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EFFECTIVENESS OF HERBICIDES ON WEED MANAGEMENT, GROWTH AND YIELD OF JUTE SEED PRODUCTION IN BANGLADESH

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ABSTRACT

The experiment was conducted at Jute Agriculture Experimental Station (JAES), Manikganj and Jute Research Sub Station, Tarabo during jute production season in 2019 and 2020 to find out the effect of some selected herbicides on weeds, yields and yield components of jute. The experiment was laid out in RCBD with three replications. Six different herbicides samples viz., T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weedings at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application) used as treatment of this experiment. All the herbicides were applied as post emergence at 15 days after sowing. Khudesama (*Echinochloa colonum*) and Angulighash (*Digitaria sanguinalis*) were controlled by tested herbicide sample Quizalofop-p-ethyl and Fluazifop – p-butyl. Mutha (*Cyperus rotundus*) was successfully controlled by Ethoxy Sulfuran. It was observed that all six herbicide samples successfully performed against five harmful weeds like- Mutha (*Cyperus rotundus*), Khudesama *(Echinochloa colonum*), Angulighas (*Digitaria sanguinalis*), Chapra (*Eleusine indica*) and Durba (*Cynodon dactylon*) the major harmful weed in jute field of Bangladesh. T_7 (weed free plot) treatment produced the maximum seed yield of 898.1 kg ha^{-1}. In case of herbicide application, highest seed yield (888.55 kg ha^{-1}) recorded in T_5 (Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15%) treatment probably the enhanced metabolic activity corroborating higher photosynthate formation and combining with the reduced weed densities.

Keywords: Noxious weed, fibre crop, jute, herbicide, intercropping

INTRODUCTION

Jute is a high land crop grown in the summer season in Bangladesh. It is the most important fibre crop as well as cash crop of the country. In Bangladesh, annually about 0.817 million ha of land is cultivated and about 0.162 million tons of fibre produced anually. To cultivate the said area, the farmers require about 5000 to 5500 tons of jute seed. Bangladesh produces world's best quality jute. The climate of Bangladesh is very suitable for quality fibre production. As a result, supply of quality jute seed will ensure the fibre quality as well as quantity to a great extent (Islam *et al.,* 2019). In many cases, farmers' collect their seeds from their friends or neighbors and thus, there is no specific system to control the quality of seeds. Hence, it is conceived that the quality of seeds produced by majority of the farmers' is of low standard (Islam *et al*., 2019). Only about 10% to 15% quality jute seeds are supplied by different national agencies but the rest amount of quality seed is yet to be managed to supply (Ferdous and Islam, 2018). Many jute farmers use to produce jute crops by their own seeds to meet their requirements but such seeds are of poor in quality (Ferdous *et al.,* 2019). After harvesting fibre crop, the crop for seed remains almost uncared for a long period. Due to this weathering, diseases and insects affect the seed crop and as such, poor quality seed is produced (Ferdous and Islam, 2018).

However, weed is considered one of the serious pests against cultivating jute which deteriorate the yield and quality of seed to a considerable extent. Heavy infestation of weed is a major constraint in jute. The hot and humid climate coupled with intermittent rainfall during the jute-growing season, encourages weed growth resulting in severe for judicious weed management.

