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Growth and yield of jute (*Corchorus olitorius* L.) varieties at different sowing time in coastal Andhra Pradesh

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Abstract
A field trial was conducted during *kharif*, 2016 at Agricultural College Farm, Bapatla to evaluate the performance of jute varieties at different sowing dates. The experiment was conducted in a randomized block design with factorial concept using three varieties of jute sown at four different dates and replicated thrice. Among the growth parameters, plant height was significantly higher at II FN of July sowing while varieties were found non-significant.S-19 variety of Jute resulted in accumulation of more drymatter at different stages while sowing during I FN of July accumulated more drymatter at different stages. The yield attributes like number of capsules/plant, seeds/capsule recorded were higher when jute was sown during I FN of July and among the varieties,S-19 performed better with more yield attributes than other two varieties. Seed and stalk yield of jute obtained were maximum with S-19 variety compared to JRO-524 and Ira varieties. Among the dates of sowing, I FN of July sown crop recorded maximum jute seed yield than other dates of sowing. However, no interaction was obtained between the varieties of jute evaluated and different dates of sowing tried.

Keywords: Jute, Dry matter production, yield attributes, and seed yield

Introduction
In India, jute is considered as a very important natural fibre crop after cotton. Almost 85% of world's jute cultivation is concentrated in Ganges delta. This fertile region is shared both by Bangladesh and India. In India, it is cultivated mainly in West Bengal having maximum area and production. Farmer's are cultivating jute due to the advantage of dynamic cropping pattern, large number of jute mills existing for processing besides availability of large water bodies for retting. The market spectrum of jute has widened in recent years due to its environment friendly quality with high tensile strength, acoustic and thermal insulation, ease of blending with both synthetic and natural fibres. It is the cheapest of all the textile fibres and is extensively used in the manufacture of packing material for agricultural and industrial products. The seed production of jute is very meager in and around the eastern states of India and they are depending on other states for certified seed material. Almost entire quantity of seed is produced in Andhra Pradesh and Maharashtra. Rainfall pattern and soils in Maharashtra and parts of Andhra Pradesh, Gujarat and Karnataka are ideal for jute seed production. It has been estimated that with the use of good quality seed, the productivity can be increased by about 15 – 20% and the average annual requirement of Jute seed is 5000 – 5500 tonnes (Bera *et al*., 2010) [2]. There is a good scope to improve the economy of rainfed farmers of Andhra Pradesh by taking the advantage of jute seed production in different regions.
Time of sowing is an important non- monetary input which is mainly dependent on the prevailing weather during the crop life cycle. Different varieties of jute have been developed reducing the duration from 150 to 120 days in the recent times. In order to identify the suitable variety of jute with appropriate sowing time for coastal Andhra Pradesh, the present trial was conducted.

Materials and Methods
A field experiment was conducted during *kharif* 2016 at Agricultural College Farm, Bapatla situated at an altitude of 5.49 m above mean sea level (MSL), 150 55'N latitude, 80^0 30' E longitude and about 8 km away from the Bay of Bengal in the Krishna Agro-climatic Zone of Andhra Pradesh, India. The experiment was conducted in a Randomised Block Design with factorial concept and replicated thrice. The total treatments were twelve (12) comprising three

(3) varieties of jute (JRO-524,Ira and S-19)and four (4) dates of sowing(I fortnight of July (14.7.2016), II fortnight of July (25.7.2016), I fortnight of August(9.8.2016) and II fortnight of August (22.8.2016) sown with 30 cm spacing between rows. The sowing dates were selected based on weather analysis of the Agro-Climatic Zone. Thinning was done at 20 days after sowing to maintain plant to plant spacing of 20 cm within the row. The soil of the experimental site was clay in texture, slightly alkaline in reaction and low in organic carbon and available nitrogen, medium in phosphorus and high in available potassium. A total rainfall of 582.2 mm was received in 25 rainy days during the crop growth period. The recommended dose of 40 kg N, 40 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied uniformly in the form of urea, single superphosphate (SSP) and muriate of potash (MOP). Entire quantity of phosphorus and potash and 1/3 of nitrogen was applied as basal. The remaining nitrogen was applied in two equal splits at 30 DAS and 60 DAS.

