide application after 5 days of sowing or transplanting, D_3 = Herbicide application after 7 days of sowing or transplanting, D_4 = Herbicide application after 9 days of sowing or transplanting, D_0 = Unweeded control.

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