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HERBICIDE USE STRATEGY AND ITS ECONOMY AS A WEED MANAGEMENT OPTION IN WHEAT VARIETIES

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Abstract

Weed pressure is an additional threat to high temperature stressed wheat crop for its optimum production. A field experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during Rabi 2017-2018 to assess the response of wheat varieties to different weed managements and its economical viability. As such three varieties i.e. BARI Gom-28, BARI Gom-29, and BARI Gom-30 along with five weed managements viz. control (no weeding), two hand weeding at 20 and 40 DAS, Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} spray at 5 DAS as pre-emergence, Affinity 50.75 WP (Isoproturon) @ 1500 g ha^{-1} spray at 25 DAS as post-emergence and Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} at 5 DAS + Affinity 50.75 WP (Isoproturon) @ 1500 g ha^{-1} at 5 & 25 DAS were treatment variables tested under split plot design.*Cynodon dactylon, Cyperus rotundus, Echinochloa colona, Eleusine indica, Chenopodium album, Alternanthera philoxeroides, Brassica kaber, Leliotropium indicum, Vicia sativa*,etc.werethe major weeds as determined based on their field intensity.Results revealed that BARI Gom-30 out-yielded other varieties with the highest grain yield (3.01 t ha^{-1}). Pre-emergence application of Panida 33EC at 5 DAS proved as suitable weed management compared to other methods. BARI Gom-30 in combination with Panida 33EC @ 2000 ml ha^{-1} spray at 5 DAS as pre-emergence gave higher yield and yield attributes while BARI Gom-28 under no weeding check showed lower grain yield (2.09 t ha^{-1}). Economically maximum gross return (Tk.75761.52ha^{-1}),net income (Tk.21775.92ha^{-1}), and BCR (1.41) were associated with Panida 33EC treatment when minimum values were obtained in the control plot (no weeding). So, the application of pre-emergence herbicide, Panida 33EC might be economically viable weed management ensuring a higher yield in wheat cultivation.

Introduction

Wheat (*Triticum aestivum* L.) is one of the world's most commonly consumed cereal grains in general and staple food of about two billion people (36% of the world population) in particular. Wheat provides about 55% carbohydrates and 20% food calories for the global population (Breiman and Graur, 1995). Wheat grain contains 71% carbohydrate, 13% protein, 1.5% fat, 12% fibre, and some vitamins and minerals. It is also used for animal feed and a unique component in industrial use which is about 12%. As the second most important cereal crop in Bangladesh, 13.16 lakh tons of grain is grown on 4.15 lakh ha land at an average annual production rate of 4.19% (BBS, 2019). But the area coverage and production may be reduced because of the rise in mean temperature by 0.66 °C since 1999 and by2.13°C in 2050 (Poulton and Rawson, 2011) and in recent past the infestation of wheat blast coupled with weeds abundance in wheat field. In general, wheat yield depends on varietal character, inputs, and agronomic management practices. The productivity of wheat is lower compared to other parts of South Asia, which could be primarily forced to short growth duration due to higher average temperature than optimum temperature (24°C) and further aggravated with seasonal weeds infestation. Weed competes with crop plants for water, nutrients, space, and solar radiation resulting in a reduction of yield by 20 to 50% (Bhan and Dixit, 1998). Besides other crops weed is a major problem for maximizing higher yields of wheat and unchecked weed growth reduces crop yield up to 57% (Singh *et al*., 1997). The shortage of labours for hand weeding makes the use of herbicides inevitable throughout the world (Hossain, 2015). Thus the application of herbicides is getting alternative attention from economic point of view (Zhang, 2003: Kaur*et al*., 2018). Considering the above facts, this experiment was undertaken to examine influence of pre and post-emergence herbicides either individual or double-action over the convention in the potential yields of some modern wheat varieties along with economic validation.

