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Assessment of different weed control methods on growth and yield of wheat

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Abstract

A field experiment was conducted at Agronomy research field, Sher-e-Bangla Agricultural University, Bangladesh during November, 2012 to March, 2013 to find out the impact of different weed control methods on growth and yield of wheat. The experiment was carried out with four weed control methods viz. W_0= control (no weeding), W_1= two hand hoe weeding at 20 DAS and 40 DAS, W_2= Topstar 80WP (Oxadiargyl 800 g/kg) @ 75 g/ha as post-emergence and W_3= Sunrice 150WG (Ethoxysulfuron 150 g/kg) @ 100 g/ha as early post-emergence herbicide using Completely Randomized Block design with three replications. Among the weed control methods Sunrice 150WG (W_3) showed minimum total number of weed (29.8/m^2), weed biomass (6.5 g/m^2), maximum weed control efficiency (57.8%), grain yield (3.9 t/ha), straw yield (5.3 t/ha), biological yield (9.2 t/ha) and harvest index (41.3%). Effective weed control method could be used for the better production of wheat.

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Introduction

Wheat (*Triticum aestivum* L.) is the second important cereal crop next to rice (Al-Musa *et al.,* 2012) in Bangladesh. Average yield of wheat in Bangladesh is very low compared to New zealand, Netherlands, Ecuador and France (8.9, 8.6, 8.0 and 7.6 t/ha) (FAO, 2013). Weeds cause more loses to agriculture than all pests (Gella *et al.,* 2013). There are innumerable reports on negative effects of weeds on crop plants (Javaid *et al.,* 2007) thus cause huge yield losses (Rathore *et al.,* 2014). Unchecked weed growth reduces crop yield up to 57% (Singh *et al.,* 1997). Weed infestation may reduce yield by 42-56% (El-Hamid *et al.,* 1998), 45.5 to 63.9% (Reddy and Reddi, 2002), 40.3% (Rajeev *et al.,* 2012), 25% to 30% (Norsworthy *et al.,* 2004), 25.35% (Dangwal *et al.,* 2010) in wheat while reduced up to 92% by competition from ryegrass (Dickson *et al.,* 2011), 17-62% due to wild oat (Marwat *et al.,* 2011).

Wheat yield severely reduced due to broad spectrum weed flora in different areas of Bangladesh (Hossain *et al.,* 2009). Number of weed species in wheat field varied country to country and up to 45 weed species have been reported in Pakistan (Qureshi and Bhatti, 2001), 33 in Iran (Buczek *et al.,* 2011), 90 in India (Rao, 2000) and 73 in Bangladesh (Begum *et al.,* 2003). Moreover, weeds serve as alternate hosts to insects, nematodes and pathogenic fungi such as common broad leaved weeds for *Fusarium* (Postic *et al.,* 2012), wild grasses and grassy weeds for wheat streak mosaic virus and its vector and wheat curl mite (Ito *et al.*, 2012).

Weeds are one of the major constraints of wheat production and weed control is the key factor in increasing yield (Lopez-Granados, 2011; Shehzad *et al.,* 2012). Weed control has been observed as one of the most important practice in crop production because good weed control will ensure maximum yield and high quality of farm produce (Njoroge, 1999). Thus current experiment was conducted to identify better weed control method for wheat cultivation.

Materials and methods

Experimental site and duration

An experiment was conducted at Agronomy field, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during period from November 2012 to March 2013.

Treatments of the experiment

Experiment consisted four weed control methods viz. W_0: No weed control measures, W_1: Hand hoe weeding at 20 DAS and 40 DAS, W_2: Topstar 80WP @ 75 g/ha, W_3: Sunrice 150WG @ 100 g/ha following Randomized Completely Block Design with three replication.