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Between crop plants and weeds factors for competiition are chiefly water, light and mineral nutrients (Talukder, 1978). Weeding is one of the most important cultural practices for the crop plants to take nutrients, moistures, light, space and sometimes controlling many diseases organisms and insect pest (Anonymous, 2002). As a result, weeding and thinning operations involve about 40% or more of the labour cost investment in jute cultivation (Ferdous *et al.,* 2020). Weeds affect light interception and passing of wind and affect photosynthesis in jute plant and ultimately crop will receive stunted growth and in a consequence yield of crop will reduce (Kundu, 1959; Islam and Rahman, 2008). Farmers should know the major species of jute weeds and their cost effective and easiest control measures for achieving maximum benefit from jute production. In Bangladesh, weeds are generally controlled by raking and niri (hand weeding) and weeding and thinning operations involve about 50% or more of the labour cost (Alam *et al*., 2019). An effective weed management practice is necessary for higher crop production and better economic return (Gaffer *et al*., 1988). Herbicide has effectiveness in terms of weed control in jute field. Use of post-emergence herbicides such as cyhalofop butyl, quizalofop ethyl and fenoxaprop-p-ethyl, which selectivity control grassy weeds in broadleaved crops like sunflower, soybean, and potato (Ito *et al*. 1998; Bedmar 1997), therefore, holds promise. However, among the available post-emergence herbicides, only quizalofop ethyl was found effective in controlling grassy weeds of jute (Ghorai *et al.* 2004). Different times Department of Agriculture Extension (DAE) submitted new herbicides to Bangladesh Jute Research Institute (BJRI) for field trial. Farmers of Bangladesh are usually reluctant to control weeds in jute fields, and those who control the weeds in their fields usually do using manual labour or hand weeding, which is not economic. Hand weeding is also laborious and time consuming; sometimes farmers are unable to hire costly labour at the peak period due to high demand of labours for other competitive Rabi crops like potato, Boro rice and vegetables. Therefore, chemical weed control is gaining popularity among the farmers. The choice of best weedicide, proper time of application and proper dose are important considerations for lucrative returns (Hossain *et al.,* 2020). Now a days, effectiveness of the herbicides and its effects on crop and yield is time demanding issue. Therefore, the present study was designed to assess the effectiveness of some selected post-emergence herbicides against weed suppression towards growth and yield of quality seed production of jute.

MATERIALS AND METHODS

The experiment was conducted at Jute Agriculture Experimental Station (JAES), Manikganj and Jute Research Sub Station, Tarabo at jute production season during 2019 and 2020 to find out the effect of different herbicides for controlling weeds in jute plots for seed production. The experiment was laid out in RCBD with three replications. Unit plot size would be 4.0 m × 2.5 m. Space between plot to plot and around the field 1.0 m and between replications 1.5 m were maintained. Manures and fertilizers were applied as per BJRI recommendations. The crop was sown on 15-03-2019 and 20-03-2020, in first and second year respectively. Six different herbicides samples viz., T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weedings at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application) were considered as treatment of this experiment. All the herbicides were supplied by Plant Protection Wing of Department of Agriculture Extension. The jute variety used in the study was BJRI Tossa Pat-8 (Robi-1). All the applied samples were sprayed after 15 DAS or two leaves stage of crop. Two hand weeding at 35 and 50 DAS was also done in case of weed free plot. The herbicides were applied in aqueous suspension with the help of a knapsack sprayer. Jute seed crops were harvested at 70-80% seed maturity level. The phyto-toxic rating was done on 15 and 30 days after spraying (DASH) of herbicides using 0 to 10 scale (0 indicates no adverse effect of herbicides on the crop, and 10 indicates 100% adverse effect of herbicides on the crop).

Data of the weeds were collected after 20 days of spraying by using 1 m × 1 m quadrate as per method. The quadrate was placed in three random places of the unit plots. In each spot all weeds inside the quadrate were

counted species wise and their average values were taken as the weed density (no. m^{-2}). After completed washing weeds fresh weight (g^{-2}), dry matter (g^{-2}) and other necessary data were recorded and analyzed. The weed species were identified in the field and laboratory through close observation of distinguishing characters and identifying keys suggested by Karim and Kabir (1995).

In each spot all weeds inside the quadrate were counted species wise and their average values were taken as the weed population m^{-2}.

$$\text{Density (no. m}^{-2}) = \frac{\text{Total number of weeds}}{\text{Total surveyed areas (m}^2)}$$

Observations on plant population, number of pods per plant, number of seeds per pod, 1000 seed weight, seed yield were recorded after harvesting the crop. Weed control efficiency (%), weed population species wise (35 DAS) and weed dry weight at harvest was recorded and analyzed using the analysis of variance technique. The data were subjected to statistical analysis, using the Statistix 10 software program. The mean differences among the treatments were adjusted by Least Significant Difference (LSD) at 0.05 level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Five weed species under different families were identified in the experimental field (Table 1).