Materials and Methods

The field experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during Rabi 2017-2018. The location of the experimental site is 90º37´ E longitude and 23º77´ N latitude. The soil belongs to the Modhupur tract (AEZ No. 28). The experiment consisted of two factors as a) Factor A: Varieties (3) i.e. V_1= BARI Gom-28, V_2= BARI Gom-29, V_3= BARI Gom-30 and b) Factor B: Weed managements (5) viz. W_0 = No weeding (Control), W_1 = Two hand weeding at 20 DAS and 40 DAS, W_2 = Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} spray at 5 DAS (pre-emergence), W_3 = Afinity 50.75WP (Isoproturon) @ 1500 g ha^{-1} spray at 25 DAS (post-emergence), W_4 = Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} spray at 5 DAS + Affinity 50.75WP (Isoproturon) @ 1500 g ha^{-1} spray at 25 DAS. The experiment was laid out in a split-plot design with three replications where the variety was placed in the main plot and weed managements in subplot. Fertilizers were applied following BARI recommendations as urea, TSP, MoP, and gypsum @ 220, 150, 50, and 120 kg ha^{-1}, respectively. The whole amount of all fertilizers and two-third amount urea was applied at the time of final land preparation and thoroughly incorporated with soil. Rest urea was added at the crown root initiation (CRI) stage (21 DAS). There were negligible infestations of insect-pests during the crop growth period. Only mole cricket and cutworm attacked the crop during the early growing stage and controlled by spraying Diazinon 60EC. Data of yield and yield contributing parameters were collected at the final harvest. Analysis of variance was done following MSTAT-C. The mean differences among the treatments were adjusted by least significant difference (LSD) at a 5% level of significance (Gomez and Gomez, 1984).

Results and Discussion

The spike length, spikelets $spike^{-1}$, grains $spike^{-1}$, and grain yield except 1000 grain weight were varied significantly due to variety (Figs. 1, 2, and 3). It was observed that BARI Gom-30 (V_3) produced longer spike (16.15cm) and at par with BARI Gom-29 (V_2), a higher number of spikelets $spike^{-1}$ (14.76) and similar with BARI Gom-29, maximum filled grain $spike^{-1}$ (42.66), grain yield (3.01 t ha^{-1}) and numerically maximum 1000-grain weight (50.84 g). Variety BARI Gom-28 (V_1) produced a lesser value of each parameter. Sultana *et al.* (2012) had observed on spike length, spikelets $spike^{-1}$, grains $spike^{-1}$, and grain yield that variety differs with each parameter. Chahal *et al.* (2003) reported a change in number of spikelets $spike^{-1}$ and Smeia *et al.* (2005) noted a varied number of grains $spike^{-1}$ across the wheat varieties. On the other hand, Hossain *et al*. (2010) noted that variety did not differ significantly in respect of 1000-grain weight.

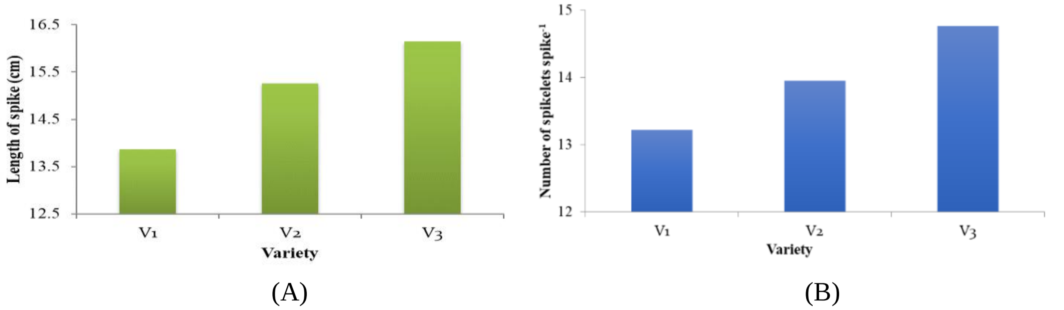
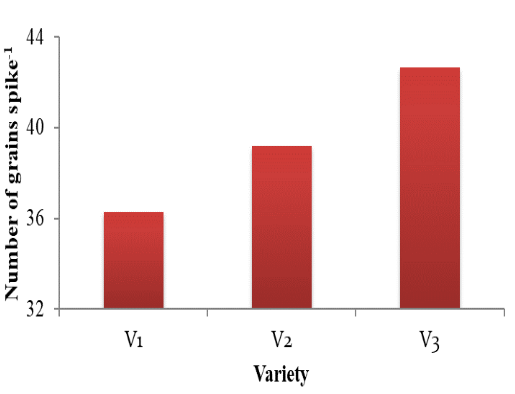
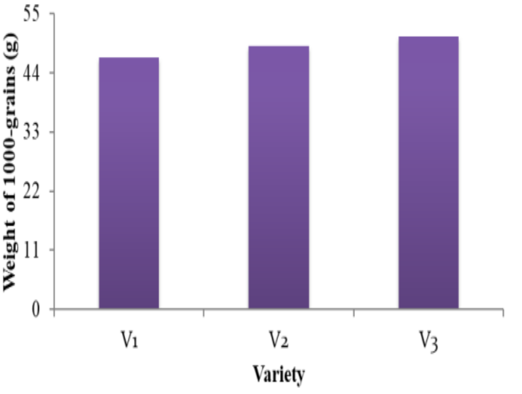