Application of treatments

In no weeding treatment, weeds were allowed to grow in the plots from sowing to harvesting of the crop. No weed control measures were applied. Whereas in case of hand hoe weeding treatment two hand hoe weedings were done at 20 and 40 DAS, respectively. Chemical herbicide Topstar 80WP (Oxadiargyl) was foliar sprayed @ 75 g/ha at 10 DAS for 3-5 days as post-emergence and Sunrice 150WG (Ethoxysulfuron) was applied @ 100 g/ha at 15 DAS when weeds were 2-3 leaf stage as early post-emergence.

Plot size, genetic material and seed rate

The size of the individual plot was 3.5 m x 2.5 m with inter plot spacing of 0.50 m and inter block spacing of 1 m. BARI Gom 26 was used as plant materials and seed rate was 120 kg/ha.

Fertilization

All fertilizers except nitrogenous fertilizers were applied at the rate of BARI recommended dose as 180 kg/ha TSP, 50 kg/ha MOP, 120 kg/ha Gypsum (BARI, 2011). Fertilizers other than nitrogen were given during final land preparation.

Seed sowing

Seeds were sown continuously in 20 cm apart rows opened by specially made iron hand tine.

Data collection

Data were collected on weed density, weed biomass, weed control efficiency, relative weed density, plant height, tiller number, plant dry matter, leaf area index, weed dry matter, effective tiller/m², spike length, number of spikelets/spike, number of filled grains/spike, 1000-grain weight, grain yield, straw yield, biological yield and harvest index. Collected weeds were first dried in sun and then kept in electrical oven for 72 hours with 80°C temperature.

Weed control efficiency was calculated with the following formula developed by Sawant and Jadav, 1985:

Weed control efficiency (WCE) = {(DWC-DWT) ÷ DWC} × 100

Where, DWC = Dry weight of weeds in unweeded treatment and DWT = Dry weight of weeds in weed control treatment

Relative weed density was calculated by using the following formula:

RWD = (Density of individual weed species ÷ Total density of all weed species) × 100

Biological yield was calculated by using following formula:

Biological yield= Grain yield + straw yield

Harvest index was calculated by using following formula:

HI (%) = (Grain yield ÷ Biological yield) × 100.

Statistical analysis

Collected data were statistically analyzed using MSTAT-C computer package program and mean differences among treatments were evaluated by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

Results and discussion

Infested weed species in the experimental field

Twenty two weed species belonging to ten families were found to infest the experimental crop. Local name, common name, scientific name, family and morphological type of the weed species have been presented in Table 1. The most important weeds were *Chenopodium album, Cyperus rotundus, Eleusine indica, Cynodon dactylon, Vicia sativa, Heliotropium indicum, Raphanus raphanistrum, Brassica kaber*. Among the twenty two species fifteen were broad leaved, five were grasses and two sedges (Table 1). Hossain *et al.,* (2010) reported that dominant weed species in wheat field were *Eleusine indica, Echinochloa colonum, Cynodon dactylon, Parapholis strigosa, Setaria glauca, Digitaria spp., Chenopodium album, Blumea lacera, Enydra fluctuans etc.* The present result varied a little bit and this might be due to seasonal variation and location.

Relative weed density (%)

Several weed species were found to dominate the field at different dates (Table 2). This may be due to crop-weed competition, weed-weed competition or allelopathic effect of one plant to others. At 75 DAT *Raphanus raphanistrum* (21.4%) and *Lindernia procumbens* (12.5%) were dominant weed species. Relative density of several weed species decreased at later stages (75 DAS) due to their completion of life cycle.

Weed population (Total number of weeds/m²)

Maximum weed population was found from W_0 (108.4/m²) while minimum from W_3 (29.8/m²) (Fig. 1a). From Fig. 1a it was observed that total number of weed was increased with the increases of days and it was continued up to 60 DAS, after that started to reduce. Similar results were also stated by Bhuiyan *et al.,* 2011, Kalhirvelan and Vaiyapuri, 2003, Mahajan *et al.,* 2003, Gnanasambandan and Murthy, 2001 and Islam *et al.,* 2001.

