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IMPACT OF INTEGRATED WEED MANAGEMENT ON BULB YIELD OF ONION

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Abstract

The experiment was conducted at Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Magura, Bangladesh during 2016-2017 and 2017-2018 to optimize weed management practice for onion bulb production through Integrated Weed Management (IWM). The experiment was laid out in a Randomized Complete Block Design with three replications. Two different herbicides (Oxadiazon and Pendimethalin) with different doses in combination with hand weeding (HW) were used as treatments. The total number of treatments were 12 *viz.* T_1=Oxadiazon@1.0 l/ha, T_2=Oxadiazon@1.5 l/ha, T_3= Oxadiazon@2.0 l/ha, T_4= Oxadiazon@1.0 l/ha + one HW at 45 DAT (Days After Transplanting), T_5= Oxadiazon@1.5 l/ha + one HW at 45 DAT,T_6= Oxadiazon@2.0 l/ha + one HW at 45 DAT, T_7=Pendimethalin@1.0 l/ha, T_8=Pendimethalin@1.5 l/ha, T_9= Pendimethalin@1.0 l/ha + HW at 45 DAT, T_{10}= Pendimethalin@1.5 l/ha+ HW at 45 DAT, T_{11}= Weed free and T_{12} = Weedy check (control). The onion var. BARI Piaz-1 was used as the test crop. The highest bulb yield (7.63 tha^{-1} in 2016 & 9.56 t ha^{-1}in 2017) and benefit cost ratio (2.14 in 2016 and 2.46 in 2017) were obtained from T_6= Oxadiazon@2.0 l/ha + one hand weeding at 45 DAT while the lowest bulb yield (4.22 t ha^{-1}in 2016 and 6.28 t ha^{-1}in 2017) was obtained from T_{12} = Weedy check (control), while lowest benefit cost ratio (1.33 in 2016 and 1.74 in 2017) from treatment T_{11} =Weed free. It was concluded that Oxadiazon@2.0 l/ha with one hand weeding at 45 days after transplanting performed better for controlling weed and maximizing bulb yield of onion.

Introduction

Onion (*Allium cepa* L.) belongs to the family Alliaceae, a group that includes bulb crops. It is a condiment crop consumed fresh and dry as a spice and one of the most important vegetable crops in the world (Ray and Yadav, 2005). Onion is a very important and major spice crop in Bangladesh. It ranks the first in production among the spices crops cultivated in the country. About 17, 37, 714 matric tones of onion produces from 4, 41, 105 acres of land during 2017-18 (BBS, 2018). Weeds are one of the main plant protection problems in onion fields. They compete with onions for light, nutrients, water, space and also are host plants of several harmful insects and pathogens (Dunan *et al.*, 1996, Kizilkaya *et al.*, 2001, Ghoshel, 2004, Qasem, 2006, Smith *et al.*, 2008). As in many crops, weeds cause yield reduction in onions owing to slow emergence, low initial growth rate, long vegetative period and low competitive ability of the crop (Boyham *et al.,* 2016). Onion is poor competitor against weeds due to their slow, vertical growth that fails to shade out weeds (Kizilkaya *et al.*, 2001). Uncontrolled weed growth caused

49 to 86 percent reduction in bulb yield of onion compared with the best herbicidal treatment (James and Harlen, 2010). Lack of effective and economically viable weed management options for onion production has been reported as a critical constraint affecting farmers' motivation to grow the crop (Waiganjo, 2004). The conventional method of weed control i.e. hand weeding and hoeing are vary laborious, time consuming and expensive. Weedicides applied at the pre-emergence stage, significantly controlled the weed population (Nargis *et al.,* 2006). Panse *et al.* (2014) reported that post–emergence herbicides kill weeds and keep the hardy weeds under control by arresting their growth through various kinds of deformities in foliage and growing points. On the other hand, Patel *et al.* (2012) was found that the application of pre-emergence herbicide followed by one hand weeding was effective for higher yield of onion. For controlling weed, integrated management through cultural, mechanical and herbicidal methods could be more efficient than single methods because onion is a narrow leafed crop and the herbicides which do not herm onion also may not herm the narrow leafed weed. Therefore, the present study was undertaken to optimize weed management practice for onion bulb production through Integrated Weed Management (IWM).

