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Influence of Plant Spacing and Post Emergence Herbicide on the Yield of White Jute (*Corchorus capsularis*)

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Abstract: A field experiment was conducted at Sher-Bangla Agricultural University, Dhaka during April to August, 2009 with a view to find out the influence of plant spacing and weed control methods on the yield of *Corchorus capsularis* (cv.CVL-1). The experiment consisted of four plant spacing *viz.* 20 cm × 10 cm, 25 cm × 10 cm, 30 cm × 10 cm (20, 25 and 30 cm rows with plants spaced at 10 cm intervals in the row) and broadcasting and four weed control methods *viz.* two times hand weeding with one raking, herbicide Whip Super® 9 EC (Fenoxaprop-P-ethyl: $C_{18}H_{16}ClNO_5$) application at 15 DAS, two hand weeding at 20 and 40 DAS and three times hand weeding at 15, 30 and 45 DAS. The dominant grass weeds were *Cynodon dactylon* (43%), *Echinochloa colonam* (29%) and *Eleusine indica* (22%). Results showed that plant spacing differed significantly and 25 cm × 10 cm spacing gave highest (3.12 t ha^{-1}) fibre yield which was statistically similar with 20 cm × 10 cm. Two times weeding and one raking gave highest (3.12 t ha^{-1}) fibre yield which was statistically similar with herbicide application (2.97 t ha^{-1}). Interaction effect showed highest fiber yield (4.02 t ha^{-1}) was obtained from 20 cm × 10 cm spacing with herbicide application. Whip Super 9 EC @ 615 ml ha^{-1} effectively controlled the grass weeds providing higher fibre yield and net 7.13 Taka return per Tk. invested whereas 6.51, 5.18 and 5.34 Tk. from two hand weedings with one raking, two hand weedings and three hand weeding respectively.

Key words: Jute % Weed control methods % Plant spacing % Herbicide

INTRODUCTION

Jute is a natural long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced from plants in the genus *Corchorus*, belonging to Malvaceae. Jute is considered as the main cash crop of Bangladesh and accounted for about 5-6% export earnings [1]. The suitable climate for growing jute (warm and wet climate) is the monsoon season. Temperatures from 20°C to 40°C and relative humidity of 70%-80% are favourable for successful cultivation. Jute requires 5-8 cm of rainfall weekly and more during the sowing period. Plant density is an important yield contributing factor which can be manipulated in jute to attain higher fibre production per unit area. The yield of many crops is known to be positively correlated with the number of plants per unit area. If the plant population is lower or higher than the optimum, the final output is adversely affected [2]. In order to obtain required plant density, one of the major yield components of jute is optimum seed rate, resulting in proper spacing to maintain the uniformity of stand for better growth and development of plant. Weed control is important management factor that affect the yield of a crop. The hot and humid climate coupled with intermittent rainfall during the jute-growing season, however, encourages weed growth resulting in severe crop-weed competition [3]; account for the yield losses up to 75 to 80% [4]. Weeding is one of the most important cultural practices for the crop plants to and sometimes controlling many diseases, organisms and insect pest [5]. However, the most effective and economic cultural practices for weed control in jute crops are not clearly known by our farmers. In Bangladesh, weeds are generally controlled by raking and *niri* (hand weeding) and weeding and thinning operations involve more than 50% of the labour cost [6]. Grasses constitute the dominant weed flora in jute fields and its management using pre-emergence herbicides is possible [7], provided the farmers get sufficient time for land preparation and herbicide application before sowing. Under rainfed conditions, however, the farmers sow jute crop early to get the full benefit of the pre-monsoon showers and it