Weed biomass

Minimum weed biomass was found from W_3 (6.5 g/m²) while maximum from W_0 (16.6 g/m²) at 75 DAS (Fig. 1b). From Fig. 1b it was observed that weed biomass was increased with the increases of days and it was continued up to 60 DAS, after that started to reduce. Similar findings were reported by Bhuiyan *et al.* (2010) who reported that pre emergence application of Oxadiargyl 400SC @ 75 g a.i. ha^{-1} had minimum dry weight of weeds which resulted satisfactory weed control than other herbicide and doses. This result is also similar with the findings of

Bhuiyan *et al.,* 2011, Gnanavel and Anbhazhagan, 2010.

Weed control efficiency

Maximum weed control efficiency was found from W_3 (67.3% at 30 DAS and 57.8% DAS) and minimum from W_1 (34.8% at 30 DAS and 27.1% at 60 DAS) over W_0 (Fig. 2). This result was dissimilar with Shultana *et al.* (2011) and Bhuiyan *et al.* (2010) who found that Topstar 80WP (oxadiazon) @ 75 g/ha showed above 80% weed control efficiency. On the other hand, this result was in agreement with the findings of Al-Mamun *et al.* (2011), Bhuiyan *et al.* (2011), Mamun *et al.* (2011), Ali *et al.* (2010), Gnanavel and Anbhazhagan (2010) and Kabir *et al.* (2008).

Table 1. Weed species found in the experimental plots of wheat (BARI Gom 26).

SL.	Local name	Common name	Scientific name	Family	Types
1	Bathua	Lambs quarter	*Chenopodium album*	Chenopodiaceae	Broad Leaf
2	Mutha	Nutgrass	*Cyperus rotundus*	Cyperaceae	Sedge
3	Durba	Bermuda grass	*Cynodon dactylon*	Poaceae	Grass
4	Ban masur	Wild lentil	*Vicia sativa*	Fabaceae	Broad Leaf
5	Chapra	Indian goose grass	*Eleusine indica*	Poacease	Grass
6	Hatishur	Wild clary	*Heliotropium indicum*	Boraginaceae	Broad Leaf
7	Ban mula	Wild raddish	*Raphanus raphanistrum*	Brassicaceae	Broad Leaf
8	Ban sarisha	Wild mustard	*Brassica kaber*	Brassicaceae	Broad Leaf
9	Shetlomi	Common cudweed	*Gnaphalium luteoalbum*	Asteraceae	Broad Leaf
10	Khet papri	Prostate false pimpernel	*Lindernia procumbens*	Scrophulariaceae	Broad Leaf
11	Gira Kata	Nutsedge	*Cyperus michelianus*	Cyperaceae	Sedge
12	Ban morich	Croton plant	*Croton sparsiflorus*	Euphorbiaceae	Broad Leaf
13	Shetodron	Leucas	*Leucas aspera*	Labiatae	Broad Leaf
14	Chanchi	Sessile joyweed	*Alternanthera sessilis*	Amaranthaceae	Broad Leaf
15	Khude shama	Jungle rice	*Echinochloa colonum*	Poaceae	Grass
16	Gaicha	Paspalum grass	*Paspalum comersoni*	Poaceae	Grass
17	Ban cheena	Torpado grass	*Panicum repens*	Poaceae	Grass
18	Malanch	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae	Broad Leaf
19	Kanta begun	Horse nettle	*Solanum carolinense*	Solanaceae	Broad Leaf
20	Foska begun	Foska begun	*Physalis heterophylla*	Solanaceae	Broad Leaf
21	Malanch	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae	Broad Leaf
22	Lazzabati	Sensitive plant	*Mimosa pudica*	Fabaceae	Broad Leaf

Table 2. Relative density (%) of different weed species infested the experimental area.

