EFFECTS OF HERBICIDES ON THE GROWTH AND YIELD OF WHEAT

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ABSTRACT

A field trial was conducted at the Regional Station, Bangladesh Wheat and Maize Research Institute (BWMRI), Rajshahi during winter season of 2023-24 to select the suitable herbicide for weed control on wheat. Nine treatments with BARI Gom 33 was used in this experimental as RCB design. Four major weeds were observed in the experimental field. The weed population and dry weight of weeds were low with Hammer 24 EC and high with control plot. The lowest dry weight of weed was found from Hammer at 35 DAS application. Among the treatments Hammer 24 EC showed higher weed control efficiency which was at par with Council WG and Hand weeding. Maximum grain yield was obtained from hand weeding which was as par with Council WG and Hammer 24 EC. The lowest grain yield was found from control treatment as anticipated. On the other hand, Council WG as per with Hammer 24 EC was economically suitable for the control of weeds comparatively with less cost. Therefore, according to weed control efficiency and economic benefits, Hammer 24 EC and Council 15 WG at 25 DAS application were found as the best herbicides for weeds control in the wheat field of Rajshahi region.

Keywords: Herbicides, weed, growth, wheat yield, weed control efficiency

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second cereal crop in Bangladesh. The average yield of wheat (3.34 t ha^{-1}) in the country is comparatively low compared to other wheat-producing countries of the world (BBS, 2024). 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, 2004). Weed is one of the most important factors responsible for 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. The low yield of wheat in Bangladesh is largely due to poor management practices, like weeding, imbalance fertilization, irrigation, etc. In order to increase wheat yields it is important to manage weeds, which resulted higher yield in wheat crop (Khan *et al.,* 2003). 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. 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

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and yield performance of wheat is still scanty under Bangladesh context. Under the above circumstances, the present study was conducted to find out the most effective weedicides to control weed in wheat field; and to evaluate the effect of herbicides on yield performance of wheat.

MATERIALS AND METHODS

The investigation was carried out at Regional Station, BWMRI, Shyampur, Rajshahi, during winter season of 2023-24 using BARI Gom 33 wheat variety. There were nine treatment combinations (Table 1).

Table 1. Different treatment and their distribution

Treatments	Rate of application	Time of application
Hammer 24 EC (Carfentazone ethyl)	0.21 mL L^{-1}	25 DAS
Ding dong 86 SL (2, 4-D Dimethyl ammonium salt 86%)	3.4 mL L^{-1}	25 DAS
Kem Amine 72 SL (2,4-D amine)	5.6 mL L^{-1}	25 DAS
Belmine 72 SL (Dimethyl ammonium salt 72%)	2 mL L^{-1}	25 DAS
Moonrise 15 WG (Ethoxysulfuron)	0.2 mL L^{-1}	25 DAS
Council 15 WG (Triafamone20%+Ethoxysulfuron 10% WG)	0.3 mL L^{-1}	25 DAS
Razor 55 SC (Attrazine 50%+ Mesotrione 5%)	4 mL L^{-1}	25 DAS
Hand weeding	One operation	25 DAS
Control	No weeding	-

The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The size of each unit plot was 20 m^2 (5 m × 4 m) having 50 cm distance between two adjacent plots as well as 1 m distance between two replications. Seeds were sown on 27 November 2023. A recommended dose of nitrogen (150 kg ha^{-1}) from urea, phosphorus (135 kg ha^{-1}) from triple super phosphate, potassium (110 kg ha^{-1}) from muriate of potash and sulphur (20 kg ha^{-1}) from gypsum and boron (1 kg ha^{-1}) from boric acid were applied. The entire amount of phosphorus, potassium, sulphur and boric acid and two-third of nitrogen were applied at the time of final land preparation. The remaining nitrogen was applied at crown root initiation (CRI) stage after 1st irrigation as top dress. Hand weeding was done at 25 days after sowing (DAS). Three irrigations were applied at CRI, maximum tillering stage and grain filling stages. The various species of weeds were counted from the samples of pre-demarcation area at post emergence from each plot. Total number of various weeds species was collected at 25 and 35 days after seeding (DAS) and oven dry weight (DW) of weeds from each sample was recorded. Data on grain yield and yield contributing characters were recorded from five randomly selected 1 m^2 samples and the mean was used statistically analyzed. Weed control efficiency was calculated as:

$$\text{WCE (\%)} = A - B/A \times 100$$

Where, A and B are the dry matter weight (g m^{-2}) of weeds of control and treated plots respectively. Input costs were also recorded to see the economic benefits of treatments.

Method of dry matter determination

The number of weeds per m^2 was calculated from 3 samples of same plot. The weed species were separated on three categories and packed and labeled separately. Then put the samples in oven for 24 hours at 105°C temperature. Dry weight weed species were measured by electric balance at normal room temperature. Grain yield was recorded from three representative sample of 1 m^2 area per plot.

All the data were analyzed by Crop Stat Model using least significant difference (LSD) with Standard Error.

RESULTS AND DISCUSSION

The four major weed species infesting in the wheat field were *Chenopodium album*, *Cynodon dectylon*, *Cyperus rotundus* and *Vicia sativa* (Table 2). Balyan et al. (2001) who has also reported the same weed species in wheat fields. *Chenopodium album sp. and Cyperus rotundus* sp. were found dominant in all the treatments. Weed population and biomass production of weeds were greatly influenced by different herbicides. All herbicide treatments significantly reduced weed population resulting lower dry biomass as compared to the control treatment in all weed species. Significantly the lowest number of weeds m^{-2} were recorded in Hammer 24 EC @ 0.21 mL L^{-1} at 25 DAS application which was followed by Council @ 0.3 mL L^{-1} 25 DAS and one hand weeding at 25 DAS. Council @ 0.3 mL L^{-}1 also reduced the weed population over control but it was not as good as Hammer 24 EC @ 0.21 mL L^{-1} and hand weeding. This might be due to less effectiveness of Council on weeds. Similar results also reported by Moinuddin *et al.* (2018).

Table 2. Number and dry weight of different weed species m^{-2} as affected by weed control methods at 25 & 35 days after sowing (DAS)

Treatments	Rate of application	*Chenopodium album*		*Cynadon dactylon*		*Cyperus rotundus*		*Vicia sativa*	
		25 DAS	35 DAS	25 DAS	35 DAS	25 DAS	35 DAS	25 DAS	35 DAS
Hammer 24 EC	0.21 mL L^{-1}	24	17	3	2	30	12	1	1
Ding dong 86SL	3.4 mL L^{-1}	42	33	12	10	48	29	3	2
Kem Amine 72 SL	5.6 mL L^{-1}	39	24	9	7	41	24	2	2
Belmine 72 SL	2 mL L^{-1}	44	29	13	11	47	27	3	2
Moonrise 15 WG	0.2 g L^{-1}	28	23	7	6	43	24	2	3
Council 15 WG	0.3 g L^{-1}	27	14	8	8	46	25	1	1
Razor 55 SC	4 mL L^{-1}	38	24	2	2	49	27	1	1
Hand weeding	One operation	42	13	13	1	22	3	3	0
$LSD_{(0.05)}$	No weeding	4.54	6.35	2.1	2.3	7.6	8.54	0.7	0.5
CV (%)		9.87	10.24	6.5	7.8	4.7	8.5	9.8	4.7