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may not be possible to delay the sowing even by a single day. Use of post-emergence herbicides such as Cyhalofop butyl, Quizalofop ethyl and Fenoxaprop-pethyl, which control weeds in broadleaved field crops like sunflower, soybean and potato [8, 9], were found to be effective. Keeping all the points in mind mentioned above, the present piece of research work was carried out to identify the optimum population density and to find out effective weed control methods for economic jute production.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during April to July, 2009. The soil of the experimental field belongs to the Shallow Red Brown Terrace Soils. Jute variety CVL-1 was used as the test crop. Two sets of treatments included in the experiment were as follows: A. Factor: Plant spacing (4) S_1= Line sowing (20 cm × 10 cm), S_2= Line sowing (25 cm × 10 cm), S_3= Line sowing (30 cm × 10 cm) and S_4= Broadcasting B. Factor: weed management (4) W_1= Recommended practices recommended by Bangladesh Jute Research Institute (2W+1R), W_2= 1 herbicide application (2-4 leaf stage of weed), W_3= 2 weeding (20 and 40 DAS) and W_4= 3 weeding (15, 30 and 45 DAS). The experiment was laid out in a split-plot design with three replications having spacing in the main plots, weeding in the sub-plots. There were 16 treatments combinations. The total numbers of unit plots were 48. The size of unit plot was 4 m × 3 m = 12 m^2. The plots were fertilized with the N, P_2O_5, K_2O and S in the form of urea, triple superphosphate (TSP), muriate of potash (MOP) and gypsum at the rate of 76.50, 10.26, 18.00 and 8.09 kg ha^{-1} respectively. One-third of N and other fertilizers were broadcasted during the time of final land preparation. The remaining two-thirds of N were top dressed in two equal splits on 20 and 35 DAS. Respective seed were sown on 6 April, 2009 by following different line sowing and broadcasting method. The seed rate was 7 kg ha^{-1}. At harvest each 2 m^2 area of one sample was harvested from each plot leaving adequate border for recording data on plant height, top, middle and base diameter of the plants. The plant height and diameters were recorded from 10 randomly selected plants with the help of bamboo scale and slide calipers, respectively. Prior to every harvest ten randomly selected plants from each unit plot were collected to take note of yield components. Two quadrat areas, each measuring 3 rows and 50 cm length along the row were separately harvested from each plot to record plant fibre-stick ratio and harvest index. The plants of the plots were harvested on 106 DAS. The yields from 10 plants and quadrats were added to the final yield. The data collected on different parameters were statistically analyzed to obtain the level of significance using the MStat-C. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Weed Infestation: In this study the jute field was infested with different types of weeds. The relative density of these weed species were also different (Table 1). Twelve different weed species were observed in the plots of study where most of them were grass weed. Among the weed species maximum relative weed density was observed for *Cynodon dactylon* (43 %) at 30 DAS which was followed by *Echinochloa colonum* (29%) and *Eleusine indica* (22%). Relative weed species of many several weeds decreased at later stages. Similar result also observed by Hasanuzzaman *et al*. [10]. In this study it was also observed that grasses and sedges were dominating weed species.

Weed Control: The significant effect on total weed population mG^2 was found due to different weeding management. Weeding treatments significantly reduced weed population. Among the treatments W_2 reduced the weed population most effectively at every growth stages. Significant differences in weed dry weight were observed due to different weeding managements (Table 2). Among the treatments W_2 (1 herbicide application at 2-4 leaf stage of weed) produced the lowest (1.94 g mG^2) amount of weed dry matter at 30 DAS which was statistically different from others and highest (4.44 g mG^2) amount of weed dry matter from W_3 (2 weeding at 20 and 40 DAS). Similar trend was also observed at 60 DAS. It reveals that use of herbicide effectively control reduce the weed biomass. The differences were more prominent at earlier growth stage (30 DAS). Alam *et al*. [11] and Singh *et al*. [12] also found similar result.

Agronomic Performance

Effect of spacing: The plant height, base, middle and top diameter, fibre yield and stick yield were significantly influenced by different plant spacing (Table 3). Significantly highest (2.73 m) plant height at harvest was found from S_1 (20 cm × 10 cm) which statistically similar

Table 1: Relative density (%) of different weed species at two different growth stages of jute

			Relative density (%)	
Botanical Name	Family	Types weed	30DAS	60 DAS
Cynodon dactylon	Gramineae	Grass	43	30
Echinochloa colonum	Gramineae	Grass	29	20
Eleusine indica	Gramineae	Grass	22	14
Cyperus rotundus	Cyperaceae	Sedge	3	2
Leucas aspera	Labiatae	Broad leaf	1	1
Solanum carolinense	Solaneaceae	Broad leaf	1	1
Brassica kaber	Cruciferae	Broad leaf	-	-
Paspalum comersoni	Gramineae	Grass	-	-
Paspalum distichum	Gramineae	Grass	-	-
Cyperus difformis	Cyperaceae	Sedge	-	-
Solanum nigrum	Solaneaceae	Broad leaf	-	-
Euphorbia hirta	Euphorbiaceae	Broad leaf	-	-

Table 2: Weed dry matter as affected by different weed management

	Weed dry matter (g m^{-2})	
Treatment	30 DAS	60 DAS
W_1	3.55 b	10.00 b
W_2	1.94 c	6.63 c
W_3	4.44 a	16.81 a
W_4	3.18 b	7.79 c
$LSD_{5\%}$	0.57	1.40
CV %	8.82	6.81

Means separation in columns followed by the same letter (s) are not significantly different at P= 0.05

Note. W_1= Recommended practices recommended by BJRI (2W+1R), W_2= 1 herbicide application (2-4 leaf stage of weed), W_3= 2 weeding (20 and 40 DAS), W_4= 3 weeding (15, 30 and 45 DAS)