SL.	Scientific Name	Days after sowing			
		30	45	60	75
1	*Chenopodium album*	8.3	7.7	13.6	8.7
2	*Cyperus rotundus*	8.1	10.1	4.6	5.1
3	*Cynodon dactylon*	21.2	14.7	8.4	9.9
4	*Vicia sativa*	3.3	11.4	9.7	3.1
5	*Eleusine indica*	14.8	7.3	8.4	7.1
6	*Heliotropium indicum*	9.2	5.7	5.4	6.8
7	*Raphanus raphanistrum*	5.0	5.1	9.6	21.4
8	*Brassica kaber*	8.7	5.8	6.6	4.4
9	*Gnaphalium luteoalbum*	1.4	3.8	5.7	3.8
10	*Lindernia procumbens*	2.8	8.1	11.0	12.5
11	*Cyperus michelianus*	3.3	4.7	3.1	3.0
12	*Croton sparsiflorus*	2.7	4.3	2.1	1.7
13	*Physalis heterophylla*	0.8	0.9	0.6	0.9
14	*Alternanthera sessilis*	2.3	1.8	1.5	1.1
15	*Echinochloa colonum*	2.0	1.8	1.7	3.1
16	*Paspalum comersoni*	2.0	2.3	2.4	0.9
17	*Panicum repens*	0.7	0.6	0.7	1.5
18	*Alternanthera philoxeroides*	1.3	0.9	1.1	0.8
19	*Solanum carolinense*	1.0	0.8	0.7	1.7
20	*Mimosa pudica*	0.8	0.5	0.7	0.9

Plant height

Different weed control methods showed non-significant variation for plant height of wheat at different days after sowing. Tallest plant was found from W_1 (84.9 cm) while shortest from W_0 (83.1 cm) at harvest (Fig. 3a). Sultana *et al.* (2012) concluded that the plant height was significantly affected by weeding regime. Similar results were also reported by Acker (2010).

Table 3. Response of wheat on different yield related attributes to different weed control methods[X].

Weed control methods[Y]	Effective tiller /m²		Spike length (cm)		No of spikelets/spike		No. of grain /spike		1000-grain weight (g)	
W_0	162	c	15.1	b	15.8	b	48.2	b	51	a
W_1	173.9	bc	17.1	a	16.4	b	48.9	b	50.5	a
W_2	181.1	ab	16.5	a	18.2	a	52.1	a	49.3	a
W_3	192.3	a	16.6	a	17.4	a	49.7	ab	51.4	a
$LSD_{0.05}$	11.9		0.8		0.9		2.4		4.6	
CV%	8.0		5.9		6.4		5.7		11.0	

[X]In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

[Y]W_0= control (no weeding), W_1= two hand hoe weeding at 20 DAS and 40 DAS, W_2= Topstar 80WP @ 75 g/ha as post-emergence and W_3= Sunrice 150WG @ 100 g/ha as early post-emergence.

Number of tiller

Number of tiller/m² of wheat showed non-significant variation among the weed control methods at different DAS. However, maximum number of tiller was found from W_3 (584.3/m²) while minimum from W_0 (459.8/m²) at harvest (Fig. 3b). These results are dissimilar with the results of Sultana *et al.* (2012).

Table 4. Response of wheat on different yield related attributes to different weed control methods[X].

Weed control methodsY	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		HI (%)	
W0	2.4	d	3.8	d	6.2	d	38.0	b
W1	3.0	c	4.3	c	7.3	c	40.5	a
W2	3.5	b	5.0	b	8.5	b	40.7	a
W3	3.9	a	5.3	a	9.2	a	41.3	a
LSD0.05	0.3		0.3		0.6		2.1	
CV%	11.0		7.7		8.5		6.4	

[X]In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

[Y]W_0= control (no weeding), W_1= two hand hoe weeding at 20 DAS and 40 DAS, W_2= Topstar 80WP @ 75 g/ha as post-emergence and W_3= Sunrice 150WG @ 100 g/ha as early post-emergence.

Plant dry matter

Maximum plant dry matter was found from W_3 (17.1 g/ plant) while minimum from W_0 (13.2 g/plant) at harvest (Fig. 3c). Acker, 2010 concluded that dry matter accumulation of wheat increased by 12-20% than the weedy check. Similar findings also reported by Zahoor *et al.* (2012).

