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DETERMINATION OF DIFFERENT DOSES OF HERBICIDE (CLIO) TO CONTROL WEEDS IN MAIZE FIELD

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Abstract

Various weed management practices including physical, mechanical, biological and chemical methods are commonly applied by the farmers. Of all possible weed control practices, use of chemicals (herbicides) stands first and a large number of herbicide groups having different mode of actions are commonly used. However, considering the effectiveness and safe use with eco-toxicological aspect, it is important to finalize the optimum dose before application to the farmer's fields. An experiment was conducted at the research field of Agronomy Division, Joydebpur, Gazipur during the *Kharif*-1 season of 2017 and *Rabi* 2017-2018 to find out the optimum rate of herbicide (CLIO) to control weeds in maize field for getting higher yield. Six treatments viz., i) CLIO @35 mL ha^{-1}, ii) CLIO @55 mL ha^{-1}, iii) CLIO @75 mL ha^{-1}, iv) CLIO @95 mL ha^{-1}, v) CLIO @115 mL ha^{-1} and vi) control were tested on maize (cv. BARI Hybrid maize-9). Herbicides were sprayed at 10 Days After Sowing (DAS) according to treatments. Weed samples were taken at 25 and 45 DAS. Major weeds flora were Bathua (*Chenopodium album*), Durba (*Cynadon dactylon*), Anguli (*Digitaria sanguinalis*), Helencha (*Jussica repens*), Hatishur (*Heliotropium indicum*), Shama (*Echinochloa crusgalli*), Bangchora, Swetlomy (*Gnaphalium japonicum*), Mutha (*Cyperus rotundus*), Shaknote (*Amaranthus viridis*), Gaicha (*Paspalum commersonii*), Chapra (*Eleusine indica*), Bon Masur (*Vicia* sp.). Weed dry matter weight significantly varied in different treatments. Weed relative density were highest in no weeding in both *Kharif*-I, 2017 and *Rabi* 2017-18. The highest dry weight of weeds at 25 DAS (14.15 g m^{-2}) and (15.16 g m^{-2}) and at 45 DAS (44.31 g m^{-2}) and (48.37 g m^{-2}), respectively in *Kharif*-1, 2017 and *Rabi* 2017-18 were found in control plot whereas the lowest in spraying of CLIO @115 gm m^{-2} both at 25 and 45 DAS. The maximum weed control efficiency (WCE) over control both at 25 DAS (84.95% in *Kharif*-, 2017 and 89.95% in *Rabi* 2017-18) and at 45 DAS (80.48% in *Kharif*-I, 2017 and 89.45% in *Rabi* 2017-18), respectively in spraying of CLIO @115 mL ha^{-1}. The maximum grain yield both in *Kharif*-I, 2017(9.77 t ha^{-1}) and *Rabi* 2017-18 (9.51 t ha^{-1}) was found in spraying of CLIO @115 mL ha^{-1} which was statistically identical with spraying of CLIO @75 mL ha^{-1} and 95.00 mL ha^{-1} and lowest in no weeding. The highest marginal benefit–cost ratio (MBCR) both in *Kharif*-1, 2017 (2.28) and *Rabi* 2017-18 (2.41) was observed in spraying of CLIO @95 mL ha^{-1} and lowest in no weeding. Results revealed that application of CLIO @ 95 mL ha^{-1} at 10 DAS of maize is economical viable, and it needs further trial to investigate eco-toxicological consequences to environment and living organisms after application.

