INFLUENCE OF PLANT SPACING AND WEED MANAGEMENT METHODS ON THE YIELD OF WHITE JUTE (*Corchorus capsularis*)

By

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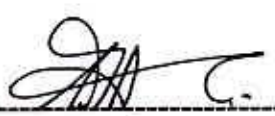

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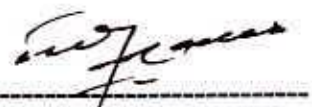

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Dedicated to
My
Beloved parents

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CERTIFICATE

This is to certify that the thesis entitled, "**INFLUENCE OF PLANT SPACING AND WEED MANAGEMENT METHODS ON THE YIELD OF WHITE JUTE (*Corchorus capsularis*)** Submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRONOMY,** embodies the result of a piece of bona fide research work carried out by **MD. SHARIFUL ISLAM,** Registration No. **01238** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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THE AUTHOR

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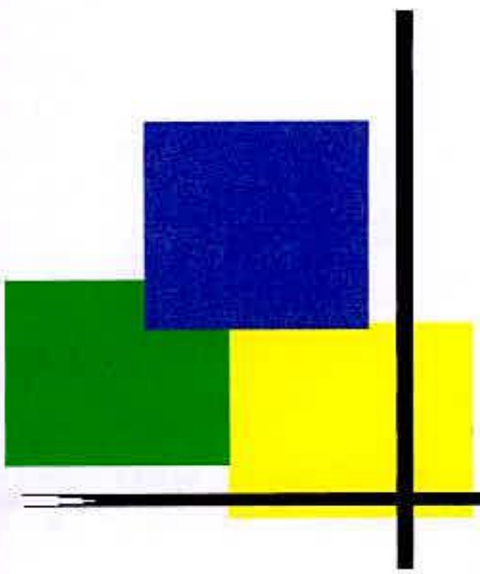
LIST OF ACRONYMS

ABBREVIATION	FULL WORD
AEZ	Agro-ecological zone
BJRI	Bangladesh Jute Research Institute
BBS	Bangladesh Bureau of Statistics
DMRT	Duncan's Multiple Range Test
GM	Gross margin
TVC	Total variable cost
CV	Coefficient of variance
cv.	Cultivar (s)
DAE	Days after emergence
DAS	Days after sowing
et al.	And others
G	Grams (s)
HI	Harvest index
Ha	Hectare (s)
BCR	Benefit cost ratio
m^2	Meter Squires
SPD	Split Plot Design
No.	Number
NS	Non-significant
t/ha	Ton per hectare
ICJC	Indian Central Jute Committee
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development institute

ABSTRACT

A field experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka during April to August, 2009 with a view to find out the influence of plant spacing and weed management methods on the yield of white jute (var.CVL-1). The experiment consisted of 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 times hand weeding at 20+40 DAS and three times hand weeding at 15+30+45 DAS and four plant spacing *viz.*, 20 cm x 10 cm, 25 cm x 10 cm, 30 cm x 10 cm (20, 25 and 30 cm row to row with plants spaced at 10 cm intervals in the row) and broadcasting. 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 x 10 cm spacing gave the highest (3.12 t ha^{-1}) fibre yield which was statistically similar with 20 cm x 10 cm. Two times weeding and one raking gave the 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 x 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 taka invested whereas 6.51, 5.18 and 5.34 taka from two times hand weeding with one raking, two times hand weeding and three times hand weeding, respectively.



Chapter 1

Introduction

INTRODUCTION

Jute (*Corchorus* sp) 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 the family Tliaceae. Jute is considered as the main cash crop of Bangladesh. It's influence on ecology and economy is so intimate that it's effects are significantly related to the agro-ecology and the socio-economic life of the people (Masum *et al.*, 2010). The suitable climate for growing jute (warm and wet climate) is the monsoon season. Temperatures ranging 20 to 40°C and a relative humidity of 70 - 80% are favourable for successful cultivation. Jute requires a weekly rainfall of 5 - 8 cm with an extra amount during the sowing period. Due to its good spinning quality, it is a good textile fibre. It helps to make best quality industrial yarn, fabric, net and sacks. It is one of the most versatile natural fibres that has been used in raw materials for packaging, textiles, non-textile, construction and agricultural sectors. Bulking of yarn results in a reduced breaking tenacity and an increased breaking extensibility when blended as a ternary blend (Basu *et al.*, 2005).

Jute grows abundantly in Bangladesh having best quality in comparison with that of India (Zakaria and Syed, 2008). Bangladesh ranked second in respect of fibre production and jute alone contributes about 1.0% to GDP. In 2007-2008, about 8.39 million tons of jute fibre were produced from 10.89 million acre of land and covered about 2.80% of the total cropped area and accounted for about 5-6% export earnings (BBS, 2009). Area and production of jute in Bangladesh from 1994-95 to 2007-2008 are present in Appendix v.

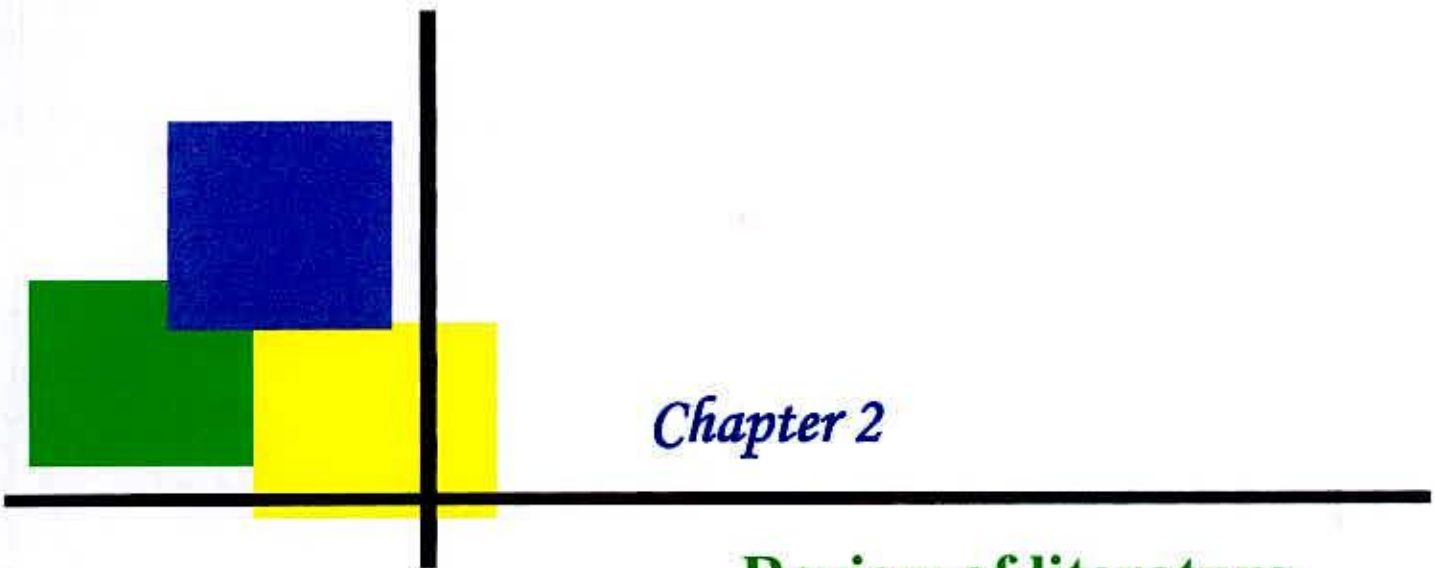
Plant density is the function of spacing between the rows and plants. Under various spacing's the plants manifest remarkable capacity to exploit environments with varying competition stresses for moisture, light, nutrition and carbon dioxide and thus, the plant growth is affected accordingly. Plant density 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 in the field. If the plant population is lower or higher than the optimum, the final output is adversely affected. 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. Hashim *et al.*, 1981 reported that four plant densities (348, 261, 323, and 174 thousand acre^{-1}) were arranged in different planting patterns of 45, 60, 67.5 cm 90 sq cm plant^{-1}. Although there were no significant differences in yield between the treatments, higher densities of population produced higher yield. Among the sowing patterns 15 cm x 7.5 cm had the highest yield followed by 22.5 cm x 5 cm and 10 cm x 11.25 cm. However, 22.50 cm row width displayed better performance compared to other row widths.

Cultural practices are important management factors 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 (Saraswat, 1999); yield losses may be up to 75 to 80% (Sahoo and Saraswat, 1988). 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 (Alam and Ali, 2010). An effective weed management practice is necessary for higher crop production and better economic return (Gaffer *et al.*, 1988). But, most effective and economic cultural practices for weed control in jute crop are not clearly known to our farmers. In Bangladesh, weeds are generally controlled by raking and niri (hand weeding) and weeding and thinning operations involve about 50% or more of the lobour cost (Alam, 2003). Grasses constitute the dominant weed flora in jute fields and its management using pre-emergence herbicides is possible (Sarkar *et al.*, 2005), provided the farmers get sufficient time for land preparation and herbicide application before sowing. Therefore, it is needed for judicious weed management.

Keeping all the points in mind mentioned above, the present piece of research work was under taken with the following objectives:

- Identify the optimum population density of jute
- Study the effect of weed management methods on jute yield
- Know the effect of herbicide application on jute yield
- Find out the interaction effect of plant spacing and weed management methods on jute yield
- Find out the economic viability of herbicide application on jute cultivation.



Chapter 2

Review of literature

REVIEW OF LITERATURE

Jute is a fibre-yielding crop with whereby the yield is obtained from the bark of individual plant. This signifies that an overall increase in vegetative growth of plants could directly be related to the crop yield. Therefore, inputs in kinds, plant density and weed management may have much to do as far as the fibre yield. Weed management and plant density has direct relation with jute yield as well as its cost. The proper weed control procedure and plant density is thus important to the farmer for lowest cost of production and less labor to gain higher yield of jute production. A brief review on the jute crop response to yield of fibre in Bangladesh and else where has been presented below:

2.1 Plant spacing of jute and other crops

Alamgir (2007) reported three population densities of 3.0, 3.5, and 4.0 lac ha^{-1} with two white jute varieties BJC-83 and CVE-3. The highest fibre yield was recorded in variety CVE-3 with 3.5 lac ha^{-1} at 120 days harvest. The crops having the population density of 3.0 lac ha^{-1} gave the highest bundle strength. Higher gross return was found in BJC-83 with population density of 4.0 lac ha^{-1} at 105 days harvesting. The highest benefit cost ratio was calculated from BJC-83 with 4.0 lac ha^{-1} (population density) and 105 days of harvesting time.