Table 1. Name of identified weeds of experimental jute field

Sl. No.	Weed species	Scientific Name	Family
1.	Mutha	*Cyperus rotundus*	Cyperaceae
2.	Khudesama	*Echinochloa colonum*	Poaceae
3.	Anguli	*Digitaria sanguinalis*	Poaceae
4.	Chapra	*Eleusine indica*	Poaceae
5.	Durba	*Cynodon dactylon*	Poaceae

Effects of herbicides on controlling weeds

Results revealed that all herbicides provided satisfactory control over Mutha (*Cyperus rotundus*), Khudesama (*Echinochloa colonum*), Anguli (*Digitaria sanguinalis*), Chapra **(***Eleusine indica***),** Durba *(Cynodon dactylon)*. Results also observed that only Mutha (*Cyperus rotundus*) was controlled by Ethoxy Sulfuran. It should be noted that Mutha (*C. rotundus*) is the most harmful weed of jute. However, the average results of weedicide samples' performance were shown in Table 2.

It was noticed that the most harmful weed Mutha (*C. rotundus*) was significantly controlled by Ethoxy Sulfuran (Moonlit 15 WG), Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG) and Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG). The highest control of Khudesama (*E. colonum*), Anguli (*Digitaria sanguinalis*) and Durba *(C. dactylon)*, were observed by Quizalophop-p-ethyl (Expel 5 EC) which were followed by Quizalophop-p-ethyl (Salvage 5EC) and Fluazifop – p-butyl (Lumax 5 EC). All the weeds along with Chapra (*Eleusine indica***)** were more effectively controlled by Quizalofop-p-ethyl 15% + Ethoxysulfuron 15% (Jute Guard 20 WDG) and Ethoxy sulfuron 10% + Fluzifop-p-butyl 10%

(Viber 20 WG). The control (no weeding and no herbicide application) plot recorded the highest weed density as compared to other treatments.

Table 2. Effect of herbicides treatment on weed densities in jute at 35 DAS (days after sowing)

	Treatment	Weed Density (no. m^{-2})					
		Mutha	**Khudesama**	**Anguli**	**Chapra**	**Durba**	**Total weed**
T_1	Quizalophop-p-ethyl (Expel 5 EC)	252	2	3	6	5	268
T_2	Quizalophop-p-ethyl (Salvage 5EC)	211	5	4	7	4	235
T_3	Fluazifop – p-butyl (Lumax 5 EC)	210	8	4	4	5	231
T_4	Ethoxysulfuron 15% (Moonlit 15 WG)	11	35	25	19	11	101
T_5	Quizalofop-p-ethyl 15% + Ethoxysulfuron 15% (Jute Guard 20 WDG)	10	5	5	3	9	32
T_6	Ethoxysulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG)	12	15	05	05	8	43
T_7	Hand weeding	03	01	02	01	01	8
T_8	Control	250	49	35	32	28	394

T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weeding at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

At Manikganj and Tarabo Mutha (*C. rotundus*), Khudesama (*E. colonum*), Anguli (*Digitaria sanguinalis*) and Durba *(C. dactylon)* were controlled more than 80% by the applied harbicides in both season (Table 3).

It was reported that the lowest total weed control efficiency was found in case of control (no weeding and no herbicide application). Ferdous *et al*. (2020) and Khan *et al*. (1999) also found similar results in relation to herbicidal efficacy in controlling broad-leaved weeds in wheat. Similar findings related to weed population in wheat field was also reported by Hossain *et al.* (2009).

The highest weed fresh weight (620.89 g m^{-1}) and dry weight (125.12 g m^{-1}) were noted in control plot (620.89 g m^{-1}) and the lowest fresh weight (15.37 g m^{-1}) and dry weight (3.1 g m^{-1}) for weed free plot (Fig 1). Among the post-emergence herbicides, the lowest weed fresh weight (620.89 g m^{-1}) and dry weight (3.5 g m^{-1}) was for Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), closely followed by Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG). The observations corroborate the findings obtained by Ghorai *et al*. (2004), Hossain *et al*. (2020), Sarkar *et al.* (2005) and Sarkar (2006).