Materials and Methods

The experiment was conducted at Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Magura during the year 2016-2017 and 2017-2018. The land was medium high land and clay loam in texture having pH of7.55. The unit plot size was 3.0 m x 1.5 m. The most popular onion variety BARI Piaz-1 was used with 42 days old seedlings. The crop was transplanted maintaining 15 cm x 10 cm spacing. The experiment was laid out in Randomized Complete Block Design with three replications. Two different herbicides (Oxadiazon and Pendimethalin) with different doses in combination with hand weeding (HW) were used as the treatment variables. The total number of treatments were 12 *viz.* T_1= Oxadiazon@1.0 l/ha, T_2=Oxadiazon@1.5 l/ha, T_3= Oxadiazon@2.0 l/ha, T_4 = Oxadiazon@1.0 l/ha + one HW at 45 DAT (Days After Transplanting), T_5= Oxadiazon@1.5 l/ha + HW at 45 DAT,T_6 = Oxadiazon@2.0 l/ha + HW at 45 DAT, T_7 = Pendimethalin@1.0 l/ha, T_8 = Pendimethalin@1.5 l/ha, T_9 = Pendimethalin@1.0 l/ha + HW at 45 DAT, T_{10} = Pendimethalin@1.5 l/ha + HW at 45 DAT, T_{11} = Weed free and T_{12} = Weedy check (control). The fertilizers were applied in the form of Urea, Triple Super Phosphate (TSP), muriate of potash (MoP), gypsum at the rate of N_{120} P_{54} K_{75} S_{20} kg/ha respectively. Half of N, K and full dose of P and S were applied at the time of final land preparation and remaining N, K was top dressed into two equal splits at 25 and 50 days after transplanting (DAT). Four irrigations at 25 DAT, 45 DAT 70 DAT and 90 DAT were provided. The crop was harvested 110 days after transplanting. Data on plant height (cm), number of leaves per plant, number of weed per m^2, neck diameter (cm), length of bulb (cm), diameter of bulb (cm), individual bulb weight (g) and yield (tha^{-1}) were collected. The Benefit Cost Ratio (BCR) was calculated on the basis of prevailing local market price of onion bulbs and cost of inputs. Data on weed density ($plantm^{-2}$), dry matter weight of weeds (gm^{-2}) were recorded from the standing crop by using quadrat of 1m x 1m. Weed control efficiency (WCE) was calculated by using the following formula used by (Das, 2008).

$$WCE\ (\%) = \frac{DMC - DMT}{DMC} x\ 100$$

Where, DMC was dry matter weight of weeds in control plot and DMT was dry matter of weeds in treated plots. The recorded data on yield and other parameters were statistically analyzed by using Statitix10 software. The difference between the treatments means were judged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Effect on weed

Different weed species were found in experimental plots. Among them, the prominent weed species were *Cyperus rotundas, Chenopodium album, Cynodon dactylon, Amaranthus viridis, Amaranthus spinosus, Physalis heterophylla, Echinochloa crusgalli etc.* Similar types of weed species were also reported in onion field (Karim *et al.*, 2014, Naresh *et al.,* 2002, Panse *et al.,* 2014 and Syed and Malik, 2001). It was found that the weed density, dry weight of weed and weed control efficiency were varied significantly among the different treatment combinations (Table 1). The highest weed density (506.67 no. m^{-2} in 2016-17 and 596.67 no. m^{-2} in 2017-18), dry weight of weed (280.44 g m^{-2} in 2016-17 and 307.29 g m^{-2} in 2017-18) and minimum weed control efficiency (0%) was found in weedy check (control) plot. Because under this treatment no weeding was done and the plot was allowed to grow weed naturally. In this situation the weed covered the whole plot prior to the onion seedlings establishment and started to take soil nutrients and natural resources such as soil moisture, sunlight etc. The lowest weed density (0 no. m^{-2}), dry weight of weed (0 g m^{-2}) and maximum weed control efficiency (100%) was found in weed free plot. Because under this treatment weeding was done immediately the weeds appear on the plot as a result there was no competition between crop and weed for soil nutrient and natural resources. Among the herbicidal treatments lowest weed density (26.67 no. m^{-2} in 2016-17 and 26 no. m^{-2} in 2017-18), lowest dry weight of weed (35.67 g m^{-2} in 2016-17 and 36.46 g m^{-2} in 2017-18) and maximum weed control efficiency (87.27% in 2016-17 and 88.11% in 2017-18) was found from the application of Oxadiazon@2.0 l/ha with one hand weeding at 45 days after transplanting. That means Oxadiazon performed better than Pendimethalin in onion field for controlling weed. Similar results were also reported by Uygur *et al.* (2010).