Bekheet *et al.* (2006) found that the planting densities (70 000, 93 000 and 140 000 plants/fed) that were obtained from planting hills at 20, 15 and 10 cm spacing within row were allocated in the main plots, while subplots were assigned to weed control treatments, namely: hand hoeing once at 15 days after sowing; applications of Gesaprim 90% (atrazine) herbicide at rate of 600 g/fed, Gesaprim 80% herbicide at a rate of 750 g/fed, and Herbazen 80% at a rate of

750 g/fed.; and unweeded (control). Results showed that planting density of 140 000 sweet sorghum/fed revealed a significant reduction in dry weight of narrow and broadleaved weeds as well as total dry weight of weeds compared with planting 70 000 plants/fed. The application of Herbazen 90% and Gesaprim 80% or 90% significantly reduced the dry weight of narrow leaved weeds, while practicing hand hoeing twice at 15 and 28 days after sowing was the best in reducing dry weight of broadleaved weeds. Application of these three herbicides reduced the total dry weight of weeds. Increasing planting density from 70 000 to 140 000 plants/fed resulted in a significant increase in stalk height, and yield of stripped stalks.

Baldwin and Graham (2006) observed that four row spacing, four population densities, and two cultivars of kenaf were examined to determine these effects on dry matter accumulation and bark content. Of all factors evaluated, only row spacing significantly affected dry matter yield. Yield was maximum at the 35.5 cm row spacing and lowest at the 71 and 101.6 cm row spacing. With regard to bast yield, calculated as a percentage of total sample dry weight, a significant cultivar x row spacing interaction occurred. However, data indicated that manipulating row spacing to maximize total stalk yield per hectare resulted in the highest bast fibre yield for the two cultivars tested. The narrowest row spacing of 35.5 cm, gave the highest biomass yield as well as the highest bark yield per hectare.

Gaytan (2004) reported that there was no cotton yield response to row distances or crop distances or crop densities. The 50-cm rows matured 85% of the bolls one week earlier; crop cover closed 10 days earlier, and developed less LAI than the 76-cm rows (control). Crop covers close, LAI and yield components were not affected by crop density. All treatments showed better fibre quality. Benefits of planting cotton in ultra-narrow rows include a short crop cycle and low machinery use.

Deligeorgidis (2002) found that in cotton the accuracy obtained in estimating mean population density increased with the increase of the mean. Furthermore, the increase in mean population density caused an exponential decrease in sample size. However, the precision level was acceptable only in high mean values, while at the same time the benefit from an increase in sample size in of no practical value.

Palomo *et al.* (2001) observed that the average yield of irrigation treatments was 55% higher than that obtained with two times irrigation. Yield component values and fibre fineness and length increased as the number of irrigation applications increased, but fibre strength decreased. Plant density did not affect yield of cotton, but the number of bolls per plant and fibre strength decreased as the plant density increased.

Bendarz *et al.* (2000) found that in cotton lower population densities led to plants with more mainstem nodes and monopodial branches with increased fruit retention, resulting in greater fruit production per plant. Boll size was inversely related to population density. Mean net assimilation rate from first flower to peak bloom was also inversely related to population density. Fruit production on a ground area basis was greater in the first sympodial position as population density increased, while fruit production on a ground area basis was greater in the first sympodial position as population density increased, while fruit production on a ground area basis in third positions and monopodial branches was greater as population density decrease. Accumulative seed cotton from sympodial branches also increased with population density. Total fruit number and seed cotton yield per acre were not influenced by population density in these studies. Yield stability across population densities was achieved through manipulation of boll occurrence and weight.

Jones and wells (1998) reported that plant population did not affect total lint yield. Because of favorable late-season weather, plants grown at 2 plants m^{-1} produced more bolls on vegetative branches and at more distal sympodial positions than plants grown at 12 plants m^{-1}. Boll weight and micronaire were generally higher for earlier bolls at all positions for the lower population density. Later bolls exhibited poorer boll and fibre properties, indicating negative effects of reduced heat unit accumulation by later bolls. The findings indicated that replanting, which might delay stand establishment by 3 to 4 wk, would be of little help toward improving fibre yield because it would rely more heavily on later produced bolls.

Boquet and Caco (1997) reported that the increased bloom production and seemingly higher yield potential, lint yield was not increased by closer row spacing in cotton crop. Significant row spacing x N fertilizer rate and row spacing x plant density yield interactions were observed.

Jones and Wells (1997) explained that the cotton plants grown at the low population density exhibited large increases in the vegetative dry weight of individual plants at maturity; however, all parameters of vegetative growth were reduced on a land area basis. Reproductive development of the 2 plants m^{-2} treatment was prolonged because of fewer early fruiting sites per unit land area, and there was average 16-d delay in flowering. No differences in total flowers per meter or flower retention occurred between treatments at final harvest.

Alam (1994) reported the effect of plant population and time of sowing on yield of a promising cotton genotype BAC-49. Four dates of planting (July 20, August 05, August 20 and September 05) and four plant population levels (1, 2, 3 and 4 plants $hill^{-1}$) were tested. The highest mean seed cotton yields were obtained from August 05 planting at Joydebpur,July 20 planting at Rangpur and Jessore, July 20, August 20 at Rangpur and Jessore, and August 05 to August 20 at Joydebpur were found to be optimum times to planting. Seed cotton yield was highest with 2 plants $hill^{-1}$ at all locations tested.

Hossain *et al.* (1988) observed that the stage of harvest had significant effect on all the agronomic characters of tossa jute studied. The average flowering stage produced maximum fibre yield of 3242 kg per hectare which was significantly higher to those of early (top splitting) and late (early pod) stages. Though, all the first and second degree interaction effects were not significant on all the agronomic characters, the higher doses of fertilizer, closer spacing and later stages of harvest in any combination showed the tendency of higher productivity.

Hashim *et al.* (1984) tested that the six treatments viz. (T_1) line sowing with 2 hoeing at 15 and 45 days; (T_2) line sowing with 3 hoeing at 15, 30 and 45 days; (T_3) line sowing with 2 hand weeding at 30 and 45 days; (T_4). Broadcast with one raking at 15 days and one hand weeding at 30 days; (T_5). Broadcast sowing with one raking at 15 days and 2 hands weeding at 30 &45 days; (T_6). Broadcast sowing with one raking at 15 days, one hand weeding at 30 days, one tanabach at 45 days and one katabachat 60 days after sowing, to find out suitable methods of cultural practices for minimizing cost of production and attaining optimum yield of fibre in *C. capsularis*. There was significant difference in yield due to different treatment and significantly higher yield was obtained (1.89 t ha^{-1}) in broadcast sowing (T6) with one raking at 15

days, one hand weeding at 30 days, one Tanabach at 45 days and one Katabach at 60 days after sowing.

Hossain (1984) observed that the response of row orientation and row spacing (22.5, 30,37,5 cm) on the growth and yield of *C. capsularis* cv. CVL-1 indicated that row orientation did not affect the growth and yield of crop. Row spacing ranging from 22.5 to 37.5 cm also did not affect the fibre yield, although, it showed an increasing trend in yield with the decrease of row distances.

Hasim *et al.* (1983) found that the optimum density of plants keeping initial population 1.74, 2.61 and 3.48 lakh ac^{-1} for maximum fibre yield using car. CVL-1. It was observed that at Faridpur with an initial population of 2.61 lakh in 22.5 x 6.73 cm spacing gave highest yield (28.48 mds ac^{-1}). At Chandina and Jagir, highest yield was obtained at 15x7.5 cm spacing where initial population was 3.48 lakh $acre^{-1}$. However, It was very difficult to achieve desired harvest populations of more that 2.5 lakh ac^{-1}.

Hossain (1983) observed that the row spacing ranging from 22.5 to 37.5 cm did not affect the fibre yield of jute, although it showed an increasing trend in yield with the decrease of row distances. The closer row spacing interacted with either row directions produced comparatively higher but statistically identical yield.

Talukder *et al.* (1983) reported that the effect of early and late sowing at various spacing on the yield of var. CVL-1, the interaction between date of sowing and spacing was significant at 5% level. Fibre yield was significantly higher on 13 March with 15x7.5 cm spacing followed by 27th March with 30

cm x 5 cm (control) and 3rd May with 15x7.5 cm^2 spacing. However, in latter two treatments, fibre yield was not significantly different between them.

Hasim and Wahhab (1982) reported that the cultivar CVL-1 was grown with three different spacing each of which varied in three different patterns like 225 cm (15x15, 22.5x10, 30x7.5), 150 cm (15x10, 22.5x6.67, 30x5) and 112.5 cm (15x7.5, 22.5x5, 30x3.75). Result revealed that the crops of 22.5 and 30 cm row to row distances gave higher fibre yield irrespective of spacing and their patterns.

Hossain and Wahhab (1982) found that the *C. olitorius*, cultivar, 0-4, the crop was sown on 5 June with spacings 30 cm x 10 cm, 30 cm x 15 cm, 31 cm x 20 cm, 45 cm x 10 cm and 45 cm x 15 cm per plant and deheading treatment was imposed on 47 days of sowing. The results revealed that the non-deheaded crops gave a slight edge over deheaded crops gave a slight edge over deheaded crops in respect of number of fruits per plant and yield of seed. However, plant spacing influenced the seed yield. Higher yields were obtained from 45x10 and 45x15 cm per plant.

Talukder and Wahhab (1982) reported that the cultivar CVL-1 was sown at 13 and 27 March and 30 April with plant spacing of 30 cm x 15 cm and 15 cm x 7.5 cm per plant. Results indicated that the crops sown on March 27 gave the highest fibre yield of 2.62 t ha^{-1} followed by March 13 and April 30 (1.88 and 1.62 ha^{-1} respectively). The spacing 15x7.5 cm per plant yielded higher but the differences were insignificant in comparison to other spacing.

Hossain and Wahhab (1982) explained that the fertilizer dose (45-5.6-18, 67.5-8.4-27 and 90-11.2-36 kg N P K per hectare), plant spacing (22.5x5, 3.x5 and 3.x10 cm per plant) and harvesting at (top splitting, average flowering and

early pod) different stages. The cultivar CVL-1 of *C.capsularis* was sown on March 30. Results indicated that the crops grown with higher doses of fertilizer and harvested at early pod stage gave higher fibre irrespective of plant spacing.