Table 3. Effectiveness of herbicides samples on weed species in jute

Sl. No	Generic Name	Trade Name	Name of Target Weeds	Doses	Effectiveness (%)			
					Manikganj		Tarabo	
					2019	2020	2019	2020
1.	Quizalophop-p-ethyl	Expel 5 EC	**Khudesama** (*Echinochloa colonum*)	650 ml ha^{-1}	82	80	83	82
			Angulighas (*Digitaria sanguinalis*)		84	81	80	81
			Durba *(Cynodon dactylon)*		83	81	82	80
2.	Quizalophop-p-ethyl	Salvage 5EC	**Khudesama** (*Echinochloa colonum*)	650 ml ha^{-1}	80	82	81	82
			Angulighas (*Digitaria sanguinalis*)		84	81	80	81
			Durba *(Cynodon dactylon)*		82	74	80	82
3.	Fluazifop – p-butyl	Lumax 5 EC	**Khudesama** (*Echinochloa colonum*)	1 L ha^{-1}	83	80	83	81
			Angulighas (*Digitaria sanguinalis*)		84	85	83	82
4.	Ethoxysulfuron 15%	Moonlit 15 WG	**Mutha** *(Cyperus rotundus)*	200 g ha^{-1}	84	83	86	82
5.	Quizalofop-p-ethyl 15% + Ethoxysulfuron 15%	Jute Guard 20 WDG	**Mutha** *(Cyperus rotundus)*	500 ml ha^{-1}	82	84	80	82
			Khudesama (*Echinochloa colonum*)		83	80	83	81
			Angulighas (*Digitaria sanguinalis*)		84	85	83	82
			Chapra (*Eleusine indica*)		70	65	70	68
6.	Ethoxysulfuron 10% + Fluzifop-p-butyl 10%	Viber 20 WG	**Mutha** *(Cyperus rotundus)*	500 ml ha^{-1}	82	80	85	84
			Angulighas (*Digitaria sanguinalis*)		82	84	80	82
			Chapra (*Eleusine indica*)		63	72	72	71

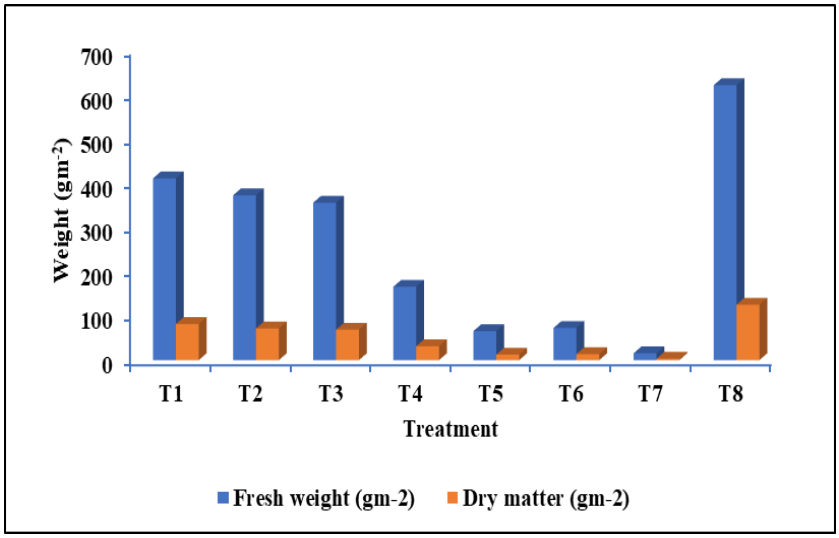


Fig. 1. Effect of herbicides on fresh weight (g^{-2}) and dry matter (g^{-2}) of different weeds grown in tossa jute at 35 DAS. Here, T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weeding at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

Effect on growth and yield

Height (1.87 m) of jute plants at harvest was the maximum in weed free plots, which was statistically at par with Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15%, closely followed by Ethoxy sulfuron 10% + Fluzifop-p-butyl 10%. Conversely, the control plots were shown the shortest plants (1.23 m) (Fig-2). The increase in plant height was possibly due to better weed control at proper time, resulting maximum utilization of moisture and nutrients by crop (Riaz *et al.*, 2006). Baldha *et al.* (1988) also reported that herbicides application significantly influences the number of spike m^{-2} in wheat. Similar results have also been reported by Kumari and Prasad (2003). Similar findings have also been documented by Pandey and Mishra (2002).