Table 1.Effect of different weed management treatment on weed

Treatments	Weed density (plant m^{-2})		Dry weight of weed (g m^{-2})		Weed control efficiency (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1- Oxadiazon@1.0 l/ha	66.00 bc	54.00 bcd	85.45b	76.66bcd	69.53f	75.12f
T_2- Oxadiazon@1.5 l/ha	59.00 bcd	45.00 cd	77.07c	77.76bc	72.50e	74.68f
T_3- Oxadiazon@2.0 l/ha	54.00 cde	45.00 cd	70.49d	68.53d	74.85d	77.68d
T_4 - Oxadiazon@1.0 l/ha + HW at 45 DAT	47.00 de	51.00 cd	63.44ef	74.63bcd	77.37c	75.71ef
T_5- Oxadiazon@1.5 l/ha + HW at 45 DAT	43.00 e	37.00 cde	70.37d	55.15e	74.90d	82.04c
T_6 - Oxadiazon@2.0 l/ha + HW at 45 DAT	26.67 f	26.00 de	35.67g	36.46f	87.27b	88.11b
T_7 - Pendimethalin@1.0 l/ha	68.00 b	92.00 b	77.44c	54.84e	72.34e	82.13c
T_8 - Pendimethalin@1.5 l/ha	64.00 bc	64.00bcd	84.51b	80.06b	69.88f	73.92f
T_9- Pendimethalin@1.0 l/ha + HW at 45 DAT	50.67de	74.00 bc	68.54de	74.45bcd	75.56d	75.76ef
T_{10} - Pendimethalin@1.5 l/ha + HW at-45 DAT	56.00 bcd	52.00 cd	60.21f	70.63cd	78.51c	76.99de
T_{11} - Weed free	0 g	0 e	0 h	0 g	100a	100a
T_{12}-Weedy check (control)	506.67a	596.67a	280.44a	307.29a	0.00 g	0.00 g
Level of significance	**	*	**	**	**	**
CV (%)	8.23	24.81	4.47	6.47	1.29	1.49

In a column, means followed by the same letter did not differ significantly by DMRT.
HW= Hand Weeding, DAT =Days after transplanting,
* = 5% level of significance and ** = 1% level of significance.

Effect on growth parameters

Growth characters of onion as influenced by different treatments revealed significant variations (Table 2). The longest plant (52.27 cm in 2016 and 52.36 cm in 2017), higher number of leaves per plant (6.87 in 2016 and 7.47 in 2017) and higher neck diameter (0.94cm in 2016 and 1.27cm in 2017) were recorded from the application of Oxadiazon@ 2.0 l/ha with one hand weeding at 45 days after transplanting. The shortest plant (45.00 cm in 2016 and 46.63cm in 2017), lower number of leaves per plant (5.07 in 2016 and 6.3 in 2017) and lowest neck diameter (0.68 cm in 2016 and 0.97cm in 2017) was recorded from weedy check (control) treatment. Because due to lacking of optimum environment under weedy condition all the growth parameters reduced and the crop has to survive competing with weeds. Similar results were reported by Uygur *et al.* (2010).

Table 2. Effect of different weed management treatments on growth parameters of onion

