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Optimization of agro-techniques to maximize productivity of quality jute (*Corchorus capsularis* L.) seed

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Abstract
To optimize sowing time, spacing and topping schedule for quality jute seed production, an experiment with three dates of sowing [25th July (D1), 9th August (D2) and 24th August (D3)], three spacing treatments [45 x 10 cm (S1), 45 x 15 cm (S2) and 60 x 15 cm (S3)] and two topping schedules [30 DAS (T1) and 45 DAS (T2)] were laid out in split-split-plot arrangements with three replications. It was observed that sowing dates influenced different growth parameters as well as yield significantly. D2 sown crop achieved higher seed yield (218 kg acre^{-1}) and statistically at par with D1 (205 kg acre^{-1}). Regarding quality characters, though insignificant but little better results were recorded with the seeds obtained from D1 in comparison with the seeds from D2. Spacing influenced all growth parameters significantly. As moderate spacing, S2 gave the highest seed yield of 177 kg acre^{-1}. Topping at 45 DAS (T2) exhibited superior performance with regard to yield and gave 13.71 % higher seed yield of jute over T1. Seed quality parameters were not significantly influenced by spacing and topping schedule. So, it can be concluded that sowing of jute during last week of July to first week of August with 45 x 15 cm and topping at 45 DAS should be recommended to harvest maximum quality jute (*capsularis*) seed in *Terai* region of West Bengal.

Keywords: jute seed, quality, sowing date, spacing, topping, yield

Introduction
Jute is the second most important commercial fibre yielding cash crop next to cotton and it is known as 'Golden Fibre of Bengal'. The significance of jute in the economy of India mainly in eastern region needs no discussion. Jute is the major textile fibre as well as raw material for non-traditional and value added non textile products. Jute is used widely in the manufacturing of different types of packaging fabrics, manufacturing hessian, sacking, carpet backing, mats, bags, tarpaulins, ropes and twines. Recently, jute fibres are used in a wide range of diversified products namely decorative fabrics, dresses, soft luggage, footwear, greeting cards, model door panels and other innumerable useful consumer products. There is a wide variation in the productivity level between jute growing states and even between the agro climatic zones within the same state. Non-availability of quality jute seed to the farmers at lower price and at proper time is one of the major constraints along with others like edapho-climatological factors, non-adoption of line sowing, imbalanced fertilizer application, improper pest management practices, and unscientific retting methods etc. for jute cultivation. Quality seed is the prerequisite to successful crop production increasing the fibre yield by 15-20 % [1]. There is also an imbalance between total seed requirement for fibre production and total seed production in the zone as a result of which seed for the zone is to be imported from other dry states. Now the prices of seeds from non-fibre producing states are rising and very often jute seeds from non-fibre producing states are not available in time. If fibre producing states together produce some quantity of jute seed, it may arrest steep increase in prices of seed and at least some quantity of good quality jute seed may be available in time. Study on the related available literatures revealed that the different components of improved method of quality jute seed production with reference to *Terai* zone like proper sowing time, schedule of topping, spacing etc. has not been systematically assessed. Keeping all the above perspectives in cognizance the present study was undertaken to optimize the date of sowing, spacing and topping schedule with regard to quality seed production of jute (*Corchorus capsularis*) in *Terai* region of West Bengal.

Materials and Methods

The present study on white jute (JRC 321) was carried out during 2011 at the University farm of Uttar Banga Krishi Viswavidyalaya at Pundibari, Cooch Behar, West Bengal being situated at $26^0$19'86" N latitude and $89^0$23'53" E longitude and at an elevation of 43 meters above mean sea level. The soil was sandy loam, having pH 5.39, medium in organic C (0.58%), low in available N (175.62 kg/ha) and medium in available P (14.56 kg/ha) and available K (204.51 kg/ha). The climate of the experimental zone is sub-tropical in nature with distinctive characteristics of high rainfall, high humidity and prolonged winter. The experiment was a randomized complete block design with split-split-plot arrangements and three replications. Date of sowing (D1- 25th July, D2- 9th August and D3- 24th August) was assigned to the main plots, spacing (S1- 45 x 10 cm, S2- 45 x 15 cm and S3- 60 x 15 cm) assigned to the sub-plots and topping (T1- 30 DAS and T2- 60 DAS) was assigned to the sub-sub-plots having total 18 treatment combinations. The uniform fertilizer dose given to each and every plot was N, P_2O_5 and K_2O @ 60:30:30 kg ha^{-1}. Out of these, half dose of N, full dose of P_2O_5 and K_2O are given as basal. The rest half of N was given after weeding at 30 days after sowing.