Introduction

Maize is an important cereal crop in Bangladesh. It ranks 3rd after rice and wheat. Its demand and production area is increasing day by day. It is used as feed for poultry, fodder for livestock and also used as various food items. Hybrid maize is a high yield potential cereal crop (Jahan, 2014). Its yield potential varies depending on variety, season and management practices. Among management options, weeding is the most critical one. Weed infestation reduces crop yield every year. Weeds cause around 33% of total crop loss in Asia and other countries (Oerke, 2006., Kobir *et al.*, 2019, Paul *et al.*, 2019., Kobir *et al.*, 2021., Paul *et al.,* 2022., Paul *et al.,* 2024b). On an average 37.3% of crop produce is damaged by weeds in Bangladesh. Various weed management practices including physical, mechanical, biological and chemical methods are commonly applied by the farmers. Of all possible weed control practices, use of chemicals (herbicides) stands first and a large number of herbicide groups having different mode of actions are commonly used. However, considering the effectiveness and safe use with eco-toxicological aspect, it is important to finalise the optimum dose before application to the farmer's fields. In Bangladesh different chemicals were used to control weeds (Hajong *et al.*, 2015, Mondal *et al.,* 2015, Hajong *et al.,* 2016, Khan *et al.,* 2016, Haque, 2017). These chemicals are very much costly and have residual effects (Ahmed *et al.,* 2016, Paul and Naidu, 2022, Paul *et al.*, 2024a,). This is also harmful for the environment and health of human beings. The indiscriminant use of herbicide destroys soil health (Paul *et al.,* 2023, Paul *et al.,* 2024a, Paul *et al.,* 2024b). Literature revealed that CLIO is effective at lower dose in controlling weeds in maize field. It is a post emergence herbicide which contains a new active ingredient namely Topramezone, a new subclass of the Hallucinogen Persisting Perception Disorder (HPPD)-inhibiting herbicide. As a result, the possibility of adverse effect of this herbicide is lower than other herbicides. Hence, the experiment was conducted to determine the optimum dose of herbicide (CLIO) to control weeds in maize field.

Materials and Methods

An experiment was conducted at the research field of Agronomy Division, Joydebpur, Gazipur during the *Kharif*-1 season of 2017 and *Rabi* 2017-2018 to find out the optimum rate of herbicide (CLIO) to control weeds in maize field for getting higher yield. The land was medium high and the soil was clay loam in texture. Six treatments viz., i) CLIO @35 mL ha^{-1}, ii) CLIO @55 mL ha^{-1}, iii) CLIO @75 mL ha^{-1}, iv) CLIO @95 mL ha^{-1}, v) CLIO @115 mL ha^{-1}, vi) no weeding were tested in this study. The unit plot size was 3m × 4m. Hybrid maize (var. BARI Hybrid maize-9) was shown on 03 April 2017 (for *Kharif*-1 season of 2017) and 17 November (for *Rabi* 2017-2018) with 60 × 20 cm spacing. Maize was fertilized with 190-90-75-80-7 kg ha^{-1} of N, P, K, S, Zn (FRG, 2012) as urea, triple superphosphate (TSP), muriate of potash (MOP), gypsum and zinc sulphate. One third of N, whole amount of TSP, MOP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3 N was top dressed at 25 and 45 (days After Sowing) DAS. Three irrigations were given to the crop at 21, 45 and 60 DAS. Herbicides were sprayed with a knapsack sprayer at 10 DAS. All other operations were done as and when required. Weed samples were collected at 25 and 45 DAS. Data on yield components were taken from 10 plants and grain yield was taken from whole plot. Collected data were analyzed statistically using MSTAT-C program.

The Relative Density (RD) and weed control Efficiency (WCE) were calculated by the following formula.

$$\text{Relative Density (RD)} = \frac{\text{No. of specific weed species}}{\text{Total no. of weeds}} \times 100$$

$$\text{Weed Control Efficiency (WCE)} = \frac{\text{Dry wt. of control plot -Dry wt. of specific plot}}{\text{Dry wt. of control plot}} \times 100$$

Results and Discussion

The results revealed that CLIO has better weed control efficacy in maize field fields. It contains a new active ingredient namely Topramezone, a new subclass of the HPPD-inhibiting herbicide. As a result, the possibility of adverse effect of this herbicide is lower than other herbicides. Major weeds flora in the experiment was Bathua *(Chenopdium album),* Durba (*Cyradon dactylon),* Anguli *(Digitaria sanguinalis),* Helencha *(Jussica repens),* Hatishur (*Heliotropium indicum),* Shama (*Echinochola crusgalli),* Bangchora, Swetlomy (*Gnaphlium japonicum),* Mutha (*Cyperus rotundus)*, Shaknote (*Amaranthus viridis),* Gaicha (*Paspalum commersonii),* Chapra (*Elusine indica), and* Bon Masur (*Vicia sp.).* Weed relative density were highest in no weeding condition in both *Kharif*-1, 2017 and *Rabi* 2017-18 (Table 1).

