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Original Article

Evaluation of Selected Herbicides on Weed Control Efficiency and Yield of Wheat

Sobnom Mustari[1], Md. Nasimul Bari[2], Md. Rafiqul Islam[3], AJM Sirajul Karim[4]

Abstract

Background: Weed control is an important issue for the proper growth of wheat. **Objective:** The purpose of the present study was to see the effect of selected herbicides on weed infestation behavior in wheat field; to determine the effect of herbicides on growth and development of wheat plants, and to evaluate the effect of herbicides on yield performance of wheat. **Methodology:** A field experiment was conducted at the Experimental Farm of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during November to May 2011-2012. Four herbicides were tested at recommended dose alone and also coupled with supplemental hand weeding in wheat crop. In addition, a weedy check (control) was also imposed for treatment comparison. The herbicides were Pendimethalin, Carfentrazone-ethyl + Isoproturon, Carfentrazone-ethyl and 2,4-D. In this way, nine treatment combinations were arranged in the RCBD experiment with three replications. **Result:** Carfentrazone-ethyl performed the best in terms of weed control efficiency (79.68%), while Pendimethalin performed the worst (52.74%). Carfentrazone-ethyl + Isoproteuron contributed to the highest tillers per unit area (226.3 m^{-2}) and the highest total dry matter (1342 g m^{-2}). Finally, Carfentrazone-ethyl + Isoproteuron also contributed to the highest grain yield of 3.56 t ha^{-1} with the highest harvest index of 0.42. Carfentrazone-ethyl + Isoproteuron accompanied by one hand weeding also contributed to statistically identical grain yield of 3.33 t ha^{-1}. Single ingredient Carfentrazone-ethyl alone and when accompanied with one hand weeding also contributed to statistically identical grain yields of 3.26 t ha^{-1} and 3.46 t ha^{-1}, respectively. **Conclusion:** The study revealed that, combined ingredient herbicide Carfentrazone-ethyl + Isoproteuron as well as Carfentrazone-ethyl alone might used at field level due to their better weed control efficiency, favourable effect on crop growth and development and higher grain yield. [*Journal of Science Foundation 2014;12(2):27-33*]

Key words: Herbicide; weed control efficiency; wheat; grain yield

Introduction

Wheat (*Triticum aestivum*) is the second important cereal crop in Bangladesh after rice. Almost 50% of the total cropped area is occupied by wheat. During 2004-05, the area under wheat cultivation was 8.36 million ha, with a production of 21.61 million tons. From nutritional point of view, wheat is superior to rice for its higher protein content. Wheat grain is rich in food value containing 12% protein, 1.72% fat, 69.60% carbohydrate and 27.20% minerals (BARI, 2004a). Average yield of wheat in Bangladesh is lower than that of other wheat growing countries (Islam, 1997). Weed is one of the most important factors responsible for

[1] Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[2]Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[3] Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[4] Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

Corresponding author: Md. Nasimul Bari, Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh; Email: bari_nasimul@yahoo.com

low yield in wheat. Wheat yield depression could be as much as 30 % under medium high and high weed infestation. However, yield loss may reach as much as 90 % under very high weed infestation (TÓTH, 1999).

Farmers in Bangladesh usually are reluctant to control weeds in wheat although there are reports of considerable yield increase in wheat due to weed control (Pandey *et al*., 2006). Farmers, however, control weeds in wheat fields through traditional method i.e., hand weeding which is laborious, time consuming and expensive. Herbicidal weed control methods offer an advantage to save labor and money, as a result, regarded as cost effective. Chemical weed control was proved to control weeds effectively, thus produce higher grain yield of wheat than hand weeding (Shah and Habibullah, 2005). With rising cost of labour, the use of herbicides is likely to be the dominant method of weed control in cereal crops in the days to come. Chemical weed control has already become popular in Bangladesh. The main reason is scarcity of labor during peak growing season, and also lower weeding cost. The total use of herbicides in Bangladesh in the year 2008 was 4024.77 tons (BCPA, 2009) compared to only 108 ton in 1989 (BBS, 1991) and the growth is almost exponential. Herbicide use till now is concentrated in rice cultivation. However, use of herbicides in wheat cultivation has also been gaining attention in recent years. But information regarding efficacy of herbicides on weed control and yield performance of wheat is still scanty under Bangladesh context. Under the above circumstances, the present study was conducted to see the effect of selected herbicides on weed infestation behavior in wheat field; to determine the effect of herbicides on growth and development of wheat plants, and to evaluate the effect of herbicides on yield performance of wheat.