The biometric observations were recorded by selecting five plants randomly from the net plot and were labelled for continuous record of biometric observations *viz*., plant height, number of capsules, number of seeds per capsule, test weight, seed yield and stalk yield at different stages of crop growth. For recording drymatter production which involve destructive sampling, five successive plants from the second row in each plot were sampled. Plant height(cm) and drymatter production (kg ha^{-1}) were taken at 30,60,90 days after sowing and at harvest. The number of days taken from date of sowing to the stage, when 50 per cent of plants have flowered, in each treatment was considered as number of days to 50 per cent flowering. When more than 80 per cent of capsules turned brown colour it was considered as matured and the number of days taken for maturity was recorded. Harvest index is the ratio of economic yield (seed yield) to the total biological yield (seed + stalk) and expressed in per cent. It was worked out by using the formula as suggested by Donald and Humblin (1976) [5].

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield(kgha}^{-1})} \times 100$$

All the data recorded in the study were subjected to statistical analysis using Fisher's method of analysis of variance suggested by Panse and Sukhatme (1978) [12] as outlined for the design adopted in this study. Statistical significance was tested by applying F-test at 0.05 level of probability. Critical differences at 0.05 levels were worked out for the effects, which were significant.

Results and Discussion

Growth parameters

Plant height (cm) of jute measured at 30, 60, 90 DAS and at harvest differed significantly for dates of sowing only and interaction between dates of sowing and varieties also was non-significant (Table 1).

At 30 DAS, highest plant height of 21.9 cm was recorded with the crop sown during 1st fortnight of July (D1) which was significantly superior over 2nd FN of July sowing. It was however, on a par with the other two dates of sowing in August. Significantly highest plant height (103.6 cm) was obtained during 2nd FN of July compared to 1st FN of August and 2nd FN of August at 60 DAS. However, it was on a par with 1st FN of July (96.1 cm). The highest plant height of 136.3 cm was observed at 90 DAS with 2nd FN of July which was significantly superior over 1st FN of August and 2nd FN of August and it was on a par with 1st FN of July (D1) sowing. At harvest, it was observed that highest plant of 139.2 cm was obtained when jute was sown during 2nd FN of July (D2) which was on a par with 1st FN of July sowing (D1). Lowest plant height was recorded with 1st FN of August (D3) and 2nd FN of August (D4) sown jute which was significantly lower than D2 sowing. Jute, being photosensitive, crop sown early during 1st FN of July and 2nd FN of July had sufficient time for its vegetative growth and produced taller plants. Delay in sowing of jute i.e., from 1st FN of August (D3) resulted in stunted plant growth due to reduction in day length and average temperatures. Similar results were also reported by Ratnam and Narayana (2014) [14], Neeraj Kumar *et al*. (2013) [10] and Okosun *et al*. (2006) [11].

Drymatter production (kg ha^{-1}) recorded at 30, 60, 90 DAS and harvest was significantly influenced by dates of sowing and varieties. (Table 1). Interaction between dates of sowing and varieties could raech level of significance only at 30 DAS.

At 30 DAS, maximum drymatter of 79 kg ha^{-1} was produced with the jute variety S-19 (V3) which was superior to Ira (V2) with 60 kg ha^{-1} and was on a par with JRO-524 (V1) with 76 kg ha^{-1}. Among the dates of sowing, the highest drymatter accumulation of 147 kg ha^{-1} was obtained with 1st FN of July sowing (D1), which was significantly superior to all the other dates of sowing tested.

Among the interaction between varieties and dates of sowing, variety S-19 (V3) sown during 1st FN of July (D1) recorded significantly highest drymatter over all the other combinations of dates of sowing and varieties while it was on a par with JRO-524 sown during 1st FN of July (Table 1a).