Five randomly selected plants from each plot were used to record the dry matter production, leaf area and leaf area index (LAI) at different crop growth stages (30, 60 and 90 days after sowing). The leaf area was measured by Systronic Leaf Area Meter (Model no- 211). After measuring leaf area of individual leaves, leaf area per plant was worked out treatment-wise and expressed in cm^2 per plant. The LAI was calculated plot-wise following the method suggested by Sestak *et al*. [2]:

$$\text{Leaf area index} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area covered by individual plant (cm}^2\text{)}}$$

At maturity, all plants from each net plot were harvested. Plants were threshed and seeds were separated, sundried, cleaned and weighed. Seed yield per acre was worked out and expressed in kilogram. For evaluation of seed quality parameters, fifty pure seeds obtained from each plot were placed in petridish containing blotting paper soaked with water. For each treatment, three petridishes were used. The number of seeds germinated was recorded after 5 days and then the germination percentage was calculated using the following formula (3).

$$\text{Germination \%} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds tested}} \times 100$$

Ten randomly selected normal seedlings were taken out carefully from each petridish for seedling root, shoot as well as total length. Shoot length was measured by taking length from the collar region to the tip of the shoot. Length in between the collar region to the tip of the root was measured with a help of scale in cm and considered as root length. The root length and shoot length of individual seedling was added to obtain seedling length which was expressed as seedling length in cm after working out the average. Ten normal seedlings earlier used for measuring seedling length were also used to determine the seedling dry weight. The dried seedling weight was recorded by using electronic balance and expressed in milligram per seedling. Seedling vigour index was calculated by multiplying total germination count with seedling dry matter as suggested by Ram *et al*. [4]. The data collected from the field and laboratory experiments were used for statistical analysis using split-split plot design. Analysis of variance for each parameter was performed using PROC GLM of Statistical Analysis System (SAS) software (Version 9.2). Mean separation of different treatments under different parameters were performed using Tukey's Studentized Range (HSD) test (P=0.05).

Results and Discussion

Up to 30 days after sowing (DAS), D1 i.e. 25thJuly sown crop recorded highest dry matter production $plant^{-1}$, leaf area $plant^{-1}$ as well as leaf area index (LAI) but at 60 and 90 DAS, D2 (sowing on 9th August) out-yielded D1 in terms of all the above-named parameters (Table 1). Regarding all the growth parameters, last date of sowing i.e. D3 (24.08.2011) performed significantly worst at all growth stages of jute seed crop (Table 1). Factually, not only the total rainfall but also the distribution of rainfall during the entire vegetative growth period is of paramount importance in case of jute fibre as well as jute seed production. Better performance of the earlier sown crop (D1) at initial stages of growth may be attributed to the fact that up to 30 DAS, 25th July sown crop received total 546 mm of rainfall while D2 and D3 received only 260.5 and 367.5 mm rainfall, respectively (Fig. 1). High rainfall at initial stages promoted luxurious vegetative growth in 25th July sown crop as compared to D2 and D3. From 60 DAS, second date of sowing (D2) started gaining much growth over D1 probably due to the following two reasons. Firstly, high rainfall in the early stage of 25th July sown crop resulted into higher weed infestation and growth which ultimately hampered the crop growth in the later stages. Secondly, as during 31 to 45 DAS, D2 i.e. 9th August sown crop received much higher amount of rainfall (329 mm) in comparison with that received by 25th July sown crop (38.5 mm), a much more favourable soil moisture regime was prevalent leading to the promotion of higher growth in case of D2. Achievement of pronounced growth by D2 over other dates of sowing at 60 DAS ultimately tantamount to better performance in terms of all growth parameters at later stages. Treatment D3 always gave the worst results because total rainfall received by 24th August sown crop during entire growing period was only 403 mm while D1 and D2 received total rainfall of 945 and 624.5 mm respectively (Fig. 1). On account of the receipt of a very meagre amount of rainfall (38.5 mm) during first 15 days, 24th August sown crop suffered a lot in terms of growth which could not be compensated during the later stages of the crop. Widest spacing i.e. S3 (spacing of 60 x 15 cm) performed excellent in terms of dry matter production $plant^{-1}$ and leaf area $plant^{-1}$ (Table 1). Achievement of more vigour by an individual plant in case of wider spacing might explain the result as all the above-mentioned growth parameters were taken, calculated and quantified per individual plant. Leaf area index (LAI) is the ratio of total leaf area and land area occupied by an individual plant and increment in spacing increases the area occupied by a single plant. That is more the spacing; less is the leaf area index. In the present experimentation also, naturally the highest LAI was evident throughout the crop growing period in case of the closest spacing i.e. S1 (45 x 10 cm) and LAI gradually decreased with the increment in spacing (Table 1). Topping management practices did not influence the growth parameters at early stage of crop growth because first topping was done after 30 days of sowing. Earlier topping i.e. topping at 30 DAS (T1) had harmful effect on plant height throughout

the crop growing stage and also dry matter accumulation plant^{-1} at initial growth stage but rendered beneficial effect in terms of other growth parameters like dry matter production plant^{-1} at 60 DAS and 90 DAS; leaf area plant^{-1} and LAI at 30 DAS, 60 DAS and 90 DAS (Table 1).