Saha and Paul (1981) reported the dry matter production, partition and yield of *Corchorous capsularis* L. cv. D-154 and *C. olitorius* L. cv. C.G. For dry matter yield, ten harvests were taken at 4 days intervals and dry weight at the early stages of growth, but at the later stages the relative order was reversed with *C. olitorius* L. having higher dry weight. Significant species differences were observed at many sages of growth. For yield and yield components, plants were harvested at 98 days after sowing. *C. olitorius* L. had variety had significantly greater plant height, middle stem diameter and green weight as well as fibre yield. For better yield, selection should be based on the stem diameter, at the base and middle and the plant height.

Hashim *et al.* (1981) found that the four plant densities (348, 261, 232&174 Thousand per acre) were arranged in different planting patterns of 45, 60, 67.5 and 90 sq cm. plant^{-1}. Although there was no significant difference in yield between the treatments, higher densities of population produced higher yield. Among the sowing patterns 15x7.5 cm pattern had the highest yield followed by 22.5x5 cm and 10x11.25 cm. However, 22.50 cm row width displayed better performance compared to other row widths.

Hashim (1980) tested three cultivars viz. D-154, CC-45, and CVL-1 in 3 spacing (15x5 cm, 22x5 cm and 25x5 cm). Resulted that the cultivars D-154 and CVL-1 gave significantly higher yield compared to CC-45. Plant spacing did not affect the fibre yield.

Rahman *et al.* (1979) found that the relative performance of the varieties CVL-1, D-154, and CC-45 at 15, 22.5 and 30 cm rows apart with 45, 79 and 112 kg /ha revealed that CVL-1 registered highest yield closely followed by D-154 and markedly by CC-45. Fifteen and 22.5 cm spacing gave more or less similar yield whereas 30 cm spacing gave slightly lower yield. Yield increased gradually with the increase of nitrogen levels but the difference was not significant.

Sobhan (1978) reported that a species of 9 inch between rows and 3 inch between plants appeared to be superior to other spacing for seed yield of mesta S-24 cultivar of *Hibiscus sabdariffa,* but plant height, base diameter and number of capsules per plant increased with the increase of row and plant spacing. The seed yield per acre increased with the decreases of row and plant spacing.

2.2 Weeding practice in jute and other crops

Prasad *et al.* (2007) reported that the post-emergence application of quizalofop-ethyl (quizalofop) 5 EC at 0.2%, followed by 1, 2 hand weedings, cost ratio were 1.92 and 1.62 over untreated control and 1.58, 1.28 over farmers' practice, respectively.

Smith (2006) reported that the herbicide application during crop establishment markedly inhibited the growth of both seedling weeds and crops. The mixture caused the highest weed and crop injury. Pendimethalin at 0.33 kg ha^{-1} had minimal effect on these crops. Weed growth, weed tolerance of herbicide treatment and crop seedling injury were higher in tossa jute. The use of low pendimethalin doses in an integrated weed management system will ensure effective control of seedling weeds, and prevent crop injury and residue accumulation in edible plant produce.

Sitangshu and Sarkar (2006) explained that highest weed control efficiency (WCE) of 96.6% was noted for the hand weeding treatment. Among the herbicides, Fenoxaprop-p-ethyl at 75 g ha^{-1} showed highest WCE (86.6%), closely followed by Quizalofop ethyl (79%). The dominant grass weed was *Echinochloa colona* (96%) and the broadleaved weeds (3%) included *Physalis minima* and *Phyllanthus niruri*. Post-emergence application of Fenoxaprop-p-ethyl @ 75 g ha^{-1} or Quizalofop ethyl @ 50 g ha^{-1} at 21 days after sowing (when the grass weeds are at four-leaf stage) effectively controlled the grass weeds giving higher jute fibre yield and net return per rupee invested (2.0 and 1.87 respectively).

Adenawoola *et al.* (2005) observed that the frequency of weeding conducive to optimum growth and yield of jute in Nigeria. Results indicated that weeding once as early as 2, 3 or 4 weeks after sowing (WAS) was not as beneficial to the growth and yield of jute as two weedings conducted at 2 and 5 WAS or 3 and 6 WAS. Weeding once every week throughout the duration of crop growth significantly ($P<0.05$) enhanced all growth and yield parameters over most of the treatments. Bearing in mind the economics of labour input and yield, two weeding operations at 2 and 5 WAS was the most promising of all the treatments.

Manuel and Panneerselvam (2005) reported that the predominant weeds in the area were *Cyperus rotundus*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Echinochloa colona*, *Panicum repens*, *Acalypha indica*, *Commelina benghalensis*, *Cleome viscosa*, *Corchorus olitorius* and *Trianthema portulacastrum*. Hoeing resulted in the lowest weed dry weight (197.60 kg ha^{-1}). The highest cane yields were obtained with hoeing (97.60 t ha^{-1}), 2.0 kg atrazine ha^{-1} (94.60 t ha^{-1}), and 1.5 kg pendimethalin/ha (92.33 t ha^{-1}).

Abhijit *et al.* (2004) reported that in three weed management practices: no weeding, manual weeding twice at 3 and 6 weeks after sowing (WAS) and wheel hoeing twice at 3 and 6 WAS. Among the three weed management treatments, the manual weeding twice at 3 and 6 WAS, which recorded the lowest weed population and weed dry weight during the entire crop period and the highest fibre yield of jute, was the best.

Billore and Brown (2001) found that in Soyabean cultivation, two-hand weeding and 2-intercultivation (farmers practice) were carried out on 3rd and 6th weeks after sowing. The prominent weed species during the experiment were *Echinochloa crus-galli, Dinebra arabica, Digitaria sanguinalis, Cyperus rotundus, Cynodon dactylon, Euphorbia geniculata, Digera arvensis, Eclipta alba, Corchorus olitorius and Acalypha indica*. The maximum and minimum nodules were associated with application of fenoxoprop-P-ethyl at 70 g ha^{-1} and 2-hand weeding, respectively. The nodule dry weight was maximum in 2-intercultivation, whereas it was minimum with weedy control. Almost all herbicides controlled weeds effectively at 30 days after sowing. At 60 days after sowing, lactofen and imazethapyr did not affect the number of weeds but showed reduction in dry weight of weeds.

Rajput (2000) explained that Application of fluchloralin at 1.0 kg ha^{-1} at 3 days before sowing, followed by hand-weeding 4 weeks after sowing + 2 wheel-hoeing at 3 and 5 weeks after sowing recorded the lowest weed density and weed dry weight. Fibre yield, net return and benefit:cost ratio were higher with this treatment. The increase of jute fibre yield ranged from 40.3% to 69.1% due to different weed management practices over unweeded control.

Iqbal *et al.* (1988) found that eight treatments-no weeding, hand weeding, weeding by hand hoe and Basalin at 1.50, 1.75, 2.00, 2.25 and 2.50 lha^{-1} were included in the experiment to evaluate the effectivenessof Basalin as a weedicide in jute (*Corchorul capsulris*). Different doses of Basalin controlled

81-92 of *Echinochloa crusgalli*, 51-59 *Eleusine indica* and 52-85 *Scirpus mucronatus* out of nine weed species identified to infest the crop. The other infested weeds including *Cyperus rotundus* were either not sensitive or slightly sensitige to Basalin. Baslin had some adverse effect on the germination of jute seeds; however, no phytotoxicity was noticed on jute plants. Hand weeding produced the highest fibre yield per plot which was identical to that of Basalin treatment at 1.75 l ha^{-1}. The lowest fibre yield was obtained from no weeding treatment which was identical to other Basalin treatments and weeding by hand hoe.

Hashim and Hossain (1987) reported that the CVL-1, Dhabdhabcy and O-9897 to find out yield due to different management practices like number of raking, weeding and their combinations. The results showed that the treatment consisting of three hand weeding gave the maximum yield and was closely followed by one raking +one weeding treatment which produced 3.15 and 3.08 t ha^{-1} fibre, respectively, both of which were significantly superior to rest of the weeding treatments.

Hashim and Hossain (1986) reported that the Cv. CVL-1 was assessed at three sites at Kishoreganj, Rangpur and JAES, Jagir. Except Kishoreganj there was no significant difference in yield due to treatments where highest yield was obtained in broadcast seeding @ 9.88 kg ha^{-1}. However, location effect was found to be significant. Combined analysis showed higher yield at spacing 15 cm x 15 cm and 18 cm x18 cm copared to other spacings and seed rates. Higher yield was obtained at Jagir among the locations.

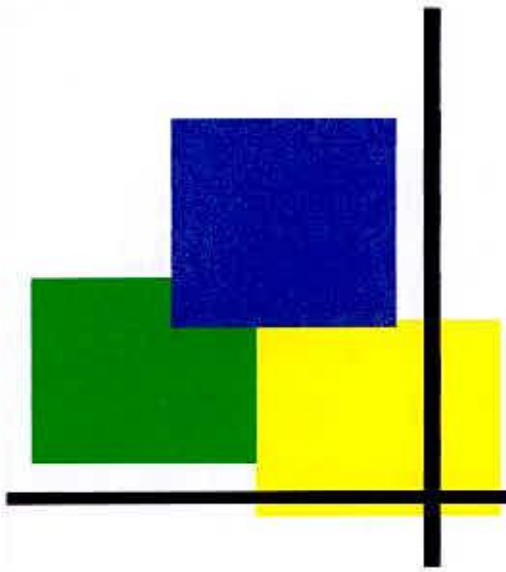
Ahad and Wahhab (1981) found that the weeding operation of the cultivar CVL-1 was carried out up to 10, 20, 30, 40 and 50 days and then discontinued and resultant yield were compared with normal 3 weeding practices. There was no significant difference in yield among the treatments except no weeding which gave the lowest yield.

Ahad and Wahhab (1980 a) explained that the minimize weeding cost by intercropping mungbean with *C. capsularis* Cv. D-154 results indicated that sowing of mugnbean after 20 days of jute sowing (Jute + mungbean) gave the maximum yield of mungbean as well as jute without any further cost of weeding.

Ahad and Wahahb (1980 b) reported that the weeding operations after 10, 20, 30, 40, 50 days after emergence (DAE) and again weeding operation upto 10, 20, 30,40 and 50 DAE were compare with no weeding and normal weeding practice results revealed that normal practice gave higher Yield compared to other treatments.

Hashim (1980) observed that the management practices like number of raking, weeding in relation to different cultivars (CVL-1), O-9897 and CVE-3) were conducted in different locations (Faridpur, Kishoreganj & Chandina) to economise crop production. One raking and one hand weeding gave signigicantly higher yield across different locations compared to other treatments consisting of more number of intercultural operations (i.e. 3 hand weedings, 2 raking+ 1 hand weeding and 1 raking +1 weeding + Tanabach & Katabach).

From above review, it is important revealed that management of spacing and weed is required for higher yield of jute.