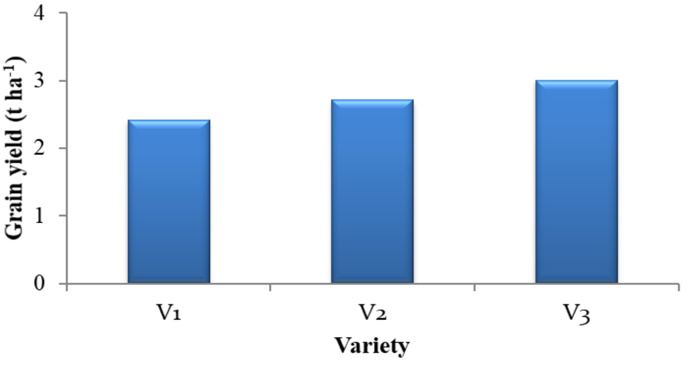
Fig. 1. Effect of variety on length of spike ($LSD_{0.05}$=1.42) (A) and spikelets $spike^{-1}$ ($LSD_{0.05}$=1.34) (B) of wheat.





(A) (B)

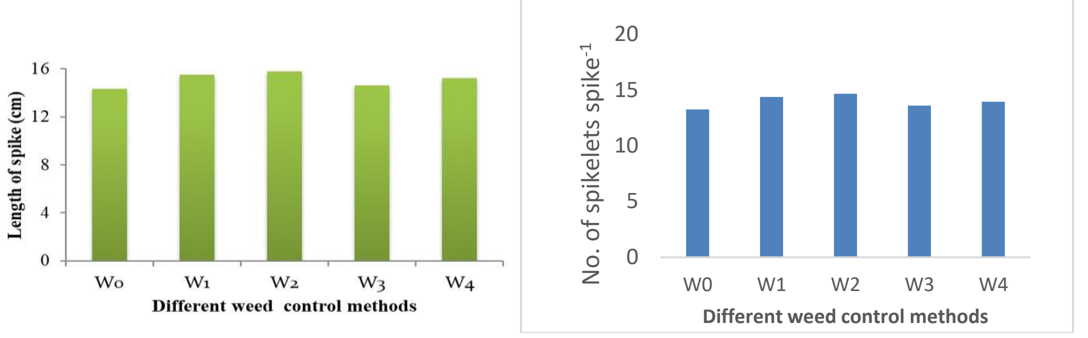
Fig. 2. Effect of variety on grains spike^{-1} ($LSD_{0.05}$=2.02) (A) and 1000 grain weight of wheat ($LSD_{0.05}$=NS) (B) of wheat.



