Res. on Crops **16** (3) : 416-421 (2015) DOI : 10.5958/2348-7542.2015.00057.1
Printed in India

Combined effect of herbicides on the weed management of rice

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(Received : May 26, 2015/Accepted : July 14, 2015)

ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh between December 2013 to May 2014. The purpose of the experiment was to investigate the combined effect of herbicides on the weed management of rice. The experiment consisted of two varieties, BR 14 (Gazi) and BRRI dhan 28 along with nine different weed management treatments such as weedy check, the recommended dose of Manage 10 WP, recommended dose of Polifit 500 EC, 70% of Manage+20% of Polifit, 20% of Manage+70% of Polifit, 60% of Manage+20% of Polifit, 20% of Manage+60% of Polifit, 50% of Manage+20% of Polifit and 20% of Manage+50% of Polifit. Twelve weed species belonging to five families infested the experimental plots. In the BR14 Variety at 20, 40 and 60 days after transplanting (DAT), lower weed population/ m^2 and weed dry weight (g/m^2), but higher weed control efficiencies of 65.52, 60.35 and 66.98% were realized, respectively. The recommended dose of Polifit 500 EC treatment resulted in the lowest weed population and weed dry weight as well as the highest weed control efficiency of 83.45, 84.93 and 87.07% at 20, 40 and 60 DAT, respectively. Therefore, to control weeds in an effective manner and in order to get the optimum grain yield in *boro* rice, an application of Polifit 500 EC should be applied.

Key words : Combined effect, herbicide, Polifit 500 EC, rice, weed management

INTRODUCTION

Bangladesh is an agro-based developing country striving to rapidly develop its economy. The economic development of the country is mainly based on agriculture. Agriculture is the single largest producing sector of the economy of Bangladesh because it comprises about 19.3% of the country's GDP and employs around 44% of the total labour force (BBS, 2011).

Crop performance is closely related to weed growth. Infestation of weeds is one of the most important causes for a low rice yield. The high competitive ability of weeds exerts a serious negative effect on crop production. Globally, actual yield losses due to pests and diseases have been estimated at approximately 40%, of which weeds caused the highest loss (32%) (Rao *et al.*, 2007). Weed infestation reduced the yield of transplanted *aman* rice on an average by 40% in Bangladesh (Haque *et al.*, 2011).

The climate as well as the edaphic condition of Bangladesh favours the growth of numerous noxious weeds. In Bangladesh, weed infestation reduces the grain yield by 70-80% in *aus* rice (early summer), 30-40% for transplanted *aman* rice (autumn) and 22-36% for modern *boro* rice cultivars (winter rice) (Mamun, 1990a; BBS, 2008). In Bangladesh, weeds are traditionally controlled by weeding by hand. This method of weed control is very laborious, time consuming, inefficient and costly.

Now-a-days, the chemical methods of weed control are gaining popularity all over the world because of their miraculous results in crop production. On the other hand, herbicides are used successfully for weed control in rice fields because they are easier to apply, cost less and lead to rapid results in comparison to the

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traditional methods of hand weeding. For the last few decades, herbicides have contributed tremendously to agriculture. The yield of *boro* rice can be increased through the improvement of cultivation practices like the proper application of herbicides. In large scale rice farming, herbicide-based weed management has become the smartest and most viable option when compared to the scarcity and high costs of labour (Singh *et al.*, 2006; Anwar *et al.,* 2012).

A combination of herbicide doses may suppress the growth of weeds in a field, while reducing potential herbicide injury to crops. The combination of herbicide results in improved weed control over a single application (Uddin *et al.,* 2010). Synergism may also occur for certain mixtures of herbicides. A mixture of herbicides is often used to enhance the efficiency of weed control and reduce selectivity (Green *et al.,* 1995).

Farmers need to apply herbicides at proper rates in the field. The rate of application depends on the intensity of weed infestation. When weed infestation occurs, farmers may need to apply optimum doses of herbicides. The research work related to the effect of combining herbicide is scarce. The present study was, therefore, undertaken to find out the single and combined effect of herbicides for the weed management of rice.