Chapter 3

Materials and Methods

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site description, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, fertilizer application, intercultural operations, data collection and statistical analysis.

3.1 Experimental period

The experiment was conducted during the period from April to July, 2009 in Kharif-1 season.

3.2 Description of the experimental site

3.2.1 Geographical location

The experiment was conducted in the Sher-e-Bangla Agricultural University farm, Dhaka, under the agro-ecological zone of Modhupur Tract, AEZ-28. For better understanding about the experimental site is shown in the Map of AEZ of Bangladesh in Appendix I.

3.2.2 Climate

The experimental area under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-August) and rainfall associated with moderately temperature during the kharif-1 season (April-August). During the experiment highest (647 mm) rainfall was observed in the month of July and average rainfall (173 mm) was found in rest of the other months. Average minimum and maximum temperature were found 25.8° C and 34° C, respectively. The weather data during the study period at the experimental site are shown in Appendix II.

3.2.3 Soil

The farm belongs to the General soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done at Soil Resource and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil are presented in Appendix III.

3.3 Experimental material

Jute variety CVL-1 was used as the test crop.

3.3.1. Description of Jute cultivar

BJRI Deshi-2 (CVL-1)

The variety was developed by BJRI which is the most popular and widely cultivated variety in Kharif-1 season. The variety is released in 1977. This plant is green in color. Leaf is green wide and oval shaped. It attains a plant height of 3.5-4.0 m and plant basal diameter can be up to 22 mm. This cultivar matures at 120-125 days of planting. The cultivar gives an average fiber yield of 5.16 t ha^{-1}.

3.3.2 Seed collection: The seeds of CVL-1 was collected from the Agronomy Department of Bangladesh Jute Research Institute (BJRI), Dhaka.

3.3.3 Experimental details

3.3.4 Experimental treatments

Two sets of treatments included in the experiment were as follows:

A. Factor: Weed management (4)

W_1=Recommended practices recommended by BJRI (2HW+1R)

W_2=1time herbicide Whip Super 9 EC (Fenoxaprop-P-ethyl: $C_{18}H_{16}ClNO_5$) application (2-4 leaf stage of weed) at 15 DAS

W_3=2 weeding (20+40 DAS)

W_4=3 weeding (15+30+45 DAS)

B. Factor: Plant spacing (4)

S_1=Line sowing, 20 cm x 10 cm

S_2=Line sowing, 25 cm x 10 cm

S_3=Line sowing, 30 cm x 10 cm

S_4=Broadcasting

3.3.5 Treatment combinations

There were 16 treatment combinations obtained from the above treatments as follows:

S_1W_1	S_3W_1
S_1W_2	S_3W_2
S_1W_3	S_3W_3
S_1W_4	S_3W_4
S_2W_1	S_4W_1
S_2W_2	S_4W_2
S_2W_3	S_4W_3
S_2W_4	S_4W_4

3.3.6 Experimental design

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 x 3 m = 12 m^2. The distances between sub-plot to sub-plot, main plot to main plot and replication to replication were, 0.75, 1.0 and 1.5 m respectively.

3.4 Conduction of the experiment

3.4.1 Preparation of experimental land

The experimental field was first opened on 15 March, 2009 with the help of a power tiller; later the land was irrigated and prepared by three successive ploughings and cross-ploughings. Each ploughing was followed by laddering to have a good tilt field. All kinds of weeds and residues of previous crop were removed from the field. The field layout was made on 5th April, 2009 according to design immediately after final land preparation. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.4.2 Fertilizer management

The plots were fertilized with the N, P_2O_5, K_2O and S at the rate of 77, 10, 18 and 8 kg ha^{-1} respectively. One-third of N and other fertilizers were broadcasted during the time of final land preparation. Rest two-third of urea was top dressed in two equal splits on 20 and 35 days after sowing.

3.4.3 Sowing of seeds

Respective seed were sown on 6 April, 2009 by following different line sowing and broadcasting method. The seed rate was 7 kg ha^{-1}. In line sowing (20 cm x10 cm), (25 cm x 10 cm), (30 cm x 10 cm) row to row and plant to plant distances were maintained.

3.4.4 Intercultural operations

Each plot was weeded as per treatments. Thinning was also done simultaneously. The final thinning of jute plant were carefully done to maintain a row to row distance and plant distance on 20 cm x 10 cm, 25 cm x 10 cm, 30 cm x 10 cm which contributed to adjusted the population density in different plots. The crop was not infested by any insects or diseases. Therefore, no insect-pests and disease control measures were adopted. Irrigation was required for the crops for two times at 45 and 60 days after sowing.

3.4.5 General observation of the experimental field

The field was investigated time to time to detect visual difference among the treatment and any kind of infestation by insects and diseases so that considerable losses by pest should be minimized. The field looked nice with normal green color plants.

3.4.6 Sampling harvesting and processing

Prior to harvest ten randomly selected plants from each unit plot were collected from out side the central 1 m^2 to take data on yield components. The jute plants of the plots were harvested on 21 July.

3.4.7 Ten plants random sampling

After harvest the following observations were recorded from 10 plants:

a) Plant height: The height was measured from the ground level to the top of the plants.

b) Base diameter / Middle diameter /Top diameter: The diameters of different portion of plants were determined by slide calipers (mm).

3.4.8 Observations of sampling

a) Fiber-Stick ratio:

The Fiber-Stick ratio was calculated from the area as follows:

$$\text{Fiber : Stick} = \frac{\text{Dry weight of fiber } (m^{-2})}{\text{Dry weight of stick } (m^{-2})}$$

b) Harvest index (HI):

Harvest index Kar and Singh (2005) was calculated from the samples as follows:

$$\text{Harvest index (HI)} = \frac{\text{Fiber Yield } (m^{-2})}{(\text{Fiber Yield + Stick yield})(m^{-2})} \times 100$$

$$\text{c) Fiber-Stick ratio} = \frac{\text{Fibre}}{\text{Stick}}$$

3.4.9 Harvesting and Leaf shedding

At harvest each 1 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. The jute plant was cut at the ground level with the help of a sickle. The fibre and stick yields were recorded from the whole individual plot. Then fibre and stick yields were recorded from the whole individual plot. Then the harvested jute plants were made into bundles. The bundle attached with tag level. The bundles of each plot were then left into stake separately for 3-5 days

for defoliation. The defoliation jute leaf was kept into the respective plot to incorporate with the soil.

3.4.10 Jute plant retting

The Bundles of jute plants were put into Jag means by arranging the bundle in row and cross row pattern in retting pond. After making the Jag it was steeped in pond water with the help of water hyacinth and other aquatic weed. The depth of water was sufficient to allow the jute bundle to float. Alam (1981) reported that at least a depth of 1.8 m. water is required for ideal retting.

3.4.11 Fiber stripping

The jute fiber was stripped from stick manually after completion of proper retting. At fiber stripping the upper layer of bark was removed from lower portion of the jute plant by hand pushing to minimize the cuttings. The fiber was washed in clean water to ensure quality fiber.

3.4.12 Drying of fiber and stick

The fiber was dried on bamboo bar under direct sunshine for 4-5 days to complete drying. The dryness of fiber was observed by 'hand touch' to ensure the dryness. The fiber bundles were assorted plot wise, tag labels and weighed. Jute sticks were also dried continuously in seven days to get dry sticks and then weighed.

3.4.13 Relative weed density (RWD)

$$\text{Relative weed density (RWD)} = \frac{\text{Density of individual weed species in the community.}}{\text{Total density of all weed species in the community.}} \times 100$$

3.4.14 Plot yield

a) After retting for about 15-17 days the extracted fibre was sun dried for 5 days to record fibre yield plot^{-1}and converted into t ha^{-1}.

b) Stick yield: Sun dried sticks yield plot^{-1} was determined and obtain from the whole plot after harvest and converted into t ha^{-1}.

3.5 Recording of data

Data on yield, yield components and quality components were recorded on the following parameters:

A. Agronomic data

i) Dates of sowing and harvesting.
ii) Plant height of randomly selected 10 plants (m)
iii) Top, middle and bottom diameter of 10 selected plants (mm)
iv) Fibre yield (t ha^{-1})
v) Stick yield (t ha^{-1})
vi) Harvest index (%)
vii) Fibre stick ratio
viii) Weeds m^{-2} plot^{-1}

B. Yield contributing characters

i) Weight of fiber 2m^{-2} plots^{-1}
ii) Weight of stick 2m^{-2} plots^{-1}
iii) Leaves plant^{-1}
iv) Branches plant^{-1}
v) Weight of weeds m^{-2}

C. Economic data

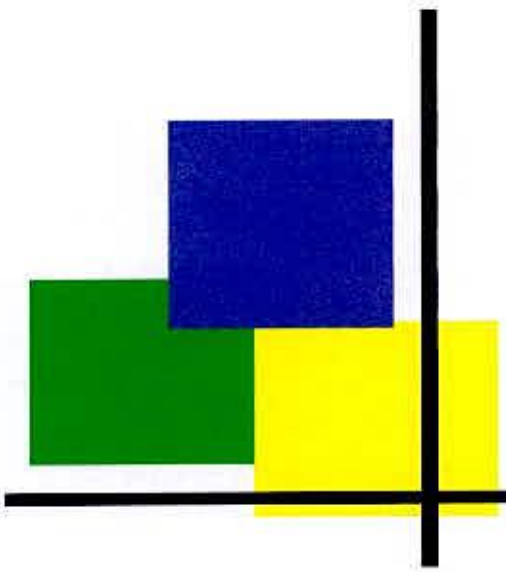
i) Total variable cost

ii) Gross margin

iii) Benefit cost ratio

3.6 Analysis of data

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.



Chapter 4

Results and Discussion

RESULTS AND DISCUSSION

The experiment was conducted to find out the efficacy of sowing management and weeding on yield of white jute (var.CVL-1). The experiment was laid out in a split-plot design with three replications and consisted of four plant spacing *viz.* 20 cm x 10 cm, 25 cm x 10 cm, 30 cm x 10 cm and broadcasting and four weed management *viz.* two times hand weeding with one raking, herbicide application at 2-4 leaf stage of weed, two times hand weeding at 20 DAS +40 DAS and three times hand weeding at 15 DAS+30 DAS +45 DAS to find out the results.

4.1 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.* (2008). In this study it was also observed that grasses and sedges were dominating weed species.