Table 1. Weed infestation in maize field at 30 and 60 days after seedling (DAS)

Treatments	Weeds species		Number of weeds m^{-2}				Relative Density (%)			
			25 DAS		45 DAS		25 DAS		45 DAS	
	Local name	Scientific name	*Kharif* 2017	*Rabi* 2017-18	*Kharif* 2017	*Rabi* 2017-18	*Kharif* 2017	*Rabi* 2017-18	*Kharif* 2017	*Rabi* 2017-18
CLIO @35 mL ha^{-1}	Bathua	*Chenopodium album*	2	5	6	2	2.74	12.50	5.79	4.90
	Durba	*Cynadon dactylon*	14	11	17	5	19.18	2.78	16.35	5.89
	Anguli	*Digitaria sanguinalis*	3	0	6	0	4.11	4.17	5.79	9.80
	Helencha	*Jussica repens*	3	4	7	6	4.11	16.67	6.73	5.89
	Hatishur	*Heliotropium indicum*	1	2	3	2	1.37	4.17	2.88	3.90
	Shama	*Echinochloa crusgalli*	25	11	32	10	34.25	12.50	30.74	28.43
	Bangchora		3	2	4	4	4.11	2.78	3.84	9.80
	Swelomy	*Gnaphalium japonicum*	0	1	1	-	0	-	0.96	0
	Mutha	*Cyperus rotundus*	3	3	7	2	4.11	19.44	6.73	7.85
	Shaknote	*Amaranthus viridis*	1	2	2	3	1.37	9.72	1.92	5.89
	Gaicha	*Paspalum commersonii*	2	4	1	-	2.74	4.17	0.96	0
	Chapra	*Eleusine indica*	16	8	18	8	21.91	5.55	17.31	11.76
	Bon Masur	*Vicia sp.*	-	7	-	1	-	5.55	-	5.89
		Total	73	84	104	93	100	100	100	100
CLIO @55 mL ha^{-1}	Bathua	*C. album*	5	5	9	5	10.64	5.45	12.50	2.74
	Durba	*C. dactylon*	1	1	2	6	2.13	6.36	2.78	19.18
	Anguli	*Digitaria sanguinalis*	0	0	3	10	0	14.55	4.17	4.11
	Helencha	*Jussica repens*	6	6	12	6	12.76	7.28	16.67	4.11
	Hatishur	*Heliotropium indicum*	0	0	3	4	0	6.36	4.17	1.37
	Shama	*Echinochloa crusgalli*	12	12	9	29	25.53	22.73	12.50	34.25
	Bangchora		0	0	2	10	0		2.78	4.11
	Swetlomy	*Gnaphalium japonicum*	-	-	-	0	-	1.81	-	0
	Mutha	*Cyperus rotundus*	11	11	14	8	23.41	10.91	19.44	4.11
	Shaknote	*Amaranthus viridis*	3	3	7	6	6.38	7.28	9.72	1.37
	Gaicha	*Paspalum commersonii*	1	1	3	0	2.13	0.91	4.17	2.74
	Chapra	*Eleusine indica*	6	6	4	12	12.76	10	5.55	21.91
	Bon Masur	*Vicia sp.*	2	2	4	6	4.26	6.36	5.55	-

