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RESEARCH ARTICLE :

Effect of dates of sowing and topping on seed yield of white jute in new Alluvial zone of West Bengal

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SUMMARY : A field experiment was carried out during the *Kharif* season of two consecutive years 2014 and 2015 at Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal with the focal objective to improve the jute seed yield in white (capsularis) jute by adoption of agro-techniques like dates of sowing and topping. The *Capsularis* variety JRC-698 was sown in three different dates (1st- 15th June, 2nd-15th July and 3rd- 15th August) with 4 topping (clipping of apical portion) operations performed at 30, 45 and 60 days after sowing (DAS) and no topping as control. Significant variations were observed on the performance of the crop under the different treatment combinations except in case of test weight. Results showed that among all the three dates of sowing, 15th June sown crop recorded maximum seed yield of 295.02 kg ha^{-1} and 333.67 kg ha^{-1} leading to higher gross return (Rs. 73926.75 ha^{-1} and Rs. 83457.25 ha^{-1}), higher net return (Rs. 46776.75 ha^{-1} and Rs. 54957.25 ha^{-1}) and high B: C ratio of 2.72 and 2.93 in 2014 and 2015, respectively. Topping at 45 DAS exhibited superior performance with regard to all the yield parameters and gave higher seed yield (319.63 kg ha^{-1} and 358.1 kg ha^{-1}) over other topping treatments which resulted in higher B: C ratio of 2.33 and 2.58 in 2014 and 2015, respectively. Among the treatment combinations, the best treatment observed was the first date of sowing (15th June) and topping at 45 days (30th July) which resulted in the highest seed yield of 353.76 kg ha^{-1} and 394.10 kg ha^{-1} leading to highest gross return of Rs. 84963.20 ha^{-1} and Rs. 95587.00 ha^{-1}, highest net return of Rs. 52963.20 ha^{-1} and Rs. 62087.00 ha^{-1} and best B:C ratio of 2.66 and 2.85, respectively in both the years.

KEY WORDS :
Date of sowing, Gross return, Jute, Seed yield, Topping

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BACKGROUND AND OBJECTIVES

Jute (*Corchorus* spp.) is one of the most important cash crops of Eastern India. It is the world's principal material for manufacturing of coarse textile for conversion into sacking and canvas. Its products like gunny bags, textile, handicrafts, agrotextiles etc. are biodegradable and environment friendly in contrast to synthetic substitutes and this has generated a renewed interest in this natural fibre in the recent past throughout the world (Majumdar *et al.*, 2009). In West Bengal, it is the most important fibre crop

occupying an area of 519 thousand ha with a production of 8075 thousand bales (Anonymous, 2016). In West Bengal, it is mainly grown for fibre production in the alluvial tract. Around 5000 metric tonnes of quality seed is required for sowing about 0.9 million hectares of jute area under cultivation in India. The majority of this area is confined to *Olitorius* jute because of its superior fibre quality and high net return. However, *Corchorus capsularis*, the other cultivated species of jute is still being commonly grown in different parts of India with its existing average seed production of around 3-4 quintals per hectare.

In India, the major jute growing states are West Bengal (56% of total acreage), Bihar, Uttar Pradesh and Assam while seed production is mainly concentrated in the Viderbha region of Maharashtra, Karnataka, Andhra Pradesh and Gujarat. The requirement of certified, foundation and breeder seed of jute is 5000, 62.5 and 0.8 ton, respectively in India (Kumar *et al*., 2010). There is an imbalance between total seed requirement for fibre production and total seed production in fibre producing states. Around 1.5 per cent of the jute area needs to be allocated for seed production to meet the seed scarcity. The quality of seed produced, its cost and availability in time at growers' level are generally uncertain resulting in dwindling fibre production of jute. For obvious economic reasons, jute research has revolved particularly around maximising fibre production consistent with quality. Some attempts were made to produce seed in fibre growing areas, but the yield level particularly with respect to capsularis was quite encouraging in the Terai Zone of West Bengal (Das *et al.*, 2014). Emphasis was laid on identifying suitable time of sowing and the role of topping under different agro-climatic situations. In jute seed crop, the apical domimance needs to be broken to induce more number of pod bearing branches from the dormant branch buds. This is generally done with the help of manual topping of the apical shoot bud. The practice of topping has been proved effective in increasing the yield levels of different crops (Singh *et al*., 2013). The topping time and its frequency are considered essential to induce the growth of maximum number of effective branches. Improper topping often increases the risk of crop failure. Besides, the recommended practice of manual topping is time consuming, strenuous and costly, thus necessitating an alternate and potent chemical substitute for manual topping. Moreover, the full expression of genetic potential of a crop could be attained with proper management practices including appropriate fertilizer management, optimum sowing time, proper spacing, good field management and pruning (Alam *et al*., 2009). Keeping all these factors in mind a field experiment was conducted during the *Kharif* season of 2014 and 2015 at the Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia in West Bengal with the objective to study and assess the optimum date of sowing for higher seed production in *Capsularis* jute with the possibilities of increasing seed yield by topping.