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

Botanical Name	Family	Types weed	Relative density(%)	
			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	-	-

Note: (-) = Trace percentage

4.2 Weed Control

The significant effect on total weed population m^{-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 time herbicide application at 2-4 leaf stage of weed) produced the lowest (1.94 g m^{-2}) amount of weed dry matter at 30 DAS which was statistically different from others and highest (4.44 g m^{-2}) amount of weed dry matter from W_3 (2 weeding at 20+40 DAS). Similar trend was also observed at 60 DAS. It reveals that use of herbicide effectively reduced the weed biomass production. The differences were more prominent at earlier growth stage (30 DAS). Alam *et al.* (1996) and Singh *et al.* (1992) also found the similar result.

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

Treatment	Weed dry matter (g m^{-2})	
	30 DAS	60 DAS
W_1	3.55	10.00
W_2	1.94	6.63
W_3	4.44	16.81
W_4	3.18	7.79
$LSD_{5\%}$	0.5756	1.401
CV %	8.82	6.81

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

4.3 Plant Height

4.3.1 Effect of spacing

Plant height of the cultivars were measured at 15, 30, 45, 60, 75 DAS and at maturity. It was found from Figure 1 and Appendix IV that the height of the plant was significantly influenced by spacing at 75 DAS. Figure 1 shows that, the height of jute plants increased rapidly at the early stages of growth and rate of progression in height was slow at the later stages. At 75 DAS significantly highest (2.36 m) plant height was observed from S_1 (20 cm x 10 cm) which was statistically similar with S_2 (25 cm x 10 cm) and lowest (2.10 m) plant height was observed from S_4 (broadcasting). Such result was in agreement with finding of Madakaze *et al.* (2007).

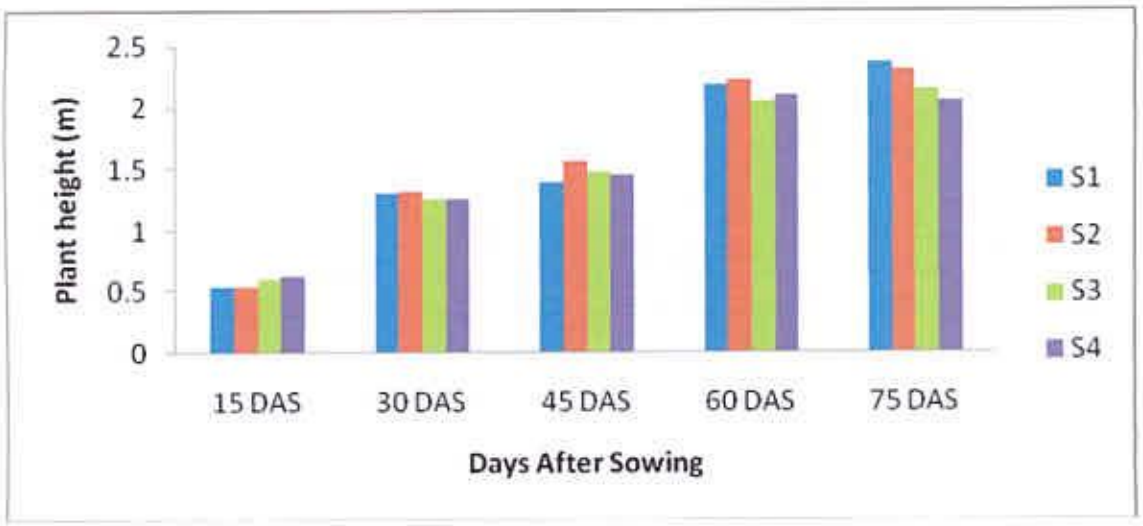


Figure 1. Effect of spacing on plant height of jute ($LSD_{.005}$ = 0.1599, 0.2261, 0.4684, 0.2730, 0.3545 at 15, 30, 45, 60 and 75 DAS, respectively.

4.3.2 Effect of weed management:

Weed management had no significant effect on plant height (Figure 2 and Appendix IV). Plant height was also unaffected by the different weed management at 15, 30, 45, 60 and 75 DAS. At 75 DAS, numerically the tallest plant (2.31 m) was obtained from W_3 (2 weeding (20+40 DAS)) and the shortest plant (2.10 m) was obtained from W_1 (Recommended practices recommended by BJRI (2W+1R)). Similar result was also observed by Smith *et al.* (2006).

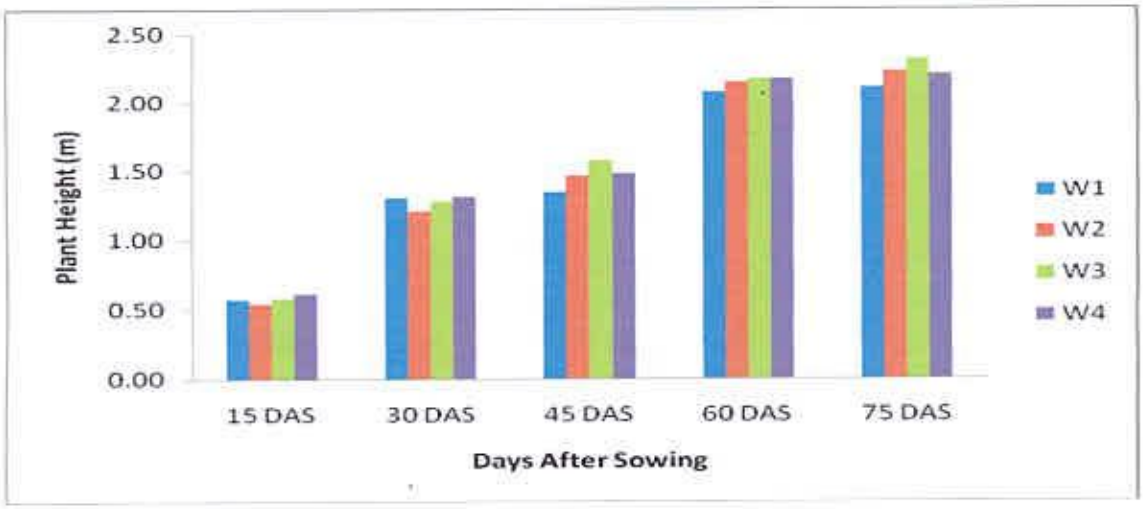


Figure 2. Effect of weed management methods on jute ($LSD_{.005}$ = 0.1599, 0.2261, 0.4684, 0.2730, 0.3545 at 15, 30, 45, 60 and 75 DAS, respectively.

4.3.3 Interaction effect of spacing and weed management

Interaction effect of spacing and weed management on plant height was found significant at different date of sampling (Table 3). At 15, 30, 45 and 60 DAS significantly highest (0.75 m), (1.40 m), (1.73 m), (2.37 m) were observed from the combination of S_4W_4 and S_4W_3, S_2W_1, S_3W_3, and S_1W_2, respectively. Lowest (0.30), (1.07), (1.29), (1.80) was found from the combination of S_2W_1, S_3W_2, S_3W_1, and S_4W_1. At 75 DAS significantly highest (2.43 m) plant height was observed from the combination of S_1W_3 and lowest (1.83 m) was found from the combination of S_4W_1.

Table 3. Interaction effect of spacing and weed management on jute

Treatment	Plant height (m)				
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1W_1	0.57	1.37	1.38	2.18	2.21
S_1W_2	0.54	1.38	1.54	2.37	2.42
S_1W_3	0.58	1.24	1.43	2.20	2.43
S_1W_4	0.61	1.22	1.51	1.95	2.37
S_2W_1	0.30	1.40	1.66	2.34	2.27
S_2W_2	0.58	1.24	1.47	2.17	2.39
S_2W_3	0.52	1.24	1.55	2.17	2.31
S_2W_4	0.54	1.35	1.55	2.19	2.25
S_3W_1	0.55	1.27	1.29	1.96	2.10
S_3W_2	0.60	1.07	1.44	1.82	2.12
S_3W_3	0.44	1.26	1.73	2.12	2.24
S_3W_4	0.58	1.38	1.47	2.31	2.12
S_4W_1	0.56	1.15	1.43	1.80	1.83
S_4W_2	0.48	1.16	1.40	2.21	2.06
S_4W_3	0.61	1.37	1.58	2.20	2.24
S_4W_4	0.75	1.30	1.38	2.20	2.25
$LSD_{5\%}$	0.1846	0.2611	0.5408	0.4093	0.3153
CV%	18.63	12.03	21.95	11.40	8.44

4.4 Yield Contributing Characters

4.4. 1 Effect of spacing

Table 4 reveals that plant height at harvesting, the base, middle and top diameter significantly influenced by different spacing. Significantly highest (2.73 m) plant height at harvest was found from S_1 (20 cm x 10 cm) which was statistically similar 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 x 10 cm) which was statistically similar with S_3 and lowest base diameter was found from S_4 (broadcasting). Highest (7.07 mm) middle diameter was found from S_3 (30 cm x 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 x 10 cm) and lowest (2.72 mm) top diameter was found from S_4 (broadcasting). Sobhan (1978) also found similar result.

Table 4. Effect of spacing on yield contributing character of jute

Treatment	Plant height at harvest (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)
S_1	2.73	9.38	6.78	3.83
S_2	2.69	10.02	6.63	4.27
S_3	2.69	9.88	7.07	3.23
S_4	2.10	8.47	5.38	2.72
LSD $_{5\%}$	0.1515	0.9095	0.915	0.7680
CV%	6.46	9.62	11.08	18.90

S_1=Line sowing (20x10), S_2=Line sowing (25x10), S_3=Line sowing (30x10) and S_4=Broadcasting

4.4. 2 Effect of weed management

Table 5 reveals that plant height at harvesting significantly influenced by different weed management but the base, middle and top diameter was unaffected. Significantly highest (2.62 m) plant height at harvest was found from W_1=Recommended practices, recommended by BJRI (2W+1R) which was statistically similar with W_2 and lowest (2.52 m) plant height was found

from W_4=3 weeding (15+30+45 DAS). Highest (9.64 mm) base diameter was found from W_2=1 time herbicide application (2-4 leaf stage of weed) and lowest base diameter was found from W_1=Recommended practices, recommended by BJRI (2W+1R). 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+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+40 DAS). Sitangshu and Sarkar (2006) also found similar result.

Table 5. Effect of weed management on yield contributing character of jute

Treatment	Plant height at harvest (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)
W_1	2.62	9.20	6.62	3.78
W_2	2.61	9.64	6.54	3.56
W_3	2.46	9.55	6.53	3.23
W_4	2.52	9.35	6.16	3.48
LSD $_{5\%}$	0.1385	NS	NS	NS
CV%	6.46	9.62	11.08	18.90

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+40 DAS), W_4=3 weeding (15+30+45 DAS)

4.4.3 Interaction effect of spacing and weed management

The plant height, base, middle and top diameter were significantly influenced by the combination of different spacing and weed management practice (Table 6). 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_2. 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.

