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Thermal requirements of Jute (*Corchorus olitorius* L.) under different growing environments in coastal A.P

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Bapatla on clay soil during *kharif* 2016 to study the thermal requirement and yield relationship in jute (*Corchorus olitorius* L.) varieties under different growing environments. The crop sown during 1st FN of July (D_1) with S-19 variety took maximum number of days for maturity and total growing degree days which reduced significantly with subsequent delay in sowing. The highest drymatter at harvest (7263 kg ha^{-1}) and seed yield (1355 kg ha^{-1}) was recorded with 1st fortnight of July sowing (D_1) for all the three varieties *viz*., JRO-524, Ira and S-19 due to higher growing degree days. Significant linear relationships were also observed for both drymatter and seed yield for all the three varieties of Jute with GDD.

Key words: *Jute, Growing Degree Days and linear relationship*

Jute is the second most important fibre crop after cotton and it is generally grown for fibre purpose in eastern states of India. Although West Bengal ranks first in terms of area and production of jute, almost entire quantity of seed is produced in Andhra Pradesh and Maharashtra. Rainfall and soil in Maharashtra and parts of Andhra Pradesh 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). Physiological and morphological developments occurring in plants are markedly influenced by temperature and solar radiation. Plants have definite temperature requirement before they attain certain phenological stages. Hence knowledge of the exact duration of all the development phases and their association with yield determination is essential for achieving high yield. Growing Degree Days (GDD) provides a scientific basis for determining the effect of temperature, radiation or photoperiod on phenological behaviour of the crop.

MATERIAL AND METHODS:

The experimental soil was clay having pH 7.6 and organic carbon 0.2 per cent. The available nitrogen, phosphorus and potassium contents were 192.4, 22, and 293 kg ha^{-1}, respectively. The experiment was laid out in Randomized Block Design with factorial concept replicated thrice and consisted of twelve treatments, *viz*., three varieties (JRO-524, Ira and S-19) and four times of sowings (1st fortnight of July, 2nd fortnight of July, 1st fortnight of August and 2nd FN of August). A uniform dose of 40:40:60 kg NPK per hectare was applied to the experimental plots. 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 and 60 DAS.

Growing Degree Days were calculated from date of sowing to harvesting of the crop to give accumulated Growing Degree Days. This was expressed as degree day. The GDD were calculated by the following equation (Iwata, 1984).

$$GDD = \frac{Tmax + Tmin}{2} - Tb$$

Where, T_{max} = Maximum temperature,
T_{min} = Minimum temperature,
T_b = Base temperature

Regression analysis was carried out for development of models for prediction of growth and yield of jute (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

At harvest, the maximum drymatter production was obtained with 1st FN of July (D_1) sowing (7263 kg ha^{-1}) which was significantly superior to 2nd FN of July (D_2) (5742 kg ha^{-1}), 1st FN of August (D_3) (3144 kg ha^{-1}) and 2nd FN of

August (D_4) sowings with 1579 kg ha^{-1}. Among the varieties tested, S-19 (V_3) recorded highest dry matter (4727 kg ha^{-1}) which was on par with the variety, JRO-524 (V_1) with 4453 kg ha^{-1} and both these varieties were significantly superior to Ira (V_2) with 4116 kg ha^{-1}. (Table 1)

Drymatter accumulation is the expression of growth and development of different morphological components. The higher drymatter accumulation recorded with 1st FN of July (D_1) 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, dry matter production. Similar findings were observed by Ali *et al*. (2004) and Guggari and Sheelavantar (2004).

Highest seed yield of 1355 kg ha^{-1} was recorded with 1st FN of July (D_1) which was significantly superior to all the other dates of sowing. Lowest seed yield was obtained when sown during 1st FN of August (D_3) with 777 kg ha^{-1} and 2nd FN of August (D_4) with 695 kg ha^{-1}. The percent decrease in seed yield of jute was 11.5, 42.6 and 48.7 with D_2, D_3 and D_4 sowing dates, respectively over D_1 sowing. Among the varieties, S-19 (V_3) took longer duration for maturity and produced significantly higher seed yield of 1098 kg ha^{-1} compared to JRO-524 (V_1) with 973 kg ha^{-1} and Ira (V_2) with an yield of 948 kg ha^{-1}.