RESOURCES AND METHODS

The impact of date of sowing and topping operation on production of seed yield in white or capsularis jute (cv. JRC-698) was studied in a field experiment during *Kharif* season of 2014 and 2015 at the Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal, India. The farm is situated very close to Tropic of Cancer having approximately 22.93º N latitude and 88.53º E Longitude with an average altitude of 9.75 meters above mean sea level (MSL). The soil of the experimental field was sandy loam with medium fertility status and neutral in reaction (pH - 6.9). The average annual rainfall was 1298.1 mm. The maximum rainfall *i.e.* about 80 per cent of the total is received from south-west monsoon during the rainy months of June to September. During the crop growing period maximum temperature varied from 25.9ºC to 34.3ºC and minimum temperature varied from 13.3ºC to 25.4ºC. The area as a whole is humid and warm except having a winter spell during December to February. Experiment having 3 replications were conducted in Split Plot Design with 3 main plots, namely dates of sowing (D_1-15th June, D_2-15th July and D_3-15th August) along with 4 subplots of topping treatments (T_1-No topping, T_2-Topping at 30 DAS, T_3-Topping at 45 DAS and T_4-Topping at 60 DAS) for the jute (*Corchorus capsularis* L.) variety JRC-698 (Shrabanti white). Each plot size was 5m X 4m.

The crop seed rate was 6 kg ha^{-1} and the spacing of 30cm × 10cm was followed. The fertilizer dose of 60:30:30 kg N, P_2O_5 and K_2O ha^{-1} was used for the crop. 50 per cent N along with a full dose of P_2O_5 and K_2O were applied as basal at the time of final land preparation and the rest amount of nitrogen was applied at 30 days after sowing (DAS). Clipping of the apical portion

(topping) to induce auxiliary branches was carried out at 30 DAS, 45 DAS and 60 DAS on separate plots. For 15th June sown crop, topping was done on 15th July (30 DAS), 30th July (45 DAS) and 15th August (60 DAS) while for 15th July sown crop, the crop was topped at 14th August (30 DAS), 29th August (45 DAS) and 14th September (60 DAS), and for the 15th August sown crop, the topping dates were 14th September (30 DAS), 29th September (45 DAS) and 14th October (60 DAS) in both the years. All improved package of practices like weeding, irrigation, intercultural operation, and pest control were adopted to raise the crop properly. In the first year (2014), the *capsularis* jute crop was harvested on 05/11/2014 (1st sowing), 21/11/2014 (2nd sowing) and 13/12/ 2014 (3rd sowing) taking a total duration of 153, 138 and 119 days, respectively. In the second year of experimentation (2015), the crop was harvested on 27/10/2015 (1st sowing), 21/11/2014 (2nd sowing) and 25/11/2015 (3rd sowing) taking a total duration of 144, 127 and 108 days, respectively.

Records on yield attributing characters namely the number of primary branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1} and test weight (g) were taken at harvest by randomly taking 10 plants from each plot and finally converting the values to a single mean value. For measuring the seed yield and stalk yield of jute, the entire produce from the net plot area (from demarcated portion, leaving the border area) was harvested, threshed, winnowed and weighed after thorough drying under the sun. Seed yield from that area was converted to yield per hectare (kg ha^{-1}). While calculating gross return prevalent market price for sale of jute seed was taken as Rs. 70.00/kg and price for sale of jute stick was considered as Rs. 10.00/kg. Net return was calculated by deducting cost of cultivation from gross income and benefit/cost ratio was calculated by dividing total cost of cultivation (Rs./ha) to gross return (Rs./ha). The critical difference (CD) for estimated treatment contrasts was worked out using standard statistical procedures as outlined in Gomez and Gomez (1984). The difference between treatment means were compared with CD value at 5 per cent level of probability and the treatments with higher effect over others were identified.