Table 6. Interaction effect of spacing and weed management on yield contributing character of jute

Treatment	Plant height (m)	Base diameter (mm)	Middle diameter (mm)	Top diameter (mm)
S_1W_1	2.47	9.26	6.87	4.17
S_1W_2	2.82	9.30	6.57	3.50
S_1W_3	2.62	9.00	6.73	3.83
S_1W_4	2.62	10.00	6.93	3.83
S_2W_1	2.79	9.57	7.07	4.77
S_2W_2	2.77	10.77	6.83	4.83
S_2W_3	2.59	10.00	6.77	3.63
S_2W_4	2.62	9.73	5.83	3.83
S_3W_1	2.69	9.80	7.10	3.57
S_3W_2	2.78	10.13	7.47	3.37
S_3W_3	2.59	10.50	7.12	2.70
S_3W_4	2.71	9.07	6.53	3.27
S_4W_1	2.16	8.20	5.43	2.60
S_4W_2	2.06	8.37	5.30	2.53
S_4W_3	2.05	8.70	5.43	2.73
S_4W_4	2.11	8.60	5.33	3.00
$LSD_{5\%}$	0.2769	1.530	1.206	1.118
CV%	6.46	9.62	11.08	18.90

4.5 Yield

4.5. 1 Effect of Spacing

Yield and stick yield were significantly influenced by different spacing but harvest index and fibre stick ratio was observed insignificant (Table 7). Significantly highest fibre yield (3.12 t ha^{-1}) and stick yield (7.05 t ha^{-1}) were found when spacing was S_2 (25 cm x 10 cm). However, as regard to differences in fibre and stick yield between the spacing S_1 & S_2 were insignificant. Alam and Ali (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 x10cm). Similar result also observed by Madakaze *et al.* (2007).

Table 7. Effect of spacing on the yield of jute

Treatment	Fibre yield (t ha^{-1})	Stick Yield (t ha^{-1})	Harvest Index (%)	Fibre Stick Ratio
S_1	3.09	6.16	35.08	0.57
S_2	3.12	7.05	32.33	0.49
S_3	2.37	5.63	31.75	0.47
S_4	2.62	5.95	33.08	0.52
LSD $_{5\%}$	0.5035	1.174	NS	NS
CV%	17.70	11.30	12.33	20.87

S_1=Line sowing (20x10), S_2=Line sowing (25x10), S_3=Line sowing (30x10) and S_4=Broadcasting

Yield

4.5.2 Effect of weed management on yield

Due to different weed management practices fibre yield and stick yield remained unaffected but harvest index and fibre stick ratio was varied significantly (Table 8). Numerically highest yield (3.12 t ha^{-1}) and highest stick yield (6.75 t ha^{-1}) was obtained from W_2 (1 herbicide application at 2-4 leaf stage of weed). Significantly highest harvest index (36.42) and fibre stick ratio (0.60) was also observed from W_2 (1 time herbicide application at 2-4 leaf stage of weed). Sitangshu and Sarkar (2006) also found similar result.

Table 8. Effect of weed management on the yield of jute

Treatment	Fibre yield (t ha^{-1})	Stick Yield (t ha^{-1})	Harvest Index (%)	Fibre Stick Ratio
W_1	2.97	5.65	34.83	0.55
W_2	3.12	6.75	36.42	0.60
W_3	2.34	6.41	28.25	0.40
W_4	2.76	5.96	32.75	0.49
LSD $_{5\%}$	NS	NS	0.06527	0.1531
CV%	17.70	11.30	12.33	20.87

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+40 DAS), W_4=3 weeding (15+30+45 DAS)

4.5.3 Interaction effect of spacing and weed management

The fibre yield, stick yield, harvest index and fibre stick ratio were significantly influenced by the combination of different spacing and weed management practices (Table 9). Significantly highest fibre yield (4.02 t ha^{-1}) was obtained from the combination of S_1W_2 which was similar to S_2W_1 (3.78 t ha^{-1}) and highest stick yield (8.00 t ha^{-1}) was observed from S_4W_3 which was statistically similar to S_2W_1 (7.80 t ha^{-1}). Significantly highest (40.67) harvest index was obtained from S_4W_2 which was significantly similar with S_1W_1 (40.33) and highest fibre stick ratio was found from S_1W_1 (0.69) and S_1W_2 (0.69). Such result was in agreement with those of Hossain *et al.* (1988).

Table 9. Interaction effect of spacing and weed management on the yield of jute

Treatment	Fibre yield (t ha^{-1})	Stick Yield (t ha^{-1})	Harvest Index (%)	Fibre Stick Ratio
S_1W_1	2.93	4.72	40.33	0.69
S_1W_2	4.02	6.85	39.00	0.69
S_1W_3	2.55	6.87	28.00	0.40
S_1W_4	2.85	6.20	33.00	0.50
S_2W_1	3.78	7.80	33.00	0.50
S_2W_2	3.18	7.58	33.00	0.50
S_2W_3	2.48	6.03	30.03	0.44
S_2W_4	3.02	6.78	33.00	0.50
S_3W_1	2.43	5.33	31.33	0.46
S_3W_2	2.45	6.83	33.00	0.50
S_3W_3	2.08	4.75	30.67	0.45
S_3W_4	2.52	5.58	32.00	0.47
S_4W_1	2.73	4.77	34.67	0.54
S_4W_2	2.82	5.75	40.67	0.50
S_4W_3	2.25	8.00	24.00	0.32
S_4W_4	2.65	5.27	33.00	0.50
$LSD_{5\%}$	0.9562	2.718	0.06527	0.1767
CV%	17.70	11.30	12.33	20.87

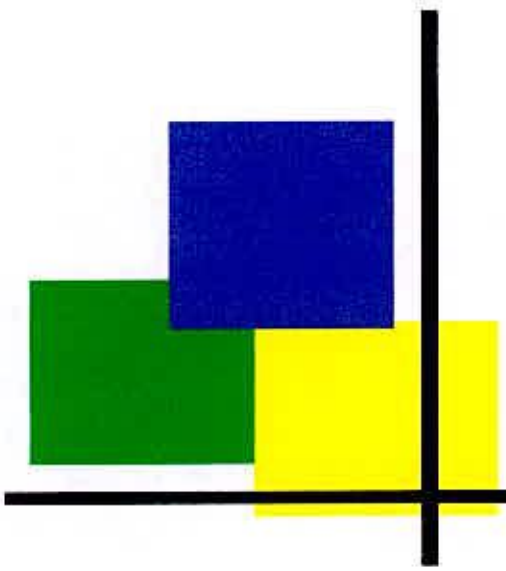
4.6 Economic performance

Gross return was found to be highest (Tk. 257630.55) in the weed management W_1. But in the benefit cost ratio (BCR) was comparatively highest (7.13) was in W_2 (1 time herbicide application at 2-4 leaf stage of weed) than other weed management practice and also the gross return (Tk. 245037.07) was remarkable. Such result is very much pertinent with another work as reported by Hossain *et al.* (1988) and Sarker *et al.* (2005) who stated that herbicide application effectively control grass weed and gave fairly good yield with better economic return.

Table 10. Cost of production and benefit cost ratio (BCR) for different weeding management of jute

Treatment	Cost (Tk. ha^{-1})					Gross return (Tk. ha^{-1})			BCR
	Fixed cost of production	Labor cost	Raking cost	Herbicide cost	Total cost	From fibre	From stick	Total	
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 = 2000/37.32x1000= 53590.57 Tk., 1 mon Stick= 500 Tk. i.e., 1 ton Stick = 500/37.32x1000= 13397 Tk.



Chapter 5

Summary and Conclusion

SUMMERY AND CONCLUSIONS

A field experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka during April to August, 2009 with a view to find out the influence of weed management methods and plant spacing on the yield of white jute (var.CVL-1). The experiment consisted of four weed management methods *viz.* two times hand weeding with one raking, one time herbicide Whip Super 9 EC (Fenoxaprop-P-ethyl: $C_{18}H_{16}ClNO_5$) application at 15 DAS, two times hand weeding at 20+40 DAS and three times hand weeding at 15+30+45 DAS and four plant spacing *viz.* 20 cm x 10 cm, 25 cm x 10 cm, 30 cm x 10 cm (20, 25 and 30 rows with plants spaced at 10 cm intervals in the row) and broadcasting. 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%). Weeding treatments significantly reduced weed population. Among the treatments W_2 (1 time herbicide application at 2-4 leaf stage of weed) reduced the weed population most effectively at every growth stages. Significant differences in weed dry weight were observed due to different weeding managements. It reveals that use of herbicide effectively reduced the weed biomass. Significantly highest (2.73 m) plant height at harvest was found from S_1 (20 cm x 10 cm), highest (10.02 mm) base diameter was found from S_2 (25 cm x 10 cm), highest (7.07 mm) middle diameter was found from S_3 (30 cm x 10 cm), highest (4.27 mm) top diameter was found from S_2 (25 cm x 10 cm).

Significantly highest (2.62 m) plant height at harvest was found from W_1=Recommended practice, recommended by BJRI (2W+1R), highest (9.64 mm) base diameter was found from W_2=1 time herbicide application (2-4 leaf stage of weed), highest (6.62 mm) middle diameter was found from W_1=Recommended practice, recommended by BJRI (2W+1R), highest (3.78 mm) top diameter was found from W_1=Recommended practice, recommended by BJRI (2W+1R). The plant height, base, middle and top diameter were

significantly influenced by the combination of different spacing and weed management practices.

Yield and stick yield were significantly influenced by different spacing but harvest index and fibre stick ratio was observed insignificant. Significantly highest fibre yield (3.12 t ha^{-1}) and stick yield (7.05 t ha^{-1}) were found when spacing was S_2 (25 cm x 10 cm). Due to different weed management fibre yield and stick yield remained unaffected but harvest index and fibre stick ratio was varied significantly. Significantly highest harvest index (36.42) and fibre stick ratio (0.60) also observed from W_2 (1 time herbicide application at 2-4 leaf stage of weed). The fibre yield, stick yield, harvest index and fibre stick ratio were significantly influenced by the combination of different spacing and weed management practices. 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 was statistically similar to S_2W_2 (7.58 t ha^{-1}). Significantly highest (40.67) harvest index was obtained from S_4W_2 which was significantly similar with S_1W_1 (40.33) and highest fibre stick ratio was found from S_1W_1 and S_1W_2.