Table 1: Effect of date of sowing, spacing and topping management practices on the growth attributes of jute seed crop

Treatments	Dry matter production plant^{-1} (g)			Leaf area plant^{-1} (cm^2)			Leaf area index		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90DAS
Date of sowing									
D1 (25.07.2011)	1.51 a	14.50 b	38.53 b	204.23 a	2520.99 b	1492.75 b	0.318 a	3.939 b	2.338 b
D2 (09.08.2011)	1.48 a	36.98 a	52.55 a	179.46 b	4118.04 a	1568.94 a	0.292 b	6.495 a	2.445 a
D3 (24.08.2011)	0.89 b	9.08 c	20.22 c	141.94 c	1504.19 c	392.00 c	0.224 c	2.371 c	0.607 c
Spacing									
S1 (45 x 10 cm)	1.17 b	16.29 b	33.69 b	164.72 b	2435.28 b	1013.83 c	0.366 a	5.412 a	2.253 a
S2 (45 x 15 cm)	1.35 a	22.29 a	36.24 b	180.53 a	2837.29 a	1151.55 b	0.267 b	4.203 b	1.706 b
S3 (60 x 15 cm)	1.35 a	21.98 a	41.36 a	180.37 a	2870.65 a	1288.31 a	0.200 c	3.189 c	1.431 c
Topping schedule									
T1 (30 DAS)	1.28 a	21.90 a	38.99 a	176.15 a	2792.57 a	1196.79 a	0.280 a	4.353 a	1.860 a
T2 (45 DAS)	1.30 a	18.47 b	35.20 b	174.27 a	2636.24 b	1105.68 b	0.276 a	4.184 a	1.734 b

Means in a column followed by same letter do not differ significantly at P ≤ 0.05

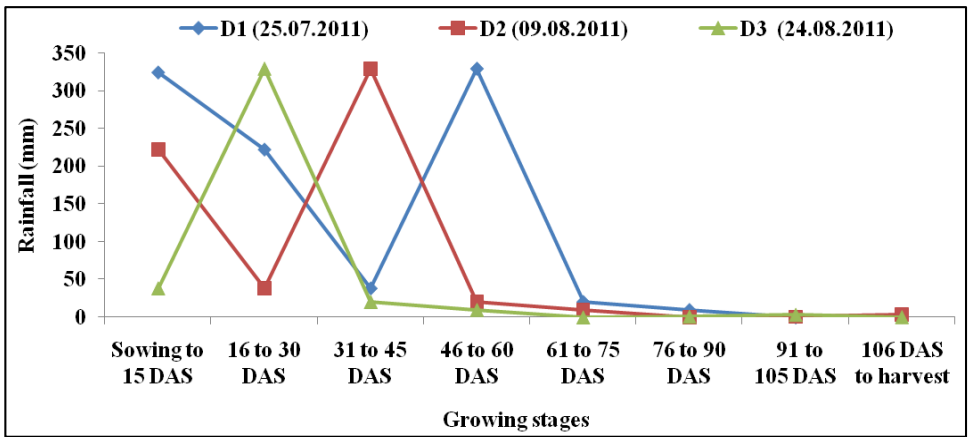

Fig 1: Variation in rainfall received during the growth period by different sowing dates

Irrespective of different treatments seed yield of jute was significantly influenced by date of sowing, spacing and topping schedule (Fig. 2). Crop grown on 9th August (D2) recorded significantly highest seed yield (218 kg acre^{-1}). This phenomenon may be attributed to the sound and better crop stand attained by D2. In case of seed yield first two dates of sowing were statistically at par (Fig. 2). For date of sowing significant differences for seed yield was also reported by Guha and Das (5). Seed yield was found maximum (177 kg acre^{-1}) with the treatment S2 (45 x 15 cm) being statistically at par with S3 i.e. spacing of 60 x 15 cm (Fig. 2). Though widest spacing i.e. S3 performed excellent in terms of growth parameters like dry matter production plant^{-1} and leaf area plant^{-1}, but yield might not increase up to the highest extent due to less plant population per unit area. Topping at 45 DAS (T2) gave 13.71% higher seed yield of jute than topping at 30 DAS (T1). Almost similar result was found in the experiment conducted in Kendrapara as per AINPJAF Annual Report [6].