OBSERVATIONS AND ANALYSIS

Significant effect of the date of sowing was observed in the case of yield attributes like number of primary branches plant^{-1}, number of pod plant^{-1} and number of seed pod^{-1} (Table 1). The treatment supremacy regarding number of primary branches per plant (4.45 and 5.75), number of pods plant^{-1} (48.85 and 58.37) and number of seeds pod^{-1} (60.0 and 71.23) in 2014 and 2015, respectively were established with the first date of sowing (15th June) which was statistically superior over the other sowing dates (15th July and 15th August). However, the test weight did not vary significantly under different date of sowing. The cause behind the better performance of the crop under 1st date of sowing (15th June) may be attributed to the fact that it is probably due to the greater interaction of the crop with the environmental factors such as temperature, humidity, rainfall etc. which in turn has favoured the growth of the crop considerably. The highest seed yield (295.02 kg ha^{-1} and 333.67 kg ha^{-1}) and stalk yield (5.32 t ha^{-1} and 6.01 t ha^{-1}) in 2014 and 2015, respectively was observed on

Table 1 : Effect of date of sowing and topping on yield attributes and yield of the jute

Treatments	Primary branches plant^{-1}		Pods plant^{-1}		Seeds pod^{-1}		Test weight (g)		Seed yield (kg ha^{-1})		Stalk yield (t ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
D_1 (15th June)	4.45	5.75	48.85	58.37	60	71.23	3.33	3.35	295.02	333.67	5.32	6.01
D_2 (15th July)	4.08	4.90	42.1	52.05	46.9	55.5	3.30	3.32	239.67	276.52	4.44	5.11
D_3 (15th August)	3.21	4.15	38.01	46.55	40.27	47.34	3.26	3.27	185.47	232.22	3.44	4.27
C.D. (P=0.05))	0.62	0.74	3.72	4.34	3.46	4.89	NS	NS	12.85	18.67	0.29	0.38
T_1(No topping)	2.9	3.9	35.6	43.1	40.4	47.71	3.28	3.3	162.03	206.5	3.6	4.24
T_2 (Topping at 30 DAS)	4.27	5.25	45.1	55.26	50.8	60.83	3.31	3.33	261.8	296.46	4.69	5.31
T_3 (Topping at 45 DAS)	4.82	6.08	49.4	61.3	58.96	68.84	3.33	3.34	319.63	358.1	5.22	6.12
T_4 (Topping at 60 DAS)	3.66	4.5	41.83	49.6	46.06	54.72	3.28	3.31	216.76	262.16	4.09	4.86
C.D. (P=0.05)	0.42	0.51	4.93	5.99	NS	NS	NS	NS	15.33	20.89	0.45	0.54

D_1-15th June, D_2-15thJuly, D_3-15th August and T_1-No topping, T_2-Topping at 30 DAS, T_3-Topping at 45 DAS, T_4-Topping at 60 DAS
NS=Non-significant

15th June sown crop. These higher value of yield attributes were instrumental in improving the overall the crop yield (both grain and straw yield) in the first date of sowing (15th June) making it superior over the other two date of sowing (Table 1). Similar results were opined by Rayhan *et al*. (2008) and Kumar *et al*. (2013) in jute sown on first week of June.

The highest number of primary branches plant^{-1} (4.82 and 6.08), number of pod plant^{-1} (49.4 and 61.3) and number of seed pod^{-1} (58.96 and 68.84) was recorded with the crop in 2014 and 2015, respectively, that were topped at 45 DAS (Table 1); while the least number of pods plant was recorded with the crop that were grown without any topping practices in both the years of experimentation. However, the topping had a beneficial effect on the yield attributes as well as seed yield and stalk yield of the crop. The best seed yield (319.63 kg ha^{-1} and 358.10 kg ha^{-1}) and stalk yield (5.22 t ha^{-1} and 6.12 t ha^{-1}) were observed when the crop wastopped at 45 DAS in 2014 and 2015, respectively; while the least values of seed yield (162.03 kg ha^{-1} and 206.50 kg ha^{-1}) and stalk yield (3.60 tha^{-1} and 4.24 tha^{-1}) in 2014 and 2015, respectively, were found with the crop that was grown with no topping practices. The reason is that the clipping off apical buds induced growth of new auxiliary branches and increases the other associated yield attribute like number of pod plant^{-1} which consequently results in an increase of seed yield to a sufficient extent. However, the yield attributes like number of seed pod^{-1} and test weight did not vary significantly under different