Materials and Methods

A field experiment was conducted at the Experimental Farm of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur under upland condition during November, 2011 to May, 2012. BARIgom24, a modern wheat variety was used as test crop. Twelve different weed control treatments were imposed in the experiment as follows: T1= Pendimethalin, T2= Carfentrazone-ethyl + Isoproteuron, T3= Carfentrazone-ethyl, T4= 2,4-D, T5= Pendimethalin + one hand weeding, T6= Carfentrazone-ethyl + Isoproteuron + one hand weeding (at 15 days after emergence), T7= Carfentrazone-ethyl + one hand weeding (at 15 days after emergence), T8= 2,4-D + one hand weeding (at 15 days after emergence), and T9= Control (unweeded). The experiment was laid out in RCBD with three replications. Wheat seeds were sown on November 25, 2011. Basal doses of 8000 kg ha-1, 220 kg ha-1, 180 kg ha-1, 110 kg ha-1and 110 kg ha-1 of compost, N, P2O5, K2O and S, respectively were added to each plot. Two-third of N and total amount of other fertilizers were applied plot wise during final land preparation before sowing. The rest amount of urea was top-dressed at crown root initiation stage i.e. 20 days after sowing (DAS) of wheat followed by irrigation. Herbicides at recommended doses were applied in the plots at 15 DAE of wheat plants. Standard management practices for MV wheat cultivation were followed (BARI, 2004b). The data on weed density and weed biomass were collected from each unit plot at 30, 60, 90DAE and at harvest. A plant quadrate (population counter) of 0.25 m^2 was placed randomly inside the plot. The infesting weeds within each quadrate were counted. The average number of three samples was then multiplied by 4 to obtain the weed density (No. m^{-2}). The weeds inside each quadrate for density count were uprooted and cleaned. The collected weeds were first dried in the sun and then in an electrical oven for 72 hours maintaining a constant temperature of 80°C. After drying, weight of dry weed was measured and expressed in g m^{-2}. Weed control efficiency (WCE): WCE was calculated with the following formula:

Weed control efficiency (WCE) = {(DMC – DMT) / DMC} x 100

Where, DMC = Weed dry matter in unweeded treatment
DMT = Weed dry matter in weed control treatment

Wheat plants were sampled at 15 days interval starting from 30DAE till maturity. At each sampling, plants were uprooted sequentially from a row length of 0.25 m from each plot. To avoid border effect, border rows and border plants were avoided. At each sampling data were recorded on tillering behavior, leaf area index and total dry matter production (g m^{-2}). Crop growth rate was calculated using the following formula:

$CGR= GA^{-1} \{(W2-W1) / (T2-T1)\}$ g $m^{-2}day^{-1}$

Where, W1= Total dry weight at time T1 (g); W2= Total dry weight at time T2 (g)
T1= Initial time (day); T2= Final time (day); GA= Ground area (m^2).

The crop was harvested on 13 March, 2012. The weight of grain and straw were recorded plot wise and adjusted at 12% moisture content. Ten plants from each plot were sampled randomly for collecting data on individual yield components. To determine grain and straw yield a $3m^2$ area from the center of each plot was harvested. All the collected data were compiled and put under analysis of variance with the help of the computer package MSTAT-C. Later the means were separated through Least Significance Difference (LSD) test at 5% level of significance.

Results and Discussion

Effect of herbicide on weed infestation behavior in wheat

Weed infestation behavior in wheat was manifested by weed density and weed biomass in this experiment. Weed density increase gradually until harvest irrespective of herbicidal treatment. Weed density varied significantly due to different weed control treatments. The highest weed density (372 m^{-2}) was found in T12 (unweeded) or control treatment and lowest weed density was found in T11 (weed free) treatment at harvest (Table 1). Among all the herbicidal treated plot the highest weed density (232.15 m^{-2}) was found in Pendimethalin treated plot (T1) at harvest, while the least (68.45 m^{-2}) was observed in the treatment receiving Pendimethalin along with one hand weeding (T5). Data indicated that, herbicides alone could not suppress weed population effectively, which, however, happened when herbicide was accompanied by one supplemental hand weeding.