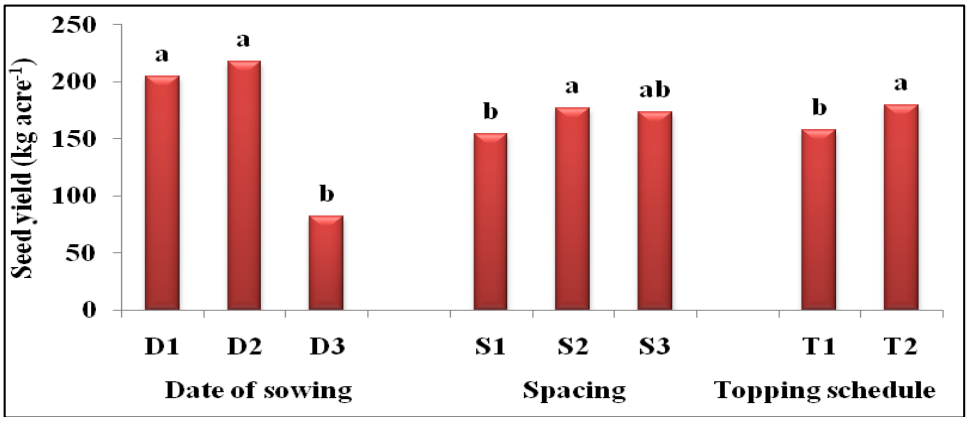

Fig 2: Seed yield of jute as influenced by different date of sowing, spacing and topping schedule (above the column followed by same letter do not differ significantly at P ≤ 0.05)

Seeds obtained from D1 (sowing on 25th July) achieved the highest germination percentage (97.33 %) and seeds obtained from sowing on 24th August (D3) recorded the least (96.33 %). The germination % varied in between 87.00 – 97.50% at

different planting dates as observed by Ali *et al.* [7] for variety O- 9897. It was indicated that in case of seedling root length, seedling shoot length, total length of the seedling, seedling dry matter along with seedling vigour index though insignificant but better results were recorded with the seeds obtained from 25th July sown crop (D1) in comparison with the seeds obtained from 9th August sown crop i.e. D2 (Table 2). That is to say, earlier two sowings produced seeds of almost equal quality. Regarding all the above-mentioned quality parameters, seeds from D3 i.e. sowing on 24th August performed the worst because of its all along poor growth and yield as mother crop. Seeds obtained from spacing of 45 x 15 cm (S2) recorded more germination percentage (97.44 %) than that with S3 i.e. 60 x 15 cm spacing (96.89 %). Seedling root length, seedling shoot length and total length of the seedling though insignificant but better results were recorded with the seeds obtained from 45 x 10 cm spacing (S1). Regarding seedling dry matter and seedling vigour index, S2 (spacing of 45 x 15 cm) exhibited the most superior result being at par with others (Table 2). Germination of 97.33% and 96.52% was recorded with seeds obtained from treatment T1 and T2 respectively. Though different topping schedules did not significantly influence any seed quality parameter, seeds obtained from treatment T1 (topping at 30 DAS) recorded slightly higher value for seedling root length, shoot length, total length of seedling and seedling dry matter as well as seedling vigour index (Table 2).

Table 2: Quality of jute seeds obtained from different dates of sowing, spacing and different topping schedule

Treatments	Germination %	Root length (cm)	Shoot length (cm)	Total length (cm)	Seedling dry matter (mg plant^{-1})	Seedling vigour index
Date of sowing						
D1 (25.07.11)	97.33	2.78 a	4.41 a	7.18 a	1.717 a	167.22 a
D2 (09.08.11)	97.11	2.71 a	4.29 a	6.99 a	1.700 a	165.03 a
D3 (24.08.11)	96.33	2.62 a	4.11 a	6.73 a	1.444 b	139.13 b
Spacing						
S1 (45 x 10 cm)	96.44	2.78 a	4.44 a	7.22 a	1.617 a	156.02 a
S2 (45 x 15 cm)	97.44	2.61 a	4.05 a	6.66 a	1.656 a	161.38 a
S3 (60 x 15 cm)	96.89	2.72 a	4.32 a	7.04 a	1.589 a	153.99 a
Topping schedule						
T1 (30 DAS)	97.33	2.77 a	4.28 a	7.05 a	1.630 a	158.71 a
T2 (45 DAS)	96.52	2.63 a	4.26 a	6.89 a	1.611 a	155.55 a

Means in a column followed by same letter do not differ significantly at $P \leq 0.05$

Conclusion

Based on the present investigation it can be concluded that direct seeding during last week of July to first week of August with 45 x 15 cm spacing should be recommended to harvest maximum quality jute seed in *Terai* region of West Bengal. Furthermore, the crop should be topped at 45 DAS to reap better yield with sustainable quality.

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