The herbicide treatments were found effective in killing the different weeds and reducing their dry matter production (Table 3). The dry matter weight of weeds was significantly decreased by one hand weeding, also applications Hammer 24 EC @ 0.21 mL L^{-1} and Council @ 0.3 mL L^{-1} at 35 DAS of as compared to dry matter weight of weed before spray (25 DAS) and control. Other herbicides also decreased the dry matter weight of weed than control but not as compared to Hammer 24 EC, hand weeding, and Council due to less effectiveness on weed. The weed control efficiency of Hammer 24 EC was very high i.e. 83.1% at 35 DAS which was followed by council 15 WG @ 0.3 g L^{-1} (82.3%) and Hand weeding (78.2%). The maximum weed population and dry weight per unit area were recorded in control treatments (no weeding) and the lowest with Hammer 24 EC applied at 35 DAS followed by council applied at 35 DAS and hand weeding (Table 5). The similar trend also found by Marwat *et al.* (2005). Overall performance, it was indicated that, Hammer 24 EC @ 0.21 mL L^{-1} at 35 DAS would be good to controlling weeds in wheat field. These results are in line with those of Balyan *et al.* (2001) who concluded that herbicides significantly affected the weed population per unit area.

Table 3. Weed dry matter production and control efficiency at 25 and 35 DAS as affected by some newly developed herbicides

Treatments	Rate of application	Weed fresh weight ($g\ m^{-2}$)		Weed dry weight ($g\ m^{-2}$)		Weed control efficiency (%)	
		25 DAS	35 DAS	25 DAS	35 DAS	25 DAS	35 DAS
Hammer 24 EC	0.21 mL L^{-1}	21.2	8.1	9.7	2.1	49.4	83.1
Ding dong 86 SL	3.4 mL L^{-1}	38.4	15.3	14.9	4.3	22.3	65.3
Kem Amine 72 SL	5.mL L^{-1}	35.4	12.6	12.7	3.8	33.8	69.3
Belmine 72 SL	2 mL L^{-1}	39.8	16.2	13.5	4.1	29.6	66.9
Moonrise 15 WG	0.2 g L^{-1}	23.1	11.8	11.2	2.9	41.6	76.6
Council 15 WG	0.3 g L^{-1}	21.5	8.3	9.8	2.2	48.9	82.3
Razor 55 SC	4 g L^{-1}	24.6	15.2	14.8	4.7	22.9	42.1
Hand weeding	One operation	26.2	8.2	9.1	2.7	52.6	78.2
Control	No weeding	52.2	59.4	19.2	12.4	-	-
$LSD_{(0.05)}$		9.21	2.33	5.17	5.909	3.45	7.87
CV (%)		10.35	8.54	7.85	10.54	9.78	11.34

Herbicides effects on yield components of wheat

Yield components like spike m^{-2}, spike length, spikelets $spike^{-1}$, grains $spike^{-1}$ and 1000-grain weight were significant effect under different herbicides on yield components of wheat as shown in Table 4. Herbicides significantly influenced on yield attributes in wheat. The maximum spikes m^{-2} (382.0) found from council and minimum spikes m^{-2} (306) from Kem Amine 72 SL. But maximum spike length (12.13), spikelets $spike^{-1}$(19.5), grains $spike^{-1}$ (42.1)) were found from Council and maximum 1000 grain weight (48.7 g) found from Hammer 24 EC. The minimum spike length (10.5 cm), spikelets $spike^{-1}$ (15.4), grains $spike^{-1}$ (34.4) and 1000 grain weight (41.80 g) were found from control treatment. The similar results also reported by Upadhyay *et al.* (2005).

Table 4. Effects of newly developed herbicides on yield attributes of wheat

Herbicides	Rate of application	Spikes m^{-2}	Spike length (cm)	Spikelets $spike^{-1}$	Grains $spike^{-1}$	1000-grain weight(g)
Hammer 24 EC	0.21 mL L^{-1}	358.6	11.4	17.7	39.4	48.7
Ding dong 86 SL	3.4 mL L^{-1}	318.7	10.7	17.0	37.1	45.2
Kem Amine72 SL	5.6 mL L^{-1}	306.0	10.9	18.3	37.3	44.8
Belmine 72 SL	2 mL L^{-1}	323.7	10.5	18.2	38.5	45.5
Moonrise 15 WG	0.2 g L^{-1}	361.6	11.7	19.2	37.5	47.9
Council 15 WG	0.3 g L^{-1}	382.0	12.1	19.5	42.1	48.3
Razor 55 SC	4 mL L^{-1}	298.7	10.9	16.8	36.7	44.7
Control	One operation	297.3	10.5	15.4	34.4	41.8
Hand weeding	No weeding	365.7	11.7	19.4	40.6	48.2
$LSD_{(0.05)}$		3.50	0.35	0.67	1.10	0.72
CV (%)		12.93	6.70	5.09	9.87	11.78