V_1=BARI Gom-28, V_2=BARI Gom-29, V_3=BARI Gom-30

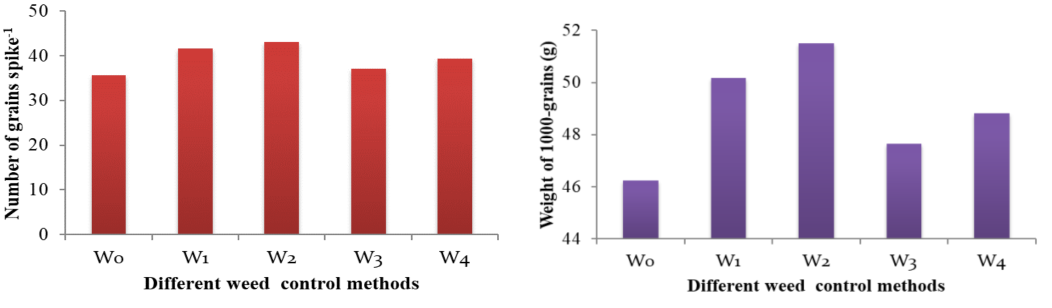
Fig. 3. Effect of variety on grain yield of wheat ($LSD_{0.05}$=0.08).

Weed managements showed significant variation in spikelets spike^{-1}, grains spike^{-1} 1000 grain weight, and grain yield except for spike length (Figs. 4, 5, and 6).Numerically longest spike length (15.77 cm) was recorded at W_2 (Panida 33EC) which also registered maximum spikelets spike^{-1} (14.68) and similar to other weed control methods, highest filled grain spike^{-1} (43.02) and was statistically similar with two hand weeding (W_1) and Panida 33EC + Affinity 50.75WP (W_4), greater 1000-grain weight (51.51 g) and at par with other weed management and highest grain yield (3.12 t ha^{-1}) which was statistically similar with two hand weeding (W_1). Treatment no weed control (W_0) was significantly inferior in all the above cases.Hossain *et al*. (2010) recorded a gradual trend of increased length (7.25 and 12.12 cm) of the spike when they applied Sencor 70WG @ 0.40 kg ha^{-1} at 60 DAS and 90 DAS, respectively. Singh *et al*. (2004) opined similar results with pre-emergence pendimethalin @ 0.75 kg ha^{-1} along with one hand weeding or 2,4-D 0.5 kg ha^{-1} at 30 DAS that gave significantly higher spikes m^{-2}. Pre-emergence herbicide, Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} spray at 5 DAS controlled weeds for greater production of yield components and grain yield as weed could not compete with wheat for nutrition, water, and sunlight.



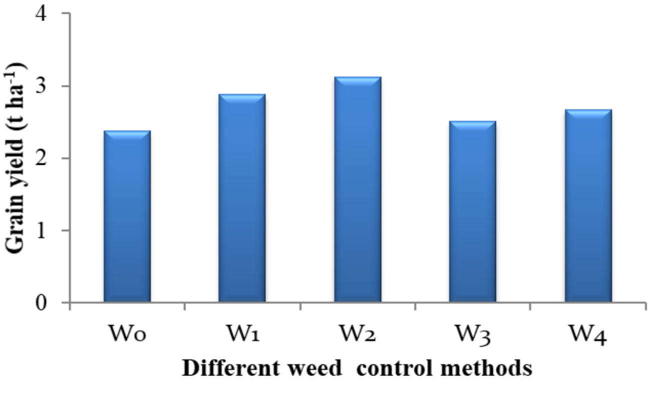
(A) (B)

Fig. 4. Effect of different weed managements on the length of spike ($LSD_{0.05}$=NS) (A) and spikelets spike^{-1} ($LSD_{0.05}$=1.39) (B) of wheat.



(A) (B)

Fig. 5. Effect of different weed managements on the grains spike^{-1} ($LSD_{0.05}$=4.71) (A) and 1000-grains weight ($LSD_{0.05}$=4.69) (B) of wheat.