Treatments	Plant height (cm)		No. of leaves plant^{-1}		Neck diameter (cm)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1- Oxadiazon@1.0 l/ha	49.40 abc	48.58e	6.47 a	6.50f	0.89 a	1.00de
T_2- Oxadiazon@1.5 l/ha	50.20 abc	49.63d	6.27 a	6.63de	0.89 a	1.09bc
T_3- Oxadiazon@2.0 l/ha	50.07 abc	50.80c	5.60 ab	6.73d	0.79 ab	1.13b
T_4 - Oxadiazon@1.0 l/ha + HW at 45 DAT	51.40 a	50.62c	6.40 a	7.17b	0.90 a	1.23a
T_5- Oxadiazon@1.5 l/ha + HW at 45 DAT	49.60 abc	51.57b	6.60 a	7.27b	0.78 ab	1.27a
T_6 - Oxadiazon@2.0 l/ha + HW at 45 DAT	52.27 c	52.36a	6.87 a	7.47a	0.94 a	1.27a
T_7 - Pendimethalin@1.0 l/ha	48.13 c	48.60e	5.80 ab	6.60ef	0.74 ab	1.02cde
T_8 - Pendimethalin@1.5 l/ha	48.47 bc	48.69e	6.40 a	6.67de	0.81 ab	1.07cde
T_9- Pendimethalin@1.0 l/ha + HW at 45 DAT	51.20 ab	50.57c	6.40 a	7.03c	0.79 ab	1.09bc
T_{10} - Pendimethalin@1.5 l/ha + HW at- 45 DAT	50.80 abc	51.26b	6.07 ab	7.20b	0.86 ab	1.13b
T_{11} - Weed free	48.20 c	49.47d	6.47 a	6.70 de	0.82 ab	1.11b
T_{12}-Weedy check (control)	45.00 d	46.63f	5.07 b	6.30 g	0.68 b	0.97e
Level of significance	**	**	*	**	**	**
CV (%)	3.52	2.65	10.12	8.64	9.26	13.46

In a column, means followed by the same letter did not differ significantly by DMRT.
HW= Hand Weeding, DAT =Days after transplanting,
* = 5% level of significance and ** = 1% level of significance.

Effect on yield parameters

The yield and yield contributing characters were varied significantly among the different treatment combinations (Table 3). The biggest bulb diameter (3.54 cm in 2016 and 4.7 cm in 2017), longest bulb (3.51cm in 2016 and 4.67cm in 2017), heaviest individual bulb (13.20 g in 2016 and 29.72 g in 2017) and highest bulb yield (7.63 tha^{-1} in 2016 and 9.56 t ha^{-1} in 2017) was recorded from the application of Oxadiazon@2.0 l/ha with one hand weeding at 45 days after transplanting. This is due to the effectiveness of Oxadiazon for controlling weed as well as proper timing of hand weeding. So, that the crop gets minimum crop weed competition and

optimum growing environment. Similar results were recorded from Patel *et al.* (2012) and Uygur *et al.* (2010).The smallest bulb diameter (2.44 cm in 2016 and 2.88 cm in 2017), shortest bulb (3.09 cm in 2016 and 2.96 cm in 2017), lightest individual bulb (8.34g in 2016 and 19.01 g in 2017) and lowest bulb yield (4.22 t ha^{-1} in 2016 and 6.28 t ha^{-1} in 2017) were recorded from weedy check (control) treatment. Because, under weedy condition the growth parameters of onion such as height and number of leaves were reduced ultimately this lowers the accumulation of photosynthates on the bulb. Similar results on variation of onion yield due to different time of planting were also reported by Devulkar *et al.* (2015) and Misra *et al.* (2014). During the year 2017-2018, the bulb yield of onion was higher than the year 2016-2017, this was because of timely showing and transplanting of onion.

Table 3. Effect of different weed management treatments on bulb yield and yield contributing characters of onion

Treatments	Bulb diameter (cm)		Bulb length (cm)		Single bulb weight (g)		Bulb yield (t ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1- Oxadiazon@1.0 l/ha	3.10 ab	3.80ef	3.38 ab	3.93f	10.67 ab	28.66k	6.85abc	7.72ef
T_2- Oxadiazon@1.5 l/ha	3.11 ab	3.94d	3.40 ab	4.01e	11.23abc	30.43i	6.96abc	8.06de
T_3- Oxadiazon@2.0 l/ha	3.17 ab	4.14c	3.52 ab	4.18d	11.58 ab	34.73e	7.00abc	8.09d
T_4 - Oxadiazon@1.0 l/ha + HW at 45 DAT	3.27 ab	4.35b	3.61 a	4.33c	11.56 ab	38.45c	6.98abc	8.56bc
T_5- Oxadiazon@1.5 l/ha + HW at 45 DAT	3.08 ab	4.37b	3.58 a	4.55b	11.89abc	42.86b	7.04abc	8.89b
T_6 - Oxadiazon@2.0 l/ha + HW at 45 DAT	3.54 ab	4.75a	3.65 ab	4.67a	13.20abc	44.58a	7.63 a	9.56a
T_7 - Pendimethalin@1.0 l/ha	3.10 ab	3.75f	3.41 ab	3.84g	10.48 bc	29.72j	6.29 bc	7.55f
T_8 - Pendimethalin@1.5 l/ha	3.41 a	3.87de	3.42 ab	3.97ef	9.49 abc	31.61h	6.51 bc	7.67f
T_9- Pendimethalin@1.0 l/ha + HW at 45 DAT	3.12 ab	4.18c	3.74 a	4.15d	13.27 a	33.06g	7.29 ab	8.22cd
T_{10} - Pendimethalin@1.5 l/ha + HW at-45 DAT	3.19 ab	4.35b	3.51 ab	4.13d	12.24 ab	37.66d	6.92abc	8.57bc
T_{11} - Weed free	2.85 bc	3.82ef	3.54 ab	3.76h	10.60 c	33.63f	6.07 c	7.44f
T_{12}-Weedy check (control)	2.44 c	2.87g	3.09 b	2.95i	8.34 d	19.01l	4.22 d	6.28g
Level of significance	**	**	*	**	**	**	**	**
CV (%)	9.25	7.34	8.05	5.64	12.42	9.34	9.39	7.58