Table 1: Weed density in wheat crop field as affected by herbicide

Treatment	Weed density (No. m^{-2})			
	30 DAE	60 DAE	90 DAE	Harvest
T1 (Pendimethalin)	28.56	44.53	118.7	232.15
T2 (Carfentrazone-ethyl + Isoproteuron)	48.34	72.42	156.32	216.21
T3 (Carfentrazone-ethyl)	21.42	76.75	120.21	140.23
T4 (2,4-D)	42.31	40.28	65.11	228.14
T5 (Pendimethalin + 1HW)	36.65	20.44	24.02	68.45
T6 (Carfentrazone-ethyl + Isoproteuron + 1HW)	44.32	24.32	32.71	88.65
T7 (Carfentrazone-ethyl + 1 HW)	24.26	28.05	48.05	156.05
T8 (2,4-D + 1 HW)	22.76	8.56	12.54	72.23
T9 (Control)	68.25	92.76	138.43	372.0
LSD (0.05)	3.34	5.63	4.94	12.49
CV(%)	6.35	8.91	4.57	5.12

In case of weed biomass, similar trend was noticed, i.e. herbicides applied alone could not suppress weed biomass effectively, and it was achieved when herbicides were supplemented by one hand weeding. The highest weed biomass at harvest, apart from control (T9), was recorded in T2 treatment receiving Carfentrazone-ethyl + Isoproteuron (105.65 g m^{-2}), while the least (3.84 g m^{-2}) was recorded in T8 treatment receiving 2,4-D + one hand weeding. Data revealed that, herbicides performed differently in suppressing weed population (Table 1) and weed biomass (Table 2). It indicated that, herbicides suppressing weed population will not essentially suppress biomass production in a similar fashion.

Weed control efficiency varied considerably among the treatments. Among the herbicides, Carfentrazone-ethyl (T3) showed higher weed control efficiency throughout the growing season, while Pendimethalin (T1) performed the worst in this regard (Table 3). At 60 DAE and at harvest, the highest weed control efficiency of 64.89% and 79.68%, respectively were recorded in T3 treatment. When supplemental hand weeding was

considered, Carfentrazone-ethyl + one hand weeding (T7) also showed the higher weed control efficiency throughout the growing season (Table 3). But at harvest, the highest weed control efficiency (93.39%) was recorded in the treatment receiving 2,4-D along with one hand weeding (T8). Data indicated that, weed control efficiency increased considerably when one hand weeding was added after herbicide application.

Table 2: Weed biomass in wheat crop field as affected by herbicide

Treatment	Weed biomass (g m^{-2})			
	30 DAE	60 DAE	90 DAE	Harvest
T1 (Pendimethalin)	7.84b	11.32	32.3	92.12
T2 (Carfentrazone-ethyl + Isoproteuron)	12.92	14.84	44.04	105.65
T3(Carfentrazone-ethyl)	13.16	15.0	21.88	46.92
T4 (2,4-D)	14.72	7.96	15.92	98.23
T5 (Pendimethalin + 1HW)	13.44	1.14	3.56	30.8
T6 (Carfentrazone-ethyl + Isoproteuron + 1HW)	13.08	2.34	12.56	17.44
T7 (Carfentrazone-ethyl + 1 HW)	8.72	1.56	8.92	27.08
T8 (2,4-D + 1 HW)	11.64	0.92	6.2	3.84
T9 (Control)	17.92	18.96	48.4	138.4
LSD (0.05)	1.49	1.19	2.54	11.10
CV(%)	36.5	42.25	37.57	46.84

Effect of Herbicide on Crop Growth and Development

Tiller Dynamics

Different herbicidal treatments affected tiller production significantly. The changes in tiller production over time were shown in Table 4. At harvest, among the herbicidal treatments, the highest number of tiller/m^2 (226.3) found in T2 treatment (Carfentrazone-ethyl + Isoproteuron) and the lowest (209.1) was found in T1 treatment (Pendimethalin). When combination of herbicide and hand weeding was considered, the highest number of tillers (233.8 m^{-2}) were recorded in T7 (Carfentrazone-ethyl + 1 HW) among the herbicidal treatments. Data indicated that, the most favourable effect on tillering was noticed in the treatments combining herbicide and hand weeding. Among the individual herbicides, combined ingredient herbicide Carfentrazone-ethyl + Isoproteuron contributed to the highest tiller development in wheat.