Plant population, number of branches $plant^{-1}$, number of pods $plant^{-1}$, seeds pod^{-1} and 1000-seed weight of jute also found responsive to the treatments under study (Table 4). Plant population and all the yield contributing characters showed highest result at T_7 treatment which was followed by T_5 treatment. T_7 treatment (weed free plot) produced the maximum yield (898.1 kg ha^{-1}) which was followed by T_5 treatment (Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15%) (888.55 kg ha^{-1}) may be due to the enhanced metabolic activity corroborating higher photosynthate formation and combining with the reduced weed densities while the lowest seed yield was recorded in the control plot (456 kg ha^{-1}). (Fig-3). Similar results have also been reported by Sarkar (2006).

Germination % (93%) was similar at T_7 and T_4 treatment (Fig-4). In case of herbicide application, highest seed yield in T_5 treatment

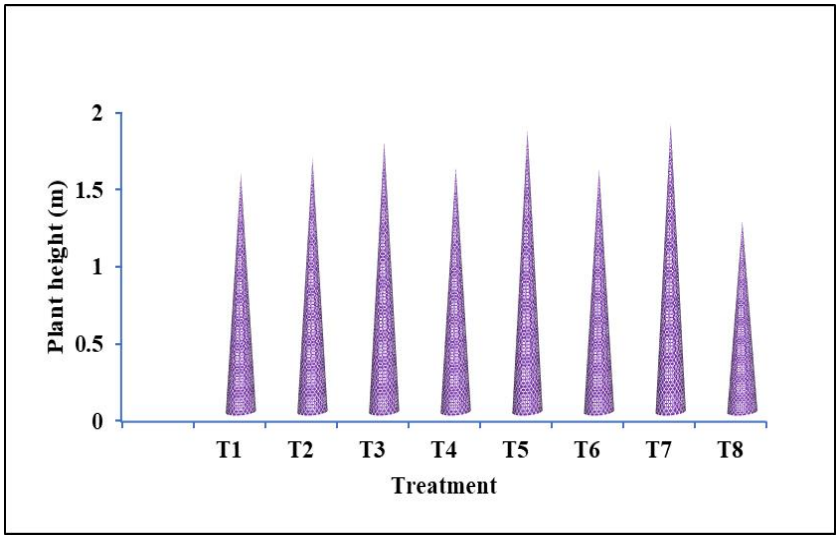


Fig. 2. Effect of herbicides on plant height of tossa jute at 30 DAS. Here, T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxy sulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weeding at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

Table 4. Effect of different herbicides on yield and yield attributes of tossa jute

Treatments	Plant Population (m^{-2})	Number of branches $plant^{-1}$	Number of Pods $plant^{-1}$	Number of seeds Pod^{-1}	Pod length (cm)	1000 seed weight (g)
T_1	37.33	2.80	20.03	189.67	7.15	1.89
T_2	36.67	2.90	19.63	197.00	7.10	1.91
T_3	36.52	2.87	20.10	199.17	7.25	1.94
T_4	38.57	3.03	19.53	198.60	7.23	1.88
T_5	39.33	3.05	20.50	200.83	7.31	1.99
T_6	38.33	3.07	19.10	188.56	7.24	1.87
T_7	40.23	3.10	20.89	205.08	7.35	2.00
T_8	32.52	2.11	17.20	175.23	7.12	1.81
LSD (5%)	4.14	1.53	2.962	5.291	0.532	0.584
CV (%)	9.90	7.92	14.04	3.59	7.43	4.28

T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxysulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weeding at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