Herbicides effects on grain and biomass yield with harvest index of wheat

Different treatments significantly influenced on grain yield and yield components of wheat. Wheat yield was found to be gradually decreased with the increase of weed populations. Maximum grain yield (4.90 t ha^{-1}) was found from hand weeding and it was at par with council (4.87 t ha^{-1}) and Hammer 24 EC (4.77 t ha^{-1}) (Table 5). Grain yield was higher due to higher yield attributes lower weed crop competition, higher absorption of nutrients and sufficient interception of sunlight as well as air circulation. Panday *et al.* (2006) found similar finding from their herbicides experiments on wheat crop. Minimum grain yield (2.97 t ha^{-1}) was found from due to control lower yield components i.e. no weeding due to high weed-crop competition, sharing of nutrients, air and sunlight by weeds. Many authors (Verma and Srivastava, 1998) reported significant yield advantage through herbicides use.

Table 5. Effects of newly developed herbicides options on grain & biomass yield with harvest index of wheat

Herbicides	Grain yield (t ha^{-1})	Biomass (t ha^{-1})	Harvest index (%)
Hammer 24 EC	4.77	9.20	51.8
Ding dong 86 SL	4.36	8.84	49.3
Kem Amine 72 SL	4.57	8.95	50.9
Belmine 72 SL	4.35	8.77	49.6
Moonrise 15 WG	4.60	9.08	50.6
Council 15 WG	4.87	9.35	52.1
Razor 55 SC	3.10	6.98	37.6
Control	2.97	6.95	42.7
Hand weeding	4.90	9.54	51.4
LSD $_{(0.05)}$	0.58	1.10	0.15
CV (%)	8.15	8.34	10.8

Economic Benefits

The economic return was calculated by reducing weeding cost, keeping all other input costs constant. Data from Table 6 revealed that the use of sprayed Council 15 WG @ 0.3 g L^{-1} at 25 DAS application has given the highest gross margin of 115800 Tk. ha^{-1} and Hammer 24 EC @ 0.21 mL L^{-1} at 25 DAS application has given second highest gross margin 112900 Tk ha^{-1}. The lowest gross margin (42400 Tk ha^{-1}) was found from control treatment.

Table 6. Cost related to herbicides uses and gross returns, gross margin by some newly developed herbicides

Treatment	Grain yield (Kg ha^{-1})	Gross return (Tk ha^{-1})	Total variable cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})
Hammer 24 EC	4770	190800	77900	112900
Ding dong 86 SL	4360	174400	78400	96000
Kem Amine 72 SL	4570	182800	79200	103600
Belmine 72 SL	4350	174000	78400	95600
Moonrise 15 WG	4600	184000	79910	104090
Council 15 WG	4870	194800	79000	115800
Razor 55 SC	3100	122000	78200	43800
Control	2970	118800	76400	42400
Hand weeding	4900	196000	88900	107100

CONCLUSION

Overall performance of the experiment observed that both weedicides and hand weeding at 25 DAS application were performed better as higher grain yield with weed control efficiency. On the other hand, Council 15 WG @ 0.3 g L^{-1} and Hammer 24 EC @ 0.21 mL L^{-1} were economically suitable for the control of weeds in wheat field. Though, hand weeding was performed better but, it was laborious and time consuming. Razor could not be used for weed control in wheat field. So, Council

15 WG @ 135 g ha^{-1} and Hammer 24 EC @ 94.5 mL ha^{-1} were found suitable for weeds control successfully in the wheat field of Rajshahi region in Bangladesh.

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