Table 3: Effect of spacing on yield contributing character and yield of jute

Treatment	Plant height (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)	Fibre yield (t ha^{-1})	Stick yield (t ha^{-1})	Harvest Index (%)	Fibre Stick Ratio
S_1	2.73	9.38	6.78	3.83	3.09	6.16	35.08	0.57
S_2	2.69	10.02	6.63	4.27	3.12	7.05	32.33	0.49
S_3	2.69	9.88	7.07	3.23	2.37	5.63	31.75	0.47
S_4	2.10	8.47	5.38	2.72	2.62	5.95	33.08	0.52
$LSD_{5\%}$	0.1515	0.9095	0.915	0.7680	0.5035	1.174	NS	NS

Note: S_1= Line sowing (20 cm × 10 cm), S_2= Line sowing (25 cm × 10 cm), S_3= Line sowing (30 cm × 10 cm) and S_4= Broadcasting

Table 4: Effect of weed management on yield contributing character and yield of jute

Treatment	Plant height (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)	Fibre yield (t ha^{-1})	Stick yield (t ha^{-1})	Harvest Index (%)	Fibre Stick Ratio
W_1	2.62	9.20	6.62	3.78	2.97	5.65	34.83	0.55
W_2	2.61	9.64	6.54	3.56	3.12	6.75	36.42	0.60
W_3	2.46	9.55	6.53	3.23	2.34	6.41	28.25	0.40
W_4	2.52	9.35	6.16	3.48	2.76	5.96	32.75	0.49
$LSD_{5\%}$	0.138	NS	NS	NS	NS	NS	0.0657	0.1531

Note. W_1= Recommended practices recommended by BJRI (2W+1R), W_2= 1 herbicide application (2-4 leaf stage of weed), W_3= 2 weeding (20 and 40 DAS), W_4= 3 weeding (15, 30 and 45 DAS)

Table 5: Interaction effect of spacing and weed management on yield contributing character and yield of jute

Treatment	Plant height (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)	Fibre yield (t haG^{1})	Stick yield (t haG^{1})	Harvest Index (%)	Fibre Stick Ratio
S_1W_1	2.47	9.26	6.87	4.17	2.93	4.72	40.33	0.69
S_1W_2	2.82	9.30	6.57	3.50	4.02	6.85	39.00	0.69
S_1W_3	2.62	9.00	6.73	3.83	2.55	6.87	28.00	0.40
S_1W_4	2.62	10.00	6.93	3.83	2.85	6.20	33.00	0.50
S_2W_1	2.79	9.57	7.07	4.77	3.78	7.80	33.00	0.50
S_2W_2	2.77	10.77	6.83	4.83	3.18	7.58	33.00	0.50
S_2W_3	2.59	10.00	6.77	3.63	2.48	6.03	30.03	0.44
S_2W_4	2.62	9.73	5.83	3.83	3.02	6.78	33.00	0.50
S_3W_1	2.69	9.80	7.10	3.57	2.43	5.33	31.33	0.46
S_3W_2	2.78	10.13	7.47	3.37	2.45	6.83	33.00	0.50
S_3W_3	2.59	10.50	7.12	2.70	2.08	4.75	30.67	0.45
S_3W_4	2.71	9.07	6.53	3.27	2.52	5.58	32.00	0.47
S_4W_1	2.16	8.20	5.43	2.60	2.73	4.77	34.67	0.54
S_4W_2	2.06	8.37	5.30	2.53	2.82	5.75	40.67	0.50
S_4W_3	2.05	8.70	5.43	2.73	2.25	8.00	24.00	0.32
S_4W_4	2.11	8.60	5.33	3.00	2.65	5.27	33.00	0.50
$LSD_{5\%}$	0.2769	1.530	1.206	1.118	0.9562	2.718	0.0652	0.1767

Table 6: Cost of production and benefit cost ratio (BCR) for different weeding management of jute

	Cost (Tk. haG^{1})					Gross return (Tk. haG^{1})			
Treatment	Fixed cost of production	Labor cost	Raking cost	Herbicide cost	Total cost	Fibre	Stick	Total	BCR
W_1	31,790	7,000	560	-	39,560	167200.80	90429.75	257630.55	6.51
W_2	31,790	280	-	2312.50	34382.50	159162.30	85874.77	245037.07	7.13
W_3	31,790	7000	-	-	38790	125400.60	75693.05	201093.65	5.18
W_4	31,790	10500	-	-	42290	147908.40	79846.12	227754.52	5.34

Note: Incase of all weeding method fixed cost was 31790 Tk., 1 Mon= 37.32 Kg., 1 mon Fibre/Bel = 2000 Tk. i.e.,1 ton Fibre price = 2000/37.32 × 1000= 53590.57 Tk., 1 mon Stick= 500 Tk. i.e., 1 ton Stick = 500/37.32 ×1000= 13397 Tk., 1 USD = 74 Tk.