Gross return was found to be highest (Tk. 257630.55) in the weed management W_1. But in the benefit cost ratio (BCR) was comparatively highest (7.13) in W_2 than other weed management practices and also the gross return (Tk. 245037.07) was remarkable.

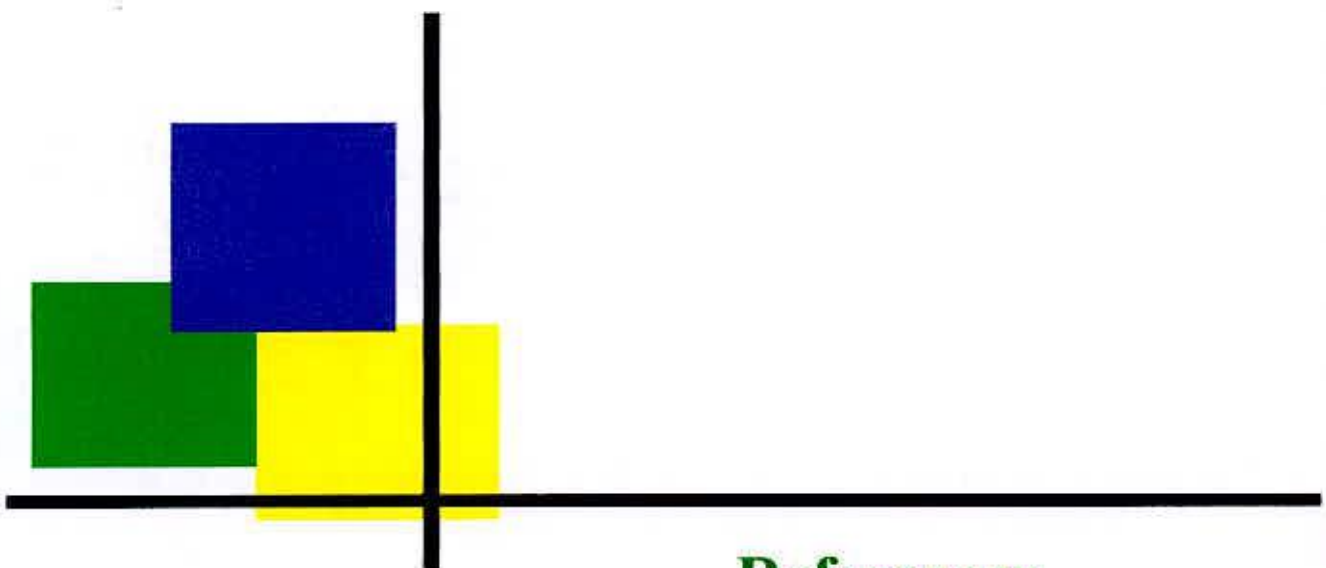
It is concluded from the present study that-

- 25 cm x 10 cm spacing was found optimum in jute cultivation for maximizing yield and at per with 20 cm x 10 cm spacing.

- BJRI weed management (2HW+1R) recommendation was optimum for fibre yield. Herbicide (Whip Super 9 EC) application would be done incase of labour shortage for better fibre yield achievement.

- Combinations of 20 cm x 10 cm spacing with herbicide application were better than other combination for jute cultivation and also yield.
- Herbicide application practice in jute cultivation can minimize the cost of production with higher yield.

However, to reach a specific conclusion and recommendation, further study and research work in this regard on jute should be done over different Agro-ecological zones.



References

REFERENCES

Abhijit, S., Guha, B. Barman, B. Munu, D. and Goswami, J. (2004) Cultural management of weed in tossa jute. Indian. J. Hill Farming. **17**(1/2): 111-116.

Adenawoola, A. R., Aladesanwa, R. D. and Adenowuro, T. D. (2005). Effects of frequency of weeding on the growth and yield of long-fruited jute (*Corchorus olitorius*) in a rainforest area of southwestern Nigeria. Crop-Protection. **24**(5): 407-411.

Ahad, M. A. and Wahahb, M. A. (1981). Effect of duration of weed competition on fibre yield of jute. *Bangladesh. J. Jte. Fib. Res.* **13**(1&2): 13-21.

Ahad, M. A. and Wahahb, M. A. (1980 a). Effect of intercropping for the minimizing of weeding cost on fibre yield of jute. *Bangladesh. J. Jte. Fib. Res.* **13**(1&2): 35-42.

Ahad, M. A. and Wahahb, M. A. (1980 b). Weed control method.. *Bangladesh. J. Jte. Fib. Res.* **11**(1): 135-145.

Alam, S. M. and Ali, N. M. (2010). Weed management practice. *Ann. Rep. Bangladesh J. Agron.* p. 174.

Alam. S. M. (2003). Weed control method. *Bangladesh. J. Jte. Fib. Res.* **10**(1): 42-47.

Alam, M. S., Islam, M. N., Zaman, A. K. M., Biswas, B. K. and Saha, M. K. (1996). Relative efficiency and economics of different cultural methods and herbicides for weed control in transplant Aus rice. *Bangladesh J. Agric. Sci.* **23**(1): 67-73.

Alam. S. M. (1996). Effect of plant geometry and number of plants per hill on the yield and quality of ground nut (*Arachis hypogaea* L.). M. S. Thesis, Department of Agronomy, BAU, Mymensing.

Alam. K. M. (1994). Weed management practice. *Ann. Rep. Bangladesh J. Agron*. p. 134.

Alam, S. M. and Ali, N. M. (1981). Reting of seed plant. *Ann. Rep. Bangladesh Jute Res. Inst*., Dhaka. p. 174.

Alamgir, M. A. (2007). Effect of population density and harvesting time on yield and quality of white jute varieties. M. S. Thesis, Department of Agronomy, SAU, Dhaka.

Basu, G., Sinha, A. K. and Chattopadhyay, S. N. (2005). Properties of Jute Based Ternary Blended Bulked Yarns. Man-Made Textiles in India.*Indian J. Agric*. Sci. **48**: 350-353.

Baldwin P. K. and Graham A. (2006). Population density and row spacing effect on dry matter yield bark content of kenaf (*Habiscus cannabinul* L.). Industrial Crops and Products. **23**(3): 244-248.

Billore, D. J. and Brown, S. (2001). Weed control method. *J. Appl. Polym. Sci.,* **11**(2): pp. 117-123

BBS. (Bangladesh Bureau of Statistics) (2009). Statistical year Book of Bangladesh. (2009). Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the people's Republic of Bangladesh.

Bekheet, M. A., Abdullah, S. S. and Ismail, A. E. (2006). Effects of plant density and weed control on sweet sorghum sugar, forage yield and associated weeds. *Assiut J. Agric. Sci.* **37**(1): 21-40.

Bendarz, C. W., Bridges, D. C. and Brown, S. M. (2000). Analysis of cotton yield stability across population densities. *J. Agron.* **92**(1): 128-135.

Boquet, D. J. and Coco, A. (1997). Yield response of cotton to row spacing nitrogen rate and plant population density. *J. Agron.* **40**(3): 22-23.

Deligeorgidis, J. W. (2002). Yield response of cotton to row spacing and plant population density.Bioeng. *J. Agron.* **4**(3): 62-73.

Gaffer, S. M., Karim, M. M. and Islam, N. (1988). Effect of population density and harvesting time on yield and quality of white jute varieties. *Ann. Rep. Bangladesh Jute Res. Inst.*, Dhaka. p. 130.

Gaytan, M. (2004). Response of cotton cv. Cian precoz 3 to row spacing and population density. Performance, Precocity and fibre quality. pp. 57-67.

Ghosh, T. (1983). Hand book on jute. FAO plant production and protection paper. pp. 86-93.

Halim, S.A. (1984). Methods of planting and intercultural operations for optimum yield. Abstract of Researches, Agricultural research on jute, Bangldesh jute Res. Inst. p. 271.

Hasanuzzaman, M., Islam, M. O. and Bapari, M. S. (2008). Efficacy of different herbicides over manual weeding in controlling in transplanted rice Aus. *J. Crop. Sci.* **23**: 67-73.

Hashim, S. A., Hossain, M. A. and Akbar. S. (1984). Performance of different plant spacing on yield of fibre, *Ann. Rep. Bangladesh Jute Res. Inst.* Dhaka. p. 15.

Hashim, S. A., Wahhad, M. A., Murshed, G. and Iqbal, S. (1981). Determination of optimum plant density for higher yield of *C. capsularis* L. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 253.

Hashim, S. A and Hossain, M. A. (1986). Effect of spacing and plant density on the fibre yield of CVL-1. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 283.

Hashim, S. A. (1980). Studies on the growth and yield of fibre of three capsulares varieties as influenced by different plant population and

weeding practice. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 243.

Hashim, S. A., Hossain, M. A. and Saha, C. K. (1987). Optimum number of weeding and inter cultural operations for higher yield. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 285.

Hasim, S. A. and Wahhab, M. A. (1982). Determination of agronomic productivity and economic profitability of various sacing and their patterns on fibre yield. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 258.

Hasim, S. A., Hossain M. A. and Akbar, S. (1983). Performance of different plant spacing on yield of fibre. *Ann. Rep. Bangladesh Jute Res. Inst.* Dhaka. p. 262.

Hossain, M. A. (1983). Response to row orientation and row spacing on growth and yield of jute. . *Bangladesh. J. Jte. Fib. Res.* **8**(1&2): 31-35

Hossain, M. A. (1984). Studies on the effect of fertilizer, pant density and stages of harvest of *C. capsularis* L. cv. CVL-1 on the yields and quality of fibre. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 271.

Hossain, M. A., Ali, A., Hashim, S. A. and Talukder, F.A. H. (1988). Response to fertilizer dose, spacing and stage of harvest on growth and yield of

Corchorus capsularis L.; cv. CVL-1. *Bangladesh. J. Jte. Fib. Res.* **13**(1&2): 13-21.

Hossain, M. A and Wahhab. M. A. (1982). Studies on the effect of fertilizers, plant density and stage of harvest on yield and quality of fibre. Abstracrt of Researches, Agricultural research on jute, Bangladesh Jute Res. Inst. p. 258.

Hossain, M. A. (1983). Studies on the effect of fertilizer, plant density and stages of harvest of capsulariI (CVL-1) on the yield and quality of fibre. Abstracrt of Researches, Agricultural research on jute, Bangladesh Jute Res. Inst. p. 264.

Hossain, M. A. and Wahhab, M. A. (1982). Seed production of deheaded and non-deheaded crop affected by plant spacings. Abstracrt of Researches, Agricultural research on jute, Bangladesh Jute Res. Inst. p. 260.