At 60 DAS, drymatter production of 1598 kg ha^{-1} was obtained with 1st FN of July sowing (D1) which was significantly superior to 2nd FN of July (D2),1st FN of August (D3) and 2nd FN of August (D4) sowings. Among the dates of sowing, highest drymatter production of 5017 kg ha^{-1} was recorded with 1st FN of July sowing (D1) which was significantly superior to 2nd FN of July (D2) with 4149 kg ha^{-1}, 1st FN of August (D3) with 2405 kg ha^{-1} and 2nd FN of August (D4) sowing with 1480 kg ha^{-1} at 90 DAS. At harvest, the maximum drymatter production was observed with 1st FN of July (D1) sowing with 7263 kg ha^{-1} which was significantly superior to 2nd FN of July (D2) (5742 kg ha^{-1}),1st FN of August (D3) (3144 kg ha^{-1}) and 2nd FN of August (D4) sowings with 1579 kg ha^{-1}. Among the varieties tested, S-19 (V3) recorded highest drymatter (4727 kg ha^{-1}) which was on a par with the variety, JRO-524 (V1) with 4453 kg ha^{-1} and both these varieties were significantly superior to Ira (V2) with 4116 kg ha^{-1}**.** (Table 1). The higher drymatter production recorded with 1st FN of July (D1) sowing might be due to cumulative effect of more plant height, optimum weather conditions like higher bright sunshine hours with optimum day length and the temperatures might have increased photosynthesis and in turn, drymatter production. Similar findings were observed by Ali *et al*. (2004) [1] and Guggari and Sheelavantar (2004) [6].

The data recorded on days to 50% flowering by jute presented in Table 1 revealed that, both varieties and dates of sowing had significantly influenced the days to 50% flowering but their interaction was not significant. It was observed that there

was a reduction in the number of days taken for days to 50% flowering from 1st date of sowing (1st FN of July (D1)) to last date of sowing (2nd FN of August (D4)). Sowing of jute during 1st FN of July (D1) took more number of days to 50% flowering (61) which was on a par with 2nd FN of July (D2) sowing (59) and both were significantly superior to 1st FN of August (D3) (55) and 2nd FN of August (D4) (49). Sowing of jute during 2nd FN of August (D4) took significantly lesser number of days to 50% flowering followed by 1st FN of August (D3) sowing. This was due to shorter day lengths, higher bright sunshine hours and low minimum temperatures. Among the dates of sowing, vegetative period became progressively shorter with progressive delay in sowings which resulted in stunted plant growth when jute was sown during 1st and 2nd FN of August (D3 and D4 sowings). Among the varieties, S-19 (V3) variety took more number of days to 50% flowering and it was significantly superior to JRO-524 (V1) and Ira (V2). Similar findings were reported by Islam (2010) [8] and Tiparaddi *et al*. (2006) [17]

Data presented in Table 1 on days to maturity revealed that there was significant influence with dates of sowing only. Both the varieties and interaction between dates of sowing and varieties were found non-significant. There was reduction in the number of days taken for maturity from 1st FN of July sowing (D1) to 2nd FN of August sowing (D4). Jute sown during 1st FN of July (D1) took significantly more number of days to mature (124) compared to 2nd FN of July (D2) (115), 1st FN of August (D3) (106) and 2nd FN of August (D4) (103). The maximum days to maturity was taken by 1st FN of July (D1) sown crop due to prolonged vegetative growth, higher temperatures and long photoperiods. Similar findings were reported by Tiparaddi *et al*. (2006) [17] and Thakuria and Sarma (1991) [16].

Yield attributes and Yield

Number of capsules per plant were significantly influenced both by jute varieties and different dates of sowing. However, the interaction between varieties and dates of sowing was non-significant (Table 2). Jute sown during 1st FN of July (D1) produced significantly higher number of capsules per plant (48.7) which was on a par with 2nd FN of July sown jute (D2) with 46.5 capsules per plant. However, these two sowing dates were significantly superior to jute sown during 1st FN of August and 2nd FN of August with regard to no. of capsules per plant. Among the varieties, S-19 (V3) variety of jute recorded significantly highest number of capsules per plant (43.6) which was on a par with the variety JRO-524 (V1). Both these varieties were significantly superior to the jute variety Ira (39.9).The decrease in number of capsules per plant observed with delay in sowings might be due to lesser plant height, shorter vegetative period, early flowering and short days. Similar results were reported by Kumar *et al*. (2005) [9] and Bhaswati Ray and Majumdar (1995) [3].