W_0= No weeding, W_1= Two hand weeding, W_2=Panida 33EC, W_3= Afinity 50.75WP, W_4=Panida 33EC + Affinity 50.75WP

Fig. 6. Effect of different weed managements on grain yield of wheat ($LSD_{0.05}$=0.27).

The combined effect of variety and weed management seems to be influencing insignificant variations regarding spike length, spikelets spike^{-1},grains spike^{-1},1000-grain weight, and grain yield (Table 1). The longest (16.70 cm) spike was measured at BARI Gom-30 with panida 33EC (V_3W_2) which was statistically similar with all other treatment combinations except V_1W_0, V_1W_3 and V_1W_4. The shortest spike (13.20 cm) was found in V_1W_0 (BARI Gom-28 and no hand weeding) and at par with V_1W_1, V_1W_2, V_1W_3, V_1W_4, V_2W_0, V_2W_1, V_2W_3, V_2W_4, and V_3W_0. Number of spikelets spike^{-1} was counted highest (15.43) from V_3W_2 which was statistically similar with all other treatment combinations except V_1W_0 and V_1W_3. The lowest (12.40) number of spikelets spike^{-1} was obtained from V_1W_0 and similar with almost all other treatment combinations. Filled grains spike^{-1} (47.38) was maximum, obtained from $V_3W_2$and followed by V_2W_1, V_2W_2, V_3W_1, V_3W_3, and V_3W_4. The lowest filled grains spike^{-1} (32.99) was found at BARI Gom-28 with no weeding (V_1W_0) which was statistically similar with all other treatment combinations except V_2W_1, V_2W_2, V_3W_1, and V_3W_4. Maximum 1000 grain weight (53.57g) was showed by BARI Gom-30 with panida 33EC (V_3W_2) and similar with all treatment combinations except V_1W_0 and V_1W_3. The lowest 1000-grain weight (43.68 g) was noted from BARI Gom-28 with no weeding (V_1W_0) which was statistically similar with almost all other treatments. Grain yield (3.52 t ha^{-1}) was marked as highest in V_3W_2 which was at par with V_3W_1 and V_2W_2 when the lowest (2.09 t ha^{-1}) from V_1W_0. Application of pre-emergence herbicide, Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} at 5 DAS completely controlled weed population thus weed free wheat crop diverted maximum dry matter towards economic units of wheat followed by greater grain yield. This result is corroborated to Sultana *et al.* (2012) who reported that the combined effect of variety and weeding methods had a significant effect on yield and yield contributing characters.

Table 1.Combined effect of varieties and weed managements on the yield and yield contributing characters of wheat

Treatment combinations	Length of spike (cm)	Spikelets spike^{-1} (No.)	Grains spike^{-1} (No.)	1000-grain weight (g)	Grain yield (t ha^{-1})
V_1W_0	13.20 d	12.40 c	32.99 d	43.68 c	2.09 g
V_1W_1	14.31 a-d	13.80 a-c	37.57 b-d	48.49 a-c	2.57 d-f
V_1W_2	14.60 a-d	13.94 a-c	39.06 b-d	49.84 a-c	2.69 d-f
V_1W_3	13.31 cd	12.78 bc	35.03 cd	45.14 bc	2.27 fg
V_1W_4	13.93 b-d	13.20 a-c	36.70 cd	46.97 a-c	2.46 d-g
V_2W_0	14.33 a-d	13.22 a-c	35.76 cd	46.10 a-c	2.43 e-g
V_2W_1	15.87 a-d	14.27 a-c	41.87 a-c	50.04 a-c	2.79 c-e
V_2W_2	16.00 ab	14.67 a-c	42.63 a-c	51.12 a-c	3.16 a-c
V_2W_3	14.63 a-d	13.61 a-c	36.68 cd	48.28 a-c	2.54 d-g
V_2W_4	15.46 a-d	14.00 a-c	38.93 b-d	49.20 a-c	2.64 d-f
V_3W_0	15.49 a-d	14.20 a-c	38.30 b-d	48.91 a-c	2.60 d-f
V_3W_1	16.40 ab	15.07 ab	45.49 ab	51.97 ab	3.29 ab
V_3W_2	16.70 a	15.43 a	47.38 a	53.57 a	3.52 a
V_3W_3	15.93 a-c	14.41 a-c	39.57 a-d	49.51 a-c	2.70 c-f
V_3W_4	16.23 ab	14.67 a-c	42.53 a-c	50.27 a-c	2.92 b-d
$LSD_{(0.05)}$	**2.67**	**2.40**	**8.15**	**8.13**	**0.46**
CV (%)	**10.50**	**10.21**	**12.29**	**9.87**	**10.18**