Iqbal, J., Karim, M. M., Islam N. and Begum, N. (1988) An evaluation of basalin against mechanical methods of weed control in jute (corchorus capsularis var. D-154). *Bangladesh J. Agril. Sci.* **20**(2): 311-316.

Jones, M. and Wells, R. (1998). Fiber yield and quality of cotton grown at two divergent population densities. Industrial Crops and Products. **38**(5): 1190-1195.

Jones, M. and Wells, R. (1997). Fiber yield and quality of cotton grown at different population densities. Industrial Crops and Products. **38**(5): 1190-1195.

Madakadze, R. H., Kadzanay, T. and Mugumw, R. (2007). Effect of plant spacing and harvesting frequency on *Corchory olitorius* leaf and seed yield. African crop science conference proceeding. **8**. pp. 279-282.

Manuel, U. G. and Panneerselvam, B. (2005). Weed management in jute. *Pakistan J. crop weed.* **18**(2): pp.27-36

Masum, S. M., Ali, M. H., Amin, A. K. M. R., Asaduzzaman, M. and Roy, T. S. (2010). Effect of Abiotic Factors on Quality of Jute Seed. *Bangladesh Res. Pub. J.* 4(1): 47-52

Palomo, G., Gaytan, M. and Godoy, A. (2001). Effect of post plantinting irrigation and population density on cotton yield and fibre quality.*J Agron.* **19**(3): 265-271.

Kar, S. and Singh, D.P. (2005). Grass weed control in jute by Targa super (quizalofop-ethyl 5% EC). Central Research Institute for Jute and Allied Fibres, pp. 193–200.

Prasad, S. S., Yadav, U. S. and Srivastava, R. K. (2007). Efficacy and economics of integrated pest management against insect pests and diseases

of olitorius jute (*Corchorus olitorius*) in eastern Uttar Pradesh. *Indian J. Agric. Sci.* 77(10): 652-656.

Rahman, M. A., Wahhab M. A., and Hashim. S. A. (1979). Growth, Yield and fibre quality of 3 varieties of capsularis as influenced by different plant population and doses of nitrogen. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 241.

Rajput, A. L. (2000). Integrated weed-management practices in white jute (*Corchorus capsularis*). *Indian J. Agron.* **45**(4): 782-786.

Saha, D. K. and Pual, N. K. (1981). Studies on the dry matter, partitioning and yield of *Corchorus capsularis* L. *Bangladesh J. Jte. Fib. Res.* **8**(1&2): 55-56.

Sahoo, K. M. and Saraswat, R. (1988). Magnitude of losses in the yields of major crops due to weed competition in India. Pesti. Info. **14**: 2–9.

Saraswat, V. N. (1999). Weed management in jute and jute based cropping system. *Jute and Allied Fibres Agriculture and Processing.* Palit, P., Pathak, S. and Singh, D.P. (eds.), Central Research Institute for Jute and Allied Fibres, Barrackpore, pp. 193–200.

Sarkar, S., Bhattacharjee, A. K., and Mitra, S. (2005). Weed management in jute by Trifluralin (48% EC) in the early jute-weed competition phase. *J. Crop Weed*, **2**: 30–33.

Singh, S. S., Singh, S. J. and Mishra, S. S. (1992). Weed management in transplanted rice (*Oryza sativa*). Under mid-land calcareous ecosystem. *Indian J. Agron.* **37**: 173-176.

Sitangshu, S. and Sarkar, G. (2006). Weed management in jute (*Corchorus olitorius* L.) by post emergence herbicides. *Tropical J. Agric.* **44**(1/2): 71-73.

Smith, M. A. K. (2006). Comparing weed and crop seedling response to pre-emergence pendimethalin application in *Corchorus olitorius* and *Abelmoschus esculentus*. Available at the following web site: http://www.sciencedirect.com/science/journal/02612194

Sobhan, M. A. (1978). Effect of different spacing on seed yield of *Hibiscus sabdariffa L. var altissima. Bangladesh J. Jte. Fib. Res.* **3**(1&2): 1-6.

Talukder, F. A. H. (1990). Agronomiicand physiological Response of recently developed *C. capsularis* and *C. olitorius* lines to various cultural practice. Ph.D. Thesis. Departmentof Botany, Dhaka University, Dhaka. pp. 18-24.

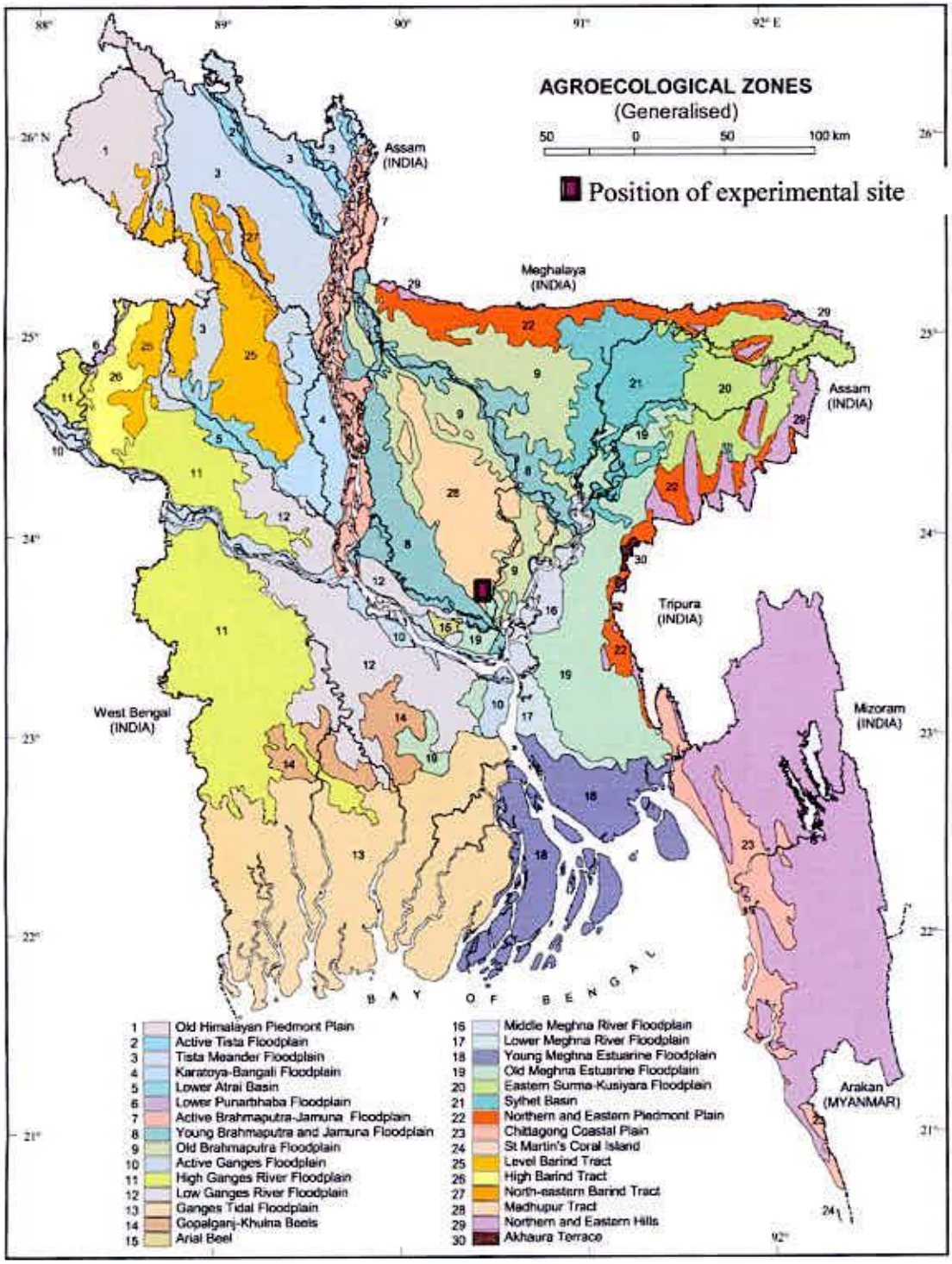
Talukder, F. A. H and Wahhab, M. A. (1982). Effect of early and late sowing at different populations on the fibre yield of jute. Abstracrt of Researches, Agricultural research on jute, Bangladesh jute Res. Inst. p. 259.

Talukder, F. A. H., Hossain M. A. and Akbar, S. (1983). Effect of early and late sowing at different populations on the yield of jute. *Ann. Rep. Bangladesh Jute Res. Inst.*, Dhaka. p. 174.

Zakaria, A. and Sayed, A. N. (2008). Jute microbiological and Biochemical Research. *Plant Tissue Cult. & Biotech.* **18**(2): 197-220.

APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Weather data (Rainfall, Temperature). 2009, Dhaka.

Month	Rainfall (mm)	Temperature (Average)	
		Min. (0°C)	Max. (0°C)
January	000	14.8	25.9
February	001	17.3	29.7
March	049	21.5	33.3
April	043	25.9	35.1
May	167	25.2	34.6
June	202	26.7	34.5
July	647	26.7	32.4
August	279	26.3	32.5
September	074	26.3	32.8
October	004	24.2	32.2
November	000	20.2	32.2
December	000	15.3	32.2

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.

Appendix III. Physicochemical properties of the initial soil.

Characteristics	Value
Particle size analysis.	
% Sand	26
% Silt	45
% Clay	29
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI), Dhaka-1207

Appendix IV. Means square values for plant height (cm) of jute at different days after sowing.

Sources of variation	DF	Means square values at different days after sowing				
		15	30	45	60	75
Replication	2	0.225	0.116	0.451	0.085	8.633
Spacing (S)	3	0.018	0.014	0.065	0.250	0.067
Error (a)	6	0.006	0.027	0.067	0.153	0.014
Weeding (W)	3	0.010	0.024	0.107	0.087	0.025
S x W	9	0.024*	0.034	0.074	0.017	0.113
Error (b)	24	0.012	0.024	0.103	0.035	0.59
CV (%)		18.63	12.03	21.95	8.44	11.40

*Significant at 5% level

**Significant at 1% level

Appendix V. Area and production of jute in Bangladesh

Year	Area in acre '0000'	Production '0000' m. tons
1994-95	1383	961
1995-96	1133	737
1996-97	1253	883
1997-98	1424	1057
1998-99	1181	812
1999-2000	1008	711
2000-01	1107	821
2001-02	1128	859
2002-03	1079	800
2003-04	1008	794
2004-05	965	732
2005-06	993	838
2006-07	1034	886
2007-08	1089	839

Source: Statistical Yearbook of Bangladesh (BBS), 2009.