Leaf area index (LAI)

Leaf area index was varied due to the variation of the weed control methods at different DAS. However, maximum LAI was found from W_3 (1.3) while minimum from W_0 (0.9) (Fig. 4a).

Weed dry matter

Minimum weed dry matter was found from W_3 (2.7 g) followed by W_2 (3.1 g) while maximum from W_0 (11.3 g) which was statistically identical with W_1 (11.4 g) at 75 DAS (Fig. 4b).

Effective tillers/m²

Maximum number of effective tillers was found W_3 (253.9/m²) while minimum from W_0 (238.9/m²)

(Table 3). Sultana *et al.* (2012) and Sujoy *et al.* (2006) reported that effective tillers increases in the weeded plots compared to weedy check.

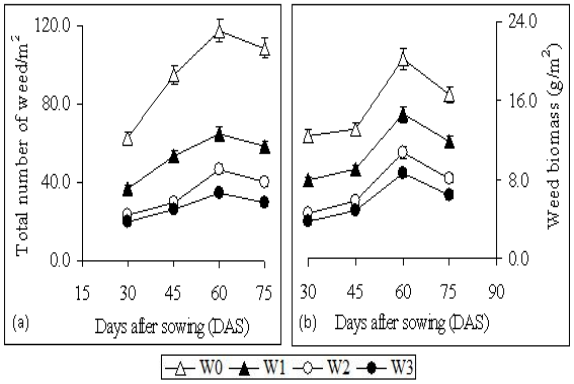

Fig. 1. Response of weed control methods on (a) total number of weed and (b) weed biomass.

Spike length

Longest spike was found from W_1 (17.1 cm) which was statistically identical with W_3 (16.6 cm) and W_2 (16.5 cm) while minimum from W_0 (15.1 cm) (Table 3).

Number of spikelet/spike

Maximum number of spikelets was found from W_2 (18.2/spike) which was statistically identical with W_3 (17.4/spike) while minimum from W_0 (15.8/spike) which was statistically identical with W_1 (16.4/spike) (Table 3).

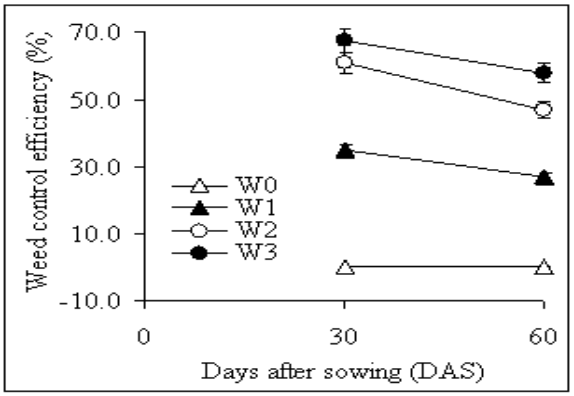

Fig. 2. Response of weed control methods on weed control efficiency.

Number of grain/spike

Maximum number of grains was found from W_2 (52.1/spike) which was statistically identical with W_3 (49.7/spike) while minimum from W_0 (48.2/spike) which was statistically identical with W_1 (48.9/spike) (Table 3). These results are in accordance with Acker (2010) and Sujoy *et al.* (2006).

1000-grain weight

1000-grain weight of wheat was not varied significantly among different weed control methods. Maximum 1000-grain weight was found from W_3 (51.4 g) while minimum from W_2 (49.3 g) (Table 3).