Significant reduction in seed yield of jute was observed with delay in sowing from 1st FN of July (D_1) to 2nd FN of August (D_4). This might be due to lower temperatures and shorter daylengths which enhanced early flowering due to shorter vegetative growth, reduced plant height and less number of capsules per plant. Similar findings were observed by Rahman *et al*. (2016), Hossain *et al*. (2015) and Neeraj Kumar *et al*. (2013).

Growing Degree Days (GDD)

The accumulated GDD during different phenophases of three jute varieties at different dates of sowing was calculated and presented in Table 2. The data revealed that the total GDD accumulated during crop growth stages of the three varieties *viz*., JRO-524, Ira and S-19 were highest during 1st FN of July (D_1) sowing compared to other sowing dates (2nd FN of July (D_2), 1st FN of August (D_3) and 2nd FN of August (D_4)). This might be due to longer crop duration with early sowing in July with optimum temperatures and bright sunshine hours during vegetative and reproductive stage that favoured crop growth for accumulating higher GDD and thereby yield. The accumulated GDD from sowing to maturity for different dates of sowing and varieties ranged from 98 to 912 degree day. The results are in accordance with the findings of Padma (2008) and Girijesh *et al*. (2011).

Table 1. Drymatter production at harvest and seed yield of Jute (*olitorius*) varieties as influenced by dates of sowing

Treatments	Drymatter production at harvest (kg ha^{-1})	Seed yield (kg ha^{-1})
Varieties (V)		
JRO-524 (V_1)	4453	973.0
Ira (V_2)	4116	948.0
S-19 (V_3)	4727	1098.0
SEm±	140.71	26.5
CD (0.05)	412.7	77.8
Dates of sowing (D)		
1st FN of July (D_1)	7263	1355.0
2nd FN of July (D_2)	5742	1198.0
1st FN of August (D_3)	3144	777.0
2nd FN of August (D_4)	1579	695.0
SEm±	162.5	30.6
CD (0.05)	476.5	89.8
Interaction (D x V)		
SEm±	281.4	53.1
CD (0.05)	**NS**	**NS**
CV (%)	10.9	9.1

Table: 2 Accumulated Growing Degree Days (GDD) during different phenophases of *olitorius Jute* varieties at different dates of sowing (data statistically not analyzed)

Growth stages	Dates of sowing				
	1st FN of July	2nd FN of July	1st FN of Aug	2nd FN of Aug	Mean
JRO-524					
Seedling emergence	146	115	179	123	141
Vegetative stage	912	898	720	655	796
50% flowering	142	124	169	171	152
50% Pod formation	402	562	286	362	403
Maturity	740	573	791	753	714
Total	**2342**	**2272**	**2144**	**2064**	
Ira					
Seedling emergence	146	154	134	104	135
Vegetative stage	873	892	799	711	819
50% flowering	217	129	135	98	145
50% Pod formation	403	471	303	381	390
Maturity	809	579	692	792	718
Total	**2448**	**2225**	**2063**	**2086**	
S-19					
Seedling emergence	186	134	179	123	156
Vegetative stage	833	911	774	674	731
50% flowering	233	218	152	116	177
50% Pod formation	427	364	302	344	359
Maturity	838	666	717	764	746
Total	**2517**	**2294**	**2124**	**2020**	

Table: 3 Relationship between total drymatter/seed yield and GDD for different Jute varieties.

Varieties	Regression equation	Coefficient of determination (R^2)
	TDM and GDD	
JRO-524	Y= 20.01X - 39699	R^2 = 0.99*
Ira	Y= 12.55X - 23578	R^2 = 0.85*
S-19	Y = 11.94X - 22306	R^2 = 0.99*
	Seed yield and GDD	
JRO-524	Y = 2.636X - 4842	R^2 = 0.98*
Ira	Y = 1.458X - 2269	R^2 = 0.83*
S-19	Y = 1.574X - 2427	R^2 = 0.95*

*Significant

Table:4 Relationship between total drymatter/seed yield and GDD of Jute varieties at different dates of sowing

Dates of sowing	Regression equation	Coefficient ofDetermination (R^2)
	TDM and GDD	
1st FN of July	Y = 3.846X - 1977	R^2 = 0.66*
2nd FN of July	Y = 11.12X - 19427	R^2 = 0.66*
1st FN of August	Y = 9.759X - 17451	R^2 = 0.97*
2nd FN of August	Y = -2.286X+ 6283.	R^2 = 0.49*
	Seed yield and GDD	
1st FN of July	Y = 1.358X - 1908	R^2 = 0.91*
2nd FN of July	Y = 1.684X - 2613	R^2 = 0.90*
1st FN of August	Y= 0.522X - 324.8	R^2 = 0.33
2nd FN of August	Y= -2.188X + 5196.	R^2 = 0.66*