Table 3: Weed control efficiency of selected herbicides in wheat crop field

Treatment	Weed control efficiency (%)			
	30 DAE	60 DAE	90 DAE	Harvest
T1 (Pendimethalin)	35.87	37.14	39.53	52.74
T2 (Carfentrazone-ethyl + Isoproteuron)	4.32	32.53	35.83	69.25
T3(Carfentrazone-ethyl)	57.52	64.89	78.21	79.68
T4 (2,4-D)	15.67	54.41	56.83	62.41
T5 (Pendimethalin + 1HW)	9.48	95.38	93.8	91.49
T6 (Carfentrazone-ethyl + Isoproteuron + 1HW)	8.45	84.53	87.92	91.63
T7 (Carfentrazone-ethyl + 1 HW)	55.05	90.36	94.91	90.4
T8 (2,4-D + 1 HW)	46.39	97.38	91	93.39
T9 (Control)	0	0	0	0
LSD (0.05)	33.34	21.67	20.4	12.47
CV(%)	42.08	18.36	17.72	9.71

Table 4: Tiller dynamics in wheat as affected by herbicide

Treatment	Tillers m^{-2}					
	30 DAE	**45DAE**	**60DAE**	**75DAE**	**90DAE**	**Harvest**
T1 (Pendimethalin)	9.6	45.2	75.4	113.6	160.4	209.1
T2 (Carfentrazone-ethyl + Isoproteuron)	20.6	65.4	68.8	107.5	174.2	226.3
T3(Carfentrazone-ethyl)	16.6	53.2	88.9	123.5	183.7	219.8
T4 (2,4-D)	6.2	67.8	75.4	122.7	174.7	216.8
T5 (Pendimethalin + 1HW)	9.8	53.8	59.4	103.2	155.3	205.5
T6 (Carfentrazone-ethyl + Isoproteuron + 1HW)	24	56.2	52.0	121.2	165.3	225.1
T7 (Carfentrazone-ethyl + 1 HW)	19.6	43	71.0	92	140.5	233.8
T8 (2,4-D + 1 HW)	28.6	55.8	65.4	126.7	179.6	216.4
T9 (Control)	8.2	46.6	62.0	112.2	168	200.0
LSD (0.05)	2.52	4.07	4.18	8.64	4.89	8.174
CV(%)	8.9	4.32	3.58	4.5	1.68	2.15

Effect of herbicide on total dry matter (TDM) production in wheat

Total dry matter production was significantly affected by herbicide (Table 5). Among the herbicidal treatments, T2 (Carfentrazone-ethyl + Isoproteuron) contributed to the highest TDM of 1342 g m^{-2}, while the lowest (880 g m^{-2}) was contributed by the treatment T7 receiving Carfentrazone-ethyl and one hand weeding. Data indicated that, T7 and T8 treatments, although supplemented by one hand weeding each, could not contribute favourably towards total dry matter production.

Table 5: Total dry matter production in wheat as affected by herbicide

Treatment	TDM (g m^{-2})					
	30DAE	**45DAE**	**60DAE**	**75DAE**	**90DAE**	**Harvest**
T1 (Pendimethalin)	57.2	186.4	443.8	587.8	931.8	984.0
T2 (Carfentrazone-ethyl + Isoproteuron)	58.4	208.4	429.2	995.2	1287.4	1342.0
T3(Carfentrazone-ethyl)	84.4	238.2	524.2	863.4	1056.6	1096.0
T4 (2,4-D)	72.4	227.2	409.8	656.0	973.8	1106.0
T5 (Pendimethalin + 1HW)	75.8	210.6	381.0	714.8	1028.0	1084.0
T6 (Carfentrazone-ethyl + Isoproteuron + 1HW)	66	273.4	498.8	863.8	1020.6	1144.0
T7 (Carfentrazone-ethyl + 1 HW)	75.8	174.6	428	754.6	833.2	880.0
T8 (2,4-D + 1 HW)	92.2	177.8	421.2	838.8	906.2	968.0
T9 (Control)	54	135	287.8	696.4	729.8	750.0
LSD (0.05)	2.267	2.496	1.96	2.90	6.42	8.724
CV(%)	2.00	0.63	0.25	0.22	0.41	0.53