Table 2 : Interaction effect of date of sowing and topping on yield attributes and yield of the jute

Dates of sowing (D) / Topping (T)	Primary branches plant^{-1}		Pods plant^{-1}		Seeds pod^{-1}		Test weight (g)		Seed yield (kg ha^{-1})		Stalk yield (t ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
D_1T_1	3.4	4.6	43.4	51.0	51.9	57.6	3.31	3.33	225.56	266.30	4.49	5.38
D_1T_2	4.80	5.90	50.0	60.08	62.00	76.0	3.34	3.36	328.24	360.3	5.67	6.12
D_1T_3	5.2	6.9	53.9	67.2	69.50	82.76	3.34	3.37	353.76	394.1	6.02	6.80
D_1T_4	4.4	5.6	48.1	55.2	56.60	68.56	3.33	3.35	272.54	314.0	5.13	5.74
D_2T_1	3.0	3.9	33.2	40.5	35.90	45.2	3.28	3.30	153.16	194.7	3.45	4.09
D_2T_2	4.58	5.32	45.0	56.2	49.70	58.0	3.31	3.33	266.6	297.0	4.76	5.32
D_2T_3	5.03	6.07	49.1	60.7	57.30	65.9	3.33	3.35	318.24	351.1	5.43	6.21
D_2T_4	3.72	4.3	41.1	50.8	44.70	52.9	3.30	3.32	220.7	263.3	4.12	4.84
D_3T_1	2.3	3.2	30.25	37.8	33.41	40.33	3.25	3.27	107.36	158.5	2.86	3.26
D_3T_2	3.44	4.52	40.3	49.5	40.7	48.50	3.27	3.29	190.56	232.1	3.65	4.48
D_3T_3	4.23	5.29	45.22	56.1	50.1	57.86	3.32	3.30	286.9	329.1	4.22	5.37
D_3T_4	2.87	3.6	36.3	42.8	36.9	42.70	3.23	3.25	157.06	209.2	3.03	4.00
D × T	1.16	1.36	9.80	10.95	NS	NS	NS	NS	17.10	17.58	0.39	0.47
C.D. (P=0.05)												
T × D	1.02	2.18	6.85	6.98	NS	NS	NS	NS	20.45	22.82	0.17	0.29
C.D. (P=0.05)												

D_1-15th June, D_2-15thJuly, D_3-15th August and T_1-No topping, T_2-Topping at 30 DAS, T_3-Topping at 45 DAS, T_4-Topping at 60 DAS
NS=Non-significant

Table 3 : Effect of date of sowing and topping on economics of production of the jute

Treatments	Total cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2014	2015	2014	2015	2014	2015	2014	2015
D_1 (15th June)	27150.00	28500.00	73926.75	83457.25	46776.75	54957.25	2.72	2.93
D_2 (15th July)	27150.00	28500.00	61177.25	70506.75	34027.25	42006.75	2.25	2.47
D_3 (15th August)	27150.00	28500.00	47382.90	59030.75	20232.90	30530.75	1.75	2.07
T_1(No topping)	27800.00	29800.00	47341.87	56888.33	19541.86	27088.33	1.70	1.91
T_2 (Topping at 30DAS)	32000.00	33500.00	65259.33	73819.33	33259.33	40319.33	2.04	2.20
T_3 (Topping at 45 DAS)	32000.00	33500.00	74607.67	86333.67	42607.66	52833.67	2.33	2.58
T_4 (Topping at 60 DAS)	32000.00	33500.00	56107.00	66951.67	24107.00	33451.67	1.75	2.00

D_1-15th June, D_2-15thJuly, D_3-15th August and T_1-No topping, T_2-Topping at 30 DAS, T_3-Topping at 45 DAS, T_4-Topping at 60 DAS

Table 4 : Interaction effect of date of sowing and topping on economics of production of the jute