*Significant

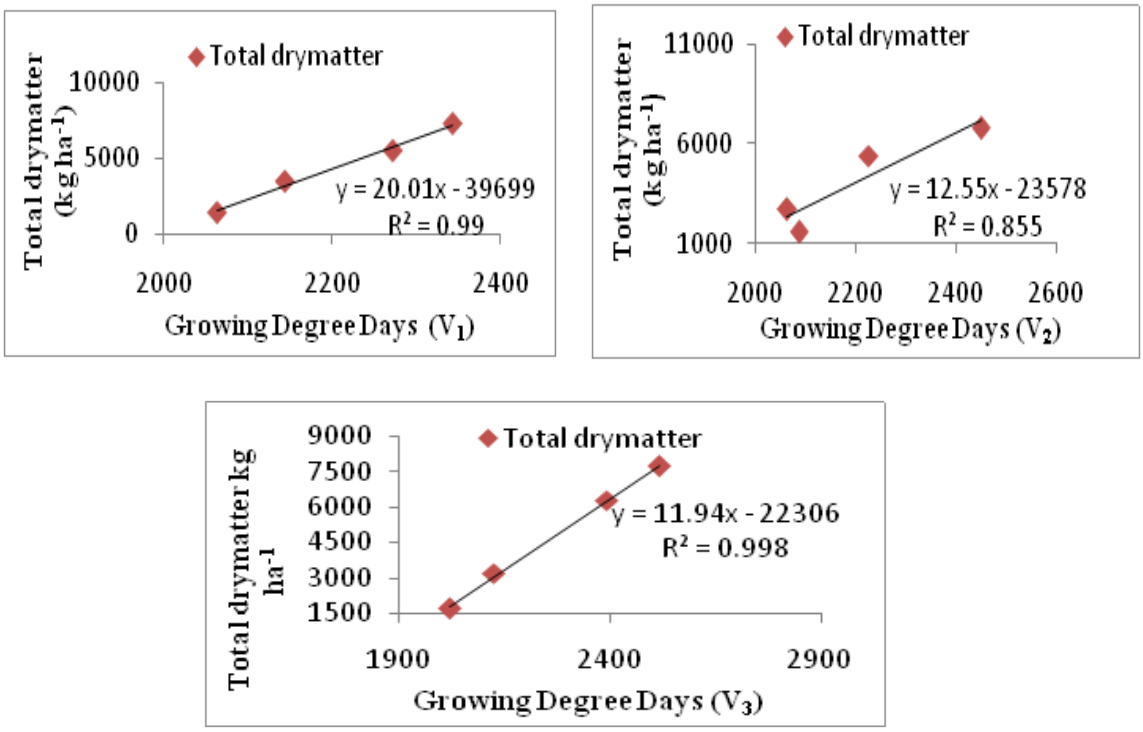

Fig:1 Relationship between total drymatter and Growing Degree Days in (V_1) JRO-524,(V_2) Ira and (V_3) S-19