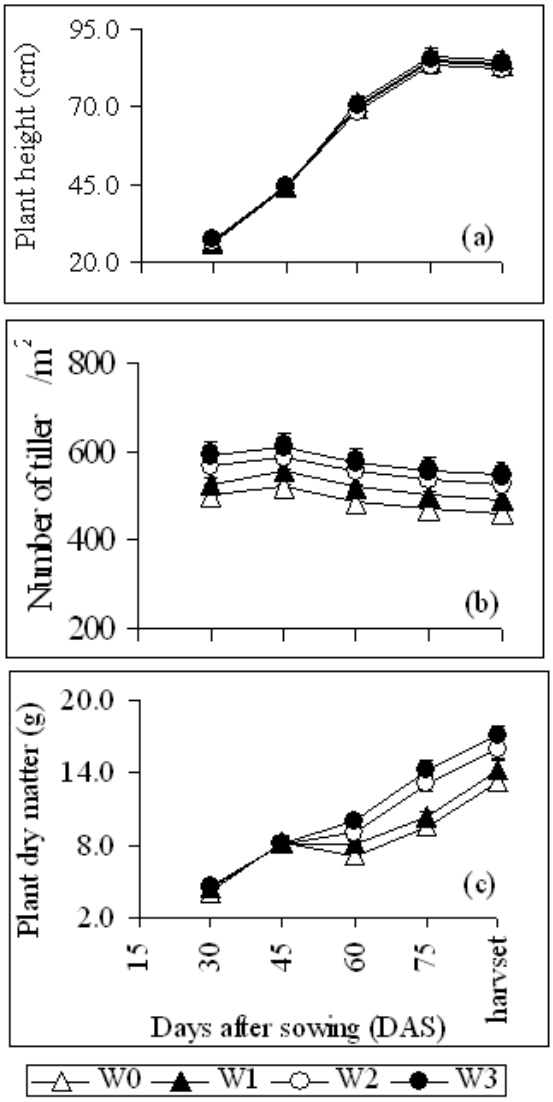

Fig. 3. Response of weed control methods on (a) plant height, (b) number of tiller and (c) plant dry matter.

Grain yield

Maximum grain yield was found from W_3 (3.9 t/ha) whereas minimum from W_0 (2.4 t/ha) (Table 4). Sultana *et al.* (2012) observed that the grain yield of wheat was significantly varied by weeding regime. Nadeem *et al.* (2007) and Sujoy *et al.* (2006) found similar results. It can be seen from the graph that the chemical weed control treatments performed better and produced higher yield. Shah and Habibullah,

(2005) also found similar results.

Straw yield

Maximum straw yield was found from W_3 (5.3 t/ha) while minimum from W_0 (3.8 t/ha) (Table 4). Sultana *et al.* (2012) and Sujoy *et al.* (2006) also observed significant variation of straw yield of wheat due to weed control methods at different crop growth stage.

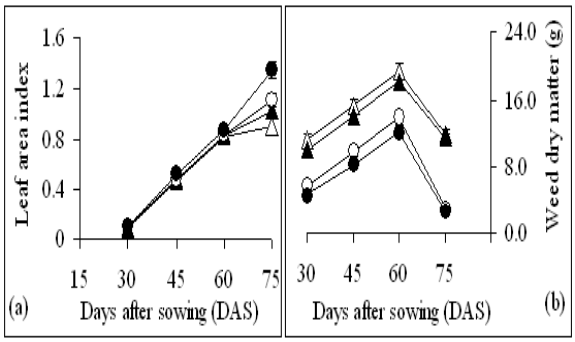

Fig. 4. Response of weed control methods on (a) leaf area index and (b) weed dry matter.

Biological yield

Maximum biological yield was found from W_3 (9.2 t/ha) whereas minimum from W_0 (6.2 t/ha) (Table 4). Zahoor *et al.* (2012) and Sujoy *et al.* (2006) also concluded that weed control methods increased biological yield of wheat reducing the weed infestation.

Harvest index

Maximum harvest index was found from W_3 (41.3%) which was statistically identical with W_2 (40.7%) and W_1 (40.5%) while minimum from W_0 (38.0%) (Table 4). Sujoy *et al.* (2006) found significant variation in harvest index of wheat due to weed control treatments.

Conclusion

Weed control methods played a vital role for the growth and yield of wheat. Among the weed control methods, Sunrice 150WG was found the best for controlling weeds as post emergence. Chemical herbicide Sunrice 150WG @ 100 g/ha applied as early post-emergence will be promising weed control practice for obtaining optimum wheat grain yield.

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