In a column, means followed by the same letter did not differ significantly by DMRT Test.
HW= Hand Weeding, DAT =Days after transplanting,
* = 5% level of significance and ** = 1% level of significance.

Cost benefit analysis

The economic performance of onion as influenced by different weed management practices are presented in the Table 4. The highest gross return as well as Benefit Cost Ratio (2.14 in 2016 and 2.46 in 2016) was found from the treatment T_6 (Oxadiazon@2.0 l/ha + Hand at 45 DAT) and the lowest Benefit Cost Ratio(1.33 in 2016 and 1.74 in 2017) from treatment T_{11} (weed free). This is because hand weeding is very laborious than spraying of herbicides also expensive and time consuming. Similar results also reported by Panse *et al.* (2014).

Table 4. Economic performance of onion as influenced by different treatments

Treatments	Total cultivation cost(Tk. ha^{-1})		Gross return (Tk. ha^{-1})		BCR	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1- Oxadiazon@1.0 l/ha	115000	115000	239750	270200	2.08	2.35
T_2- Oxadiazon@1.5 l/ha	118000	118000	243600	282100	2.06	2.39
T_3- Oxadiazon@2.0 l/ha	121000	121000	245000	283150	2.02	2.34
T_4 - Oxadiazon@1.0 l/ha + HW at 45 DAT	125000	131000	244300	299600	1.95	2.29
T_5- Oxadiazon@1.5 l/ha + HW at 45 DAT	126000	134000	246400	311150	1.96	2.32
T_6 - Oxadiazon@2.0 l/ha + HW at 45 DAT	125000	136000	267050	334600	2.14	2.46
T_7 – Pendimethalin@1.0 l/ha	127000	128000	220150	264250	1.73	2.06
T_8 - Pendimethalin@1.5 l/ha	130000	130000	227850	268450	1.75	2.07
T_9- Pendimethalin@1.0 l/ha + HW at 45 DAT	133000	133000	255150	287700	1.92	2.16
T_{10} - Pendimethalin@1.5 l/ha + HW at- 45 DAT	135000	135000	242200	299950	1.79	2.22
T_{11} - Weed free	160000	150000	212450	260400	1.33	1.74
T_{12}-Weedy check (control)	110000	125000	147700	219800	1.34	1.76

Urea-Tk. 16/kg, TSP-Tk. 15kg^{-1}, MoP-Tk.15 kg^{-1}, Gypsum- Tk. 10 kg^{-1}, Zinc sulphate –Tk.100 kg^{-1}, Boric acid-Tk. 100 kg^{-1}, Labour- Tk. 400man^{-1}day^{-1}, Irrigation- 3000ha^{-1} irrigation^{-1}, Leas value- Tk. 25000ha^{-1} for 5 months, Seed-1500 kg^{-1}, Sale price-Tk. 30 kg^{-1} bulb in 2016 and Tk. 35 kg^{-1} bulb in 2017 .

Conclusion

Application of pre-emergence herbicide Oxadiazon@2.0 l/ha with one hand weeding at 45 days after transplanting showed highest weed control efficiency, benefit cost ratio and increased bulb yield of onion.

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