W_0= No weeding; W_1= Two hand weeding: W_2=Panida 33EC: W_3= Afinity 50.75WP: W_4=Panida 33EC+Affinity 50.75WP and V_1=BARI Gom-28: V_2=BARI Gom-29: V_3=BARI Gom-30

As the labour cost is increasing sharply due to labour shortage in pick period so introducing the application of herbicide should be economically viable as per analysis. The analysis of weed managements revealed that cost of production was highest (Tk. 58385.60 ha^{-1}) from W_1 (Two hand weeding at 20 and 40 DAS) due to the higher rate of labour wedge and the lowest cost (TK. 53135.60 ha^{-1}) was calculated from W_0 (no weeding, control). The cost of production was varied from Tk. 53885.60 ha^{-1} to Tk. 54385.60 ha^{-1} due to the use of two different herbicides. The highest gross return (Tk. 75761.52 ha^{-1}) was obtained from the treatment W_2 (Panida 33EC, Pendimethalin @ 2000 ml ha^{-1} spray at 5 DAS as pre-emergence) and the lowest gross return (Tk. 57906.62 ha^{-1}) was obtained from no weeding treatment (W_0). The second-highest gross return (Tk.70128.48 ha^{-1}) was obtained from two hand weeding (W_1) as the biological yield was higher after W_2. On the other hand, the lowest gross return (Tk. 57906.62 ha^{-1}) was marked at W_0 (control) attributed due to the minimum biological yield as plants were stressed under weed pressure caused by no weeding during their life span. As such the highest net income (Tk. 21775.92 ha^{-1}) was obtained from Panida 33EC (W_2) followed by the highest BCR (1.41) and no weeding treatment showed minimum values, Tk. 4771.02 ha^{-1} and 1.09, respectively (Table 2). Rashid *et al.* (2012) reported that net income from herbicide application in rice was 116% higher than hand weeding owing to increased yield and lower cost.

Table 2. Cost-benefit analysis of different weed management practices on wheat

Treatment	Cost of production (Tk. ha^{-1})			Gross return (Tk. ha^{-1})			Gross margin (Tk. ha^{-1})	BCR
	Other Cost of production	Weeding cost	Total cost	Grain	Straw	Total		
W_0	53135.6	0	53135.60	53979.12	3924.0	57906.62	4771.02	1.09
W_1	53135.6	5250	58385.60	65594.88	4533.6	70128.48	16142.88	1.20
W_2	53135.6	850	53985.60	71061.12	4700.4	75761.52	21775.92	1.41
W_3	53135.6	750	53885.60	57167.76	4092.0	61259.76	7374.16	1.14
W_4	53135.6	1250	54385.60	60903.02	4357.2	65260.22	10874.62	1.20

W_0= No weeding; W_1= Two hand weeding: W_2=Panida 33EC: W_3= Afinity 50.75WP: W_4=Panida 33EC+Affinity 50.75WP and V_1=BARI Gom-28: V_2=BARI Gom-29: V_3=BARI Gom-30

Conclusion

The use of herbicide is found suitable as alternative weed management where labour cost could be minimized. Wheat var.BARI Gom-30 could be cultivated along with Panida 33EC (Pendimethalin) @ 2000 ml ha^{-1} spray (at 5 DAS) as a pre-emergence herbicide for its optimum economic yield harvest.

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