with S_2 and S_3 and lowest (2.10 m) plant height was found from S_4. Highest (10.02 mm) base diameter was found from S_2 (25 cm × 10 cm) which is statistically similar with S_3 and lowest base diameter was found from S_4 (broadcasting). Highest (7.03 mm) middle diameter was found from S_3 (30 cm × 10 cm) and lowest middle diameter was found from S_4 (broadcasting). Highest (4.27 mm) top diameter was found from S_2 (25 cm × 10 cm) and lowest (2.72 mm) top diameter was found from S_4 (broadcasting). Significantly highest fibre yield (3.12 t haG^{1}) and stick yield (7.05 t haG^{1}) were found when spacing was S_2 (25 cm × 10 cm). However, as regard to differences in fibre and stick yield between the spacing S_1 & S_2 were insignificant. Alam *et al*., (2010) also found similar result. Highest harvest index (35.08) and fibre stick ratio (0.57) was found from S_1 (Line sowing (20 cm × 10 cm).

Effect Of Weed Management: From Table 4 it was observed that due to different weed management practice only plant height, harvest index and fibre stick ratio differed significantly but the diameter of the base, middle and top, fibre yield and stick yield remained unaffected. Significantly highest (2.62 m) plant height at harvest was found from W_1= Recommended practices recommended by BJRI (2W+1R) which statistically similar with W_2 and lowest (2.52 m) plant height was found from W_4= 3 weeding (15, 30 and 45 DAS). Highest (9.64 mm) base diameter was found from W_2=1 herbicide application (2-4 leaf stage of weed) and lowest base diameter was found from W_1=Recommended practices recommended by BJRI (2W+1R). Numerically highest (6.62 mm) middle diameter was found from W_1= Recommended practices recommended by BJRI (2W+1R) and lowest middle diameter was found from W_4= 3 weeding (15, 30 and 45 DAS). Highest (3.78 mm) top diameter was found from W_1= Recommended practices recommended by BJRI (2W+1R) and lowest (3.23 mm) top diameter was found from W_3= 2 weeding (20 and 40 DAS). Numerically highest yield (3.12 t haG^{1}) was and highest stick yield (6.75 t haG^{1}) obtained from W_2 (1 herbicide application at 2-4 leaf stage of weed). Highest plant height (2.62 m) was observed from W_1 (2W+1R). Significantly highest harvest index (36.42) and fibre stick ratio (0.60) also observed from W_2 (1 herbicide application at 2-4 leaf stage of weed).

Interaction Effect Of Spacing And Weed Management: The plant height, base, middle and top diameter, fibre yield and stick yield were significantly influenced by the combination of different spacing and weed management practice (Table 5). Significantly highest (2.79 m) plant height at harvest was found from S_2W_1 and lowest (2.05 m) plant height was found from S_4W_3. Highest (10.77 mm) base diameter was found from S_2W_2 and lowest (8.20 mm) base diameter was found from S_4W_1. Highest (7.47 mm) middle diameter was found from S_3W_2 and lowest (5.30 mm) middle diameter was found from S_4W_4. Highest (4.83 mm) top diameter was found from S_2W_2 and lowest (2.53 mm) top diameter was found from S_4W_2. Significantly highest fibre yield (4.02 t ha^{-1}) was obtained from the combination of S_1W_2 which similar to S_2W_1 (3.78 t ha^{-1}) and highest stick yield (7.80 t ha^{-1}) was observed from S_2W_1 which is statistically similar to S_2W_2 (7.58 t ha^{-1}). Such result was in agreement with those of Hossain *et al*. [13]. Significantly highest (40.67) harvest index was obtained from S_4W_2 which was significantly similar with S_1W_1 (40.33) and highest (0.69) fibre stick ratio was found from S_1W_1 and S_1W_2.

Economic Performance: Gross return was found to be highest (Tk. 257630.55) in the W_1 weed management treatment. But in the benefit cost ratio (BCR) this treatment was comparatively higher (7.13) than other weed management practices and also the gross return (Tk. 245037.07) was remarkable. This result is supported by another study as reported by Hossain *et al*. [13] and Sarker [14] who stated that herbicide application effectively controlled grass weeds and gave increased yields with better economic returns.

CONCLUSION

It can be concluded that plant spacing 25 cm × 10 cm spacing gave highest (3.12 t ha^{-1}) fibre yield which was statistically similar with 20 cm × 10 cm. Two times weeding and one raking gave highest (3.12 t ha^{-1}) fibre yield which was statistically similar with herbicide application (2.97 t ha^{-1}). Interaction effects showed the highest fiber yield (4.02 t ha^{-1}) was obtained from 20 cm × 10 cm spacing with herbicide application. Whip Super 9 EC® @ 615 ml ha^{-1} effectively controlled the grass weeds providing higher fibre yield and net 7.13 Tk. return per Taka invested compared to 6.51, 5.18 and 5.34 Tk from two hand weeding with one raking, two hand weeding and three hand weeding respectively.

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