		Total	47	47	72	87	100	100	100	100
CLIO @75 mL ha^{-1}	Bathua	*Chenopodium album*	2	2	2	5	4.65	4.90	3.92	4.90
	Durba	*Cynadon dactylon*	5	5	6	1	11.65	5.89	11.76	5.89
	Anguli	*Digitaria sanguinalis*	0	0	0	0	0	9.80	0	9.80
	Helencha	*Jussica repens*	6	6	8	6	13.95	5.89	15.68	5.89
	Hatishur	*Heliotropium indicum*	2	2	3	0	4.65	3.90	5.89	3.90
	Shama	*Echinochloa crusgalli*	10	10	8	12	23.25	28.43	15.68	28.43
	Bangchora		4	4	7	0	9.30	9.80	13.72	9.80
	Swetlomy	*Gnaphalium japonicum*	-	-	-	-	-	0	-	0
	Mutha	*Cyperus rotundus*	2	2	3	11	4.65	7.85	5.89	7.85
	Shaknote	*Amaranthus viridis*	3	3	3	3	6.98	5.89	5.89	5.89
	Gaicha	*Paspalum commersonii*	-	-	-	1	-	0	-	0
	Chapra	*Eleusine indica*	8	8	8	6	18.60	11.76	15.68	11.76
	Bon Masur	*Vicia sp.*	1	1	3	2	2.32	5.89	5.89	5.89
		Total	43	43	51	94	100	100	100	100
CLIO @95 mL ha^{-1}	Bathua	*Chenopodium album*	1	1	2	5	4.55	2.74	6.90	4.90
	Durba	*Cyradon dactylon*	1	1	3	1	4.55	19.18	10.34	5.89
	Anguli	*Digitaria sanguinalis*	-	-	-	0	-	4.11	-	9.80
	Helencha	*Jussica repens*	5	5	3	6	22.72	4.11	10.34	5.89
	Hatishur	*Heliotropium indicum*	-	-	2	0	-	1.37	6.90	3.90
	Shama	*Echinochloa crusgalli*	3	3	5	12	13.63	34.25	17.24	28.43
	Bangchora		1	1	-	0	4.55	4.11	-	9.80
	Swetlomy	*Gnaphalium japonicum*	-	-	2	-	-	0	6.90	0
	Mutha	*Cyperus rotundus*	6	6	5	11	27.27	4.11	17.24	7.85
	Shaknote	*Amaranthus viridis*	4	4	-	3	18.18	1.37	-	5.89
	Gaicha	*Paspalum commersonii*	-	-	-	1	-	2.74	-	0
	Chapra	*Eleusine indica*	-	-	5	6	-	21.91	17.24	11.76
	Bon Masur	*Vicia sp.*	1	1	2	2	4.55	-	6.90	5.89
		Total	22	22	29	101	100	100	100	100
CLIO @115 mL ha^{-1}	Bathua	*Chenopodium album*	-	-	3	2	-	4.90	10.00	2.74
	Durba	*Cynadon dactylon*	-	-	2	5	-	5.89	6.67	19.18
	Anguli	*Digitaria sanguinalis*	1	1	1	0	4.54	9.80	3.33	4.11
	Helencha	*Jussica repens*	11	11	8	6	50.00	5.89	26.66	4.11
	Hatishur	*Heliotropium indicum*	1	1	2	2	4.54	3.90	6.67	1.37
	Shama	*Echinochloa crusgalli*	-	-	-	10	-	28.43	-	34.25