Treatments	Total cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2014	2015	2014	2015	2014	2015	2014	2015
D_1T_1	27150.00	28500	60689.20	72441.00	33539.20	43941.00	2.24	2.54
D_1T_2	32000.00	33500.00	79676.80	86421.00	47676.80	52921.00	2.49	2.58
D_1T_3	32000.00	33500.00	84963.20	95587.00	52963.20	62087.00	2.66	2.85
D_1T_4	32000.00	33500.00	70377.80	79380.00	38377.80	45880.00	2.20	2.37
D_2T_1	27150.00	28500.00	45221.20	54529.00	18071.20	26029.00	1.67	1.91
D_2T_2	32000.00	33500.00	66262.00	73990.00	34262.00	40490.00	2.07	2.21
D_2T_3	32000.00	33500.00	76576.80	86677.00	44576.80	53177.00	2.39	2.59
D_2T_4	32000.00	33500.00	56649.00	66831.00	24649.00	33331.00	1.77	1.99
D_3T_1	27150.00	28500.00	36115.20	43695.00	8965.20	15195.00	1.33	1.53
D_3T_2	32000.00	33500.00	49839.20	61047.00	17839.20	27547.00	1.56	1.82
D_3T_3	32000.00	33500.00	62283.00	76737.00	30283.00	43237.00	1.95	2.29
D_3T_4	32000.00	33500.00	41294.20	54644.00	9294.20	21144.00	1.29	1.63

D_1-15th June, D_2-15thJuly, D_3-15th August and T_1-No topping, T_2-Topping at 30 DAS, T_3-Topping at 45 DAS, T_4-Topping at 60 DAS

topping treatments.

Among the interaction effects, first date of sowing (15th June) with topping at 45 days (30th July) was the best treatment as it resulted in the highest number of primary branches plant^{-1} (5.2 and 6.9), number of pod plant^{-1} (53.9 and 67.2) and number of seed pod^{-1} (69.50 and 82.76) as well as highest seed yield (353.76 kg ha^{-1} and 394.10 kg ha^{-1}) and stalk yield (6.02 t ha^{-1} and 6.80 t ha^{-1}) in 2014 and 2015, respectively over all other treatment combinations (Table 2). All these results are in concordance with the findings recorded by Das *et al.* (2014) in white jute (topping at 45 days) crop.

The cost of cultivation was estimated to be equal for all the sowing dates whereas it varied with the different topping practices during both the years. The minimum cost of cultivation (Rs. 27150.00 ha^{-1} and Rs. 28500.00 ha^{-1} in 2014 and 2015, respectively) was observed under the no topping practices. The cost of cultivation was more for the other three topping practices as it includes the labour charges necessary for clipping off the apical portion at suitable growth phases (Table 3). However, the first date of sowing (15th June) realised high gross return (Rs. 73926.75 and Rs.83457.25 ha^{-1}) , net return (Rs. 46776.75 ha^{-1} and Rs. 54957.25 ha^{-1}) and B:C ratio (2.72 and 2.93) in 2014 and 2015, respectively as compared to the other dates of sowing (15th July and 15th August) (Table 3).

Topping at 45 DAS achieved a maximum gross return (Rs. 74607.67 ha^{-1} and Rs. 86333.67 ha^{-1}), high net return (Rs. 42607.66 ha^{-1} and Rs. 52833.67 ha^{-1}) and higher B: C ratio (2.33 and 2.58) in 2014 and 2015, respectively due to the maximum yield realised under it over the other topping treatments (Table 3). Among the interaction effects, the best treatment was observed in case of first date of sowing (15th June) and topping at 45 days (30th July) which resulted in the highest gross return of Rs. 84963.20 ha^{-1} and Rs. 95587.00 ha^{-1}, highest net return of Rs. 52963.20 ha^{-1} and Rs. 62087.00 ha^{-1} and best B:C ratio of 2.66 and 2.85, respectively in both the years (Table 4). These results are similar to the results opined by Das *et al.* (2014) in white jute where topping was done at 45 days old crop. Though the employment of topping increased the cost of cultivation to some extent over the no topping practices but there was significant yield increase due to the adoption of topping which boosted the production to the sufficient extent, so, gross return, net return and ultimately the benefit: cost ratio became higher over traditional cultivation of jute seed crop with no topping.

Conclusion:

There is scope to improve total seed yield in jute by adjustment of date of sowing and topping at appropriate stage of growth. Early sowing *i.e. on* and before 15th June and pruning of apical buds at 45 days age of the crop *i.e* by 30th July could be recommended for enhancement of total seed yield along with its attributing characters like number of primary branches number of pods plant^{-1} and number of seed pod^{-1} in *Capsularis* or white jute in new alluvial zone of West Bengal under rainfed situation.

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