MATERIALS AND METHODS

Experimental Details

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh between December 2013 to May 2014. The purpose of the study was to determine the combined effect of herbicides on the weed management and crop performance of rice. The soil of the experimental field was more or less neutral with a pH value of 6.7, moderate in organic matter and fertility level (UNDP and FAO, 1988). The experimental treatments were as follows : Factor A : Cultivars, V_1–BR 14 (Gazi), V_2–BRRI dhan 28 and Factor B : Combined treatments of herbicides, T_0–Weedy check (no weeding), T_1–Recommended dose of Manage 10 WP (Pyrazosulfuron-ethyl), T_2–Recommended dose of Polifit 500 EC (Pretilachlor), T_3–70% of Manage 10 WP+20% of Polifit 500 EC, T_4–20% of Manage 10 WP+70% of Polifit 500 EC, T_5–60% of Manage 10 WP+20% of Polifit 500 EC, T_6–20% of Manage 10 WP+60% of Polifit 500 EC, T_7–50% of Manage 10 WP+20% of Polifit 500 EC and T_8–20% of Manage 10 WP+50% of Polifit 500 EC. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The total number of plots was 2 × 9 × 3= 54 and each plot size was 4.0 × 2.5 m. The distance maintained between the individual plot was 0.5 m and the distance between the replications was1.0 m. Seeds of rice varieties BR 14 and BRRI dhan 28 were collected from the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh.

Crop Husbandry

Healthy seeds were selected by the specific gravity method. Seeds were then immersed in buckets of water for 24 h. After 24 h, the seeds were taken out of the water and kept thickly spread in gunny bags. The seeds started sprouting after 48 h and were ready to sow. The sprouted seeds were sown in the wet nursery bed on 1 December 2013. The field was opened with a power tiller and, subsequently, ploughed four times with a country plough followed by laddering. After the land was prepared, the field was laid out. Weeds and stubble were removed and cleaned from the individual plot. In the experiment, chemical fertilizers were applied at the rate of 270 kg urea, 75 kg TSP, 60 kg MoP, 10 kg gypsum and 5 kg zinc sulphate/ha. The entire amount of all fertilizers except urea was applied when the land was prepared. Urea was applied in three equal instalments at 15, 30 and 45 days after transplanting (BRRI, 2011).The seedlings were uprooted on 11 January 2014 without causing much mechanical injury to the roots and they were immediately transferred to the main field. Fourty-day-old seedlings were transplanted into the well prepared puddled field on 11 January 2014 at the rate of a three seedlings/hill, and the row and hill distances were maintained at 25 and 15 cm, respectively. The experimental plots were irrigated as and when it was necessary.

Observations

The seedlings were sprayed with herbicides. No remarkable infestation of insect

and disease organisms was noticed in the field. As a result, no plant protection measures were taken. The crops were harvested at full maturity. The maturity of the crops was determined when 90% of the grains became golden yellow in colour. The fully mature crop of each plot was harvested from 1 m^2 of the central area with a sickle. Just before harvesting, five hills excluding the border plants, the harvest area of each plot were selected at random and uprooted to collect data on the yield components. BR 14 was harvested on 10 May and BRRI dhan 28 on 20 April 2014. Then the harvested crops of each plot were bundled separately, properly tagged and brought to the threshing floor. The crops were then threshed and the fresh weights of the grain and straw were recorded in relation to their plots. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun-dried and the yields of grain and straw/plot were recorded and converted to t/ha.

Statistical Analysis

The experiment was laid out in RCBD with a split plot arrangement with three replications. The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was conducted with the help of a computer package, MSTAT-C. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results include the combined effect of herbicides on the weed management and crop performance of rice. Tables 1 to 3 show the mean results of the different characters. 12 weed species belonging to five families infested the experimental field. The 12 species of weeds included five grasses, three broad leaves and four sedges. Table 1 presents the local name, scientific name, family, morphological type and life cycle of the weed in the experimental plot. The important weeds of the experimental plots were : *Echinochloa crusgalli, Panicum repens, Cyperus rotundus, Leersia hexandra, Cynodon daetylon, Monochoria vaginalis, Cyperus difformis, Scirpus juncoides, Polygonum hydropiper, Fimbristylis miliacea, Digitaria sanguinalis* and *Oxalis europaea*.

Effect of Variety

The variety of rice significantly influenced the weed population, total weed dry weight and weed control efficiency at 20, 40 and 60 days after transplanting (DAT). At all the sampling dates, a higher number of weeds was found in BRRI dhan 28, showing the highest values of 63.81, 83.93 and 167.30/m^2 at 20, 40 and 60 DAT, respectively, and a lower number of weeds/m^2 was obtained in BR 14, which exhibited the highest values of 49.33, 70.63 and 134.90/m^2 at 20, 40 and 60 DAT, respectively (Table 1). The number of weeds or the weed population, depends on the soil, environment, varieties and other factors. As a result, variations in the weed population occurred. At the sampling dates, higher weed dry weight (g/m^2) was found in BRRI dhan 28, the highest dry weight values were 2.93, 8.59 and 47.72 g/m^2 at 20, 40 and 60 DAT, respectively, and the lowest dry weight values were (g/m^2) found in BR 14 where the values were 2.26, 7.12 and 37.26 g/m^2 at 20, 40 and 60 DAT, respectively (Table 1). The dry weight of weeds depended on the weed size, weight and type. Higher weed control efficiency (%) at the sampling dates of 20 and 60 days after transplanting (DAT) was found in BR 14 of