	Bangchora		4	4	3	4	18.19	9.80	10.00	4.11
	Swetlomy	*Gnaphalium japonicum*	1	1	2	-	4.54	0	6.67	0
	Mutha	*Cyperus rotundus*	-	-	3	2	-	7.85	10.00	4.11
	Shaknote	*Amaranthus viridis*	4	4	-	3	18.19	5.89	-	1.37
	Gaicha	*Paspalum commersonii*	-	-	-	-	-	0	-	2.74
	Chapra	*Eleusine indica*	-	-	6	8	-	11.76	20.00	21.91
	Bon Masur	*Vicia sp.*	-	-	-	1	-	5.89	-	-
		Total	22	22	30	64	100	100	100	100
No weeding	Bathua	*Chenopodium album*	5	5	16	2	4.90	12.50	5.45	4.90
	Durba	*Cyradon dactylon*	6	6	7	5	5.89	2.78	6.36	5.89
	Anguli	*Digitaria sanguinalis*	10	10	16	0	9.80	4.17	14.55	9.80
	Helencha	*Jussica repens*	6	6	8	6	5.89	16.67	7.28	5.89
	Hatishur	*Heliotropium indicum*	4	4	7	2	3.90	4.17	6.36	3.90
	Shama	*Echinochloa crusgalli*	29	29	25	10	28.43	12.50	22.73	28.43
	Bangchora		10	10	-	4	9.80	2.78		9.80
	Swetlomy	*Gnaphalium japonicum*	0	0	4	-	0	-	1.81	0
	Mutha	*Cyperus rotundus*	8	8	12	2	7.85	19.44	10.91	7.85
	Shaknote	*Amaranthus viridis*	6	6	8	3	5.89	9.72	7.28	5.89
	Gaicha	*Paspalum commersonii*	0	0	1	-	0	4.17	0.91	0
	Chapra	*Eleusine indica*	12	12	13	8	11.76	5.55	10	11.76
	Bon Masur	*Vicia sp.*	6	6	7	1	5.89	5.55	6.36	5.89
		Total	102	102	124	122	100	100	100	100

Weed dry matter weight was significantly varied in different treatments. The highest dry weight of weeds at 25 DAS (14.15 g m^{-2}) and (15.16 gm m^{-2}) and at 45 DAS (44.31 g m^{-2}) and (48.37 gm m^{-2}), respectively in *Kharif*-1, 2017 and *Rabi* 2017-18 were found in control plot whereas the lowest in spraying of CLIO @115 mL ha^{-1} both at 25 and 45 DAS (Table 2).

Table 2. Dry weight of weeds and weed control efficiency in maize field at 25 DAS and 45 DAS as affected by different doses of CLIO

Treatments	At 25 DAS				At 45 DAS			
	Weed dry Weight (gm m^{-2})		Weed control Efficiency (%)		Weed dry weight (gm m^{-2})		Weed control Efficiency (%)	
	Kharif-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18
T1	7.75	8.76	45.22	55.24	19.95	23.94	54.98	57.92
T2	4.10	5.11	71.02	81.02	16.56	18.50	62.67	68.62
T3	3.15	4.16	77.73	75.73	11.56	13.44	74.16	77.17
T4	2.20	3.21	84.45	89.47	8.85	8.84	80.03	88.14
T5	2.13	3.14	84.95	89.95	8.65	8.58	80.48	89.45
T6	14.15	15.16	-	-	44.31	48.37	-	-

T_1= CLIO @35 mL ha^{-1}, T_2=CLIO @55 mL ha^{-1}, T_3= CLIO @75 mL ha^{-1}, T_4= CLIO @95 mL ha^{-1}, T_5= CLIO @115 mL ha^{-1}, T_6= No weeding

The results corroborate with previous investigation (Mondal *et al.*, 2015, Paul *et al.*, 2015a, Paul *et al.*, 2015c, Paul *et al.*, 2017). The maximum WCE over control both at 25 DAS (84.95% in *Kharif*-1, 2017 and 89.95% in *Rabi* 2017-18) and at 45 DAS (80.48% in *Kharif*-1, 2017 and 89.45% in *Rabi* 2017-18) respectively in spraying of CLIO @115 mL ha^{-1} (Table 2). The maximum grain yield both in *Kharif*-1, 2017(9.77 t ha^{-1}) and *Rabi* 2017-18(9.51 t ha^{-1}) was found in spraying of CLIO @115 mL ha^{-1} which was statistically identical with spraying of CLIO @ 75 mL ha^{-1} and 95 mL ha^{-1} and lowest in no weeding (Table 3).