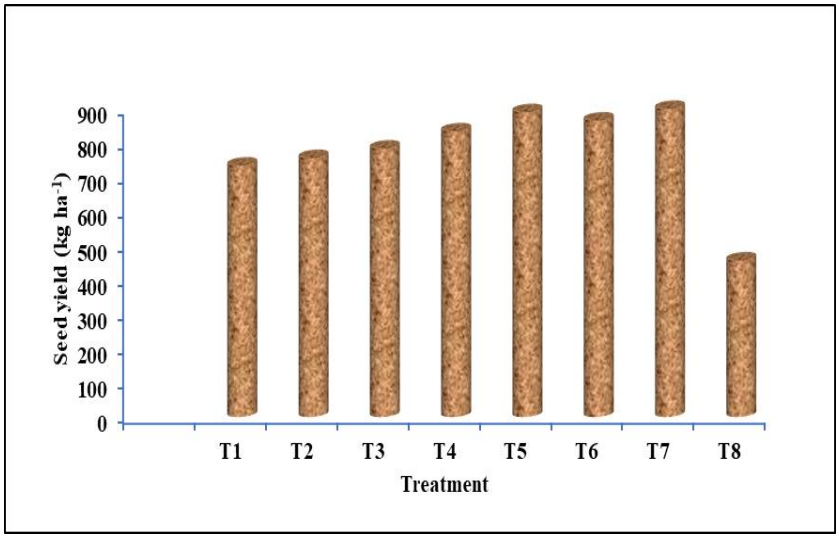


Fig. 3. Effect of herbicides on seed yield of tossa jute. Here, T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxy sulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxysulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weeding at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

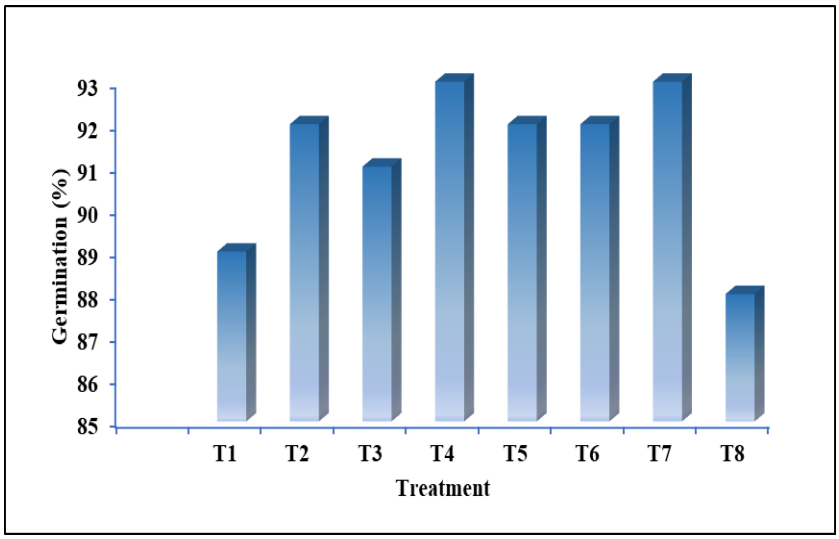


Fig. 4. Effect of herbicides on germination (%) of tossa jute seed. Here, T_1 = Quizalophop-p-ethyl (Expel 5 EC), T_2 = Quizalophop-p-ethyl (Salvage 5EC), T_3 = Fluazifop – p-butyl (Lumax 5 EC), T_4 = Ethoxysulfuron 15% (Moonlit 15 WG), T_5 = Quizalofop-p-ethyl 15% + Ethoxysulfuron 15% (Jute Guard 20 WDG), T_6 = Ethoxysulfuron 10% + Fluzifop-p-butyl 10% (Viber 20 WG), T_7 = Hand weeding (Weedings at 35 and 50 DAS) and T_8 = Control (no weeding and no herbicide application).

Effect on crop phytotoxicity

The herbicide applied with different doses as practiced during the experimentation did not show any visual phytotoxic symptom in any stage of crop growth in terms of epinasty, hyponasty, chlorosis, necrosis, scorching, wilting injury to leaf tips and leaf surface of jute.

CONCLUSION

From the above study, it can be concluded that six herbicide samples differently performed and controlling five harmful weeds like- Khudesama (*Echinochloa colonum*), Angulighas (*Digitaria sanguinalis*), Mutha (*Cyperus rotundus*) and Durba (*Cynodon dactylon*) in jute field of Bangladesh. In the case of herbicideal control, highest seed yield (888.55 kg ha^{-1}) shown in Quizalofop-p-ethyl 15% + Ethoxy sulfuron 15% treated plots may might be due to the reduced weed densities and weed dry weight (Table 2 and Fig. 1) facilitating enhancement of metabolic activity corroborating higher photosynthate formation and combining with the reduced weed densities in the crop. Though the seed yield was the highest in the hand weeded plot, but considering the scarcity of labour in the peak period of the cropping season and labour cost, herbicidal control options could be considered as an alternative option for weed management in jute.

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