Table 1. The effect of the variety of rice on weed population, dry weight and weed control efficiency in *boro* rice

Variety	Weed population (No./m^2)			Dry weight of weeds (g/m^2)			Weed control efficiency (%)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
V_1	49.3b	70.6b	134.9b	2.3b	7.12b	37.3b	65.5a	60.4b	67.0a
V_2	63.8a	83.9a	167.3a	2.9a	8.6a	47.7a	56.6b	61.3a	64.1b
C. V. (%)	4.89	6.40	3.07	6.52	6.99	5.29	1.38	1.44	1.79
Level of significance	**	**	**	**	**	**	**	**	**

V_1–BR 14 (Gazi), V_2–BRRI dhan 28. There is no significant difference between results followed by the same letter or results that are not followed by a letter. However, results followed by dissimilar letters are significantly different as per Duncan's Multiple Range Test (DMRT). **Significant at P=0.01 level.

65.52 and 66.98%, respectively, and lower weed control efficiency of 56.59 and 64.13% was obtained in BRRI dhan 28 at 20 and 60 DAT, respectively. However, the highest weed control efficiency of 61.32% was found in BRRI dhan 28 at 40 DAT and a lower weed population was found in BR 14 (60.35%) at 40 DAT (Table 1). When the dry weight of weeds was low, the weed control efficiency (%) was higher.

Effect of Weed Management Practices

The weed population/m^2 was influenced by weed management practices. The highest weed population/m^2 was found in the weedy check treatment, showing the highest weed population values of 273.73, 291.83 and 324.53/m^2 at 20, 40 and 60 DAT, respectively, and the lowest weed population/m^2 was found in the treatment with the recommended dose of Polifit when the values were 11.34, 23.50 and 50.00/m^2 at 20, 40 and 60 DAT, respectively (Table 2). The weed population was the highest in the weedy check condition, and under different weed management treatments, the weed population decreased. Rekha *et al.* (2003) also reported that the weed population was lower in all weed management treatments compared to the control plot. The weed management practices at 20, 40 and 60 DAT had a significant effect on the total dry weight (g/m^2). The highest weed dry weight (g/m^2) was found in the weedy check condition, showing the highest weed dry weight values of 6.66, 20.10 and 122.91 g/m^2 at 20, 40 and 60 DAT, respectively, and the lowest (g/m^2) was found in the condition of the recommended dose of Polifit treatment, showing the lowest weed population values of 1.11, 3.08 and 15.94 g/m^2 at 20, 40 and 60 DAT, respectively (Table 2). There was a significant effect on weed control efficiency (%) at 20, 40 and 60 DAT. The highest weed control efficiency (%) was found in the recommended dose of Polifit application showing the highest values of 83.45, 84.93 and 87.07% at 20, 40 and 60 DAT, respectively, and zero efficiency (%) was found in the weedy check treatment at 20, 40 and 60 DAT, respectively (Table 2).

Effect of Interaction between Variety and Weed Management

The interaction between variety and weed management practices was found to be significant at 20, 40 and 60 DAT. The highest weed population/m^2 was found in the V_2T_0 treatment (BRRI dhan 28 × weedy check), showing the highest values of 296.3, 306.00 and 356.00/m^2 at 20, 40 and 60 DAT, respectively, and the lowest was found/m^2 in the V_1T_2 treatment (BR 14 × recommended dose of Polifit) of 10.67, 19.00 and 36.00/m^2 at 20, 40 and 60 DAT, respectively (Table 3). Significant variation was found in weed dry weight due to the interaction between variety and weed management at 20, 40 and 60 DAT. The highest weed dry weight (g/m^2) was found

Table 2. The effect of weed management practices on weed population, dry weight and weed control efficiency in *boro* rice