Data presented in Table 2 on number of seeds per capsule was significantly influenced by varieties and dates of sowing only but not by their interaction. With regard to dates of sowing, the maximum number of seeds per capsule were obtained with 1st FN of July (D1) (195.4) which was on a par with 2nd FN of July (D2) (194.6) and 1st FN of August (D3) (189.7) sown jute, while, it was significantly superior with 2nd FN of August sowing (D4) (182.6). Among the varieties, S-19 (V3) recorded significantly highest number of seeds per capsule (194.6) which was on a par with the variety JRO-524 (V1) (191.3) and both were significantly superior to Ira (V3) (186).

Data pertaining to thousand seed weight of jute (g) was presented in Table 2 which revealed that both varieties and dates of sowing had significantly influenced the test weight. However, the interaction between varieties and dates of sowing of jute was non-significant. Among the dates of sowing, the maximum test weight was obtained with 2nd FN of July (D2) which was on a par with 1st FN of July, 1st FN of August and 2nd FN of August. Among the varieties, S-19 (V3) recorded significantly highest test weight of 2.9 g which was found to be superior to Ira (V2) (2.7) and was on a par with JRO-524 (V1) (2.8). Though test weight is a genetic character, delay in sowings resulted in a decrease of test weight. This might be due to weather factors like temperature, sunshine hours and daylength which might have influenced higher test weight. Similar observations were reported by Sarkar and Sinha (2004) and Chittapur and Kulkarni (2003).

Seed and stalk yield of jute was significantly influenced both by the dates of sowing and varieties. However the interaction between them was non-significant (Table 2). Higher seed yield of 1355 kg ha^{-1} was recorded with 1st FN of July (D1) sown jute which was significantly superior to all the other dates of sowing. Lowest seed yield was obtained when sown during 1st FN of August (D3) with 777 kg ha^{-1} and 2nd FN of August (D4) with 695 kg ha^{-1}. The percent decrease in seed yield of jute was 11.5, 42.6 and 48.7 with D2, D3 and D4 sowing dates, respectively over D1 sowing. Significant reduction in seed yield of jute was observed with delay in sowing from 1st FN of July (D1) to 2nd FN of August (D4). This might be due to lower temperatures and shorter day lengths which enhanced early flowering due to shorter vegetative growth, reduced the plant height and also with less number of capsules per plant. Among the varieties, S-19 (V3) variety took longer duration for maturity and produced significantly higher seed yield of 1098 kg ha^{-1} compared to JRO-524 (V1) with 973 kg ha^{-1} and Ira (V2) with an yield of 948 kg ha^{-1}. The percent increase in seed yield of jute S-19 variety was 15.8 over Ira variety and 12.8 over JRO-524 variety. Similar results were reported by Rahman *et al*. (2016) [13] and Hossain *et al*. (2015) [7]

Stalk yield of jute was maximum at 1st FN of July sowing (D1) with 5191 kg ha^{-1} which was significantly superior to 2nd FN of July (D2) with 3802 kg ha^{-1}, 1st FN of August (D3) with 1595 kg ha^{-1} and 2nd FN of August (D4) with 1149 kg ha^{-1} (Table 2). Delay in sowing of jute resulted in decreased stalk yield which might be due to shorter crop duration, shorter daylengths and high bright sunshine hours during their crop growth period. Among the three varieties, the maximum stalk yield of jute was obtained with the variety S-19 (V3) with 3149 kg ha^{-1} which was significantly superior to other two varieties JRO-524 (V1) with 2871 and Ira (V2) with 2783 kg ha^{-1}. The percent increase in stalk yield of jute S-19 variety was 13.1 over Ira variety and 9.6 over JRO-524 variety. Significant reduction in stalk yield of jute was observed with delay in sowings probably due to unfavourable weather conditions during their crop growth period.