Table 3. Yield and yield contributing characters of maize as affected by different weed management methods

Treatments	Plant height (cm)		Cob length (cm)		Cob diameter (cm)		1000-grains weight (gm)		Grain yield (t ha^{-1})	
	Kharif-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18
T_1	236.3	248.7	21.13	25.12	4.58	4.67	391.8	387.5	8.35	8.52
T_2	219.4	248.4	20.20	18.34	4.87	4.75	295.5	312.1	8.45	8.77
T_3	224.2	226.3	17.86	21.44	5.46	5.57	292.6	324.7	8.62	8.24
T_4	248.4	236.8	21.43	22.12	4.47	4.82	397.7	392.8	9.56	9.44
T_5	212.3	224.2	18.33	20.21	4.85	4.79	324.1	295.5	9.77	9.51
T_6	226.3	235.4	17.67	21.13	5.11	5.44	312.1	292.7	4.25	4.37
CV (%)	14.56	13.45	14.44	8.59	32.72	21.35	13.76	13.92	12.98	16.22
$LSD_{(0.05)}$	3.76	4.22	3.97	3.97	2.95	4.21	4.57	4.25	2.97	3.11

T_1= CLIO @35 mL ha^{-1}, T_2=CLIO @55 mL ha^{-1}, T_3= CLIO @75 mL ha^{-1}, T_4= CLIO @95 mL ha^{-1}, T_5= CLIO @115 mL ha^{-1}, T_6= No weeding

The maximum benefit–cost ratio (MBCR) in *Kharif*-1, 2017 (2.28) was obtained from CLIO @75 mL ha^{-1} which closely followed by CLIO @95 mL ha^{-1} of same MBCR but in *Rabi* 2017-18 (2.41) both performed similar with spraying of CLIO @75 mL ha^{-1} followed by @95 mL ha^{-1} and lowest in no weeding (Table 4).

Table 4. Cost and Benefit analysis of maize as influenced by different weed control management practice

Treatments	Gross return (Tk ha^{-1})		Total variable cost (Tk ha^{-1})		Gross margin (Tk ha^{-1})		MBCR	
	Kharif-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18	*Kharif*-1, 2017	*Rabi* 2017-18
T_1	93,424	99,455	80,700	80,700	12,724	18,755	2.16	2.23
T_2	93,280	1,09,512	80,900	80,900	12,380	28,612	2.15	2.35
T_3	1,03,880	1,13,896	81,200	81,200	22,680	32,696	2.28	2.40
T_4	1,04,002	1,14,580	81,400	81,400	22,602	33,180	2.28	2.41
T_5	1,06,070	1,16,373	83,828	83,828	22,242	32,545	2.27	2.39
T_6	83,812	89,805	79,900	79,900	3,912	9,905	2.05	2.12

Price: 15 Tk Kg^{-1}. T_1= CLIO @35 mL ha^{-1}, T_2=CLIO @55 mL ha^{-1}, T_3= CLIO @75 mL ha^{-1}, T_4= CLIO @95 mL ha^{-1}, T_5= CLIO @115 mL ha^{-1}, T_6= No weeding, MBCR = maximum benefit–cost ratio

Conclusion

Chemical weed control technique is always prioritized first to the farmers due to its' quick response and effective weed control efficacy. However, selection of an optimized dose for each and every herbicide is crucial considering its' effectivity and eco-toxicological aspect. A chemical herbicide named CLIO was used to finalize an optimum dosage for weed control in maize field. The herbicide CLIO contains a new active ingredient named Topramezone, a new subclass of the HPPD-inhibiting herbicide. As a result, the possibility of adverse effect of this herbicide is lower than other herbicides. From the experimental results and findings, it might be concluded that CLIO has effective weed control efficacy on different weed species in maize fields. Application of CLIO @ 95 mL ha^{-1} at 10 DAS of maize is economically profitable and it needs further trials to investigate eco-toxicological consequences to environment and living organisms after application.

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