Weed management practices	Weed population (No./m^2)			Dry weight of weeds (g/m^2)			Weed control efficiency (%)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T_0	273.7a	291.8a	324.5a	6.7a	20.1a	122.9a	0i	0h	0g
T_1	115.2b	132.5b	264.0b	3.1b	10.8b	65.7b	52.9h	46.6g	46.6f
T_2	11.3e	23.5f	50.0i	1.1f	3.1h	15.9g	83.4a	84.9a	87.1a
T_3	18.8d	39.3e	126.2e	2.2c	6.2e	33.2d	67.1e	68.8d	73.0d
T_4	13.3e	27.5f	68.3h	1.5e	3.9g	18.5fg	77.5b	80.7b	85.0b
T_5	19.5d	48.3d	154.2d	2.3c	7.4d	34.0d	65.5f	63.2e	72.4d
T_6	16.7d	33.5e	86.2g	1.6e	4.8f	19.6f	75.3c	75.8c	84.1b
T_7	23.2c	63.0c	182.0c	2.9b	8.5c	45.8c	56.7g	57.8f	63.1e
T_8	17.5d	36.0e	104.2f	1.9d	6.0e	26.7e	71.1d	69.7d	78.8c
C. V. (%)	4.89	6.40	3.07	6.52	6.99	5.29	1.38	1.44	1.79
Level of significance	**	**	**	**	**	**	**	**	**

T_0–Weedy check, T_1–Recommended dose of Manage, T_2–Recommended dose of Polifit, T_3–70% of Manage+20% of Polifit, T_4–20% of Manage+70% of Polifit, T_5–60% Manage+20% of Polifit, T_6–20% Manage+60% of Polifit, T_7–50% Manage+20% of Polifit, T_8–20% Manage+50% of Polifit. There is no significant difference between results followed by the same letter or results that are not followed by a letter. However, results followed by dissimilar letters are significantly different as per Duncan's Multiple Range Test (DMRT). **Significant at P=0.01 level.

in the V_2T_0 treatment (BRRI dhan 28 × weedy check), showing the highest values of 6.76, 22.20 and 133.00 g/m^2 at 20, 40 and 60 DAT, respectively, and the lowest was found in the V_1T_2treatment (BR 14 × recommended dose of Polifit), showing the highest values of 0.96, 2.28 and 14.12 g/m^2 at 20, 40 and 60 DAT, respectively (Table 3). Significant variation was found in weed control efficiency (%) due to the interaction between variety and weed management at 20, 40 and 60 DAT. The highest weed control efficiency (%) was found in the V_1T_2treatment (BR 14 × recommended dose of Polifit), which achieved the highest efficiency of 85.37, 87.33 and 87.49% at 20, 40and 60 DAT, respectively, and zero efficiency (%) was found in the V_2T_0treatment (BRRI dhan 28 × weedy check) (Table 3).

Table 3. The effect of the interaction between the variety of rice and weed management practices on the weed population, dry weight and weed control efficiency in *boro* rice

Variety × Weed management practices	Weed population (No./m^2)			Dry weight of weeds (g/m^2)			Weed control efficiency (%)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
$V_1 \times T_0$	251.0b	277.7b	293.0b	6.7a	18.0b	112.8b	0m	0m	0j
$V_1 \times T_1$	85.0d	118.3d	248.0d	3.0d	9.7d	61.6d	54.3j	48.0k	45.4i
$V_1 \times T_2$	10.7j	19.0k	36.0m	0.9h	2.3j	14.1j	85.4a	87.3a	87.5a
$V_1 \times T_3$	16.3ghi	34.3hij	108.3j	1.8f	6.1g	30.1g	72.7e	66.3g	73.3e
$V_1 \times T_4$	13.3ij	25.3jk	64.33l	1.1gh	3.56i	15.9j	82.3b	80.2c	85.9abc
$V_1 \times T_5$	17.0fghi	48.0f	136.0h	1.9f	6.5g	30.3g	71.3ef	64.0h	73.2e
$V_1 \times T_6$	14.0ij	30.0hij	68.0l	1.4g	4.8h	16.6j	78.9c	73.3e	85.3bc
$V_1 \times T_7$	22.0ef	49.0f	172.0f	1.9ef	7.7f	36.6f	70.1f	57.3j	67.6f
$V_1 \times T_8$	14.7hij	34.0hij	88.0k	1.7f	6.0g	17.4ij	74.7d	66.7g	84.6bcd
$V_2 \times T_0$	296.3a	306.0a	356.0a	6.8a	22.2a	133.0a	0m	0m	0j
$V_2 \times T_1$	145.3c	146.7c	280.0c	3.28c	12.1c	69.7c	51.5k	45.2l	47.7h
$V_2 \times T_2$	12.0ij	28.0ij	64.0l	1.3gh	3.9hi	17.8ij	81.5b	82.5b	86.6ab
$V_2 \times T_3$	21.3efg	44.3fg	144.0g	2.6d	6.4g	36.3f	61.5h	71.3f	72.7e
$V_2 \times T_4$	13.3ij	29.7hij	72.3l	1.8f	4.2hi	21.2hi	72.8e	81.0bc	84.0cd
$V_2 \times T_5$	22.0ef	48.7f	172.3f	2.7d	8.4ef	37.8f	59.8i	62.3i	71.6e
$V_2 \times T_6$	19.3efgh	37.0ghi	104.3j	1.9ef	4.8h	22.7h	71.6e	78.2d	82.9d
$V_2 \times T_7$	24.3e	77.0e	192.0e	3.8b	9.2de	55.0e	43.2l	58.4j	58.6g
$V_2 \times T_8$	20.3efg	38.0gh	120.3i	2.2e	6.0g	36.0f	67.5g	72.8ef	72.9e
CV (%)	4.89	6.40	3.07	6.52	6.99	5.29	1.38	1.44	1.79
Level of significance	**	**	**	**	**	**	**	**	**