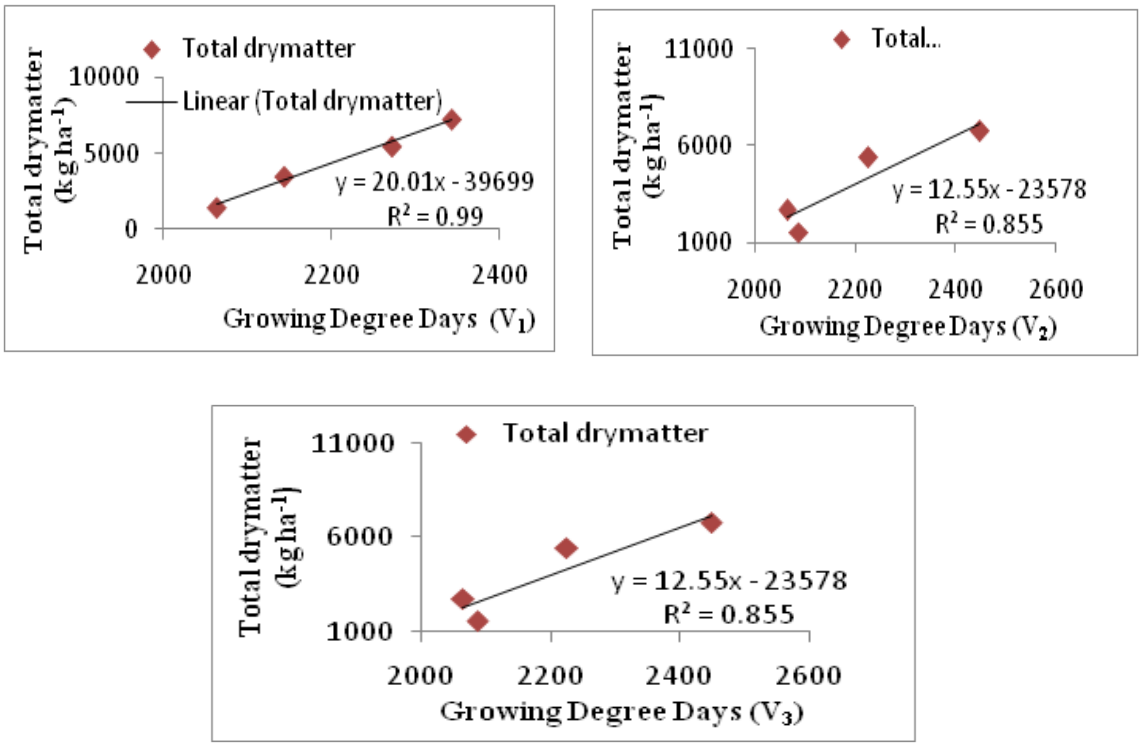

Fig:2 Relationship between seed yield and Growing Degree Days in (V_1) JRO-524, (V_2) Ira and (V_3) S-19

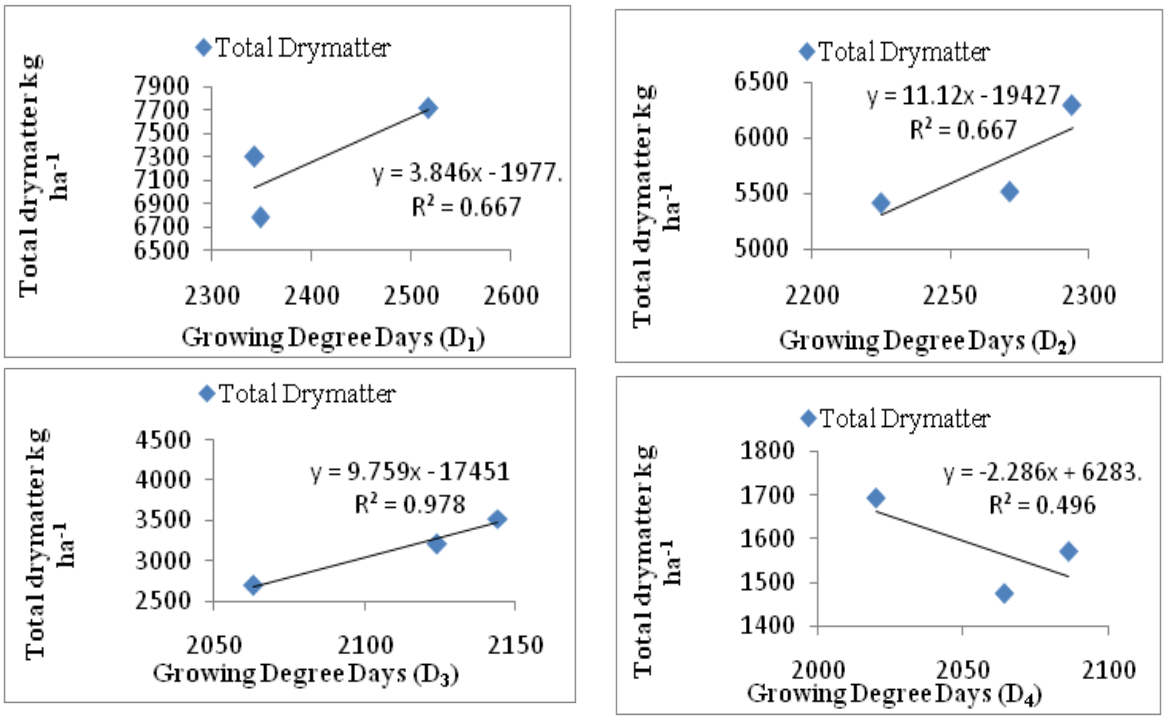

Fig:3 Relationship between Total drymatter and Growing Degree Days (GDD)at different dates of sowing D_1, D_2, D_3 and D_4