Harvest index of jute was significantly influenced by dates of sowing only. Varieties of jute could not reach the level of significance. Interaction effect between varieties and dates of sowing was also found to be non-significant. Harvest index was highest with 2nd FN of August (D4) sown jute which was significantly superior to all the other dates of sowing.

Table 1: Plant height (cm) and drymatter production (kg ha^{-1}) of jute (*C. olitorius*) varieties at 30, 60, 90 DAS and at harvest as influenced by dates of sowing

Treatments	Plant height(cm)				Drymatter production (kgha^{-1})				Days to 50% flower-ing	Days to maturity
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest		
Varieties (V)										
JRO-524 (V1)	20.1	81.5	102.1	103.5	76.0	1069	3221	4453	55	112
Ira (V2)	21.1	79.6	97.1	99.6	60	1009	3197	4116	55	112
S-19 (V3)	21.2	83.1	105.2	107.0	79	1079	3370	4727	57	113
S.Em±	0.58	2.35	2.45	2.44	2.95	41.12	178.6	140.71	0.55	0.78
CD (0.05)	NS	NS	NS	NS	8.0	NS	NS	413	1.6	NS
Dates of sowing (D)										
1st FN of July (D1)	21.9	96.1	134.5	136.1	147	1598	5017	7263	61	124
2nd FN of July (D2)	19.3	103.6	136.3	139.2	46	978	4149	5742	59	115
1st FN of August (D3)	21.5	68.9	75.8	77.7	41	873	2405	3144	55	106
2nd FN of August (D4)	20.4	56.7	58.9	60.2	54	76	1480	1579	49	103
S.Em±	0.67	2.71	2.83	2.82	3.40	47.49	206.29	162.48	0.6	0.9
CD (0.05)	1.9	7.9	8.2	8.2	10	139	65	476	2.0	2.6
Interaction (D x V)	NS	NS	NS	NS	S	NS	NS	NS	NS	NS
CV(%)	9.7	9.9	8.3	8.1	14.1	13.5	18.9	10.9	3.4	2.4

Table 1a: Interaction between jute varieties and dates of sowing for drymatter production at 30 DAS

Dates of sowing (D)/Varieties (V)	1st FN of July (D1)	2nd FN of July (D2)	1st FN of August (D3)	2nd FN of August (D4)
JRO-524 (V1)	152.5	52.4	43.0	59.5
Ira (V2)	108.1	33.3	46.2	55.0
S-19 (V3)	182.2	53.2	34.0	48.2
S.Em±	5.90			
CD (0.05)	17.0			
CV (%)	14.1			

Table 2: Yield attributes and yield of jute (*C. olitorius*) varieties as influenced by dates of sowing

Treatments	No. of Capsules/ plant	No. of seeds /capsule	Test weight (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)
Varieties						
JRO-524 (V1)	42.5	191.3	2.8	973	2871	28.3
Ira (V2)	39.9	186.0	2.7	948	2783	28.9
S-19 (V3)	43.6	194.6	2.9	1098	3149	28.9
S.Em±	0.75	2.25	0.03	26.5	82.9	0.7
CD (0.05)	2.2	6.6	0.1	78	243	NS
Dates of sowing (D)						
1st FN of July (D1)	48.7	195.4	2.8	1355	5191	20.7
2nd FN of July (D2)	46.5	194.6	2.9	1198	3802	24.0
1st FN of August (D3)	36.6	189.7	2.8	777	1595	32.7
2nd FN of August (D4)	36.0	182.6	2.8	695	1149	37.5
S.Em±	0.87	2.60	0.03	30.6	95.7	0.8
CD (0.05)	2.5	7.6	0.1	90	281	2.5
Interaction (D x V)	NS	NS	NS	NS	NS	NS
CV (%)	6.2	4.0	4.2	9.1	9.7	8.9

Conclusion

It can be concluded that for coastal Andhra Pradesh, sowing of jute during 1st FN of July resulted in higher growth and yield attributes and seed yield compared to other dates of sowing tested. Similarly among the varieties, S-19 jute variety performed better with higher seed yield compared to JRO-524 and Ira tried in the experiment.

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