V_1–BR 14 (Gazi), V_2–BRRI dhan 28, T_0–Weedy check, T_1–Recommended dose of Manage, T_2–Recommended dose of Polifit, T_3–70% of Manage+20% of Polifit, T_4–20% of Manage+70% of Polifit, T_5–60% Manage+20% of Polifit, T_6–20% Manage+ 60% of Polifit, T_7–50% Manage+20% of Polifit and T_8–20% Manage+50% of Polifit.
There is no significant difference between results followed by the same letter or results that are not followed by a letter. However, results followed by dissimilar letters are significantly different as per Duncan's Multiple Range Test (DMRT).
**Significant at P=0.01 level.

CONCLUSIONS

The present study was undertaken to evaluate the combined effect of herbicides on the weed management of rice at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh between December 2013 to May 2013. The experiment was conducted with two varieties of rice, BR 14 (Gazi) and BRRI dhan 28, with nine different weed management treatments, such as weedy check, the recommended dose of Manage 10 WP, recommended dose of Polifit 500 EC, 70% of Manage+20% of Polifit, 20% of Manage+70% of Polifit, 60% of Manage+20% of Polifit, 20% of Manage+60% of Polifit, 50% of Manage+20% Polifit, 20% of Manage+50% of Polifit and all herbicides applied at 8 DAT.

Among the different weed management treatments, a pre-emergence and an early post-emergence herbicide and their combination were applied to the target plots. The data of weed parameters were collected at 20, 40 and 60 DAT of rice plants. Weed parameters, such as the weed population (No./m^2), weed dry weight (g/m^2) and weed control efficiency (%) were recorded. The most dominant weed species in the experimental plots were *Echinochloa crusgalli, Scirpus juncoides, Cyperus rotundus* and *Cynodon dactylon.* Other important weeds were : *Cyperus difformis, Fimbristylis miliacea, Panicum repens, Leersia hexandra, Polygonum*

hydropiper, Monochoria vaginalis, Oxalis europaea and *Digitaria sanguinalis.* Weed population, dry weight and weed control efficiency were significantly affected by the variety of rice and weed management practices. A higher weed population/m^2, weed dry weight (g/m^2) and a lower percentage of weed control efficiency were found in BRRI dhan 28. BR 14 resulted in a lower weed population/m^2, weed dry weight (g/m^2) and a higher percentage of weed control efficiency. Among these weed control treatments, the application of Polifit 500 EC, followed by the application of 20% of Manage+70% of Polifit at 8 DAT, resulted in the lowest weed population/m^2 and weed dry weight (g/m^2), but the highest percentage of weed control efficiency. The weedy check (T_o) condition resulted in the highest weed population. The highest weed population and dry weight, and the lowest percentage of weed control efficiency were observed in BRRI dhan 28 when no weeding was done and the lowest values of the weed population and dry weight, but the highest percentage of weed control efficiency was found in the application of Polifit 500 EC at 8 DAT with a combination of BR 14 (V_1T_2). The results of the present study suggest that BR 14 variety could be grown with Polifit 500 EC at eight DAT to maximize yield of *boro* rice.

ACKNOWLEDGEMENTS

This work was carried out with the support of "Cooperative Research Program for Agricultural Science & Technology Development (Project title : Development of prediction system for management of rice weeds under climate change, Project No. PJ01052603)", Rural Development Administration, Republic of Korea.

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