Yield performance of wheat as affected by herbicide

Herbicides significantly affected grain yield of wheat in this experiment. Grain yield of wheat (cv. BARIGom-24) ranged from 2.96 ton ha^{-1} in control treatment (T9) to 3.56 t ha-1 in T2 treatment receiving combined ingredient herbicide Carfentrazone-ethyl + Isoproteuron (Table 6). The highest grain yield in T2 treatment was the resultant effect of highest effective tillers per unit area and the highest number of grains in

individual spike. This treatment also scored the highest harvest index (0.42) compared to all other treatments. Data revealed that, T7 treatment receiving supplemental hand weeding along with Carfentrazone-ethyl herbicide contributed to the second highest grain yield of 33.46 t ha^{-1}. This treatment, although produced the highest number of tillers m-2 and highest number of spikelets $spike^{-1}$, produced lower number of grains $spike^{-1}$ resulting lower grain yield compared to T2 treatment. Higher wheat grain yield under Carfentrazone-ethyl + Isoproteuron was also reported by Hossain *et al*., (2009). Particularly, tanks mixing of Isoproteuron with a number of herbicides had been reported to contribute favourably towards wheat grain yield (Upadhyay *et al*., 2005).

Table 6: Yield and yield contributing characters of wheat (cv. BARI Gom-24) as affected by herbicide

Treatment	Total tiller no.\m²	Effective tiller no.\m²	Spike length (cm)	Spiklet /spike	Grains /spike	1000 grain wt.(gm)	Grain yield (t\ha)	Harvest Index
T1	212.1	112.6	16.11	16.26	35.06	55.31	3.18	0.38
T2	226.3	132.4	16.14	16.33	36.23	52.25	3.56	0.42
T3	219.8	126.7	15.67	15.13	32.73	54.75	3.26	0.33
T4	216.8	118.6	13.92	16.23	35.3	49.9	3.03	0.35
T5	209.5	107.8	16.04	16.1	35.66	54.1	3.44	0.38
T6	225.1b	122.7	15.72	15.93	33.13	54.0	3.33	0.39
T7	233.8	128.7	16.41	16.66	34.3	53.83	3.46	0.39
T8	216.4	108.5	16.34	16.13	40.96	53.06	3.05	0.34
T9	205	107.5	15.94	15.04	32.64	53.04	2.96	0.34
LSD	10.32	8.773	.971	.704	5.414	4.49	0.37	5.06
CV(%)	2.71	4.16	3.63	2.60	8.98	4.95	8.23	7.84

T1=Pendimethalin; T2=Carfentrazone-ethyl + Isoproteuron; T3=Carfentrazone-ethyl; T4=2,4-D; T5= Pendimethalin + 1 hand weeding (HW); T6= Carfentrazone-ethyl + Isoproteuron + 1 HW (15 DAE); T7= Carfentrazone-ethyl + 1 HW (15 DAE); T8= 2,4-D + 1 HW (15 DAE); T9=Control (unweeded)

The study revealed that, post emergence application of Carfentrazone-ethyl (Hammer 24EC) provided better weed control efficiency in wheat field which was attributed by lower weed density as well as biomass under this treatment when compared to other herbicidal treatments. The efficiency of post-emergence weed control in wheat was also claimed to be superior to that under pre-emergence weed control (STREIT, *et al*., 2003). However, combined ingredient herbicide Carfentrazone-ethyl + Isoproteuron contributed to better crop growth and development, TDM production and highest grain yield as observed through this study. Carfentrazone-ethyl either alone or in combination with supplemental hand weeding also contributed to statistically identical grain yield. The study thus recommended that, Carfentrazone-ethyl can be used at field level at recommended dose due to its higher weed control efficiency, satisfactory grain yield, and beneficial favourable effects on crop growth and development. However, best results might be obtained if Carfentrazone-ethyl is fortified with Isoproteuron.

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