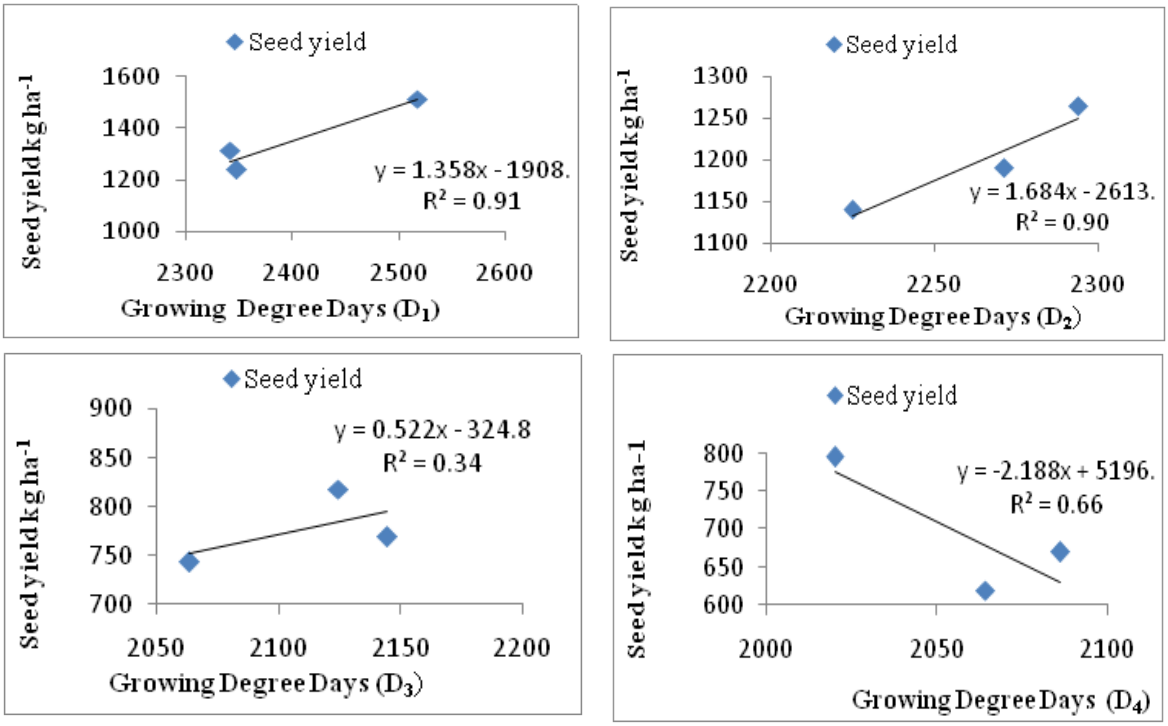

Fig: 4 Relationship between Seed yield and Growing Degree Days at different dates of sowing D_1, D_2, D_3 and D_4

Relationship between total drymatter (TDM) / seed yield with GDD

To test the dependence of TDM and seed yield on GDD, regression analysis was conducted for three varieties and four dates of sowing and linear regression equations were obtained, where total drymatter (TDM) / Seed yield were taken as dependent variable and GDD as independent variable. Based on data of experiment on four sowing dates and three varieties (Table 3 & 4) the values of coefficient of determination (R^2) obtained for all three varieties and four dates of sowing indicated their variation (%) of TDM and Seed yield for GDD.

Regression equations were significant for all the three varieties (JRO-524, Ira and S-19) and four dates of sowings [1st FN of July (D_1), 2nd FN of July (D_2), 1st FN of August (D_3) and 2nd FN of August (D_4)] with regard to TDM and seed yield. Among the three varieties, total drymatter of both JRO-524 and S-19 varieties were predicted with 99% and Ira with 85% accuracy with accumulated GDD at maturity (Fig 1&2). However, for seed yield, JRO-524 and S-19 were predicted with 98 and 95% accuracy. The values of coefficient of determination (R^2) obtained for all four dates of sowings (D_1 to D_4) with regard to TDM (66, 66, 97 and 49) while for seed yield they were 91, 90, 33 and 66%, respectively. (Fig. 3&4)

It can be concluded that higher accumulated heat units (GDD) for 1st FN of July sowing with S-19 variety due to initial higher temperatures and longer duration of the crop resulted in vigorous growth, thereby higher drymatter and seed yield. Significant linear relationships were observed for both dry matter and seed yield of all the three varieties of Jute crop with GDD.

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